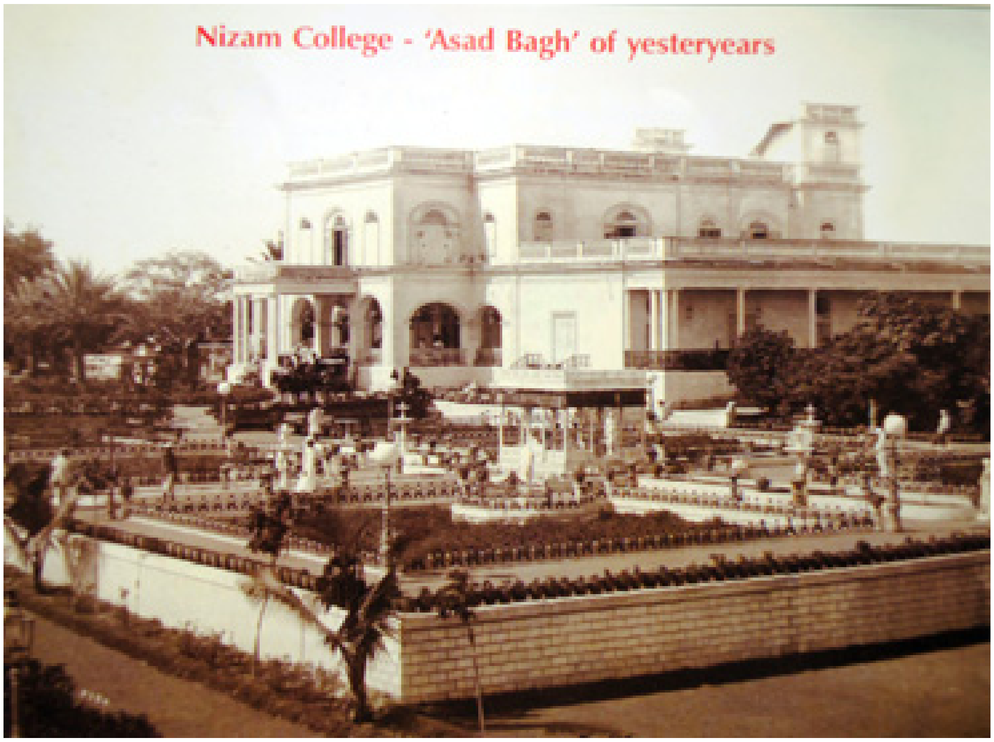
NEET PHYSICS



Centre for Educational Development of Minorities

OsmaniaUniversity

Minorities Welfare Department, Govt. of Telangana

Nizam College Campus, Gunfoundary, Hyderabad - 500 001.

Phone / Fax: 040-23210316; www.tscedm.com; email: cedm_ou@yahoo.com

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By

Dr. Kaleem Ahmed Jaleeli,
M. Sc., Ph.D.
Assistant Professor,
Department of Physics,
Nizam College,
(Osmania University)
Hyderabad

CENTRE FOR EDUCATIONAL DEVELOPMENT OF MINORITIES
Osmania University
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Author

Dr. Kaleem Ahmed Jaleeli : Assistant Professor, Department of Physics,
Nizam College, (Osmania University) Hyderabad.

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PREFACE

Taking competitive examinations has became the order of the day for any educated young man who is desirous of seeking any coveted job, a seat in any prestigious college. The approach required for such competitive examination is different from that of taking an academic examination.

It was observed that most of the minority candidates do not fare well at these competitive examinations not because they lack in talents but because they can neither afford to join the private coaching centres nor could purchase the required study material.

In order to improve the participation and performance of the candidates belonging to minorities in such competitive examinations, the Minorities Welfare Department, State Government sponsored a project to Osmania University. The University in turn established Centre for Educational Development of Minorities (CEDM) in 1994 in Nizam College. Since then, the Centre has been offering free coaching for the benefit of candidates belonging to minority communities appearing for various job seeking and admission seeking competitive examinations at Hyderabad and other minority concentrated districts of the state. In respect of job-seeking examinations, the Centre is providing free coaching and study material for TS TRT, TS TET etc. and for admission oriented examinations such as NEET, EAPCET, ICET, ECET, EdCET, DEECET and POLYCET etc. In addition to these coaching programmes, the Centre is also providing free coaching and study material to X class Urdu medium minority students in minority concentrated districts of the state to strengthen their educational foundation and to improve their performance in SSC Public Examination.

We wish to place on record the pains the compilers have taken to summarize and arrange the important questions. The Centre gratefully acknowledges their services.

If these study materials are of any help to the candidates, we feel immensely rewarded for the humble efforts we have put in.

Hyderabad
April 2024

Prof. S. A. Shukoor,
DIRECTOR

INDEX

Page No

CONCEPTUAL QUESTIONS

1. The reliability of a measurement depends on
   1) precision 2) accuracy 3) systematic error 4) random error
2. The error due to resolution of a measuring instrument is
   1) personal error 2) random error 3) systematic error 4) gross error
3. The error due to resolution of a measuring instrument is
   1) least count error 2)permissible error 3) systematic error 4) all the above
4. The random error which exists invariably in screw gauge
   1) least count error 2) Zero error 3) gross error 4) backlash error
5. The errors which are estimated by statistical methods are
   1) systematic errors 2) random errors 3) theoretical errors 4) gross errors
6. The measure of accuracy is
   1) absolute error 2) relative error 3) percentage error 4) both 2 and 3
7. The decrease in percentage error
   1) increases the accuracy 2) does not effect the accuracy
   3) decreases the accuracy 4) both 1 and 3
8. Even when the measured quantity is not dimensionless, ……………of the following is a dimensionless error
   1) gross error 2) absolute error 3) instrumental error 4) relative error
9. Mean value – Measured value gives
   1) absolute error 2) relative error 3) random error 4) gross error
10. The errors that always occur in the measurement with screw gauge is
    1) random errors 2) systematic errors 3) gross errors 4) negligible errors
11. A physicist performs an experiment and takes 200 readings. He repeats the same experiment and now takes 800 readings. By doing so
    1) the probable error remains same 2) the probable error is four times
    3) the probable error is halved 4) the probable error is reduced by a factor ¼
12. The Last digit in the measurement gives the first. ………digit
    1) certain 2) significant 3) uncertain 4) insignificant
13. More the number of significant figures shows more the
    1) accuracy 2) error 3) number of figures 4) value
14. If a measured quantity has n significant figures, the reliable digits in it are
    1) n 2) n-1 3) 2n 4) n/2
15. If the significant figures are more,
    1)percentage error is more and accuracy is less
    2)percentage error is less and accuracy is more
    3)percentage error is less and accuracy is less
    4)percentage error is more and accuracy is more
16. The mathematical operation in which the accuracy is limited to least accurate term is
    1) addition 2) subtraction
    3) multiplication & division 4) both 1 and 2
17. The time period of a seconds pendulum is measured repeatedly for three times by two stop watches A,B. If the readings are as follows

S.NO	A	B
1.	2.01 sec	2.56 sec
2.	2.10 sec	2.55 sec
3.	1.98 sec	2.57 sec

    1) A is more accurate but B is more precise
    2) B is more accurate but A is more precise
    3) A,B are equally precise

4) A,B are equally accurate

18. With a highly advanced precision instrument
1) percentage error can be reduced
2) totally accurate value can be measured
3) true value can be found out
4) all the above

19. If Y = a + b, the maximum percentage error in the measurement of Y will be
1) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100$ 2) $\left(\frac{\Delta a}{a+b}+\frac{\Delta b}{a+b}\right)\times 100$
3) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100$ 4) $\left(\frac{\Delta a}{a-b}-\frac{\Delta b}{a-b}\right)\times 100$

20. If Y = a - b, the maximum percentage error in the measurement of Y will be
1) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100$ 2) $\left(\frac{\Delta a}{a-b}+\frac{\Delta b}{a-b}\right)\times 100$
3) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100$ 4) $\left(\frac{\Delta a}{a-b}-\frac{\Delta b}{a-b}\right)\times 100$

21. If Y = a x b, the maximum percentage error in the measurement of Y will be
1) $\left(\frac{\Delta a}{a}\times 100\right)/\left(\frac{\Delta b}{b}\times 100\right)$ 2) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100$
3) $\left(\frac{\Delta a}{a}\times 100\right)\times\left(\frac{\Delta b}{b}\times 100\right)$ 4) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100$

22. If Y = a/b, the maximum percentage error in the measurement of Y will be
1) $\left(\frac{\Delta a}{a}\times 100\right)/\left(\frac{\Delta b}{b}\times 100\right)$ 2) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100$
3) $\left(\frac{\Delta a}{a}\times 100\right)\times\left(\frac{\Delta b}{b}\times 100\right)$ 4) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100$

23. The S.I. Unit of pressure is
1. newton 2. Nm^{-1} 3. pascal 4. poise

24. The dimensional formula for strain energy density is
1. $M^1L^2T^{-3}$ 2. $M^1L^2T^3$ 3. $M^1L^{-1}T^{-2}$ 4. $M^1L^2T^{-2}$

25. The physical quantities which have the same dimensions as $[T^{-1}]$ are
1. Frequency and Angular velocity
2. Velocity gradient and radio active disintegration
3. Both 1 and 2 4. Wave number, Rydberg's constant

26. The physical quantity having the same dimensional formula as that of force is
1. weight 2. tension 3. thrust 4. 1, 2, 3

27. $N.m^{-1}$ is the SI unit of
1. Force constant 2. Spring constant 3. Surface tension 4. 1,2 and 3

28. The physical quantities having same dimensions of energy is
1. Torque 2. Moment of force 3. Moment of couple 4. 1,2, 3

29. The dimension of mass is zero in the following physical quantities.
1. Gravitational potential 2. latent heat 3. Specific heat capcity 4. 1, 2, 3

30. The SI unit of a physical quantity is $[J.\ m^{-2}]$. The dimensional formula for that quantity is

1. M^1L^{-2} 2. $M^1L^0T^{-2}$ 3. $M^1L^2T^{-1}$ 4. $M^1L^{-1}T^{-2}$

31. [Jm^{-2}] is the unit of
1. Surface tension 2. Viscosity 3. Strain energy 4. Intensity of energy

32. [Jm^{-3}] may be the unit of
1. Strain energy density 2. Modulus of Elasticity (y, k, n)
3. Both 1 & 2 4. Strain energy

33. The dimensional formula for potential energy is
1. $M^2L^2T^{-2}$ 2. $M^1L^{-2}T^{-2}$ 3. $M^1L^2T^{-2}$ 4. $M^1L^2T^{-3}$

34. The dimensional formula for moment of couple is
1. $M^1L^2T^{-1}$ 2. $M^1L^2T^{-2}$ 3. $M^{-1}L^2T^{-2}$ 4. $M^1L^1T^{-2}$

35. 1 a.m.u is equal to
1. 1.66 x 10^{-24} g 2. 1.66 x 10^{-27} g 3. 1.66 x 10^{24} g 4. 1.66 x 10^{27} g

36. 'POISE' is the
1. C.G.S. unit of Surface tension 2. C.G.S. unit of Viscosity
3. M.K.S. unit of Viscosity 4. M.K.S. unit of Surface energy

37. Pressure x Volume =
1. Work 2. Power 3. Modulus of Elasticity 4. Pressure.

38. The dimensional formula for Magnetic Moment of a magent is
1. $M^0L^2T^0A^1$ 2. $M^0L^2T^0A^{-1}$ 3. $M^0L^{-2}T^0A^{-1}$ 4. $M^0L^{-2}T^0A^{-1}$

39. Magnetic flux and Magnetic induction field strength differ in the dimensions of
1. Mass 2. Length 3. time 4. 1,2, 3

40. Linear Momentum and Angular momentum have the same dimensions in
1. Mass and length 2. Length and time 3. Mass and time 4.Mass, length and time

41. Impulse and Angular velocity have the same dimensions in
1. Mass 2. Length 3. Time 4. Mass, length and time

42. In the following, the one which is not a physical quantity is
1. Power 2. Momentum 3. Latent heat 4. radian

43. Kilo watt hour is the unit of
1. Power 2. Energy 3. time 4. Electric current

44. The angle subtended at the centre of a circle by an arc whose length is equal to the diameter of the circle is
1. radian 2. 2 radian 3. π radian 4. π /2 radian

45. Which of the following is not a unit of time?
1. Mean solar day 2. Lunar Month 3. Leap year 4. Light year

46. The following is not used as the unit of work
1. erg 2. Joule 3. Electron volt 4. Volt

47. In the following, the one which has not been expressed properly is
1. $\frac{stress}{strain} = Nm^{-2}$ 2. Surface tension = Nm^{-1}
3. Energy = $Kgms^{-1}$ 4. Pressure = Nm^{-2}

48. The derived unit is
1. Candela 2. mole 3. Kelvin 4. Tesla

49. SI unit of Coefficient of viscosity is
1. Pascal s^{-1} 2. Pascal -s
3. N/m^2/unit velocity 4. N/m/unit velocity gradient

50. Read the following statements carefully and pick out the correct choice of answer.
A: Susceptibility is expressed as Am^{-1}.
B: Magnetic flux is expressed as JA^{-1}
1. A is correct but B is wrong 2. A is wrong but B is correct.
3. Both A and B are wrong 4.Both A and B are correct.

51. Read the following statements carefully and pick out the correct choice of answer.
A :Electromotive force is expressed in newtons.

B: Electric intensity is expressed in VC^{-1}

1. Both A and B are correct
2. Both A and B are wrong
3. A is correct but B is wrong
4. A is wrong but B is correct

52. The following does not give the unit of energy

1. watt second 2. Kilowatt hour 3. newton meter 4. pascal metre

53. 1 fermi is equal to

1. 10^{-15} m 2. 10^{-9} micron 3. $10^{-5}A^0$ 4. 1,2, 3

54. If n is the numeric, U is the name of the unit, then

1. $n \alpha U$ 2. $n \propto \frac{1}{U}$ 3. $n \alpha \frac{1}{U^2}$ 4. $n \alpha U^2$

55. "Impulse per unit area " has same dimensions as that of

1.coefficient of viscosity
2. surface tension
3. bulk modulus
4. gravitational potential

56. The following pair does not have same dimensions

1. Pressure, Modulus of Elasticity
2. Angular velocity, velocity gradient
3. Surface tension and force constant
4. Impulse and torque

57. If μ is the permeability and $\in$ is the permittivity then $\frac{1}{\sqrt{\mu \in}}$ is equal to

1. Speed of sound
2. Speed of light in vacuum
3. Speed of sound in medium
4. Speed of light in medium

58. The following is a unitless and dimensionless quantity

1. Angle
2. Solid angle
3. Mechanical equivalent of heat
4. Refractive index.

59. The unitless quantity is

1. Velocity gradient
2. Pressure gradiant
3. displacement gradient
4. force gradient

60. The one which is not a dimensionless quantity is

1. Moment of Momentum
2. Moment of force
3. Moment of inertia
4. 1, 2 & 3

61. If the unit of tension is divided by the unit of Surface tension the derived unit will be same as that of

1. mass 2. length 3. area 4. work

62. Atto is ___________

1. An instrument used to measure gradient
2. An insturment used to measure the altitude
3. 10^{18} metre 4. 10^{-18} metre

63. N m s^{-1} is the unit of

1. Pressure 2. Power 3. Potential 4. Pressure gradient

64. $\left[\frac{Permeability}{Permittivity}\right]$ will have the dimensions of :

1. $M^0L^0T^0A^0$ 2. $M^2L^2T^4A^2$ 3. $M^2L^4T^{-6}A^{-4}$ 4. $M^{-2}L^{-4}T^6A^4$

65. One second is defined more accurately as

1. 1650763.73 periods of Krypton clock
2. 652189.63 periods of Krypton clolck
3. 1650763.73 periods of Caesium clock
4. 9,192,631,770 periods of Caesium clock

66. The number of micron in 1 metre is

1. 10 2. 10^3 3. 10^6 4. 10^9

67. Stefan's constant has the unit as

1. J S^{-1} m^{-2} k^4 2. Kg s^{-3} k^4 3. w m^{-2} k^{-4} 4. N.m.s^{-2} k^{-4}

68. Which one of the following is not measured in the units of Energy

1. (Couple) x (angle turned through)
2. Moment of inertia x (angular velocity)^2
3. Force x distance
4. impulse x time

69. An example to define length in the form of time at a place is
1. Wrist watch 2. Linear expansion of iron rod
3. Frequency of ripples on the surface of water 4. Seconds pendulum

70. The one which is not the unit of length is
1. Angstrom unit 2. micron 3. Parsecond 4. Steradian

71. The physical quantity having the same dimensional formula as that of entropy is :
1. Latent heat 2. Thermal capcity 3. Heat 4. Specific heat

72. JS is the unit of
1. Energy 2. Angular Momentum 3. Momentum 4. Power

73. Which of the following cannot be expressed as dyne cm^{-2}?
1. Pressure 2. Longitudinal stress
3. Longitudinal strain 4. Young's Modulus of Elasticity

74. The unit of atmospheric pressure is :
1. metre 2. kg.wt 3. gm $.cm^{-2}$ 4. bar

75. The ratio between pico and giga is
1. 10^{21} 2. 10^{-21} 3. 10^{14} 4. 10^{8}

76. 1 Micron = ----nanometer
1. 10^{-6} 2. 10^{-10} 3. 10^{3} 4. 10^{-3}

77. Which of the following has smallest value?
1. Peta 2.femto 3. Yotta 4.Yocto

78. henry is the unit of
1. Self inductance (or) Mutual inductance
2. e.m.f 3. capacity 4. Conductivity

79. 1 Kilo watt hour is equal to ---- eV
1. 2.25×10^{25} 2. 3.6×10^{18} 3. 1.6×10^{10} 4. 2.25×10^{20}

80. Consider the following two statements A and B and identify the correct answer.
A) The size (u) of the unit of physical quantity and its numerical magnitude (n) are related to each other by the relation nu = constant
B) The choice of mass, length and time as fundamental quantities is not unique.
1) A is true but B is false 2) B is true but A is false
3) Both A and B are true 4) Both A and B are false

81. **A:** When we change the unit of measurement of a quantity, its numerical value changes.
R: Smaller the unit of measurement, smaller is its numerical value.
1. A and R are correct and R is correct explanation of A
2. A and R are correct and R is correct not correct explanation A
3. A is true and R is false 4. A is false and R is true

82. **A:** If $u_1 \; and \; u_2$ are units and n_1, n_2 are their numerical values in two different systems then $n_1 > n_2 \Rightarrow u_1 < u_2$.
R: The numerical value of physical quantity is inversely proportional to unit
1. A and R are correct and R is correct explanation of A
2. A and R are correct and R is correct not correct explanation A
3. A is true and R is false 4. A is false and R is true

83. The numerical value of a measurement is
1. directly proportional to unit 2. inversly proportional to unit
3. Both 4. None

84. Consider the following two statements A and B and identify the correct answer.
A) The MKS system is a coherent system of units
B) In SI, joule is the unit for all forms of energy
1) A is true but B is false 2) B is true but A is false
3) Both A and B are true 4) Both A and B are false

85. Study the following

List - I	***List - II***
a) Fundamental unit	I) rad

b) Derived unit — II) Kg-Wt
c) Practical unit — III) N
d) Supplementary unit — IV) Kg

The correct match is

	a	b	c	d
1.	I	IV	II	III
2.	IV	III	II	I
3.	II	III	IV	I
4.	I	II	III	IV

86 Set the following units of energies in increasing order.

a) joule	**b) eV**	**c) K.W.H**	**d) erg**
1. a	b	c	d
2. b	d	a	c
3. d	c	b	a
4. b	a	c	b

87. **A:** Plane angle is a dimensionless quantity.
R: All supplementary quantities are dimension less.
1. A and R are correct and R is correct explanation of A
2. A and R are correct and R is correct not correct explanation A
3. A is true and R is false   4. A is false and R is true

88. **A:** Light year is a unit of time
R: Light year is the distance traveled by light in vaccum in one year.
1. A and R are correct and R is correct explanation of A
2. A and R are correct and R is correct not correct explanation A
3. A is true and R is false   4. A is false and R is true

89. Which of the following is not a unit of time
a) par-sec   b) light-year   c) micron   d) sec
1) a and c are correct   2) a and b are correct
3) a,b and c are correct   4) all are correct

90. The SI unit of inductance, henry can be written as
a) weber/ampere   b) Volt second/ampere
c) joule(ampere)$^{-2}$ d) ohm-second
1) a & c are correct   2) a & b are correct
3) a, b, & c are correct   4) all are correct

91. The S.I. unit of Moment of inertia is : **(1999 E)**
1. kg/m^2 2. kg m^2 3. N/m^2 4. Nm^2

92. The unit of Luminous intensity is: **(1994 E)**
1. Candela   2. Watt   3. Lumen   4. Ampere.

93. siemen is the S.I unit of **(1991 E)**
1. Electrical conductance   2. Electrical conductivity
3. Potential difference   4. Inductance

94. The SI unit of magnetic flux is **(1990 E)**
1. maxwell   2. weber   3. tesla   4. gauss

95. The fundamental unit which has the same power in the dimensional formula of surface tension and coefficient of viscosity is **(1989 E)**
1. mass   2. length   3. time   4. none

96. Electron volt is the unit of **(1988 E)**
1. power   2. P.D   3. charge   4. energy

97. The SI unit of magnetic pereability is
1) Am^{-1} 2) Am^{-2} 3) Hm^{-2} 4) Hm^{-1}

98. Which of the following quantities has the units Kg m^2 s^{-3} A^{-2}?
1) resistance 2) inductane 3) capacitance 4) magnetic flux

99. Dyne - Second is the unit of
1. Force 2. Momentum 3. Energy 4. Power

100. Torr is the unit of physical quantity
1. density 2. pressure 3. torque 4. None

101. The unit of Young's Modulus is
1. $N.m^{-1}$ 2. N.m 3. $N.m^{-2}$ 4. $N.m^2$

102. The S.I. value of Mechanical equivalent of heat is:
1. 4.2 2. 1 3. 2.4 4. 2

103. Column I gives three physicll quantities. Select the appropritate units for these from the choices given in column II. Some of the physical quantities may have more than one choice

Column-I	**Column - II**
a) Capacitance	d) Ohm second
b) Inductance	e) $\text{Coulomb}^2\ \text{joule}^{-1}$
c) Magnetic induction	f) Coulomb volt^{-1}
	g) newton (ampere / $\text{metre})^{-1}$
	h) Volt second $(\text{ampere})^{-1}$

	a	**b**	**c**
1.	e	d	g
2.	h	d	e
3.	e	g, h	g
4.	e,f	d, h	d,e

104. Match List I with List II and select the correct answer using the codes given below the lists.

List - I	***List - II***
a) Joule	e) Henry-amp/sec
b) Watt	f) Farad-Volt
c) Volt	g) Coulomb-volt
d) Coulomb	h) Oersted-cm
	i) Amp-gauss
	j) Amp^2-ohm

1) $a \to e; b \to j; c \to i; d \to h$ 2) $a \to g; b \to j; c \to e; d \to f$
3) $a \to g; b \to j; c \to e; d \to i$ 4) $a \to f; b \to j; c \to e; d \to g$

105. Match List I with List II and select the correct answer using the codes given below the Lists.

	List - I	***List - II***
A)	Distance between earth and stars	I) Micron
B)	Inter atomic distance in a solid	II) Angstrom
C)	Size of the nucleus	III) Light year
D)	Wave length of infrared laser	IV) Fermi
		V) Kilometer

	A	B	C	D
1)	V	IV	II	I
2)	III	II	IV	I
3)	V	II	IV	III
4)	III	IV	I	II

106. Arrange the following lengths in increasing order
I. 1 Angstrom II. 1 Micro III. 1 Fermi IV. 1 light year

1. III, I, II, IV 2. I, II, III, IV 3. III, II, I, IV 4. II, III, I, IV

107. Arrange the following multiples in decreasing order

I. Milli II. Centi III. Nano IV. Pico

1. IV, II, I, III 2. II, I, III,IV 3. I, III, II, IV 4. III, IV, I, II

108. Arrange the following physical quantities increasing order of their magnitudes

I. 10^6 dyne II. 1 N III. 3 Kg mS^{-2} IV. $10^7 gm\ cm\ S^{-2}$

1. II I III IV 2. IV I III II
3. II III I IV 4. I II III IV

109. Consider the following two statements A and B and identify the correct answer.

A) Two quantities which are to be added must have the same dimensions

B) Two quantities which are to be multiplied must have the same dimensions.

1) A is true but B is false 2) B is true but A is false

3) Both A and B are true 4) Both A and B are false

110. Choose the correct statement

1) a dimentionally incorrect equation may be correct

2) a dimentionally correct equation is always correct

3) a dimensionally correct equation may be incorrect

4)a dimensionally incorrect equation is never incorrect.

111. Consider the following two statements A and B. Identify the correct answer.

A) The quantity $\frac{e^2}{\in_0 ch}$ is dimension less

B) $\frac{1}{\sqrt{\mu_0 \in_0}}$ has the dimensions of velocity and is numerically equal of velocity of light.

1) A is true but B is false 2) B is true but A is false

3) Both A and B are true 4) Both A and B are false

112. Choose the false statement from given statements.

I. Relative permittivity is dimensionless variable

II. Angular displacement has neither units nor dimensions

III. Refractive index is dimensionless variable

IV. Permeability of vaccum is dimensional constant

1) only I and II are correct 2) Only II is correct

3) Only III correct 4) Only IV is correct

113. Match the physical quantities given in Column I with suitable dimensions expressed in Column II.

Column I	**Column II**
a) Angular momentum	e) $M^{-1}L^2T^{-1}$
b) Torque	f) MT^{-2}
c) Gravitational constant	g) ML^2T^{-2}
d) Tension	h) ML^2T^{-1}

The correct match is

1) $c \to f; d \to e$ 2) $a \to h; b \to g$ 3) $a \to g; c \to f$ 4) $b \to f; a \to e$

114. Arrange the following physical quantities in the decreasing order of dimension of length

I. Density II. Pressure III. Power IV. Impulse

1. I, II, III, IV 2. III, II, I, IV 3. IV, I,II, III 4. III, IV, II, I

115. A book with many printing errors contains four different expressions for the displacement 'y' of a particle executing simple harmonic motion. The wrong formula on dimensional basis

i. $y = A\sin\left(2\pi t/T\right)$ ii. $y = A\sin\left(Vt\right)$

iii. $y = A/T\sin\left(t/A\right)$ iv) $y = \frac{A}{\sqrt{2}}\left(\sin\omega t + \cos\omega t\right)$

1) ii only 2) ii and iii only 3) iii only 4) iii and iv only

116. **A:** Surface tension and spring constant have the same dimensions.

R: Both are equivalent to force per unit length

1. A and R are correct and R is correct explanation of A
2. A and R are correct and R is correct not correct explanation A
3. A is true and R is false 4. A is false and R is true

117. **A:** Method of dimensions cannot be used for deriving formulae containing trigonometrical ratios.

R: Trigonometrical ratio's have no dimensions.

1. A and R are correct and R is correct explanation of A
2. A and R are correct and R is correct not correct explanation A
3. A is true and R is false 4. A is false and R is true

118. Which of the following is dimensionless

a) Boltzmann's constant b) Planck's constant
c) Poisson's ratio d) Relative constant

1) a and b are correct 2) c and b are correct 3) c and d are correct 4) d and a are correct

119. Which of the following pairs have same dimensions.

a) Torque and work b) Angular momentum and work
c) Energy and Young's modulus d) Light year and wavelength

1) a and b are correct 2) b and c are correct 3) c and d are correct 4) d and a correct

120. The pair of physical quantities that have same dimensions are

a) Reynold number and coefficient of friction b) Latent heat and gravitational potential
c) Curie and frequency of light wave d) Planck's constant and torque

1) b and c are correct 2) a and b are correct 3) a,b and c are correct 4) all are correct

121. Some physical constants are given in List - I and their dimensional formulae are given in List - 2. Match the following : **(2007 E)**

List - I	**List - 2**
a) Planck's constant	e) $\left[ML^{-1}T^{-2}\right]$
b) Gravitational constant	f) $\left[ML^{-1}T^{-1}\right]$
c) Bulk modulus	g) $\left[ML^{2}T^{-1}\right]$
d) Coefficient of Viscosity	h) $\left[M^{-1}L^{3}T^{-2}\right]$

	a)	**b)**	**c)**	**d)**
1)	h	g	f	e
2)	f	e	g	h
3)	g	f	e	h
4)	g	h	e	f

122. Names of units of some physical quantities are given in List - I and their dimensional formulae are given in List - II. Match the correct pair of the lists. **(2005 E)**

List - I	List - II
a) Pa s	e) $\left[L^2T^{-2}K^{-1}\right]$
b) NmK^{-1}	f) $MLT^{-3}K^{-1}$
c) $J\,kg^{-1}\,k^{-1}$	g) $ML^{-1}T^{-1}$
d) $Wm^{-1}k^{-1}$	h) $\left[ML^2T^{-2}K^{-1}\right]$

	a	b	c	d
1.	h	g	e	f
2.	g	f	h	e
3.	g	e	h	f
4.	g	h	e	f

123. The dimensional equation for magnetic flux is **(2003 M)**
1) $ML^2T^{-2}I^{-1}$ 2) $ML^2T^{-2}I^{-2}$ 3) $ML^{-2}T^{-2}I^{-1}$ 4) $ML^{-2}T^{-2}I^{-2}$

124. The dimensional formula for coefficient of kinematic viscosity is : **(2002 M)**
1. $M^0L^{-1}T^{-1}$ 2. $M^0L^2T^{-1}$ 3. ML^2T^{-1} 4. $ML^{-1}T^{-1}$

125. The dimensional formula for Magnetic induction is **(2000 M)**
1. $MT^{-1}A^{-1}$ 2. $MT^{-2}A^{-1}$ 3. MLA^{-1} 4. $MT^{-2}A$

126. The dimnsional formula for latent heat is **(1999 E)**
1. MLT^{-2} 2. ML^2T^{-2} 3. $M^0L^2T^{-2}$ 4. MLT^{-1}

127. Dimensions of impulse are : **(1998 M)**
1. MLT^{-2} 2. M^2LT^{-1} 3. MLT^{-1} 4. ML^2T^{-1}

128. Dimensional formula for capacitance is **(1997E)**
1. $M^{-1}L^{-2}T^4I^2$ 2. $M^1L^2T^4I^{-2}$ 3. $M^1L^2T^2$ 4. MLT^{-1}

129. Modulus of Elasticity is dimensionally equivalent to **(1996 E)**
1. Stress 2. Surface tension
3. Strain 4. Coefficient of viscosity

130. Dimensions of C x R (Capacity x Resistance) is **(1995 E)**
1. frequency 2. energy 3. time period 4. current

131. The physical quantity that has no dimensions is: **(1995 E)**
1. angular velocity 2. linear momentum 3. angular momentum 4. strain

132. $M^1L^{-1}T^{-2}$ represents **(1995 M)**
1. Stress 2. Young's Modulus 3. Pressure 4. All the above

133. Dimensional formula for Angular momentum **(1995 M)**
1. ML^2T^{-1} 2. $M^1L^3T^{-1}$ 3. $M^1L^1T^{-1}$ 4. ML^3T^{-2}

134. The pair of physical quantities not having the same dimensional formula are. (1993E)
1. acceleration, gravitational field strength 2. Torque, angular momentum
3. Pressure, Modulus of Elasticity 4. All the above

135. A pair of physical qunatities having the same dimensional formula are **(1993 M)**
1. Momentum and impulse 2. Momentum and energy
3. Energy and pressure 4. Force and power

136. The dimensional formula for universal gravitational constant is **(1992 E)**
1. $M^1L^3T^{-2}$ 2. $M^0L^2T^{-2}$ 3. $M^1L^2T^{-2}$ 4. $M^{-1}L^3T^{-2}$

137. A pair of physical quantities having the same dimensional formula are **(1992 M)**
1. Force and Work 2. Work and energy 3. Force and Torque 4. Work and Power

138. The pair of physical quantities having the same dimensional formula is **(1991 E)**
1. Angular Momentum and torque
2. Torque and strain energy

3. Entropy and power
4. Power and Angular momentum

139. Planck's constant has the dimensions as that of **(1990 E)**
1. Energy 2. Power
3. Linear momentum 4. Angular momentum

140. The physical quantity which has no dimensions is **(1989 E)**
1. stress 2. strain
3. momentum 4. angular velocity

141. Dimensional formula of Torque is **(1987 E)**
1. MLT^{-2} 2. ML^2T^{-2} 3. ML^2T^{-3} 4. MLT^{-3}

142. The dimensional formula for angular velocity is **(1984 E)**
1. $M^{-1}L^1T^0$ 2. $M^0L^{-1}T^{-1}$ 3. $M^{-1}L^{-1}T^0$ 4. $M^0L^0T^{-1}$

143. The dimensional formula $M^{-1}L^3T^{-2}$ refers to **(1983 E)**
1. Force 2. Power 3. Gravitational constant 4. Energy

144. Of the following quantities which one has the dimensions different from the remaining three?
1) energy density
2) force per unit area
3) product of charge per unit volume and voltage
4) Angular momentum per unit mass

145. The dimensions of resistivity in terms of M, L, T and Q, where Q stands for the dimensions of charge is
1) $ML^3T^{-1}Q^{-2}$ 2) $ML^3T^{-2}Q^{-1}$ 3) $ML^2T^{-1}Q^{-1}$ 4) $MLT^{-1}Q^{-1}$

146. The physical quantities not having same dimensions are
1) torque and work 2) momentum and Planck's constant
3) stress and Young's modulus 4) speed and $\left(\mu_0 \in_o\right)^{-1/2}$

147. Dimensions of $\frac{1}{\mu_0 \in_0}$, where symbols have their usual meaning are
1) $L^{-1}T$ 2) L^2T^2 3) L^2T^{-2} 4) LT^{-1}

148. Which one of the following represents the correct dimensions of the coefficient of visocosity?
1) $ML^{-1}T^2$ 2) MLT^{-1} 3) $ML^{-1}T^{-1}$ 4) $ML^{-2}T^{-2}$

149. The dimensional formula for impulse is:
1. MLT^{-2} 2. MLT^{-1} 3. ML^2T^{-1} 4. M^2LT^{-1}

150. The dimensions of calorie are
1. ML^2T^{-2} 2. MLT^{-2} 3. ML^2T^{-1} 4. ML^2T^{-1}

151. Specific heat in joule per kg per ^{0}c rise of temperature, its dimensions are:
1. $MLT^{-1}K^{-1}$ 2. $ML^2T^{-2}K^{-1}$ 3. $M^0L^2T^{-2}K^{-1}$ 4. $ML^2T^{-2}K^{-1}$

152. The SI unit of a physical quantity having the dimensional formula of $ML^0T^{-2}A^{-1}$
1. tesla 2.weber 3.amp meter 4.amp m²

153. The following pair does not have the same dimensions
1. Moment of inertia and Torque 2. Linear Momentum and impulse
3. Angular Momentum and Plank's constant 4. Work and internal energy

154. Match List I with List II and select the correct answer.

List - I	***List - II***
A) Spring constant	I) $M^1L^2T^{-2}$
B) Pascal	II) $M^0L^0T^{-1}$
C) Hertz	III) $M^1L^0T^{-2}$
D) Joule	IV) $M^1L^{-1}T^{-2}$

The correct match is

	A	B	C	D
1)	III	IV	II	I
2)	IV	III	I	II
3)	IV	III	II	I
4)	III	IV	I	II

155.Match List I with II and select the correct answer:

List-I	**List-II**
A.Spring constant	1. $M^1L^2T^{-2}$
B.pascal	2. $M^0L^0T^{-1}$
C.hertz	3. $M^1L^0T^{-2}$
D.joule	4. $M^1L^{-1}T^{-2}$

	A	**B**	**C**	**D**
a)	3	4	2	1
b)	4	3	1	2
c)	4	3	2	1
d)	3	4	1	2

156. The correct order in which the dimensions of length increases in the following physical quantities is

a) permittivity b) resistance c) magnetic permeability d) stress

1) a, b, c, d 2) d, c, b, a 3) a, d, c, b 4) c, b, d, a

157. The correct order in which the dimensions of “length “ decreases in the following physical quantities is

a) Coefficient of viscocityb) Thermal capacity c) Escape velocity d) Density

1.b,c,a,d 2.a,b, c,d 3. c,d,b,a 4.a,d,c,b

158. The correct order in which the dimensions of “time” increases in the following physical quantities is

a) Stress b) Period of revolution of satellite

c) Angular displacement d) Coefficient of thermal conductivity

1. a b c d 2. d c b a

3. a d c b 4. d a c b

159. Let $\in_0$ denote the permittivity of the vacuum and μ_0 is permeability of vacuum. If *M*=mass,
L=length, *T*=time and *I* = electric current, then

a) $\in_0 = M^{-1}L^{-3}T^2I$ b) $\in_0 = M^{-1}L^{-3}T^4I^2$ c) $\mu_0 = MLT^{-2}I^{-2}$ d) $\mu_0 = ML^2T^{-1}I$

1) a & c are correct 2) b & c are correct 3) c & d are correct 4) d & a are correct

160. What are the dimensions of $K = \dfrac{1}{4\pi \in_0}$?

1) $C^2N^{-1}M^{-2}$ 2) NM^2C^{-2} 3) NM^2C^2 4) unitless

161. Match the physical quantities given in Column I with suitable dimensions expressed in Column II.

Column I	**Column II**
a) Angular momentum	g) ML^2T^{-2}

b) Latent heat	h) ML^2Q^{-2}
c) Torque	i) ML^2T^{-1}
d) Capacitane	j) $ML^3T^{-1}Q^{-2}$
e) Inductance	k) $M^{-1}L^{-2}T^2Q^2$
f) Resistivity	l) L^2T^{-2}

	a	b	c	d	e	f
1.	i	l	g	k	h	j
2.	l	i	k	g	j	h
3.	i	l	h	j	g	k
4.	h	j	g	k	i	l

162. Study the following.

List - I	***List - II***
a) Same negative dimensions of mass	I) pressure, Rydberg constant
b) same negative dimensions of length	II) Mangnetic induction field, potential
c) same dimensions universal gravitational	III) Capacity, of time constant
d) Same dimension of current	IV) Energy density, surface tension

	a	b	c	d
1	III	I	IV	II
2.	III	IV	I	II
3.	I	II	III	IV
4.	II	I	IV	III

LEVEL- I

NUMERICAL QUESTIONS

ACCURACY, PRECISION, TYPES OF ERRORS AND COMBINATION OF ERRORS

MODEL QUESTIONS

163. The accuracy in the measurement of the diameter of hydrogen atom as 1.06 x 10^{-10} m is

1) 0.01 2) 106 x 10^{-10} 3) $\frac{1}{106}$ 4) 0.01 x 10^{-10}

164. A physical quantity is represented by x = $M^aL^bT^{-c}$. The percentage of errors in the measurements are $\alpha\%, \beta\%, \gamma\%$ then the maximum percentage error is

1) $\alpha a+\beta b-c\gamma$ 2) $\alpha a+\beta b+\gamma c$ 3) $\alpha a-\beta b-\gamma c$ 4) $\alpha a-\beta b+\gamma c$

165. The length of a rod is measured as 31.52 cm. Graduations on the scale are up to

1) 1 mm 2) 0.01 mm 3) 0.1 mm 4) 0.02 cm

PRACTICE QUESTIONS

166. The accuracy in the measurement of speed of light is 3.00 x 10^8 m/s is

1) $\frac{1}{300}\%$ 2) $\frac{1}{3}\%$ 3) 3% 4) $\frac{1}{30}\%$

167. In an experiment, a physical quantity is given by $Y=\frac{a^2b}{c^3}$. The permissible percentage error

1) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}+\frac{\Delta c}{c}\right)\times 100$ 2) $\left(2.\frac{\Delta a}{a}+\frac{\Delta b}{b}-\frac{3\Delta c}{c}\right)\times 100$

3) $\left(2.\frac{\Delta a}{a}+\frac{\Delta b}{b}+\frac{3\Delta c}{c}\right)\times 100$ 4) $\left(2.\frac{\Delta a}{a}-\frac{\Delta b}{b}-\frac{3\Delta c}{c}\right)\times 100$

168. The percentage error in a measurement of 6 mm is 0.1 %, the error is (in mm)
1) 0.6 2) 0.06 3) 0.006 4) 0.001

SIGNIFICANT FIGURES, ROUNDING OF NUMBERS

MODEL QUESTIONS

169. If the value of 103.5 kg is rounded off to three significant figures, then the value is
1) 103 2) 103.0 3) 104 4) 10.3

170. The number of significant figures in $6.023\times 10^{23}\ mole^{-1}\ is$
1) 4 2) 3 3) 2 4) 23

171. The side of a cube is 2.5 metre, the volume of the cube to the significant figures is
1) 15 2) 16 3) 1.5 4) 1.6

172. When a force is expressed in dyne, the number of significant figures is four. If it is expressed in Newton, the number of significant figures will become (10^5 dyne =1N)
1) 9 2) 5 3)1 4) 4

173. $\sqrt{2}$ is
1) 1.414 2) 1.4 3) 1.0 4) 1

174. The mass of a box is 2.3 kg. Two marbles of masses 2.15 g and 12.48 g are added to it. The total mass of the box is
1) 2.3438 kg 2) 2.3428 kg 3) 2.34 kg 4) 2.31 kg

PRACTICE QUESTIONS

175. The number of significant figures in 0.00386 is
1) 5 2) 3 3) 6 4) 2

176. The number of significant figures in 0.010200 is
1) 6 2) 5 3) 6 4) 2

177. When the number 0.046508 is reduced to 4 significant figures, then it becomes
1) 0.0465 2) 4650.8×10^{-5} 3) 4.651×10^{-2} 4) 4.650×10^{-2}

178. The radius of a sphere is 5 cm. Its volume will be given by(according to theory of significant figures
1) 523.33 cm^3 2) 5.23×10^2 cm^3 3) 5.0×10^2 cm^3 4) 5×10^2 cm^3

179. When 13546 is rounded off to four significant figures it becomes
1) 1355 2) 13550 3) 1355×10^1 4) 135.5

180. $\sqrt{3.0}$ is
1) 1.732 2) 1.7 3) 1.73 4) 1.8

181. When 24.25×10^3 is rounded off to three significant figures
1) 242 2) 243 3) 24.380×10^3 4) 24.2×10^3

182. Universal gravitational constant given by 6.67×10^{-11} N m^2 kg^{-2}, the no. of significant figure in it is
1) 14 2) 2 3) 3 4) 11

183. When we express the velocity of light 30,00,00,000 in standard form up to three significant figures it is
1) 3×10^8 ms^{-1} 2) 3.00×10^8 ms^{-1} 3) 3×10^{10} cms^{-1} 4) 3×10^6 ms^{-1}

184. What is the value of $\sqrt{79.62}$ is
1) 8.923 2) 8.9230 3) 8.92300 4) 8.9326

185. The number of significant figures in the numbers 672.9 and 2.520×10^7 are
1) 4,4 2) 3,4 3) 4,3 4) 3,3

186. With due regard to significant figures, the value of (46.7 – 10.04) is
1) 36.7 2) 36.00 3) 36.66 4) 30.6

187. The diameter of a sphere is 4.24m. Its surface area with due regard to significant figures is.

1) 5.65 m^2 2)56.5 m^2 3)565 m^2 4)5650 m^2

188. The value of $\pi / 53.2$ with due regard to significant figures is.

1) 0.0591 2) 0.0590 3) 0.590 4) 0.5906

189. Round off to 3 significant figures a) 20.96 and b) 0.0003125

1) 21.0 ; 312 ×10^{-4} 2) 21.0 ; 3.12 × 10^{-4} 3) 2.10 ; 3.12 ×10^{-4} 4) 210; 3.12 × 10^{-4}

UNITS, DIMENSIONS, DIMENSIONAL FORMULA
MODEL QUESTIONS

190. 1 Pascal = _____ C.G.S units (or) dyne Cm^{-2}

1. 10 2. $\frac{1}{10}$ 3. 100 4. 1000

191. L, C, and R represent the physical quantities inductance, capacitance and resistance respectively. The combinations that have the dimensions of frequency are

1. $\frac{1}{CR}$ 2. $\frac{R}{L}$ 3. $\frac{1}{\sqrt{L.C}}$ 4. 1,2, & 3

192. The dimension of time in Electrical intensity is

1. -1 2. -2 3. -3 4.3

193. If 'm' is the mass of a body, 'a' is amplitude of vibration, and 'ω' is the angular frequency, $\frac{1}{2}$ ma$^2\omega^2$ has same dimensional formula as

1. Work 2. moment of force 3. energy 4. all the above

194. The dimensional formula for pressure gradient is

1. $ML^{-1}T^{-2}$ 2. $M^1L^{-2}T^{-2}$ 3. $M^1L^2T^{-2}$ 4. $M^1L^{-1}T^{-3}$

195. The dimensional formula for Areal velocity is

1. $M^0L^{-2}T^{-1}$ 2. $M^0L^{-2}T^1$ 3. $M^0L^2T^{-1}$ 4. $M^0L^2T^1$

196. SI Unit of a physical quantity whose dimensional formula is $M^{-1}L^{-2}T^4A^2$ is

1.ohm 2. volt 3. sieman 4. farad

197. If the unit of length is doubled and that of mass and time is halved, the unit of energy will be :

1. doubled 2. 4 times 3. 8 times 4. same

198. The energy (E). angular momerntum (L) and universal graviational constant (G) are choosen as fundamental quantities. The dimensions of universal gravitational constant in the dimensional formula of planks constant(h) is **(2008 E)**

(1) 0 (2) -1 3) $\frac{5}{3}$ (4) 1

199. One mach number is equal to

1)$1KmS^{-1}$ 2)$1N/m^2$ 3) velocity of light 4) speed of sound

200. Barn is the unit of nuclear cross section. It is equal to

1)$10^{-20}m^2$ 2)$10^{-28}m^2$ 3)$10^{-30}m^2$ 4)$10^{-14}m^2$

201. One Torr is eqaul to

1) 1cm of Hg 2) $1N/m^2$ 3)1 mm of Hg 4) 1 atm pressure

202. Dimensions of solar constant are

1)$\left[M^0L^0T\right]$ 2)$\left[M^1L^1T^{-2}\right]$ 3)$\left[M^1L^{-1}T^{-2}\right]$ 4)$\left[M^1T^{-3}\right]$

203. The intensity of a wave is defind as the energy transmitted per unit area per second. Which

of the following represents the dimensional formula for the intensity of the wave?

1) MT^{-2} 2) MT^{-3} 3) MT^{-1} 4) $ML^{4}T$

204. Debye is a unit of

1) rms velocity 2) Force
3) specific gravity 4) Electric dipole moment

205. One shake is equal to

1) $10^{-8}s$ 2) $10^{-9}s$ 3) $10^{-10}s$ 4) $10^{9}s$

206. The physical quantity which has the dimensional formula $M^{1}T^{-3}$ is

1) surface tension 2) solar constant 3) Density 4) Compressibility

207. The dimensions of (velocity) ^{2} /radius are the same as that of

1) Planck' s constant 2) gravitational constant
3) dielectric constant 4) none of above

208. Given M is the mass suspended from a spring of force constant. k. The dimensional formula for $\left[M/k\right]^{1/2}$ is same as that for

1) frequency 2) time period 3) velocity 4) wavelength

209. Given that $\tan\theta = v^2/rg$ gives the angle of banking of the cyclist going round the curve. Here v is the speed of cyclist, r is the radius of the curve and g is acceleration due to gravity. Which of the following statments about this relation is true?

1) it is both dimensionally as well as numerically correct
2)it is neither dimensionally correct nor numerically correct
3) it is dimensionally correct but not numerically
4) it is numerically correct but not dimensionally

210. The unit of "impulse per unit area" is same as that of

1) viscosity 2)surface tension 3) bulk modulus 4) noneof the above

211. $\dfrac{1}{\sqrt{\text{Capacitance}\times\text{Inductance}}}$ have the same unit as

1) time 2) velocity 3)velocity gradient 4) none of the above

212. The unit of latent heat is equivalent to the unit of

1) $(\text{force})^2$ 2) $(\text{acceleration})^2$ 3) $(\text{velocity})^2$ 4) $(\text{density})^2$

213. The numerical values of the Young modulus in SI is β .Its numerical value in cgs system?

1) β 2) 10β 3) $\beta/10$ 4) $\beta/100$

214. The dimension of magnetic field in M, L, T and C (Colomb) is given as **(AIEEE 2008)**

1) $MT^{-1}C^{-1}$ 2) $MT^{-2}C^{-1}$ 3) $MLT^{-1}C^{-1}$ 4) $MT^{2}C^{-2}$

215. The SI unit of magnetic permeability is **(AIEEE 2002)**

1) Am^{-1} 2) Am^{-2} 3) Hm^{-2} 4) Hm^{-1}

216. Which one of the following represents the correct dimensions of the coefficient of visocosity? **(AIEEE 2004)**

1) $ML^{-1}T^{2}$ 2) MLT^{-1} 3) $ML^{-1}T^{-1}$ 4) $ML^{-2}T^{-2}$

217. What are the dimensions of $K = \dfrac{1}{4\pi\in_0}$? **(AIEEE 2004)**

1) $C^{2}N^{-1}M^{-2}$ 2) $NM^{2}C^{-2}$ 3) $NM^{2}C^{2}$ 4) unitless

PRACTICE QUESTIONS

218. $[M^1L^2T^{-3}A^{-2}]$ is the dimensional formula of :
1. Electric resistance 2. Capacity 3. Electric potential 4. Specific resistance

219. If C is the capcity, V is the potential difference, the energy stored in a capcitor is given by $E=\frac{1}{2}CV^2$. The dimension of time in cv^2 is
1. -2 2. 2 3. 1 4. -1

220. If L is the inductance, 'i' is current in the circuit, $\frac{1}{2}Li^2$ has the dimensions of
1. Work 2. Power 3. Pressure 4. Force

221. The physical quantity having dimensions 2 in length is
1. Power 2. Acceleration 3. Force constant 4. Stress

222. $(\text{Coulomb})^2 J^{-1}$ can be the unit of
1. Electric resistence 2. Electric energy 3. Electric capacity 4. Electric power

223. The ratio $\frac{L}{R}$ [L : inductance R : ressistance] has the dimensions of :
1. Velocity 2. Acceleration 3. time 4. Force

224. The dimension of length in electrical resistance is
1. 2 2. 1 3. -2 4. -1

225. If J and E represent the angular momentum and rotational kinetic energy of a body, $\frac{J^2}{2E}$ represents the following physical qunatity.
1. Moment of couple 2. Moment of force 3. Moment of inertia 4. Force

226. If $e, \in_0, h \text{ and } c$ respectively represents electric charge, permittivity of free space, Planck's constant and speed of light then $\frac{e^2}{\in_0 hc}$ has the dimensions of
a) angle b) relative density c) strain d) current
1) a & b are correct 2) d & c are correct
3) a, b & c are correct 4) a,b,c & d are correct

227. The dimensional formula for the product of two physical quantities P and Q is ML^2T^{-2}. The dimensional formula of $\frac{P}{Q}$ is MT^{-2}. Then P and Q respectively are: **(2001 M)**
1. Force and velocity 2. Momentum and displacement
3. Force and displacement 4. Work and Velocity

228. The fundamental physical quantities that have same dimension in the dimensional formula of Torque and Angular Momentum are **(2000 E)**
1. mass, time 2. time, length 3. mass, length 4.time, mole

229. The physical quantity which has the dimensional formula as that of $\frac{energy}{mass \times length}$ is **(2000 M)**
1. Force 2. Power 3. Pressure 4. Acceleration

230. If m is the mass, Q is the charge and B is the magnetic induction, *m/BQ* has the same dimensions as : **(1999 M)**
1. Frequency 2. Time 3. Velocity 4. Acceleration

231. Dimensions of 'ohm' are same as that of [h-Planck's constant e - charge] **(1998 E)**

1. $\frac{h}{e}$ 2. $\frac{h^2}{e}$ 3. $\frac{h}{e^2}$ 4. $\frac{h^2}{e^2}$

232. Dimensional of $\frac{L}{RCV}$ are

1) A^{-1} 2) A^{-2} 3) A 4) A^2

233. If *L* has the dimensions of length, *V* that of potential and $\in_0$ is the permittivity of free space then quantity $\in_0 LV$ has the dimensions of

1) current 2) charge 3) resistance 4) voltage

234. In an inductive circuit current I is flown. The work done is equal to $\frac{1}{2}LI^2$. The dimensions of LI^2 are

1. ML^2T^{-2} 2. Not expressible in M, L,T 3. ML^{-1} 4. $M^2L^2T^2$

235. Given M is the mass suspended from a spring of force constant k the dimensional formula for $\left(\frac{M}{k}\right)^{\frac{1}{2}}$ is same as that for

1. Wavelength 2. Velocity 3. Time period 4. Frequency

236. The dimensions of $\frac{1}{2}\varepsilon_0.E^2$ (ε_0 - Electrical permittivity, E - Electrical field, is

1. MLT^{-1} 2. ML^2T^{-2} 3. MLT^{-2} 4. No Answer

PRINCIPLE OF HOMOGENEITY OF DIMENSIONS

MODEL QUESTIONS

237. The velocity of an object varies with time as V = $At^2 + Bt + C$. Taking the unit of time as 1 sec and Velocity as ms^{-1}, the units of A, B, C respectively are:

1. $ms^{-3}, ms^{-2}, ms^{-1}$ 2. $ms^{-2}, ms^{-1}, ms^{-3}$ 3. $ms^{-1}, ms^{-2}, ms^{-3}$ 4. $ms^{-1}, ms^{-1}, ms^{-1}$

238. The velocity $v\left(in\, ms^{-1}\right)$ of a particle is given in terms of time $t\left(in\, \sec ond\right)$ by the equation, $v = at + \frac{b}{(t+c)}$. The dimensions of a , b, c are

The correct match is

	a	b	c
1)	L	T	LT^2
2)	LT^2	LT	L
3)	LT^{-2}	L	T
4)	L^2	LT	T^2

PRACTICE QUESTIONS

239. The distance travelled by a body in time 't' is given by $x = a + bt + ct^2$ where x is distance, t is time a,b and c are constants. the dimesional formula for a, b and c respectively are :

1. L, L^1T^{-1}, L^1T^{-2} 2. L^1T^{-1}, L^1T^{-2}, L 3. L^1T^{-2}, L^1T^{-1}, L 4. L, L, L

240. If the displacement S of a body in time 't' is given by $S = At^3 + Bt^2 + Ct + D$, the dimensions of A are

1. L^1T^3 2. T^{-3} 3. L^1T^{-3} 4. L^1

241. Force F = $at + bt^2$ where t is time. The dimensions of a and b are:

1. $\left[MLT^{-3}\right]$ and $\left[MLT^{-4}\right]$ 2. MLT^{-3} and MLT^{-2}
3. MLT^{-1} and MLT^{0} 4. MLT^{-4} and MLT^{-1}

242. $\mu = A + \frac{B}{\lambda} + \frac{C}{\lambda^2}$ is dimensionally correct. The dimensions of A, B and C respectively are (μ , A, B, C are constants)
1. No dimensions, L, L^2 2. L^2, No dimensions,L
3. L, L^2, No dimensions 4. L, L^2, no dimensions

243. According to Bernoulli's theorem $\frac{p}{d} + \frac{v^2}{2} + gh =$ constant. The dimensional formula of the constant is (P is pressure, d is density, h is height, v is velocity and g is accelaration due to gravity) **(2005 M)**
1) $M^0L^0T^0$ 2) M^0LT^0 3) $M^0L^2T^{-2}$ 4) $M^0L^2T^{-4}$

244. A certain physical quantity is calculated from the formula $x = \frac{\pi}{3}\left(a^2 - b^2\right)h$ where h, a and b, all are lengths. Then x is :
1. velocity 2.acceleration 3.area 4. volume

USES OF DIMENTIONAL ANALYSIS METHOD
TO CONVERT A PHYSICAL QUANTITY FROM ONE SYSTEM OF UNITS TO ANOTHER
MODEL QUESTIONS

245. The surface tension of a liquid in CGS system is 45 dyne cm^{-1}. Its value in SI system in is
1. 4.5 Nm^{-1} 2. 0.045 Nm^{-1} 3. 0.0045 Nm^{-1} 4. 0.45 Nm^{-1}
246. If minute is the unit of time, 10 ms^{-2} is the unit of acceleration and 100 kg is the unit of mass, the new unit of work in joule is
1. 10^5 2. 10^6 3. 6 x 10^6 4. 36x 10^6
247. The magnitude of force is 100 N. What will be its value if the units of mass and time are doubled and that of length is halved?
1. 25 N 2.100 N 3.200 N 4. 400 N
248. A motor pumps water at the rate of V m^3 per second, against a pressure P Nm^{-2}. The power of the motor in watt is
1. PV 2. $\frac{P}{V}$ 3. $\frac{V}{P}$ 4. $\left(V - P\right)$
249. If the units of length and force are increased by four times the unit of energy will be increased by
1. 16% 2.1600% 3. 1500% 4. 400%

PRACTICE QUESTIONS

250. The value of universal gravitational cosntant G in CGS system is 6.67×10^{-8} dyne cm^2 gm^{-2}. Its value in SI system in is
1.6.67x10^{-11} Nm^2 kg^{-2} 2.6.67x$10^{-5}$$Nm^2$ kg^{-2} 3. 6.67x10^{-10} Nm^2 kg^{-2} 4. 6.67x10^{-9} Nm^2 kg^{-2}
251. The value of density of mercury in CGS system is 13.56 gm cm^{-3} . Its value is SI system is
1. 135.6 kg. m^{-3} 2. 13.56 kg m^{-3} 3. 1.356 kg m^{-3} 4. 13560 kg m^{-3}
252. The viscosity of a liquid is 0.85 kg $m^{-1}s^{-1.}$ Its value in CGS system is
1. 8.5 gm $cm^{-1}s^{-1}$ 2. 85 gm $cm^{-1}s^{-1}$ 3. 0.85 gm $cm^{-1}s^{-1}$ 4. 0.085 gm $cm^{-1}s^{-1}$
253. Young's modulus of steel is 19 x 10^{10} Nm^{-2}. Its value in dyne cm^{-2} is
1. 19 x 10^{11} 2. 19 x 10^{17} 3. 19 x 10^{13} 4. 19 x 10^{21}
254. If the unit of force is 1000N and unit of pressure is 40 pascal, the unit of length is
1. 50 cm 2.0.05 m 3. 0.5 m 4. 5 m

PHYSICAL WORLD AND MEASUREMENTS

255. The value of g is 9.8 ms^{-2}. Its value in a new system in which the unit of length is kilometre and that of time 1 minute is
1. 35.3 Km $minute^{-2}$ 2. 3.53 Km $minute^{-2}$ 3. 353 Km $minute^{-2}$ 4. 0.353 Km $minute^{-2}$

256. If kg, meter and minute are taken as the units of mass, length and time then the numerical value of force of 1000 dyne is
1. 300 units 2. 3600 units 3. 0.36 units 4. 36 units

257. If the unit of mass is $\frac{1}{2}$ kg and that of length is 2m and the unit of time is one second, the unit of pressure is
1. 2 pascal 2. 0.5 pascal 3. 0.25 pascal 4. 1.0 pascal

258. If the fundamental units of length, mass and time are halved, the unit of momentum will be
1. doubled 2.halved 3. same 4. four times

259. If the fundamental units of length, mass and time are doubled, the unit of force will be
1. doubled 2.halved 3. same 4. four times

260. If the magnitude of mass is 1 kg that of time is 1 minute and that of acceleration due to gravity is 10 ms^{-2}, the magnitude of energy in joule
1. 3.6 x 10^5 2. 3.6 x 10^{-5} 3. 3.6 x 10^2 4. 10

261. If the unit of length is quadrupled and that of force is doubled, the unit of power increases to --- times
1. 8 2. 4 3. 2 4. 16

262. If the unit of force is 5 N and that of length is 10m, the unit of energy in joule is
1. 0.5 2. 50 3. 2 4. 15

263. If the unit of force is 12 N, that of length is 3 m and that of time is 4 s, the unit of mass in new system is
1. 6.4 Kg 2. 64 kg 3. 640 Kg 4. 128 Kg

264. 1 MeV = --- joule
1. 10^6 2. 1.6 x 10^{-13} 3. 1.6 x 10^{-19} 4. 3.6 x 10^6

265. In C.G.S. system the magnitude of the force is 100 dyne. In another system where the fundamental physical quantities are kilogram, metre, and minute, the magnitude of force is **(2001 E)**
1. 0.036 2.0.36 3. 3.6 4. 36

266. S.I. unit and C.G.S unit of a quantity vary by 10^3 times, it is : **(1994 E)**
1. Boltzman constant 2.Gravitationalconstant'
3. Plank's constant 4. Angular Momentum

TO CHECK THE CORRECTNESS OF A GIVEN PHYSICAL RELATION

MODEL QUESTIONS

267. The final velocity of a particle falling freely under gravity is given by $V^2 - u^2 = 2gx$ where x is the distance covered. If v = 18 kmph.
g = 1000cm s^{-2}, x = 120 cm then u = ----ms^{-1}
1. 2.4 2. 1.2 3. 1 4. 0.1

PRACTICE QUESTIONS

268. The equation which is dimensionally correct among the following is
1. $V = u + at^2$ 2. $S = ut + at^3$ 3. $S = ut + at^2$ 4. $t = S + av$

269. The displacement in n^{th} second of uniformly acelerated motion is given by
$S_{n^{th}} = u + \frac{a}{2}(2n-1)$ This equation is dimensionally
1. correct 2. not correct
3. can be made correct by multiplying the right hand side of equation by n.
4. can be made correct by dividing the left hand side of the equation by n.

TO ESTABLISH RELATION BETWEEN DIFFERENT PHYSICAL QUANTITIES

MODEL QUESTIONS

270. The velocity of sound in air (V) pressure (P) and density of air (d) are related as $V \alpha p^x d^y$. The values of x and y respectively are

1. $1, \frac{1}{2}$ 2. $-\frac{1}{2}, -\frac{1}{2}$ 3. $\frac{1}{2}, \frac{1}{2}$ 4. $\frac{1}{2}, -\frac{1}{2}$

271. The dimensions of 'k' in the relation V = $k\ avt$ (where V is the volume of a liquid passing through any point in time t, 'a' is area of cross section, v is the velocity of the liquid) is

1. $M^1L^2T^{-1}$ 2. $M^1L^1T^{-1}$ 3. $M^0L^0T^{-1}$ 4. $M^0L^0T^0$

272. If force 'F', acceleration 'A' and time 'T' are taken as fundamental quantities then the dimensions of energy are :

1. A^2T 2. $F\ AT^2$ 3. F^2T 4. $FA^{-1}T^{-1}$

273. If pressure 'p' depends upon velocity'v' and density 'd', the relationship between p, v and d is

1. $p\ \alpha\ vd$ 2. $p\ \alpha\ v^2d$ 3. $p\ \alpha\ \frac{v^3}{d}$ 4. $p\ \alpha\ \frac{v^2}{d^2}$

274. The period of oscillation 'T' of a loaded spring depends upon the mass of load 'M' and force costant K of the spring. If the constant of proportionality is 2 π , the dimensional formula for 'T' is

1. T = $2\pi\frac{M}{K}$ 2. T = $2\pi\frac{K}{M}$ 3. T = $2\pi\sqrt{\frac{K}{M}}$ 4. $T = 2\pi\sqrt{\frac{M}{K}}$

275. If force (F), work (W) and Velocity (V) are taken as fundametal quantities then the dimensinal formula of Time (T) is **(2007 M)**

1) $W^1F^1V^1$ 2) $W^1F^1V^{-1}$ 3) $W^{-1}F^{-1}V^{-1}$ 4) $W^1F^{-1}V^{-1}$

PRACTICE QUESTIONS

276. IF (force)^x = $\frac{(Mass)^2(radius)^2}{(time\ period)^4}$ the value of x is

1. 1 2. 2 3. 3 4. 4

277. The acceleration of a particle moving along the circumference of a circle depends upon the uniform speed 'v' and radius 'r' . If $a\ \alpha\ v^x r^y$ the values of x and y are

1. 2, 2 2.2, 1 3. 1, 1 4.2, -1

278. Velocity of waves on water is given by $V = Kg^a\lambda^b$ where g is acceleration due to gravity, λ the wave length and K is a constant. The values of a and b are

1.$-\frac{1}{2}, -\frac{1}{2}$ 2. $\frac{1}{2}, 2$ 3. 2, 2 4.$\frac{1}{2}, \frac{1}{2}$

279. The mass (M) of a stone that can be moved by water current depends upon velocity 'V' of the stream, density of water d and acceleration due to gravity 'g' .The relation between the mass and velocity is

1. $M\alpha V^6$ 2. $M\alpha V^2$ 3. $M\alpha\frac{1}{d^2}$ 4.$M\alpha\sqrt{V}$

280. The period of oscillation of a simple pendulum is expected to depend upon the length of the pendulum (l), and acceleration due to gravity (g). The constant of proportionality is 2 π . Then T =

1. $\frac{2\pi l}{g}$ 2. $2\pi\sqrt{\frac{g}{l}}$ 3. $2\pi\sqrt{\frac{l}{g}}$ 4. $\frac{2\pi g}{l}$

281. If C, R, C and I denote capacity resistance, inductance and electric current respectively, the quantities having the same dimensions of time are **(2006 E)**

a) CR b) L/R c) $\sqrt{LC}$ d) LI^2

1) a and b only 2) a and c only 3) a and d only 4) a, b and c only

PHYSICAL WORLD AND MEASUREMENTS

282. In planetarymotion the areal velocity of position vector of a planet depends on angular velocity ω and the distance of the planet from sun (r). If so the correct relation for areal velocity is **(2003 E)**

1) $\frac{dA}{dt} \alpha\ \omega r$ 2) $\frac{dA}{dt} \alpha\ \omega^2 r$ 3) $\frac{dA}{dt} \alpha\ \omega r^2$ 4) $\frac{dA}{dt} \alpha \sqrt{\omega r}$

283. If pressure P, Velocity V, and time T are taken as fundamental physical quantities the dimensional formula for force is **(2000 E)**

1. PV^2T^2 2. $P^{-1}V^2T^{-1}$ 3. PVT^2 4. $P^{-1}V.T^2$

284. Velocity of a wave is directly proportional to modulus of Elasticity 'E' and density 'd' of a medium. The expression of 'V' using dimensional analysis is **(1997 E)**

1. $V = \frac{E}{\sqrt{d}}$ 2. $V = \frac{\sqrt{E}}{d}$ 3. $V = \sqrt{\frac{E}{d}}$ 4. $V = \sqrt{ED}$

285. $V \alpha\ g^x.h^y$ where V is velocity g is acceleration due to gravity and h is height. Then x and y are **(1994 E)**

1. $\frac{1}{2}, \frac{1}{2}$ 2. $\frac{1}{2}, -\frac{1}{2}$ 3. $-\frac{1}{2}, \frac{1}{2}$ 4. $1, \frac{1}{2}$

286. Dimensional analysis of the equation $(Velocity)^x = (\Pr essure\ difference)^{\frac{3}{2}}.(density)^{\frac{-3}{2}}$ gives the value of x as: **(1986 E)**

1. 1 2. 2 3. 3 4. -3

287. For the equation F = $A^a v^b d^c$ where F is force, A is area, v is velocity and d is density, with the dimensional analysis gives the following values for the exponents. **(1985 E)**

1. a=1, b = 2, c =1 2. a =2, b =1, c= 1 3. a =1, b =1, c= 2 4. a = 0, b =1 , c = 1

288. If force F, LengthL and timeT are chosen as fundamental quantities,the dimensional formula for Mass is

1. FLT 2. $F^{-1}L^{-1}T^{-2}$ 3. $F^{-2}L^{-2}T^{-2}$ 4. $F^1L^{-1}T^2$

289. If Force F, Mass M and time T are chosen as fundamental quantities the dimensional formula for length is

1. FMT 2. $FM^{-1}T^2$ 3. FL^2T^{-2} 4. $F^{-1}L^{-2}T^{-2}$

290. If the velocity 'V', the kinetic energy 'k' and time 'T' are taken as fundamental quantities the dimensional formula of surface tension is.

1. KV^2T^2 2. $KV^{-2}T^{-2}$

3. $K^2V^2T^{-2}$ 4. $K^2V^{-2}T^{-2}$

LEVEL - II

NUMERICAL QUESTIONS

ACCURACY, PRECISION, TYPES OF ERRORS AND COMBINATION OF ERRORS

MODEL QUESTIONS

291. The error in the measurement of the length of the simple pendulum is 0.2 % and the error in time period 4%. The maximum possible error in measurement of $\frac{L}{T^2}$ is

1) 4.2% 2) 3.8% 3) 7.8% 4) 8.2%

292. The least count of a stop watch is 1/5 sec. The time of 20 oscillations of a pendulum is measured to be 25 sec. The maximum percentage error in this measurement is

1) 8% 2) 1% 3) 0.8% 4) 16%

293. The diameter of a wire as measured by a screw gauge was found to be 1.002 cm, 1.004 cm

and 1.006 cm. The absolute error in the third reading is

1) 0.002 cm 2) 0.004 cm 3) 1.002 cm 4) zero

294. Dimensional formula for a physical quantity X is $M^{-1}L^3T^{-2}$. The errors in measuring the quantities M,L and T respectively are 2%, 3%, and 4%. The maximum percentage error that occurs in measuring the quantity X is

1) 19% 2) 9% 3) 17% 4) 21%

PRACTICE QUESTIONS

295. The heat generated in a circuit is dependent on the resistance, current and time of flow of electric current. If the percentage errors measured in the above physical quantities are 1%, 2% and 1%, the maximum error in measuring the heat is

1) 2% 2) 3% 3) 6% 4) 1%

296. While measuring acceleration due to gravity by simple pendulum a student makes a positive error of 1% in length of the pendulum and negative error of 3% in the value of time period. His percentage error in the measurement of the value of 'g' is

1) 2% 2) 1% 3) 7% 4) 10%

297. The percentage errors in a,b,c are $\pm 1\%, \pm 3\%$ and $\pm 2\%$ respectively. The percentage error in $x = \frac{ab^2}{c^3}$ can be

1) $\pm 13\%$ 2) $\pm 7\%$ 3) $\pm 4\%$ 4) $\pm 1\%$

298. The percentage error in the measurement of mass and speed are 2% and 3% respectively. The maximum percentage error in the estimation of kinetic energy of a body measuring its mass and speed will be

1) 11% 2) 8% 3) 5% 4) 1%

299. The heat generated in a circuit is given by Q = i^2 Rt joule , where 'i' is current, R is resistance and t is time. If the percentage errors in measuring I, R and t are 2%, 1% and 1% respectively. The maximum error in measuring heat will be

1) 2% 2) 3% 3) 4% 4) 6%

300. The density of a cube can be measured by measuring its mass and the length of its side . If the maximum errors in the measurement of mass and length are 3%, and 2% respectively, the maximum error in the measurement of the density of the cube is

1) 9% 2) 19% 3) 10% 4) 90%

301. The length and breadth of a rectangular object are 25.2 cm and 16.8 cm respectively and have been measured to an accuracy of 0.1 cm. The relative error and percentage error in the area of the object are.

1) 0.01 ; 1% 2) 0.1 ; 10% 3) 1 ; 100 % 4) 0.2 ; 20%

302. The error in the measurement of the length of simple pendulum is 0.1 % and the error in time period is 3%. The maximum possible error in the measurement of $\frac{L}{T^2}$ is

1)6.1 % 2) 6.0 % 3) 3.1 % 4) 6.2 %

SIGNIFICANT FIGURES, ROUNDING OF NUMBERS

MODEL QUESTIONS

303. The velocity of light in vacuum is 30crore m/s. This is expressed in standard form upto 3 significant figures as

1) 0.003×10^{11} m/s 2) 300×10^6 m/s 3) 3.00×10^8 m/s 4) 0.030×10^{10} m/s

304. The length, breadth and thickness of a rectangular lamina are 1.024 m, 0.56, and 0.0031 m. The volume is …………..m^3

1) 1.8×10^{-3} 2) 1.80×10^{-3} 3) 0.180×10^{-4} 4) 0.00177

PRACTICE QUESTIONS

305. The diameter of a cylinder is 0.55 cm, its length is 1.35 cm. Its volume is……cm^3

1) 0.3240 2) 0.32 3) 0.324 4) 3.2

PHYSICAL WORLD AND MEASUREMENTS

306. The volume of a sphere is 1.76 cm^3. The volume of 25 such spheres according to the idea if significant figures is (in cm^3)

1) 44.00 2) 44.0 3) 44 4) 4.4

307. $(2.0)^{10}$ is

1) 1024 2) 1.024×10^{10} 3) 1.0×10^3 4) one kilo

308. A body of mass m = 3.513 kg is moving along the x-axis with a speed of 5.00 ms^{-1}. The magnitude of its momentum is recorded as **(AIEEE 2008)**

1) $17.56\,kg\,ms^{-1}$ 2) $17.57\,kg\,ms^{-1}$ 3) $17.6\,kg\,ms^{-1}$ 4) $17.565\,kg\,ms^{-1}$

UNITS, DIMENSIONS, DIMENSIONAL FORMULA
MODEL QUESTIONS

309. The following equation is dimensionally correct.

1. pressure = Energy per unit area 2. pressure = Energy per unit volume
3. pressure = Force per unit volume
4. pressure = Momentum per unit volume per unit time

310. If 'R' is Rydberg constant, h is Planck's constant, C is velocity of light, Rhc has the same dimensional formula as that of

1. Energy 2. Force 3. Angular momentum 4. Power

311. Two soaps *A* and *B* are given. Dimensions of *B* are 50% more than each dimensions of *A*. Soap content of *B* as compared to *A* is

1) 1.5 2) 2.25 3) 3.375 4) 4

312. If the ratio of fundamental units in two systems is 1 :3, then the ratio of momenta in the two systems is

1. 1:3 2. 1:9 3. 1:27 4. 3:1

313. E, m, J and G denote energy, mass, angular momentum and gravitational constant respectively. Then the dimensions of $\frac{EJ^2}{m^5G^2}$ are same as that of

1. angle 2.length 3. mass 4. time

PRACTICE QUESTIONS

314. If 'Muscular strength' times 'Speed' is equal to power, then dimensional formula for ' Muscular strength' is

1. MLT 2. MLT^{-2} 3. ML^2T^{-2} 4. ML^0T^{-2}

315. If P is pressure, ρ is the density then $\frac{P}{\rho}$ has the same dimensions of :

1. Force per unit Mass 2. Energy per unit Mass
3. Power per unit velocity 4. relative density

316. If C denotes the capacity and L denotes the inductance, the dimensions 'LC' are same as that of

1. $M^0L^0T^2$ 2. $M^1L^0T^2$ 3. $M^1L^1T^{-2}$ 4. $M^0L^1T^2$

317. The physical quantity that has the same dimensions as $\sqrt{\frac{I}{MB}}$ is

1. mass 2. time 3. length 4. velocity

318. If m is the mass of drop of a liquid of radius 'r' then $\frac{mg}{\pi r}$ has the same dimensions of :

1. Surface tension 2. tension
3. Young's Modulus 4. Coefficient of viscosity

319. The quantity $\frac{e^2}{2\varepsilon_o.hc}$ has the dimensions of

1. $M^1L^3T^{-2}$ 2. $M^1L^2T^{-1}$ 3. $M^0L^0T^0$ 4. $M^0L^0T^{-1}$

320. Dimenstions of 'ohm' are same as

1) $\frac{h}{e}$ 2) $\frac{h^2}{e}$ 3) $\frac{h}{e^2}$ 4) $\frac{h^2}{e^2}$

321. If the relation $V = \frac{\pi}{8}\frac{\Pr^4}{nl}$ .Where the letters have their usual meanings, the dimensions of V are

1) $M^0L^3T^0$ 2) $M^0L^3T^{-1}$ 3) $M^0L^{-3}T^{-1}$ 4) $M^1L^3T^0$

322. In SI system of unit of radioactivity is

1) Becquerrel 2) Curie 3) Rutherford 4) None of these

323. The dimensions of intensity of wave are

1) $\left[ML^2T^{-3}\right]$ 2) $\left[ML^0T^{-3}\right]$ 3) $\left[ML^{-2}L^{-3}\right]$ 4) $\left[M^1L^2L^3\right]$

324. The mass of the liquid flowing per second per unit area of cross- section of the tube is proportional to (pressere difference across the ends) ^{n} and Which of the following relations between m and n is correct.

1)m = n 2) m = -n 3) $m^2 = n$ 4) $m = -n^2$

325. Three of the quantities defined below have the same dimentional formula. Identify them

i) $\sqrt{Energy/mass}$ ii) $\sqrt{pressure/density}$

iii) $\sqrt{Force/linear\ density}$ iv) $\sqrt{Angular\ frequency/radius}$

1) i,ii,iii 2) ii,iii,iv 3) iii,iv,i 4) iv,i,ii

326. The following do not have the same dimensions as the other three? Given that l = length, m = mass, k= force consatnt, I= momentum of inertia, B = magnetic induction, P_m =magnetic dipole moment, R= radius, g = acceleration due to gravity

1) $\sqrt{l/g}$ 2) $\sqrt{I/P_mB}$ 3) $\sqrt{k/m}$ 4) $\sqrt{R/g}$

327. The velocity of the waves on the surface of water is proportional to $\lambda^\alpha \rho^\beta g^\gamma$ where λ =wave length, ρ = density and g = acceleration due to gravity .Which of the following relation is correct?

1) $\alpha = \beta \neq \gamma$ 2) $\beta = \gamma \neq \alpha$ 3) $\gamma = \alpha \neq \beta$ 4) $\alpha \neq \beta \neq \gamma$

328. The product of energy and time is called action. The dimensional formula for action is same as that for

1) force $\times$ velocity 2) impulse $\times$ distance 3) power 4) angular energy

329. Given that I= moment of inertia, $P_m =$ magnetic ipole momentum and B= magnetic induction, then the dimensional formula for I/P_mB is same as that of

1) time 2) length 3) $time^2$ 4) $length^2$

330. Suppose speed of light (c), force (F) and kinetic energy (K) are taken as the fundamental units, then the dimensional formula for mass will be

1) KC^{-2} 2) KF^{-2} 3) CK^{-2} 4) FC^{-2}

331. The Richardson equation is given by $I = AT^2e^{-B/kT}$. The dimensional formula for

AB^2 is same as that for A and B are constant

1) IT^{-2} 2)k T 3) Ik^2 4) Ik^2/T

332. Given that m = mass, l = length, t = time and i = current. The dimensions of ml^2/t^3i are the same as that of

1) electric field 2) electric potential 3) capacitance 4) inductance

333. Given that v is the speed, r is radius and g is acceleration due to gravity. Which of the following is dimensionless?

1) v^2r/g 2) v^2/rg 3) v^2g/r 4) v^2rg

334. The frequency of vibration of a string is given by $v=\frac{p}{2l}\left[\frac{F}{m}\right]^{\frac{1}{2}}$

Here p is the number of segments in which the string is divided, F is the tension in the string and l is its length. The dimensional formula for m is

1) $M^0L^0T^0$ 2) $ML^{-1}T^0$ 3) ML^0T^{-1} 4) M^0LT^{-1}

335. $S^2 = at^4$. Here S is measured in metres, t in second. Then the unit of 'a' is

1) $\mathrm{m^2s^4}$ 2) $\mathrm{m^2s^{-4}}$ 3) $\mathrm{ms^2}$ 4) $\mathrm{ms^{-2}}$

336. Given that $y=a\cos(t/p-qx)$, where t represents time in second and x representsdistance in metre.Which of the following statements is true ?

1) the unit of x is same as that q 2) the unit of x is same as that of p
3) the unit of t is same as that of q 4) the unit of t is same as that of p

337. The equation of the stationary wave is $y = 2A\sin\left(\frac{2\pi ct}{\lambda}\right)\cos\left(\frac{2\pi x}{\lambda}\right)$

1) the unit of ct is same as that of λ 2) the unit of x is same as that of λ

3)the unit of 2 π c/ λ is same as that of π x/ λ t

4) the unit of ct / λ is same as that of x/ λ

338. Given that $\int\frac{dx}{\sqrt{2ax-x}} = a^n\sin^{-1}\left[\frac{x-a}{a}\right]$ where a=constant. Using dimensional analysis, the value of n is

1) 1 2) 0 3) -1 4) none of the above

339. Given that the displacement of an oscillating particle is given by y = A sin [Bx+Ct+d]. The dimensional formula for (ABCD) is

1) $M^0L^{-1}T^0$ 2) $M^0L^0T^{-1}$ 3) $M^0L^{-1}T^{-1}$ 4) $M^0L^0T^0$

340. Suppose, the torque acting on a body is given by τ =KL+MI/ ω. Where L = angular momentum, I= moment of inertia, ω =angular speed. The dimensional formula for KM is same as that for

1) time^2 2) time^4 3) time^{-2} 4) time^{-4}

341. If L,R,C and V respectively represent inductance resistance, capacitance and potential difference then the dimensions of $\frac{L}{RCV}$ are the same as those of

1) Charge 2) $\frac{1}{Charge}$ 3) Current 4) $\frac{1}{Current}$

342. In the following dimensionally consistent equation $F = \frac{X}{Linear\ Density} + Y$, where F is the force, the dimenstional formula for X and Y are given as

1) $M^2L^0T^{-2}, MLT^{-2}$ 2) $M^2L^{-2}T^{-2}, MLT^{-2}$ 3) MLT^{-2}, ML^2T^{-2} 4) $M^0L^0T^0, ML^0T^0$

343. With usual notation, the following equation, said to give the distance covered in the n[th] second i.e., $S_n = u + a\frac{(2n-1)}{2}$ is

1) numerically correct only 2) dimensionally correct only
3) both dimensionally and numerically correct
4) neither numerically nor dimensionally correct

344. Dimensions of $\frac{1}{\mu_0 \in_0}$, where symbols have their usual meaning are **(AIEEE 2003)**

1) $L^{-1}T$ 2) L^2T^2 3) L^2T^{-2} 4) LT^{-1}

PRINCIPLE OF HOMOGENEITY OF DIMENSIONS

MODEL QUESTIONS

345. The work done '*w*' by a body varies with displacement 'x' as $w = Ax + \frac{B}{(c-x)^2}$. The dimensional formula for 'B' is.

1. ML^2T^{-2} 2. ML^4T^{-2} 3. MLT^{-2} 4. ML^2T^{-4}

346. In the equation $y = A\ Sin\left[kt - \frac{x}{\lambda}\right]$, the dimensional formula for k is

1. $M^0L^0T^{-1}$ 2. $M^0L^0T^0$ 3. M^0LT^0 4. ML^0T^0

347. The pressure of a gas $p = \frac{RT}{V-b}.e^{\left(\frac{-aV}{RT}\right)}$. If V be the volume of gas, R be the universal gas constant and T be the absolute temperature. The dimensional formula of 'a' is same as that of

1. V 2. p 3. T 4. R

348. Hydrostatic pressure 'P' varies with displacement 'x' as $P = \frac{A}{B}\log(Bx^2 + c)$ where A, B and C are constants. The dimensional formula for 'A' is.

1. $M^1L^{-1}T^{-2}$ 2. MLT^{-2} 3. $ML^{-2}T^{-2}$ 4. $ML^{-3}T^{-2}$

PRACTICE QUESTIONS

349. The dimensions of 'a' in Vanderwaal's equation $\left(p + \frac{a}{V^2}\right)(V - b) = RT$ is (V-volume, P-Pressure, R-Universal gas constant, T- Temperature)

1. $M^1L^{-1}T^{-2}$ 2. $M^1L^5T^{-2}$ 3. $M^0L^3T^0$ 4. $M^0L^6T^0$

350. The Vander waal's equation for ideal gas is given by $\left(p + \frac{a}{V^2}\right)(V-b) = RT$ where P is pressure, V is volume a and b are constants, R is universal gas constant and T is absolute

temperature. Then the dimensions of $\frac{a}{b}$ are same as that of

1. Force 2. Momentum 3. Energy 4. Power

351. The velocity of a freely falling body in a resisting medium at any time 't' is given by

$V = \frac{A}{B\left[1-e^{Bt}\right]}$ The dimensions of 'A ' are

1. L 2.LT^{-2} 3. LT^{-1} 4. LT

352. The position of particle at any time 't' is given by $S(t) = \frac{V_0}{\alpha}\left[1-e^{-\alpha.t}\right]$ where $\alpha > 0$ and V_0 is constant velocity. The dimensions of α are

1. T^1 2. T^{-1} 3. L^1T^{-1} 4. $L^{-1}T$

353. The position of a particle at time 't' is given by the equation $x(t) = \frac{V_0}{A}\left(1-e^{AT}\right)$ where V_0 is a constant and A > 0. Dimensions of V_0 and A respectively are **(2004 E)**

1) M^0LT^0 and T^{-1} 2) M^0LT^{-1} and LT^{-2}

3) M^0LT^{-1} and T 4) M^0LT^{-1} and T^{-1}

354. The Vanderwaal's equation for a gas is $\left(P+\frac{a}{V^2}\right)(V-b) = nRT$ where P, V, R , T and n represent the pressure, volume, universal gas constant, absolute temperature, and number of moles of a gas respectively 'a' and 'b' are constants. The ratio b/a will have the following demensional formula **(2002 E)**

1. $M^{-1}L^{-2}T^2$ 2. $M^1L^{-1}T^{-1}$ 3. ML^2T^2 4. MLT^{-2}

355. The velocity 'V' of a particle varies with distance 'x' and time 't' as V = $A\sin Bx.\cos Ct$ when A, B, C are constants, then $\frac{AB}{C}$ will have the dimensions of

1.velocity 2. acceleration 3. pressure 4. strain

356. In the relation $P = \frac{\alpha}{\beta}e^{-\alpha z/K\theta}$; P is pressure, K is Boltzmann's constant, Z is distance and θ is temperature. The dimensional formula of β will be

1) $\left[M^0\, L^2\, T^0\right]$ 2) $\left[M^1\, L^2\, T^1\right]$ 3) $\left[ML^0\, T^{-1}\right]$ 4) $\left[M^0\, L^2\, T^{-1}\right]$

357. Given that $p = \frac{RT}{V-b}e^{-aV/RT}$ .The dimentional formula of a is same as that of V = volume, T = temperature, P = pressure, R = universal gas constant

1) V 2) p 3) T 4) R

USES OF DIMENTIONAL ANALYSIS METHOD
TO CONVERT A PHYSICAL QUANTITY FROM ONE SYSTEM OF UNITS TO ANOTHER
MODEL QUESTIONS

358. If the units of mass, time and length are 100 g, 20 cm and 1 minute respectively the equivalent energy for 1000 erg in the new system will be

1. 90 2. 900 3. 2×10^6 4. 300

359. Certain amount of energy is measured as 400 units. If the fundamental units of length, mass and time, each are doubled the magnitude of the same energy in the new system will be --- units.

1. 200 2.400 3. 800 4. 600

360. The units of force, velocity and energy are 100 dyne, 10 cm s^{-1} and 500 erg respectively. The units of mass, length and time are

1. 5 g, 5 cm, 5 s 2. 5 g, 5 cm, 0.5 s 3. 0.5 g, 5 cm, 5 s 4. 5 g, 0.5cm, 5 s

361. The height of Mercury barometer is 76 cm and density of Mercury is 13.6 g/cc. The corresponding height of water barometer is SI system is

1. 10.336 m 2.103.36 m 3. 5.5 m 4.1.0336 m

362. A certain amount of energy is measured as 500 units. If the fundamental units of length, Mass and time each are doubled then the magnitude of energy in new system will be

1. 1000 units 2. 250 units 3. 500 units 4. 2000 units

PRACTICE QUESTIONS

363. If the unit of length is 5 cm and unit of mass is 20g, then the density of a substance which is 8 g/cc in the new system is

1. 80 units 2. 40 units 3. 50 units 4.100 units

364. The value of g = 9.8 m s^{-2}. Its value in Km hr^{-2} is.

1. 278326 2. 15376 3. 227004 4.127008

365. The power of a motor is 1600 watt. If the unit of mass is doubled and units of length and time are halved, the power of the motor in new system is

1. 400 units 2. 6400 units 3. 3200 units 4. 4800 units

366. If the unit of work is 100 joule, the unit of power is 1 kilo watt, the unit of time in second is

1. 10^{-1} 2.10 3. 10^{-2} 4.10^{-3}

367. If the fundamental units in the systems of measurement are in the ratio 2 : 3, then the units of surface tension in the system will be in the ratio of

1. 2 : 3 2. 3 : 2 3. 4 : 9 4. 9 : 4

368. The ratio of SI unit to the CGS unit of planck's constant is

1. 10^7:1 2. 10^4 :1 3. 10^6 :1 4. 1 :1

369. If the unit of velocity is equal to the velocity of light and acceleration is 10 ms^{-2}, the unit of time is

1. 3 x 10^7 s 2. 3 x 10^{-7} s 3. 3 x 10^{-5} s 4. 3 x 10^{-4} s

370. If the unit of force is 1 KN unit of length is 1 km and unit of time is 100 s in a- new system, then the new unit of mass is

1. 1000 kg 2. 1 kg 3. 10,000 kg 4. 100 kg

371. If the unit of force is 4 N unit of length is 4 m and unit of mass is $\frac{1}{4}$kg in a new system, then the new unit of velocity is

1. 8 ms^{-1} 2. 16 ms^{-1} 3. 4 ms^{-1} 4. 1 ms^{-1}

TO CHECK THE CORRECTNESS OF A GIVEN PHYSICAL RELATION

MODEL QUESTIONS

372. The equation which is dimensionally consistent in the following is Where S_n = distance travelled by a body in n^{th} second,

u = initial velocity a = acceleration
T = time period r = radius of the orbit
M = Mass of the sun
G=universal gravitational constant.
C = RMS velocity P = pressure.
d = density.

1. $S_n = u + a\left(n - \frac{1}{2}\right)$ 2. $T = \sqrt{\frac{4\pi^2 r^3}{GM}}$ 3. C = $\sqrt{\frac{3p}{d}}$ 4. 1, 2, 3

PRACTICE QUESTIONS

373. The thrust developed by a rocket motor is given by $F = mV + A(P_1 - P_2)$ where m is the mass, V is the velocity of gas A is area of cross section of the nozzle. P_1, P_2 are

pressures of the exhaust gas and surrounding atmosphere. Then this equation is

1. dimensionally correct 2.dimensionally wrong
3. some times correct and some times wrong 4. algebrically correct

TO ESTABLISH RELATION BETWEEN DIFFERENT PHYSICAL QUANTITIES

MODEL QUESTIONS

374. The velocity of a body is expressed as

V = $G^a M^b R^c$ where G is gravitational constant. M is mass, R is radius. The values of exponents a, b and c are :

1. $\frac{1}{2}, \frac{1}{2}, -\frac{1}{2}$ 2. 1, 1, 1 3. $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$ 4.1,1, $\frac{1}{2}$

375. The value of x in the formula $Y = \frac{2mgl^x}{5bt^3e}$ where m is the mass, 'g' is acceleration due to gravity, l is the length, 'b' is the breadth, 't' is the thickness and e is the extension and Y is Young's Modulus is

1. 3 2. 2 3. 1 4. 4

PRACTICE QUESTIONS

376. The frequency 'n' of transverse waves in a string of length l and mas per unit length m, under a tension T is given by n = $kl^a T^b m^c$ where k is dimensionless. Then the values of a, b, c, are

1. $\frac{1}{2}, \frac{1}{2}, -\frac{1}{2}$ 2. -1, $\frac{1}{2}, -\frac{1}{2}$ 3. $-\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$ 4. $-\frac{1}{2}, -\frac{1}{2}, -\frac{1}{2}$

377. If the couple per unit twist C is related to the rigidity modulus 'n', radius of the wire 'r' and length of the wire 'l' according to the equation C = $Kn^x r^y l^z$. Where k is dimensionless constant, the values of x, y and z respectively are:

1. 1,1,1 2. 2,4,1 3. 1, -4, 2 4. 1, 4, -1

378. If the centrifugal force on a body moving on the circumference of a circle is related to the mass M, velocity V and radius of the circular orbit r as $F \alpha\ M^a V^b r^c$, the values of a, b and c respectively are

1. 1, 1, 2 2.1, 2, 1 3. 1, 2, 2 4.1, 2, -1

379. If the time period 'T' of a drop under surface tension 's' is given by the formula T = $\sqrt{d^a r^b s^c}$ where d is the density, r is the radius of the drop. If a =1, c=-1 then the value of b is: **(1993 E)**

1. 1 2. 2 3. 3 4. -1

380. The viscous force F acting on a rain drop of radius 'a' falling through air of coefficient of viscosity 'η' with terminal velocity V is given by $F \alpha\ \eta^x a^y V^z$. Then the values of x, y and z are

1. -1, 2, 3 2.-1,-1,-1 3.1,2,3 4.1,1,1

381. If dimensions of length are expressed as where $G^x C^y h^z$ where G, C and h are universal gravitational constant and speed of light and Planck's constant respectively, then

a) $x = 1/2, y = 1/2$ b) $x = 1/2; z = 1/2$ c) $y = -3/2; z = 1/2$ d) $y = 1/2; z = 3/2$

1) a & c are correct 2) b & d are correct 3) a & b are correct 4) b & c are correct

382. If the time period (T) of vibration a liquid drop depends on surface tension (S). radius (r) of the drop and density (ρ) of the liquid, then the expressions of T is

1) $T = K\sqrt{\frac{\rho r^3}{S}}$ 2) $T = K\sqrt{\frac{\rho^{1/2} r^3}{S}}$ 3) $T = K\sqrt{\frac{\rho r^3}{S^{1/2}}}z$ 4) none

383. If the units of velocity of light 'C', Gravitational constant 'G' and Planck's Constant 'h' are taken as fundamental units, the dimensional formula for Mass in the new system will be :

1. [C G h] 2. $\left[C^{\frac{1}{2}}G^{\frac{1}{2}}h^{\frac{1}{2}}\right]$ 3. $\left[C^{\frac{1}{2}}G^{-\frac{1}{2}}h^{\frac{1}{2}}\right]$ 4. $[C^2G^2h^2]$

LEVEL-III

MODEL QUESTIONS

384. The measured mass and volume of a body are 53.63 gm and 5.8 cm^3 respectively, with possible errors of 0.01 gm and 0.1 c.c. the maximum percentage error in density is about
1) 0.2% 2) 2% 3) 5% 4) 10%

385. The following observations were taken for determining the surface tension of water by capillary rise method. Diameter of the capillary $D = 1.25 \times 10^{-2}$ m, rise of water in capillary tube $h = 1.45 \times 10^{-2}$ m, $g = 9.80\, ms^{-2}$ and using the relation $T = \left(\frac{rhg}{2}\right) \times 10^3\ N/m,$ the possible percentage error in surface tension T is
1) 0.15% 2) 1.5% 3) 15% 4) 2.4%

386. The resistance of metal is given by V=IR. The voltage in the resistance is $V = (8 \pm 0.5)$ V and current in the resistance is $I = (2 \pm 0.2)$ A, the value of resistance with its percentage error is
1) $(4 \pm 16.25\%)\Omega$ 2) $(4 \pm 2.5\%)\Omega$ 3) $(4 \pm 0.04\%)\Omega$ 4) $(4 \pm 1\%)\Omega$

387. In an experiment, the values of refractive indices of glass were found to be 1.54, 1.53, 1.44, 1.54, 1.56 and 1.45 in successive measurements
i) mean value of refractive index of glass ii) mean absolute error
iii) relative error and iv) percentage error are respectively,
1) 1.51, 0.04, 0.03, 3% 2) 1.51, 0.4, 0.03, 3%
3) 15.1, 0.04, 0.03, 3% 4) 15.1, 0.04, 0.3, 3%

388. In an experiment to determine the value of acceleration due to gravity 'g' using a simple pendulum, the measured value of length of the pendulum is 31.4 cm known to 1 mm accuracy and the time period for 100 oscillations of pendulum is 112.0s known to 0.01s accuracy. The accuracy in determining the value of 'g' is.
1) $(25.03 \pm 0.58)cms^{-2}$ 2) $(25 \pm 0.58)cms^{-2}$
3) $(25.3 \pm 0.1)cms^{-2}$ 4) $(25.5 \pm 0.3)cms^{-2}$

389. A rectangular metal slab of mass 33.333 g has its length 8.0 cm, breadth 5.0 cm and thickness 1mm. The mass is measured with accuracy up to 1 mg with a sensitive balance. The length and breadth are measured with vernier calipers having a least count of 0.01 cm. The thickness is measured with a screw gauge of least count 0.01 mm. The percentage accuracy in density calculated from the above measurements is
1) 13% 2) 130% 3) 1.3% 4) 16%

390. Two physical quantities are represented by P and Q. The dimensions of their product is $M^2L^4T^{-4}I^{-1}$ and the dimensions of their ratio is I^{-1}. Then P and Q respectively are
1. Magnetic flux and Torque acting on a Magnet.
2. Torque and Magnetic flux.
3. Magnetic Moment and Polestrength
4. Magnetic Moment and Magnetic permeability.

PHYSICAL WORLD AND MEASUREMENTS

391. A quantityX is given by X= $\in_0 L\frac{\Delta V}{\Delta t}$ where $\in_0$ is the permitttivity of free space, *L* is a length. ΔV is a potential difference and Δ t is a time interval. The dimensional formula for X is the same as that of

1) resistance 2) charge 3) voltage 4) current

392. A gas bubble from an explosion under water oscillates with a period 'T' proportional to $p^a d^b E^c$ where p is static pressure, d is density of water, E is the total energy of the explosion. The values of a, b and c respectively are:

1. $\frac{5}{6}, \frac{-1}{2}, \frac{-1}{3}$ 2. $\frac{-5}{6}, \frac{1}{2}, \frac{1}{3}$ 3. $\frac{5}{6}, \frac{1}{2}, \frac{1}{3}$ 4. $\frac{1}{2}, \frac{5}{6}, \frac{-1}{3}$

393. In the formula $x = 3yz^2$, x and z have dimensions of capacitence and magnetic induction field strength respectively. The dimensions of y in MKSQ system are

1. $M^{-3}L^{-2}T^4Q^4$ 2. $M^{-2}L^{-2}T^2Q^2$ 3. $M^{-3}L^{-2}T^4Q^4$ 4. $M^2L^2T^{-3}Q^{-1}$

394. The rate of flow of a liquid Q through a capillary tube depends upon the pressure gradient, *(P/l)*, radius of the capillary (r) and coefficient viscosity h and constant of proportionality is $\pi / 8$ .The equation for the rate of flow of the liquid Q is given by

1. $Q = \frac{\pi pr^2}{8\eta l}$ 2. $Q = \frac{\pi pr^4}{8\eta l}$ 3. $Q = \frac{\pi}{8}.pr^2.\eta^2.l$ 4. $\frac{8\eta l}{\pi pr^4}$

395. The frequency 'n' of a vibrating string depends upon its length 'l' linear density 'm' and tension 'T' in the string. The equation for the frequency of the string is (given the constnat of proportionality as 1/2)

1. $n = \frac{1}{2l}.\sqrt{\frac{T}{m}}$ 2. $n = \frac{1}{2l}.\sqrt{\frac{m}{T}}$ 3. $n = \frac{1}{2l}.\sqrt{T.m}$ 4. $n = \frac{l}{2}.\sqrt{\frac{T}{m}}$

396. If kinetic energy 'K', velocity 'v' and time 'T' are chosen as the fundamental units, the formula for surface tension S=

1. $\frac{v^2T^2}{AK}$ 2. $\frac{v^2}{AKT^2}$ 3. $\frac{AKT^2}{v^2}$ 4. $\frac{AK}{v^2T^2}$

397. If P represents radiation pressure 'C' represents speed of light and Q represents radiation energy striking a unit area per second then non-zero integers x, y and z such that $P^x.Q^y.C^z$ is dimensionless are :

1. x =1, y =1, z = -1 2. x=1, y=-1, z=1 3. x = -1, y =1, z =1 4. x=1, y=1, z=1

398. If the unit of power is 1 million erg per minute, the unit of force is 1000 dyne and that of time is $\frac{1}{10}$ s, the unit of mass in the new system is

1. 6 g 2. 60 g 3. 106 g 4. 1 g

399. The initial and final temperatures are recorded as $(40.6 \pm 0.3)^0 C$ and $(50.7 \pm 0.2)^0 C$. The rise in temperature is

1) 10.1^0 C 2) $(10.1 \pm 0.3)^0 C$ 3) $(10.1 \pm 0.5)^0 C$ 4) $(10.1 \pm 0.1)^0 C$

400. In the measurement of a physical quantity $X = \frac{A^2B}{C^{1/3}D^3}$. The percentage errors introduced in the measurements of the quantities A,B,C and D are 2%, 2%, 4% and 5% respectively. Then the minimum amount of percentage of error in the measurement of X is contributed by

1) A 2) B 3) C 4) D

PRACTICE QUESTIONS

401. Two resistances are expressed as $R_1(4 \pm 0.5\%)\Omega$ and $R_2(12 \pm 0.5\%)\Omega$. The net resistance when they are connected in series with percentage error is (In series $R = R_1 + R_2$)

1) $(16 \pm 1\%)\Omega$ 2) $(16 \pm 6.25\%)\Omega$ 3) $(16 \pm 22\%)\Omega$ 4) $(16 \pm 2.2\%)\Omega$

402. There are atomic (Calcium) clocks capable of measuring time with an accuracy of 1 part in 10^{11}. If two such clocks are operated to precision, then after running for 5000 years, these will record a difference of

1) 1 day 2) 1 sec 3) 10^{11} sec 4) 1year

403. If the length of a simple pendulum is recorded as (90.0 ± 0.02) cm and period as (1.9 ± 0.02) sec, the percentage of error in the measurement of acceleration due to gravity is

1) 4.2 2) 2.1 3) 1.5 4) 2.8

404. In the determination of the Young's modulus of a given wire, the force, length, radius and extension in the wire are measured as $(100 \pm 0.01)N,\ (1.25 \pm 0.002)m,$ $(0.001 \pm 0.00002)m,$ and $(0.01 \pm 0.00002)m,$ respectively. The percentage error in the measurement of Young's modulus is

1) 4.37 2) 2.37 3) 0.77 4) 2.77

405. In an experiment, the values of two resistances were measured as $R_1 = (5.0 \pm 0.2)\Omega$ and $R_2 = (10.0 \pm 0.1)\Omega$, their combined resistance in parallel is

1) $(4.4 \pm 6\%)$ 2) $(3.3 \pm 7\%)$ 3) $(5.5 \pm 5\%)$ 4) $(3.3 \pm 5\%)$

406. The radius (r) , length (/) and resistance (x) of a thin wire are $(0.2 \pm 0.02)cm, (80 \pm 0.1)cm,$ and $(30 \pm 1)\Omega$ respectively . The percentage error in the specific resistance is

1) 23.2% 2) 25.4% 3) 26% 4) 27.5 %

407. The formula for the capacity of a condenser is given by $C = \frac{A}{d}$ when A is the area of each plate and d is the distance between the plates. Then the dimensions of missing quantity is

1. $\epsilon_0 = M^{-1}L^{-3}T^4A^2$ 2. $\epsilon_0 = M^1L^3T^{-4}A^{-2}$ 3. $\epsilon_0 = M^{-1}L^3T^4A^{-2}$ 4. $\epsilon_0 = M^{-1}L^{-2}T^4A^2$

408. $\frac{8\,\pi\,\varepsilon_0\,kx}{Q^2}$ is a dimensionless quantity,

ε_0 -permittivity of free space. K - energy;
Q - charge. Then the dimensions of x are.

1. MLT^2 2. MLT^{-1} 3. M^0LT^0 4. $ML^{-1}T^{-1}$

409. If F is the force, μ is the permeability, H is the intensity of magnetic field and i is the electric current, then $\frac{F}{\mu Hi}$ has the dimensions of

1. mass 2. length 3. time 4. energy

410. A quantity x is defined by the equation $x = 3CB^2$. where C is capacitance in farad, B represents magnetic induction field strength in tesla. The dimensions of x are

1. ML^{-2} 2. $ML^{-2}T^{-2}$ 3. $M^1L^{-2}T^2I^2$ 4. $L^{-1}I^{-1}$

411. The electrical conductivity, σ is given by $\sigma = \frac{ne^2.T}{2m}$ where n is equal to number of free electrons per cubic meter. C is charge on electron T is relaxation time m and is mass of

electron. The dimensional formula for σ is

1. $M^{-1}L^{-3}T^{3}A^{2}$ 2. $M^{1}L^{-3}T^{3}A^{3}$ 3. $M^{-1}L^{-3}T^{3}A^{-2}$ 4. $M^{-1}L^{-2}T^{3}A^{-2}$

412. The number of particles crossing unit area perpendicular to X-axis in unit time is given by N = $-D\dfrac{(n_2-n_1)}{(x_2-x_1)}$ where n_1 and n_2 are number of particles per unit volume for the value of x meant to x_2 and x_1, D is the diffusion constant. The dimensions of D are

1. LT^{-1} 2. $L^{2}T^{-1}$ 3. LT 4. $L^{-1}T$

413. A small steel ball of radius r is allowed to fall under gravity through a column of viscous liquid of coefficient η. After some time the velocity of the ball attains a constant value known as terminal velocity, V_T. The terminal velocity depends on mass of the ball 'm', coefficient of viscosity 'η' , the radius of the ball 'r' and acceleration due to gravity g. The relationship between terminal velocity and other factors given is :

1. $V_T \alpha \dfrac{mg}{\eta r}$ 2. $V_T \alpha \dfrac{\eta r}{mg}$ 3. $V_T \alpha\ \eta rmg$ 4. $V_T \alpha \dfrac{mgr}{\eta}$

414. If the period of vibration of a tuning fork depends upon the density 'd' Young's modulus of the material 'y' and the length of the spring 'L' then time period T is proportional to (I.I.T)

1. $Ld^{2}y^{\frac{1}{2}}$ 2. $Ld^{\frac{1}{2}}.y^{-\frac{1}{2}}$ 3. $L.d^{\frac{3}{2}}.y^{\frac{3}{2}}$ 4. $L.d^{\frac{-3}{2}}.y^{\frac{-3}{2}}$

415. The unit of Mass is α kg. The unit of length is β metre and the unit of time is γ second. The magnitude of calorie in the new system is [1 calorie = 4.2 Joules]

1. $4.2\alpha^{2}\beta^{2}\gamma^{2}$ new units 2. 4.2 $\alpha^{-1}\beta^{-2}\gamma^{2}$ new units

3. $\alpha^{-1}\beta^{-2}\gamma^{2}$ new units 4. $\dfrac{1}{4.2}\alpha^{-1}\beta^{-2}\gamma^{2}$ new units

416. When a current of (2.5 ± 0.5) ampere flows through a wire, it develops a potential difference of (20 ± 1) volt, the resistance of the wire is

1) $(8\pm2)\Omega$ 2) $(10\pm3)\Omega$ 3) $(18\pm4)\Omega$ 4) $(20\pm6)\Omega$

417. Two objects A and B are of lengths 5 cm and 7 cm determined with errors 0.1 cm and 0.2 cm respectively. The error in determining (a) the total length and (b) the difference in their lengths are

1) $(12\pm0.3),(2\pm0.3)$ 2) $(7\pm0.3),(2\pm0.3)$

3) $(12\pm0.3),(12\pm0.3)$ 4) $(12\pm0.3),(2\pm0.6)$

418. In a new system of units, unit of mass is 10kg, unit of length is 1 km and unit of time is 1 minute. The value of 1 joule in this new hypothetical system is

1) 3.6×10^{-4} new units 2) 6×10^{7} new units

3) 10^{11} new units 4) 1.67×10^{4} new units

419. The period of a body under S.H.M. is represented by T $\propto P^{a}D^{b}S^{c}$, where P is the pressure, D is the density and S is surface tension then the values of a,b and c are

1) 1,3, 1/3 2) $\dfrac{-3}{2},\dfrac{1}{2},1$ 3) $-1,-2,3$ 4) $\dfrac{-1}{2},\dfrac{-3}{2},\dfrac{-1}{2}$

420. The moment of inertia of a body rotating about a given axis is 12.0 kg m^2 in the SI system. What is the value of the moment of inertia in a system of units in which the unit of length is 5 cm and the unit of mass is 10 g

1) 2.4 x 10^3 2) 6.0 x 10^3 3) 5.4 x 10^5 4) 4.8 x 10^5

421. The density of a material is 8 g/c.c. In a unit system in which the unit length is 5 cm and unit

mass is 20 g, what is the density of the material?

1) 0.02 2) 50 3)40 4)12.5

422. The velocity of water waves may depend on their weavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensional analysis gives the relation between these quantities as:

1) $V^2 = K\lambda^{-1}g^{-1}\rho^{-1}$ 2) $V^2 = K\lambda g$ 3) $V^2 = K\lambda\rho g$ 4) $V^2 = K\lambda^3 g^{-1}\rho^{-1}$

423. In a system of units in which the unit of mass is a kg, unit of length is b metre and the unit of time is c second, the magnitude of a calorie is

1) $\frac{4.2c}{ab^2}$ 2) $\frac{4.2c^2}{ab^2}$ 3) $\frac{abc}{4.2}$ 4) $\frac{4.2}{abc}$

424. The formula , $W = (F + 2Ma)\upsilon^n$, where W is the work, F is the force, M is the mass, a is the acceleration and υ is the velocity can be made dimensionally correct for

1) n =0 2) n = 1 3) n =-1 4) no value of n

425. A quantity is given by $X = \frac{\varepsilon_0 lV}{t}$ where, V is the potential difference and l is the length.

Then X has dimensions same as that of

1)resistance 2) charge 3) voltage 4) current

426. The frequency (n) of a turing fork depends upon the length (L) of its prongs, the density (d) and Young's modulus(Y) of its meterial. It is given as $n \alpha L^a d^b Y^c$. the values of a,b,and c are

1) 1, 1/2 , -1/2 2) -1 , - 1/2., 1/2 3) 1/2., -1, -1/2 4) 1/2, -1/2, 1

427. If the unit of force, energy and velocity are 10N, 100J and 5 m/s , the unit of mass

1) 1 kg 2) 2 kg 3) 3 kg 4) 4 kg

428. The value of 60 joule/ min on a system which has 100g, 100 cm and 1min as fundamental unit is

1) 2.16×10^6 2) 2.16×10^4 3) 2.16×10^3 4) 2.16×10^5

429. The velocity of sound in air is 332m/s. If the unit of length is km and unit of time is hour, then the value of velocity is

1) 1146 km/h 2) 1195 km/h 3) 1086 km/h 4) 1218 m/h

430. A highly rigid cubical block A of small mass M and side L is fixed rigidly on to another cubical block of same dimensions and of low modulus of rigidity η such that the lower face of A com pletely covers the upper face B.The lower face of B is rigidly held on a horizontal surface.Asmall force F is applied perpendicular to one of the side face of A.After the force is with drawn, block A executes small oscilla tions, the time period of which is given by

1) $2\pi\sqrt{M\eta L}$ 2) $2\pi\sqrt{\frac{M\eta}{L}}$ 3) $2\pi\sqrt{\frac{ML}{\eta}}$ 4) $2\pi\sqrt{\frac{M}{L\eta}}$

431. Conversion of 1 MW power in a system of units having basic uints of mass, length and time as 10kg,1 deci metre and 1minute respectively is

1) 2.16×10^{10} uint 2) 2×10^4 unit 3) 2.16×10^{12} units 4) 1.26×10^{12} unit

432. A body of mass m, accelerates uniformly from rest to V_1 in time t_1. The instantaneous power **(AIEEE 2004)**

1) $\frac{mV_1t}{t_1}$ 2) $\frac{mV_1^2t}{t_1^2}$ 3) $\frac{mV_1t^2}{t_1}$ 4) $\frac{mV_1^2t}{t_1^2}$

433. In the relation $P = \frac{\alpha}{\beta}e^{-\alpha z/K\theta}$; P is pressure, K is Boltzmann's constant, Z is distance and

θ is temperature. The dimensional formula of β will be **(AIEEE 2004)**

1) $\left[M^0 L^2 T^0\right]$ 2) $\left[M^1 L^2 T^1\right]$ 3) $\left[ML^0 T^{-1}\right]$ 4) $\left[M^0 L^2 T^{-1}\right]$

LEVEL-IV

434. In a system of units, the Planck's constant (h), the gravitational constant (G) and the speed of light(c) are taken as the fundamental units. The dimensional formula of force in this system of units?

1) $h^0G^{-1}c^4$ 2) $h^{-1}G^0c^4$ 3) $h^{-1}G^4c^0$ 4) $h^4G^2c^{-2}$

435. Let us assume that the acceleration due to gravity be 10 m/s^2. If acceleration due to gravity (g), the velocity (v) acquired by a body after falling from rest for 5 seconds and the momentum (p) acquired by a mass of 1 kg in falling freely from rest for 10 seconds are taken as the fundamental units, then the value of the unit of time in terms of second?

1) 1 s 2) 2 s 3) 5 s 4) 10 s

436. Let us assume that the acceleration due to gravity be 10 m/s^2. If acceleration due to gravity (g), the velocity (v) acequired by a body after falling from rest for 5 seconds and the momentum (p) acquired by a mass of 1 kg in falling freely from rest for 10 seconds are taken as the fundamental units, then the value of the unit of mass in terms of kg?

1) 1 kg 2) 2 kg 3) 5 kg 4)10 kg

437. The velocity of a spherical ball through a viscous liquid is given by v= $v_0(1-e^{kt})$, where v_0 is the initial velocity and *t* represents time. If k depends on radius of ball (r), coefficient of viscosity (η) and mass of the ball (m), then

1) k = mr/η 2) k = η m/r 3) k = r η/m 4) k = mrη

438. Two full turns of the circular scale of a screw gauge cover a distance of 1 mm on its main scale. The total number of divisions on the circular scale is 50. Further, its is found that the screw gauge has a zero error of -0.03 mm. While measuring the diameter of a thin wire, a student notes the main scale reading of 3 mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is **(AIEEE 2008)**

1) 3.67 mm 2) 3.38 mm 3) 3.32 mm 4) 3.73 mm

LEVEL-V

MORE THAN ONE ANSWER TYPE QUESTIONS

439. In two systems of units, the relation between velocity, acceleration and force is given by

$v_2 = \dfrac{v_1\varepsilon^2}{\tau}$, $a^2 = a_1\varepsilon t, F_2 = \dfrac{F_1}{\varepsilon t}$ where ε and τ are constants then in this new system

1) $m_2 = \dfrac{m_1}{\varepsilon^2\tau^2}$ 2) $m_2 = \varepsilon^2\tau^2 m_1$ 3) $L_2 = \dfrac{L_1\varepsilon^3}{\tau^3}$ 4) $L_2 = \dfrac{L_1\tau^3}{\varepsilon^3}$

440. Two objects have life times given by t_1 and t_2. If t is the life time of an object lying midway between these two times on the logarithmic scale then

1) $\log_{10}(t) = \dfrac{1}{2}\left[\log_{10}(t_1) + \log_{10}(t_2)\right]$ 2) $t = \dfrac{t_1 + t_2}{2}$

3) $t = \sqrt{t_1 t_2}$ 4) $\dfrac{1}{t} = \dfrac{\dfrac{1}{t_1} + \dfrac{1}{t_2}}{2}$

441. The quantity $\frac{1}{2}\varepsilon_0 E^2$ has dimensional formula same as

1) $\frac{1}{2}CV^2$ 2) $\frac{1}{2}LI^2$ 3) $\frac{1}{2}\frac{B^2}{\mu_0}$ 4) Pressure

MATRIX MATCHING TYPE QUESTION

442. Match the following

Column-I	Column-II
A. Pressure	E. $ML^{-1}T^{-2}$
B. Stress	F. Nm^{-2}
C. Energy per unit volume	G. $M^0L^0T^0$
D. Strain	H. Jm^{-3}

Read the passage and answer the following questions

In a new system unit of mass is 10kg unit of length is 5m and unit of time is 10s.

443. 10 Pa =

1) 500 new units 2) 1000 new units 3) 1500 new units 4) 2000 new units

444. 5N =

1) 5 new units 2) 10 new units 3) 15 new units 4) 20 new units

445. 20 g/cc =

1) 2.5×10^2 new units 2) 2.5×10^3 new units

3) 2.5×10^4 new units 4) 2.5×10^5 new units

PHYSICAL WORLD AND MEASUREMENTS

KEY

1) 2	2) 3	3) 4	4) 4	5) 2	6) 4	7) 1	8) 4	9) 1	10) 2
11) 4	12) 3	13) 1	14) 2	15) 2	16) 4	17) 1	18) 1	19) 2	20) 2
21) 2	22) 2	23) 3	24) 3	25) 3	26) 4	27) 4	28) 4	29) 4	30) 2
31) 1	32) 3	33) 3	34) 2	35) 1	36) 2	37) 1	38) 1	39) 2	40) 3
41) 3	42) 4	43) 2	44) 2	45) 4	46) 4	47) 3	48) 4	49) 2	50) 2
51) 2	52) 4	53) 4	54) 2	55) 1	56) 4	57) 4	58) 4	59) 3	60) 4
61) 2	62) 4	63) 2	64) 3	65) 4	66) 3	67) 3	68) 4	69) 4	70) 4
71) 2	72) 2	73) 3	74) 4	75) 2	76) 3	77) 4	78) 1	79) 1	80) 3
81) 3	82) 2	83) 2	84) 1	85) 2	86) 2	87) 1	88) 4	89) 3	90) 4
91) 2	92) 1	93) 1	94) 2	95) 1	96) 4	97) 4	98) 1	99) 2	100) 2
101) 3	102) 2	103) 1	104) 2	105) 2	106) 1	107) 2	108) 3	109) 1	110)3
111) 3	112) 2	113) 2	114) 4	115) 3	116) 1	117) 1	118) 3	119) 4	120) 1
121) 4	122) 4	123) 1	124) 2	125) 2	126) 3	127) 3	128) 1	129) 1	130) 3
131) 4	132) 4	133) 1	134) 1	135) 1	136) 4	137) 2	138) 2	139) 4	140) 2
141) 2	142) 4	143) 3	144) 4	145) 1	146) 2	147) 3	148) 3	149) 2	150) 1
151) 3	152) 1	153) 1	154) 1	155) 1	156) 3	157) 1	158) 4	159) 2	160) 2
161) 1	162) 1	163) 3	164) 2	165) 3	166) 2	167) 3	168) 3	169) 3	170) 1
171)2	172) 4	173) 4	174) 4	175) 2	176) 2	177) 3	178) 4	179) 2	180) 2
181) 4	182) 3	183) 2	184) 1	185) 1	186) 1	187) 2	188) 1	189) 2	190) 1
191) 4	192) 3	193) 4	194) 2	195) 3	196) 4	197) 3	198) 1	199) 4	200) 2
201) 3	202) 4	203) 2	204) 4	205) 1	206) 2	207) 4	208) 2	209) 1	210)1
211) 3	212) 3	213) 2	214) 1	215) 4	216) 3	217) 2	218) 1	219) 1	220) 1
221) 1	222) 3	223) 3	224) 1	225) 3	226) 3	227) 3	228) 3	229) 4	230) 2
231) 3	232) 1	233) 2	234) 1	235) 3	236) 4	237) 1	238) 3	239) 1	240) 3
241) 1	242) 1	243) 3	244) 4	245) 2	246) 4	247) 1	248) 1	249) 3	250) 1
251) 4	252) 1	253) 1	254) 4	255) 1	256) 4	257) 3	258) 2	259) 3	260) 1
261) 1	262) 2	263) 2	264) 2	265) 3	266) 2	267) 3	268) 3	269) 1	270) 4
271) 4	272) 2	273) 2	274) 4	275) 4	276) 2	277) 4	278) 4	279) 1	280) 3
281) 4	282) 3	283) 1	284) 3	285) 1	286) 3	287) 1	288) 4	289) 2	290) 2
291) 4	292) 3	293) 1	294) 1	295) 3	296) 3	297)1	298) 2	299) 4	300) 1
301) 1	302) 1	303) 3	304) 1	305) 2	306) 2	307) 3	308)3	309) 2	310) 1
311) 3	312) 1	313) 1	314) 2	315) 2	316) 1	317) 2	318) 1	319) 3	320) 3
321) 2	322) 1	323) 2	324) 2	325) 1	326) 3	327) 3	328) 2	329) 3	330) 1
331) 3	332) 2	333) 2	334) 2	335) 2	336) 4	337) 4	338) 2	339) 2	340) 4
341) 4	342) 1	343) 3	344) 3	345) 2	346) 1	347) 2	348) 4	349) 2	350) 3
351) 2	352) 2	353) 4	354) 1	355) 4	356) 1	357)2	358) 1	359) 3	360) 2
361) 1	362) 2	363) 3	364) 4	365) 2	366) 1	367) 2	368) 1	369) 1	370) 3
371) 1	372) 4	373) 2	374) 1	375) 1	376) 2	377) 4	378) 4	379) 3	380) 4
381) 4	382) 1	383) 3	384) 2	385) 2	386) 1	387) 1	388) 1	389) 3	390) 1
391) 4	392) 2	393) 1	394) 2	395) 1	396) 4	397) 2	398) 1	399) 3	400) 3
401) 2	402) 2	403) 2	404) 1	405) 2	406) 1	407) 1	408) 3	409) 2	410) 1
411) 1	412) 2	413) 1	414) 2	415) 2	416) 1	417) 1	418) 1	419) 2	420) 2
421) 2	422) 2	423) 2	424) 4	425) 4	426) 2	427) 4	428) 1	429) 2	430) 4
431) 3	432) 2	433) 1	434) 1	435) 3	436) 2	437) 3	438) 2	439) 1, 3	
440) 1, 3		441) 3, 4		442) A - E,F,H :B - E,F,H : C - E, F, H, D - G					
443) 1	444) 2	445) 4							

KINEMATICS

CONCEPTUAL QUESTIONS

1. Correct statement among the following is

   1) When displacement is zero, distance travelled is not zero.

   2) When displacement is zero, distance travelled is also zero.

   3) When distance is zero, displacement is not zero.

   4) Distance travelled and displacement are always equal.

2. The numerical ratio of displacement to distance is

   1) Always less than 1. 2) Always greater than 1.

   3) Always equal to 1. 4) May be less than 1 or equal to one.

3. Study the following

List - I	**List - II**
a)A body covers first half of distance with a speed V_1 and second half of distance with a speed V_2.	e)Average velocity is $\sqrt{\frac{gh}{2}}$
b)A body covers first half of a time with a speed V_1 and second half of a time with a speed V_2.	f) Average speed is $\frac{V_1 + V_2}{2}$
c)A body is projected vertically up from ground with certain velocity .	g) Average speed is $\frac{2V_1V_2}{V_1 + V_2}$ Considering its total motion.
d)A body freely released from a height h	h) Average velocity is zero

The correct match is

1) $a \to f; b \to g; c \to e; d \to h$ 2) $a \to g; b \to f; c \to h; d \to e$

3) $a \to h; b \to g; c \to h; d \to e$ 4) $a \to e; b \to f; c \to h; d \to g$

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

4. **A:** If the distance travelled by body is directly proportional to the square of time taken, then its speed is increasing with time.

R: The speed is equal to the time rate of change of distance.

1) A 2) B 3) C 4) D

5. **A :** Average velocity of the body may be equal to its instantaneous velocity.

R : The body having uniform motion in one dimension.

1) A 2) B 3) C 4) D

6. If a particle moves in a circle describing equal angles in equal intervals of time, the velocity vector

1) remains constant. 2) changes in magnitude.

3) changes in direction. 4) changes both in magnitude and direction.

7. **A :** The relative velocity between the bodies is equal to sum of the velocities of two bodies.

R:Some times, relative velocity between two bodies is equal to difference in velocities of the two

1) A 2) B 3) C 4) D

8. Among the following, the one which moves with non-uniform velocity is

1) Light in a homogeneous medium.

2) Sound in a homogeneous medium.

3) A freely falling body. 4) All the above.

9. The distance covered by a moving body is directly proportional to the square of the time. The acceleration of the body is

1) increasing 2) decreasing 3) zero 4) constant

10. Choose the correct statement :

1) The area of displacement - time graph gives velocity.

2) The slope of velocity - time graph gives acceleration.

3) The slope of displacement - time graph gives acceleration.

4) The area of velocity - time graph gives average velocity.

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

11. **A:** A body can have acceleration even if its velocity is zero at a given instant of time.

R :A body is momentarily at rest when it reverse its direction of motion.

1) A　2) B　3) C　4) D

12. **A:**In retarded motion the displacement and acceleration are in opposite directions.

R: Acceleration is rate of change of velocity

1) A　2) B　3) C　4) D

13. **A:**When range of a projectile is maximum, its angle of projection may be 45^0 or 135^0.

R:Horizontal range = $\frac{u^2 \sin 2\theta}{g}$. When $\theta = 45^0$ or 135^0 the range is same.

1) A　2) B　3) C　4) D

14. **A:** When a body is projected at an angle 45^0, its maximum height is half than that of horizontal range.

R:Horizontal range = $\frac{u^2 \sin 2\theta}{g}$ and maximum height = $\frac{u^2 \sin^2 \theta}{2g}$

1) A　2) B　3) C　4) D

15. A particle constrained to move on a straight line path. It returns to the starting point after 10 s. The total distance covered by the particle during this time is 30m. Which of the following statements about the motion of the particle is false ?

a) displacement of the particle is zero

b) average speed of the particle is $3ms^{-1}$

c) displacement of the particle is 15m

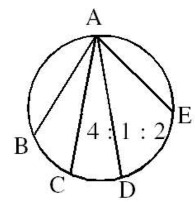
d) Average velocity is $3ms^{-1}$

1) a　2) b　3) c　4) d

16. Velocity-time graph of a body thrown vertically up is

1) a straight line　2) a parabola　3) a hyperbola　4) circle

17. A disc arranged in a vertical plane has several grooves directed along chords drawn from a point 'A' as shown in the figure. Several bodies begin to slide down the respective grooves from 'A' simultaneously. The ratio of their times of slide will be in the ratio (neglect friction and air resistance)



1) AB : AC : AD : AE　　2) 1 : 1 : 1 : 1

3) AE : AD : AC : AB　　4) 1:2:3:4

18. A ball dropped from one metre above the top of a window crosses the window in 't_1' second. If the same ball is dropped from 2m above the top of the same window, time taken by it to cross the window is 't_2's. Then

1) $t_2 = t_1$　　2) $t_2 = 2t_1$　　3) $t_2 > t_1$　　4) $t_2 < t_1$

19. To reach the same height on the moon as on the earth, a body must be projected up with

1) Higher velocity on the moon.

2) Lower velocity on the moon.

3) Same velocity on the moon and earth.

4) It depends on the mass of the body.

20. A body is projected up with velocity 'u'. It reaches a point in its path at t_1 and t_2 from the time of projection. Then t_1+t_2 is

1) $\frac{2u}{g}$　　2) $\frac{u}{g}$　　3) $\sqrt{\frac{2u}{g}}$　　4) $\sqrt{\frac{u}{g}}$

21. At the maximum height of a body thrown vertically up

1) Velocity is not zero but acceleration is zero.

2) Acceleration is not zero but velocity is zero.

3) Both acceleration and velocity is zero.

4) Both acceleration and velocity are not zero.

22. A ball is dropped freely while another is thrown vertically downward with an initial velocity 'v' from the same point simultaneously. After 't' second they are separated by a distance of

1) $\frac{vt}{2}$　　2) $\frac{1}{2}gt^2$　　3) vt　　4) $vt + \frac{1}{2}gt^2$

23. The average velocity of a freely falling body is numerically equal to half of the acceleration due to gravity. The velocity of the body as it reaches the ground is

1) g　　2) $\frac{g}{2}$　　3) $\frac{g}{\sqrt{2}}$　　4) $\sqrt{2}g$

24. Two bodies of different masses are dropped simultaneously from the top of a tower. If air resistance is proportional to the mass of the body, then,

1) the heavier body reaches the ground earlier.

2) the lighter body reaches the ground earlier.

3) both the bodies reach the ground simultaneously.

4) cannot be decided.

25. In the case of a body falling freely from small height

1) the changes of position are equal in equal intervals of time.

2) the changes of velocity are equal in unequal intervals of time.

3) the changes of acceleration is zero in unequal intervals of time.

4) All the above are true.

26. Velocity - displacement graph of a freely falling body is

1) Straight line passing through the origin

2) Straight line interesting 'x' and 'y' axes

3) Parabola 4) Hyperbola

27. Displacement - time graph of a body projected vertically up is

1) a straight line 2) a parabola 3) a hyperbola 4) a circle

28. Two balls of different masses are thrown vertically upwards with the same speed. They pass through the point of projection in their downward motion, with the

1) heavier ball having more speed 2) lighter ball having more speed

3) both having same speed 4) both having different speeds

29. A man standing in a lift falling under gravity releases a ball from his hand. As seen by him, the ball

1) falls down 2) remains stationary 3) goes up 4) executes SHM

30. If the acceleration due to gravity is gms^{-2}, a sphere of lead of density $\delta kg/m^3$ is gently released in a column of liquid of density 'd' kg/m^3 (δ>d), the sphere will fall vertically with

1) an accleration of $8m/s^2$ 2) no acceleration

3) an accleration of $g\left(1-\frac{d}{\delta}\right)m/s^2$ 4) an acceleration $g\ \delta/d\ m/s^2$

31 Consider the following statements A and B and identify the correct answer

A) A body falling freely under the action of gravity does not have one dimensional motion.

B) A body moving uniformly in one frame may be accelerating in some other frame of reference.

1) both A & B are true 2) A is true but B is false

3) B is true but A is false 4) both A & B are false

KINEMATICS

32. Consider the following statements A and B and identify the correct answer.

A) The speed acquired by a body when falling in a vacuum for a given time is dependent on the mass of the falling body.

B) A stone falls freely from rest and the total distance covered by it in the last second of its motion equals the distance covered by it in the first three seconds of its motion. The stone remains in the air for 5s. [$g=10ms^{-2}$]

1) both A & B are true   2) A is true but B is false

3) B is true but A is false   4) both A & B are false

33. Consider the following statements A and B and identify the correct answer.

A) Two balls of different masses are thrown vertically upwards with the same initial velocity. They rise to the same maximum height above the ground.

B) Two balls of different masses are thrown vertically upwards with the same speed. They pass through the point of projection in their downward motion with the same speed. (neglect air resistance)

1) both A & B are true 2) A is true but B is false

3) B is true but A is false 4) both A & B are false

34. A man standing at the top of a tower has two spheres A and B. He drops sphere A downwards and throws sphere B horizontally at the same time. Which of the following is correct ?

a) both the spheres will reach the ground simultaneously

b) A will reach the ground first

c) B will reach the ground first

1) a is correct   2) b is correct   3) c is correct   4) none

35. A body is projected up with a speed 'u' and the time taken by it is 'T' to reach the maximum height 'H'. Pick out the correct statement.

a) It reaches H/2 in T/2 s.

b) It acquires velocity u/2 in T/2 s.

c) Its velocity is u/2 at H/2

d) same velocity at 2T

1) a is correct   2) b is correct   3) c is correct   4) d is correct

36. Study the following.

List - I	**List - II**
a) Constant speed and varying velocity	I) At height point of body projected vertically up
b) Zero displacement and finite distance	II)Uniform circular motion
c)Zero velocity and finite acceleration	III) At any intermediate point of freely

	falling body.
d)Non-zero velocity and non-zero	IV)Body on reaching point of projection acceleration.

The correct match is

	a	b	c	d		a	b	c	d
1)	IV	II	III	I	2)	II	IV	I	III
3)	III	I	IV	II	4)	I	III	II	IV

37. Angle between velocity and acceleration vectors in the following cases.

List - I	**List - II**
a) Vertically projected body	e) 90^0
b) For freely dropped body	f) changes from point to point
c) For projectile	g) zero
d) In uniform circular motion	h) 180^0

The correct match is

1) $a \to h; b \to g; c \to f; d \to e$
2) $a \to f; b \to g; c \to h; d \to e$
3) $a \to e; b \to f; c \to h; d \to g$
4) $a \to g; b \to h; c \to e; d \to f$

38. Study the following

List - I	**List - II**
a) Horizontal motion of a projectile	e) zero velocity
b) Freely falling body	f)retarded motion from a small height
c) Parachutist	g) uniform descending down
acceleration	from an aeroplane
d)Maximum height of	h) uniform velocity a body thrown vertically up

The correct match is

1) $a \to g; b \to f; c \to h; d \to e$
2) $a \to h; b \to g; c \to f; d \to e$

3) $a \to e; b \to h; c \to f; d \to g$ 4) $a \to f; b \to e; c \to g; d \to h$

39. Three bodies are projected in three ways with same speed from top of a tower. Set the times of reaching ground by them in increasing order

a) vertically up b) vertically down

c) horizontally

1) b, a, c 2) c, a, b 3) b, c, a 4) a, b, c

40. From the top of a tower two bodies are projected with the same initial speed of $40ms^{-1}$, first body vertically upwards and second body vertically downwards. A third body is freely released from the top of the tower. If their respective times of flights are T_1, T_2 and T_3, identify the correct descending order of the times of flights.

1) T_1, T_2, T_3 2) T_2, T_3, T_1 3) T_2, T_1, T_3 4) T_1, T_3, T_2

41. **A:** A ball is projected with $60ms^{-1}$ at 60^0 with the horizontal simultaneously a toy car starts moving with $30ms^{-1}$ from the same point and in the same horizontal direction as the ball moves. The ball always lies above the toy car.

R : Bodies moving with same uniform velocity cover equal displacements in equal intervals of time.

1) A 2) B 3) C 4) D

42. Consider the following statements A and B and identify the correct answer

A) The speed of the oblique projectile is minimum at the top of the path.

B) In case of a projectile motion, if the range 'R' is 'n' times the maximum height 'H' then the angle of projection 'θ' is equal to $\tan^{-1}(4/n)$

1) both A & B are true 2) A is true but B is false

3) B is true but A is false 4) both A & B are false

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

43. **A:**In case of projectile the angle between velocity and acceleration changes from point to point.

R:Because its horizontal component of velocity remains constant while vertical component of velocity changes from point to point due to acceleration due to gravity.

1) A 2) B 3) C 4) D

44. **A:**In projectile motion, the angle between the instantaneous velocity and acceleration at the height point is 180^0.

R:At the highest point, velocity of projectile will be in horizontal direction only.

1) A 2) B 3) C 4) D

45. **A:**The path followed by one projectile as observed by another projectile is a straight line.

R:The relative velocity between two projectiles at a given place does not change with time.

1) A 2) B 3) C 4) D

46. **A:** The horizontal displacement of a projectile varies linearly with time.

R : Projectile motion is uniform motion along horizontal and accelerated motion along vertical.

1) A 2) B 3) C 4) D

47. **A:** If a body is projected obliquely at angle 'θ' above horizontal with initial speed 'u' then its speed at the instant when its velocity makes an angle 'α' above the horizontal is $\left(\frac{u\cos\theta}{\cos\alpha}\right)$

R: Horizontal component of velocity of projectile remains constant.

1) A 2) B 3) C 4) D

48. A passenger in a train drops a ball from the window of a train running at an acceleration 'a'. A pedestrian, on the ground by the side of the rails, observes the ball falling along

1) the vertical with an acceleration $\sqrt{g^2+a^2}$

2) the vertical with an acceleration $\sqrt{g^2-a^2}$

3) a parabola with an acceleration $\sqrt{g^2+a^2}$

4) a parabola with an acceleration 'g'

49. The path of one projectile as seen from another projectile is a

1) straight line 2) parabola 3) hyperbola 4) circle

50. A particle moves in a plane with a constant acceleration in a direction different from the initial velocity. The path of the particle is

1) Straight line 2) Arc of circle

3) Parabola 4) Ellipse

51. For a projectile, the physical quantity that remains constant is

1) Vertical component of velocity and kinetic energy.

2) Potential energy and kinetic energy.

3) Horizontal component of velocity and acceleration.

4) Potential energy and accleration.

52. Match List I with List II for a projectile

List - I	List - II
a) For two angles θ and (90–θ) with same magnitude of velocity	e) $\frac{P\vec{i}.P\vec{i}}{g}$

of projection

b) Equation of parabola of a projectile $y = Px - Qx^2$

f) Maximum height = 25% of $\frac{P^2}{Q}$

c) Radius of curvature of path of a body projected with velocity $(P\vec{i} + Q\vec{j})$ ms^{-1} at highest point

g) Range = Maximum height

d) Angle of projection $\theta = \tan^{-1}(4)$

h) Range is same

The correct match is

1) $a \to f; b \to h; c \to g; d \to e$ 2) $a \to h; b \to f; c \to e; d \to g$

3) $a \to e; b \to g; c \to f; d \to h$ 4) $a \to e; b \to g; c \to h; d \to f$

53. Velocity of a projectile in its flight

1) remains constant

2) first decreases, becomes zero and then increases.

3) first decreases reaches minimum and then increases.

4) First increases reaches maximum and then decreases.

54. When atmospheric resistance is taken into account for the projectile, the time of flight compared to that without atmospheric resistance

1) increase 2) decrease 3) remains the same 4) data insufficient

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

55. **A:** Only vertical component of velocity of a projectile is known, time of flight can be calculated but horizontal range cannot be calculated.

R: Time of flight depends on horizontal component and range depends on vertical component of velocity projection.

1) A 2) B 3) C 4) D

56. At the maximum height of a projectile, the velocity and acceleration are

1) parallel to each other 2) antiparallel to each other

3) perpendicular to each other 4) inclined to each other at 45^0

57. Consider the following statements A and B and identify the correct answer

A) The maximum range 4 times the maximum height attained during its flight in the case of a projectile.

B) In the case of a projectile the range 'R' is related to the time of flight 'T' as $R = 5T^2$. If $g = 10ms^{-2}$, the angle of projection is 45^0

1) both A & B are true 2) A is true but B is false

3) B is true but A is false 4) both A & B are false

58. Set the ranges for following projectiles in increasing order for same velocity of projection.

a) $\theta = 15^0$ b) $\theta = 45^0$ c) $\theta = 55^0$ d) $\theta = 85^0$

1) d, a, c, b 2) a, b, c, d 3) d, c, b, a 4) b, c, a, d

59. A body is projected from a point with different angles of projections 20^0, 35^0, 45^0, 60^0 with the R_1, R_2, R_3 and R_4. Identify the correct order in which the horizontal ranges are arranged in increasing order

1) R_1, R_4, R_2, R_3 2) R_2, R_1, R_4, R_3 3) R_1, R_2, R_4, R_3 4) R_4, R_1, R_2, R_3

60. A projectile has

1) minimum velocity at the point of projection and maximum at the maximum height.

2) maximum at the point of projection and minimum at the maximum height.

3) same velocity at any point in its path.

4) zero velocity at the maximum height irrespective of the velocity of projection.

61. For a body thrown horizontally from the top a tower

1) The time of flight depends both on 'h' and 'u'.

2) The horizontal distance depends only on 'u', but not on 'h'.

3) The time of flight and horizontal distance depend on 'h' but not 'u'.

4) The horizontal distance depends on 'u' and 'h'.

62. From the top of a building a ball 'A' is dropped while another ball 'B' is thrown horizontally at the same time. Then

1) the ball 'A' hits the ground first 2) the ball 'B' hits the ground first

3) both A&B hit the ground at the same time

4) any ball may hit the ground first

63. A hunter aims his gun and fires a bullet directly at a monkey on a tree. At the instant the bullet leaves the gun, the monkey drops. The bullet

1) cannot hit the monkey.

2) may hit the monkey if its weight is more than 30 kg. wt.

3)may hit the monkey if its weight is less than 30 kg. wt.

4) hits the monkey irrespective of its weight.

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

64. **A:**For a body projected horizontally from the top of a tower, the velocity on reaching the ground depends both on velocity of projection and height of the tower.

R:For a projectile velocity varies both in horizontal and vertical directions.

1) A 2) B 3) C 4) D

65. **A:**If a bomb is dropped from an aeroplane moving horizontally with constant velocity then the bomb appears to move along a vertical straight line for the pilot of the plane.

R:Horizontal component of velocity of the bomb remains constant and same as the velocity of the plane during the motion under gravity.

1) A 2) B 3) C 4) D

66. **A:**Time taken by the bomb to reach the ground from a moving aeroplane depends on height of aeroplane only.

R:Horizontal component of velocity of the bomb remains constant and vertical component of vertical of bomb changes due to gravity.

1) A 2) B 3) C 4) D

67. The area under the velocity-time graph between any two instant $t = t_1$ and $t = t_2$ gives the distance convered in time $\delta t = t_2 - t_1$

1) only if the particle moves with a uniform velocity

2) only if the particle moves with a uniform acceleration

3) only if the particle moves with an acceleration increasing at a uniform rate

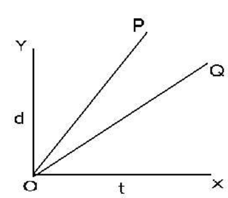
4) in all cases irrespective of whether the motion is one of uniform velocity, or of uniform acceleration or of variable acceleration

68. A particle starts with velocity u and moves with constant acceleration a. What is the nature of graph between the time (t) and displacement (x)?

1) Straight line 2) Symmetric parabola

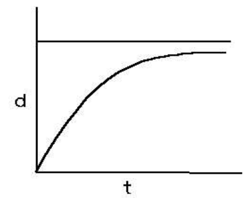
3) Asymmetric parabola 4) Rectangular hyperbola

69. The displacement - time graphs of two bodies A and B are OP and OQ respectively. If $\angle$POX is 60^0 and $\angle$QOX is 45^0, the ratio of the velocity of A to that of B is



1) $\sqrt{3}:\sqrt{2}$ 2) $\sqrt{3}:\sqrt{1}$ 3) $1:\sqrt{3}$ 4) 3:1

70. The distance of a particle as a function of time is shown below. The graph indicates that



1) The particle starts with certain velocity, but the motion is retarded and finally the particle stops

2) The velocity of the particle is constant throughout

3) The acceleration of the particle is constant throughout

4) The particle starts with a constant velocity the motion is in acceleration and finally the particle moves with another constant velocity.

71. The slope of velocity - time curve at any instant of time gives

1) displacement 2) velocity 3) acceleration 4) all the above

72. If the distance travelled by a particle and corresponding time be laid off along y and x axes respectively, then the correct statement of the following is

1) the curve may lie in fourth quadrant 2) the curve may lie in second quadrant

3) the curve exhibits peaks corresponding to maxima

4) the curve may droop as time passes

73. In relation to a velocity - time graph

1) the curve can be a circle

2) the area under the curve and above the time axis between any two instants gives the average acceleration

3) the slope at any instant gives the rate of change of acceleration at that instant

4) the area under the curve and above the time axis gives the displacement

74. The displacement - time graph of a particle moving with respect to a fixed point is a straight line

1) the object is stationary with zero velocity

2) the acceleration of the object is zero

3) both the above 4) none of the above

75. For a uniform motion

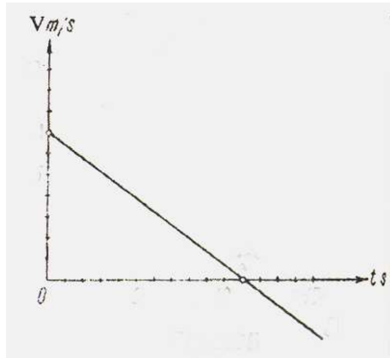
1) the velocity - time graph is a straight line parallel to time axis

2) the postion - time graph is a parabola

3) the acceleration - time graph is a straight line inclined with time axis

4) none of the above

76. Velocity - time graph for the motion of a certain body is given below. Then the body is



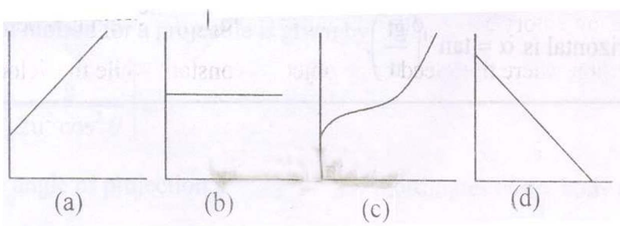
1) moving with constant velocity.

2) uniformly accelerated and retarded in the same direction.

3) moving with uniform acceleration.

4) uniformly retarded and then accelerated in opposite direction.

77. The figure below shows four graphs of displacement versus time, the graph that shows a constant, positive, non-zero velocity is



1) a 2) b 3) c 4) d.

Directions:

A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B) If both Assertion and Reason are true, but Reason is not correct explanation of the Assertion.

C) If Assertion is true, but the Reason is false.

D) If Assertion is false, but the Reason is true.

78. **A :** The displacement time graph of a body moving with uniform velocity is a straight line.

R : The displacement is proportional to time.

1) A 2) B 3) C 4) D

79. If a body is projected with an angle θ to the hirizontal , then **(2008 E)**

1. its velocity is always prependicular to its acceleration.

2. its velocity becoms zero at its maximum height

3. its velocity makes zero angle with the horizontal at its maximum height

4. the body just before hitting the ground , the direction of velocity coincides with the accleration

80. A body, freely falling under gravity will have uniform

1) speed 2) velocity 3) momentum 4) acceleration

4)Depends upon mass and volume of ball.

81. Distances covered by a freely falling body (starting from rest) during 1st, 2nd, 3rd .... nth of its motion are proportional to

1) even numbers 2) odd numbers

3) all integral numbers 4) square of integral numbers

82. A lead sphere of mass 20 kg has the same diameter as an aluminium sphere of mass 72 kg. The spheres are simultaneously dropped from a lower. When they are 10m from the ground, they have identical

1) Kinetice energy 2) Potential energy 3) Momentum 4) Acceleration

83. A person standing at some distance from a high tree, throws a stone taking aim at a fruit hanging from that tree. The fruit begins to fall freely at the time, when the person throws the stone. Correct statement among the following is

1) The stone moves above the falling fruit.

2) The stone strikes the fruit if the stone is thrown with a definite velocity.

3) The stone moves below the falling fruit.

4) The stone always hit the fruit.

84. A gun is fired aiming at a target. At the moment of firing, the target is released and freely falls under gravity. Then the bullet **(1995 E)**

1) will miss the target by passing above it.

2) hits the target.

3) will miss the target by passing below it.

4) may or may not hit.

85. The area under the velocity-time graph between any two instant $t = t_1$ and $t = t_2$ gives the distance convered in time $\delta t = t_2 - t_1$

1) only if the particle moves with a uniform velocity

2) only if the particle moves with a uniform acceleration

3) only if the particle moves with an acceleration increasing at a uniform rate

4) in all cases irrespective of whether the motion is one of uniform velocity, or of uniform acceleration or of variable acceleration

86. A particle starts with velocity u and moves with constant acceleration a. What is the nature of graph between the time (t) and displacement (x)?

1) Straight line 2) Symmetric parabola

3) Asymmetric parabola 4) Rectangular hyperbola

LEVEL - I

DISPLACEMENT AND DISTANCE

MODEL QUESTIONS

87. A body is moving along the circumference of a circle of radius 'R' and completes half of the revolution. Then, the ratio of its displacement to distance is

1) $\pi:2$ 2) 2:1 3) $2:\pi$ 4) 1:2

88. A particle experiences constant acceleration for 6s after starting from rest. If it travels a distance s_1 in the first 2s and a distance s_2 in the next 2s and a distance s_3 in the last 2s, then $s_1:s_2:s_3$ is

1) 1:1:1 2) 1:2:3 3) 1:3:5 4) 1:5:9

89. Starting from rest a body travels 36m in the first 2 second of its journey. Distance it can travel in the 11^{th} second is

1) 72 m 2) 108 m 3) 144 m 4) 189 m

90. A bullet travelling horizontally loosess $1/20^{th}$ of its velocity while piercing a wooden plank. Number of such planks required to stop the bullet is

1) 6 2) 9 3) 11 4) 13

91. If the distance between the sun and the earth is 1.5×10^{11} m and velocity of light is 3×10^{8} m/s, then the time taken by a light ray to reach the earth from the sun is

1) 500 s 2) 500 minute 3) 50 s 4) 5×10^3s

92. Two motor cars starting off with a time gap of 2 minute, travel in the same direction with the same acceleration. Time taken by the second car since its departure to complete $(1/9)^{th}$ of the distance covered by the first car is

1) 1 s 2) 1 m 3) 2 s 4) 2 m

PRACTICE QUESTIONS

93. A body starting from rest with uniform acceleration travels distance s_1 in the first 't' second and travels a distance s_2 with uniform velocity in the next 2t second. Then

1) $s_2 = 4s_1$ 2) $s_2 = 2s_1$ 3) $s_1 = 4s_2$ 4) $s_1 = 2s_2$

94. A bullet fired into a fixed target looses half of its velocity in penetrating 15 cm. Before coming to rest, it can penetrate a further distance of

1) 5 cm 2) 15 cm 3) 7.5 cm 4) 10 cm

95. A body moves from one corner of an equilateral triangle of side 10 cm to the same corner along the sides. Then the distance and displacement are respectively

1) 30 cm & 10 cm 2) 30 cm & 0 cm 3) 0 cm & 30 cm 4) 30 cm & 30 cm.

96. A body completes one round of a circle of radius 'R' in 20 second. The displacement of the body after 45 second is

1) $\frac{R}{\sqrt{2}}$ 2) $\sqrt{2}$ R 3) $2\sqrt{R}$ 4) 2R

SPEED AND AVERAGE SPEED

MODEL QUESTIONS

97. A body moves from A to B with a constant speed of 20 kmph and then from B to A with a constant speed of 30 kmph. Then the average speed of the car is

1) 25 kmph 2) 24 kmph 3) 0 kmph 4) 10 kmph

98. A body moves with a speed of 20 kmph in the first 5s and with a speed of 30 kmph in the next 5s. Then, the average speed of the body is

1) 25 kmph 2) 24 kmph 3) 0 kmph 4) 10 kmph

PRACTICE QUESTIONS

99. If a body moves half of the distance between two points with a speed of 10 kmph and remaining half with a constant speed of 15kmph, then the average speed of the body is

1) 12.5 kmph 2) 12 kmph 3) 0 kmph 4) 10 kmph

VELOCITY

MODEL QUESTIONS

100. A body starting from rest and travelling with uniform acceleration has a velocity of 40 m/s after 10 second at A. Velocity of the body 4 second before it crosses the point 'A' is

1) 16 m/s 2) 20 m/s 3) 24 m/s 4) 32 m/s

101. A particle is moving in a circule in a radius 'r' with a consatnt speed 'v' . Theb change in velocity after the particle has travelled a distance equal to $\left(\frac{1}{8}\right)$ of the circumference of the circle is: **(2006 E)**

1. Zero 2. 0.500 v 3. 0.785 v 4. 0.125 v

102. A boat is moving with a velocity (3i+4j) with respect to ground. The water in the river is moving with a velocity (-3i-4j) with respect to ground. The relative velocity of boat with respect to water is**(1991 E)**

1) 6i+8j 2) zero 3) 6i 4) 8j

103. A car moves along a straight line whose motion is given by $S=12t+3t^2-2t^3$, where s is in meters and 't' is in seconds. The velocity of the car at the start will be **(A 2002)**

1. 7 m/s 2) 9 m/s 3) 12 m/s 4) 16 m/s

AVERAGE VELOCITY

MODEL QUESTIONS

104. For a body moving with uniform acceleration 'a', initial and final velocities in a time interval 't' are 'u' and 'v' respectively. Then, its average velocity in the time interval 't' is

1) $\left(v+\frac{at}{2}\right)$ 2) $\left(v-\frac{at}{2}\right)$ 3) (v-at) 4) $\left(u+\frac{at}{2}\right)$

105. A particle is at x +5 m at t = 0, x = -7 m at t = 6 s and x =+2m at t = 10 s. The average velocity of the particle during the intervals (a) t = 0 to t = 6 s (b) t = 6 s to t = 10 s, (c) t = 10 s, is respectively

1) $-2ms^{-1}, 2.25ms^{-1}, -0.3ms^{-1}$ 2) $2ms^{-1}, -2.25ms^{-1}, 0.3ms^{-1}$

3) $0.3ms^{-1}, 2ms^{-1}, -2.25ms^{-1}$ 4) $2.25ms^{-1}, -0.3ms^{-1}, -2ms^{-1}$

ACCELERATION

MODEL QUESTIONS

106. The velocity of a body as a function of time is $V = t^3 - 6t^2 + 10t + 4$. Set the accelerations of a body in increasing order at given times

a) t = 0 sec b) t = 1 sec c) t = 5 sec

1) b, a, c 2) a, b, c 3) c, b, a 4) c, a, b

107. A body moves with a velocity of 3m/s due east and then turns due north to travel with the same velocity. If the total time of travel is 6s, the acceleration of the body is

1) $\sqrt{3}$ m/s^2 towards north west 2) $\frac{1}{\sqrt{2}}$ m/s^2 towards north west

3) $\sqrt{2}$ m/s^2 towards north east 4) all the above

108. Distance travelled by a body is given by $2S=(10t+5t^2)$m. The acceleration of the body is

1) 2.5 m/s^2 2) 5 m/s^2 3) 10 m/s^2 4) 0.5 m/s^2

109. Two cars are travelling towards each other on a straight road at velocities 15 m/s and 16 m/s respectively. When they are 150m apart, both the drivers apply the brakes and the cars decelerate at 3 m/s^2 and 4 m/s^2 until they stop. Separation between the cars when they come to rest is

1) 86.5 m 2) 89.5 m 3) 85.5 m 4) 80.5 m

110. For a projectile the range and maximum height are equal. The angle of projection is

1) 45^0 2) 0^0 3) 76^0 4) 90^0

111. If a body travels 30m in an interval of 2s and 50m in the next interval of 2s, then the acceleration of the body is

1) 10 m/s^2 2) 5 m/s^2 3) 20 m/s^2 4) 25 m/s^2

112. A proton in a uniform electric field moves along a straight line with constant acceleration starting from rest. If it attains a velocity $4x10^3$ km/s in a distance of 2cm, the time

required to reach the given velocity is

1) 10^{-3}s   2) 10^{-6}s   3) 10^{-8}s   4) 10^{-5}s

PRACTICE QUESTIONS

113. A body starting with a velocity 'v' returns to its initial position after 't' second with the same speed, along the same line. Acceleration of the particle is

1) $\frac{-2v}{t}$ 2) $\frac{2v}{t}$ 3) $\frac{v}{2t}$ 4) $\frac{t}{2v}$

114. The velocity of body moving along the x-axis is given by v = 4t-2.5t^2. Its acceleration after 3s is

1) 1.5 cm/s^2 2) -11 cm/s^2 3) 4 cm/s^2 4) 5 cm/s^2

115. A point moves in a straight line so that its displacement 'x' metre at a time 't' second is such that t = $(x^2-1)^{1/2}$. Its acceleration in m/s^2 at time 't' second is

1) $\frac{1}{x}$ 2) $\frac{1}{x^3}$ 3) $\frac{-t}{x^2}$ 4) $\frac{t}{x^2}$

116. A body moves with constant speed 'v' along the circumference of a circle of radius 'r'. If it completes half of the revolution in 't's, then the magnitude of the average acceleration is

1) 0   2) $\frac{2v}{t}$ 3) $\frac{v}{t}$ 4) All the above

117. A car moving on a straight road accelerates from a speed of 4. 1m/s to a speed of 6.9 m/s in 5.0 s. Then its average acceleration is

1) $0.5ms^{-2}$ 2) $0.6ms^{-2}$ 3) $0.56ms^{-2}$ 4) $0.65ms^{-2}$

118 The distances travelled by a body starting from rest and travelling with uniform acceleration, in successive intervals of time of equal duration will be in the ratio **(1999 E)**

1) 1:2:3   2) 1:2:4   3) 1:3:5   4) 1:5:9

119. The displacement is given by x=2t^2+t+5(m). The acceleration at t=2s is **(1995E)**

1) 4 m/s^2 2) 8 m/s^2 3) 10 m/s^2 4) 15m/s^2

UNIFORM ACCELERATION

MODEL QUESTIONS

120. Velocity of a body moving with uniform acceleration of 3m/s^2 is changed through 30m/s in certain time. Average velocity of body during this time is 30m/s. Distance covered by it during this time is

1) 300 m   2) 200 m   3) 400 m   4) 250 m

PRACTICE QUESTIONS

121. A body starts from rest and moves with an uniform acceleration. The ratio of distance covered in the nth second to the distance covered in 'n' second is

1) $\left(\frac{2}{n}-\frac{1}{n^2}\right)$ 2) $\left(\frac{1}{n^2}-\frac{1}{n}\right)$ 3) $\left(\frac{2}{n^2}-\frac{1}{n}\right)$ 4) $\frac{2}{n}+\frac{1}{n^2}$

FORMULAE FOR MOTION WITH CONSTANT ACCELERATION

MODEL QUESTIONS

122. Two cars 1 & 2 starting from rest are moving with speeds $V_1\, and\, V_2$ m/s $(V_1 > V_2)$. Car 2 is ahead of car '1' by s meter when the driver of the car '1' sees car '2'. What minimum retardation should be given to car '1' to avoid collision. **(2002 A)**

1) $\frac{V_1-V_2}{S}$ 2) $\frac{V_1+V_2}{S}$ 3) $\frac{(V_1+V_2)^2}{2S}$ 4) $\frac{(V_1-V_2)^2}{2S}$

123. A particle starts moving from rest under uniform acceleration. It travels a distance 'x' in the first two seconds and a distance 'y' in the next two seconds. If y = nx, then n=

(1993 E)

1) 1 2) 2 3) 3 4) 4

PRACTICE QUESTIONS

124. A bus accelerates uniformly from rest and acquires a speed of 36kmph in 10s. The acceleration is **(1996 M)**

1) 1 m/s^2 2) 2 m/s^2 3) 1/2 m/s^2 4) 3 m/s^2

125. A car moving at a speed of 20 m/s is subjected to a uniform retardation of 5 m/s^2. It stops in a time of

1) 100s 2) 4s 3) 3s 4) 5s

126. A bus accelerates uniformly from rest and acquires a speed of 75 km/hr in 20seconds. The accelearation of the bus is **(2002 A)**

1) 10 m/s^2 2) 5 m/s^2 3) 2 m/s^2 4) 1 m/s^2

127. Speeds of two identical cars are U and 4U at a specific instant. The ratio of the respective deistance in which the two cars are stopped from that instant is **(2002 A)**

1) 1:1 2) 1:4 3) 1:8 4) 1:16

MOTION UNDER GRAVITY

MODEL QUESTIONS

128. A body falls freely from rest. If the velocity acquired is numerically equal to the displacement, then the velocity acquired is

1) 9.8 m/s 2) 19.6 m/s 3) 29.4 m/s 4) 39.2 m/s

129. A body dropped from the top of a tower reaches the ground in 4s. Height of the tower is

1) 39.2 m 2) 44.1 m 3) 58.8 m 4) 78.4 m

130. A ball dropped freely takes 0.2s to cross the last 6m distance before hitting the ground.

Total time of fall is (g = 10 m/s^2)

1) 2.9 s 2) 3.1 s 3) 2.7 s 4) 0.2 s

131. Bodies are dropped from a height in successive intervals of half a second. The relative velocity of one with respect to the other is

1) g 2) g/2 3) $g^{1/2}$ 4) g^2

132. A body thrown vertically upwards reaches the highest point in 2s. Velocity of projection is

1) 9.8 m/s 2) 19.6 m/s 3) 29.4 m/s 4) 39.2 m/s

133. Two balls are projected simultaneously with the same velocity 'u' from the top of a tower, one vertically upwards and the other vertically downwards. Their respective times of the journeys are t_1 and t_2. At the time of reaching the ground, the ratio of their final velocities is

1) 1:1 2) 1:2 3) 2:3 4) 2:1

134. Two bodies are projected simultaneously with the same velocity of 19.6 m/s from the top of a tower, one vertically upwards and the other vertically downwards. As they reach the ground, the time gap is

1) 0 s 2) 2 s 3) 4 s 4) 6 s

135. The time taken by a vertically projected body before reaching the ground is

1) directly proportional to initial velocity.

2) directly proportional to square of initial velocity.

3) inversely proportional to square of initial velocity.

4) inversely proportional to initial velocity.

136. A body projected vertically upwards with a velocity of 19.6 m/s reaches a height of 19.8m on earth. If it is projected vertically up with the same velocity on moon, then the maximum height reached by it is

1) 19.18 m 2) 3.3 m 3) 9.9 m 4) 118.8 m

137. A body projected vertically up with a velocity of 10m/s reaches a height of 20m. If it is projected with a velocity of 20m/s, then the maximum height reached by the body is

1) 20 m 2) 10 m 3) 80 m 4) 40 m

138. A body is dropped from the top of a tower. Simultaneously, another body is projected vertically up. If they meet with equal velocity 'V', then initial velocity of the body projected upwards is

1) V 2) V/2 3) V/4 4) 2V

139. Two bodies begin to fall freely from the same height. The second one begins to fall τ s after the first. The time after which the 1st body begins to falls, the distance between the bodies equals to *l* is

1) $\frac{l}{g\tau}+\frac{\tau}{2}$ 2) $\frac{g\tau}{l}+\tau$ 3) $\frac{\tau}{lg}+\frac{2}{\tau}$ 4) $\frac{g}{l\tau}+\frac{\tau}{2}$

140. A balloon starts from rest, moves vertically upwards with an acceleration g/8 ms^{-1}, A stone falls from the balloon after 8 s from the start. Tthe time taken by the stone to

reach the ground ($g = 9.8\ ms^{-2}$).is

1) $4s$ 2) $8s$ 3) $2s$ 4) $12s$

141. Two bodies of different masses m_a and m_b are dropped from two different heights viz 'a' and 'b'. Ratio of times taken by the two, to drop through these distances is

1) a : b 2) $\sqrt{b} : \sqrt{a}$ 3) $\sqrt{a} : \sqrt{b}$ 4) $a^2 : b^2$

142. From a building two balls A & B are thrown such that A is thrown upwards and B downwards (both vertically with constant speed). If V_A and V_B are their respective velocities on reaching the ground then **(2002 A)**

1) $V_B < V_A$ 2) $V_A = V_B$ 3) $V_A > V_B$

4) Their velocities depends on their masses.

PRACTICE QUESTIONS

143. A body projected up with a velocity 'u' reaches a height 'h'. To reach double the height, it must be projected up with a velocity of

1) 2u 2) u/2 3) $\sqrt{2}u$ 4) u/$\sqrt{2}$

144. A body dropped from a height reaches the ground is 5s. The velocity with which it reaches the ground is

1) 0 m/s 2) 49 m/s 3) 29 m/s 4) 9.8 m/s

145. A body is thrown up with velocity 'u' to reach a height 'h'. When the velocity is half the initial velocity, its height from the top point of projection is

1) $\frac{h}{2}$ 2) $\frac{h}{4}$ 3) $\frac{3h}{4}$ 4) h

146. A body thrown up with some initial velocity reaches a maximum height of 50m. Another body with double the mass thrown up with double the initial velocity will reach a maximum height of**(1996 E)**

1) 100m 2) 200m 3) 400m 4) 50m

147. The distance moved by a freely falling body (starting from rest) during the 1st, 2nd and 3rd ... nth second of its motion, are proportional to **(1992 M)**

1) (n-1) 2) (2n-1) 3) (n^2-1) 4) $(2n-1)/n^2$

148. A body let fall from the top of a building reaches the ground in 3s. Height of the building is

1) 14.7m 2) 24.4m 3) 44.1m 4) 66.2m

149. A ball released from a height 'h' touches the ground in 't's. After t/2s since dropping, the height of the body from the ground

1) $\frac{h}{2}$ 2) $\frac{h}{4}$ 3) $\frac{3h}{4}$

150. A pebble is thrown vertically upwards from a bridge with an initial velocity of 4.9 m/s. It strikes the water after 2s. Height of the bridge is

1) 19.6m 2) 14.7m 3) 9.8m 4) 4.9m

PROJECTILES

MODEL QUESTIONS

151. The launching speed of a certain projectile is five times the speed it has at its maximum height. Its angle of projection is

1) $\theta = \cos^{-1}(0.2)$ 2) $\theta = \sin^{-1}(0.2)$ 3) $\theta = \tan^{-1}(0.2)$ 4) $\theta = 0^0$

152. It was calculated that a shell when fired from a gun with certain velocity and at an angle of elevation $\frac{5\pi}{36}$ radian should strike a given target in actual practice, it was found that a hill just intervened the trajectory. The angle of elevation at which the gun should be fired in order to hit the target is

1) $\frac{5\pi}{36}$ radian 2) $\frac{7\pi}{36}$ radian 3) $\frac{11\pi}{36}$ radian 4) $\frac{13\pi}{36}$ radian

153. A cricket ball is hit for a six leaving the bat at an angle of 45^0 to the horizontal with kinetic energy 'k'. At the top, K.E. of the ball is

1) Zero 2) k 3) $\frac{k}{2}$ 4) $\frac{k}{\sqrt{2}}$

TRAJECTORY OF AN OBNLIQUE PROJECTILE

PRACTICE QUESTIONS

154. Trajectory of a projectile is ($y=Ax-Bx^2$). Its horizontal range is

1) AB 2) A/B 3) B/A 4) A^2+B^2

155. The trajectory of a projectile in a vertical plane is $y = ax - bx^2$ where a, b are constants and 'x' and 'y' are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection from the horizontal is

1) $\tan^{-1}$ (a) 2) $\tan^{-1}$ (b) 3) $\tan^{-1}\left(\frac{a}{b}\right)$ 4) $\tan^{-1}\left(\frac{b}{a}\right)$

TIME OF FLIGHT (OBLIQUE PROJECTILE)

MODEL QUESTIONS

156. If a body is thrown with a velocity of 19.6m/s making an angle of 30^0 with the horizontal, then the time of flight is

1) 1 s 2) 2 s 3) $2\sqrt{3}$ s 4) 5 s

157. A bullet is fired with a velocity of $196ms^{-1}$ at an angle of 30^0 with the horizontal. Time of

flight of the bullet is

1) 10 s 2) 20 s 3) 30 s 4) 40 s

MAXIMUM HEIGHT (OBLIQUE PROJECTILE)

MODEL QUESTIONS

158. The angle of projection to have maximum height and range in the ratio 1:4 is

1) 30^0 2) 45^0 3) 60^0 4) 75^0

159. A stone is proected with a velocity $20\sqrt{2}$ m/s at an angle of 45^0 to the horizontal. The average velocity of stone during its motion from starting point to its maximum height is ($g = 10\ m/s^2$)

1) $10\sqrt{5}$ m/s 2) $20\sqrt{5}$ m/s 3) $5\sqrt{5}$ m/s 4) 20 m/s

160. A ball is projected, with a K.E. = E at an angle 'θ' with the horizontal. At the highest point of parabola, KE is

1) E Cosθ 2) E Cos$^2\theta$ 3) E Sinθ 4) E Sin$^2\theta$

PRACTICE QUESTIONS

161. A base ball player can throw a ball to a maximum distance of 60m. Then he can throw it vertically to a maximum height of

1) 10 m 2) 30 m 3) 60 m 4) 100 m

162. If K.E. = P.E. at the highest point of parabolic path, angle of projection is

1) 30^0 2) 45^0 3) 60^0 4) 70^0

HORIZONTAL RANGE

MODEL QUESTIONS

163. Keeping the velocity of projection constant, the angle of projection is increased from 0^0 to 90^0, then the horizontal range of the projectile

1) goes on increasing upto 90^0 2) decreases upto 90^0

3) increases upto 45^0 and decreases afterwards

4) decreases upto 45^0 and increases afterwards

164. A bomb at rest is exploded and the pieces are scattered in all directions with a maximum velocity of $20ms^{-1}$. Dangerous distance from that spot is ($g = 10\ m/s^2$)

1) 10 m 2) 20 m 3) 30 m 4) 40 m

PRACTICE QUESTIONS

165. If a body is projected with a velocity of 9.8 m/s making an angle of 45^0 with the horizontal, then the range of the projectile is

1) 39.2 s 2) 9.8 s 3) 4.9 s 4) 19.6 s

166. A particle is projected with an initial velocity of 200 m/s in a direction making an angle of 30^0 with the vertical. The horizontal distance covered by the particle in 3s is

1) 300 m 2) 150 m 3) 175 m 4) 125 m

MAXIMUM HORIZONTAL RANGE

MODEL QUESTIONS

167. A ball is projected from the ground with a velocity 'u' such that its range is maximum

1) Its velocity at half the maximum height is $\frac{\sqrt{3}}{2}u$

2) Its velocity at the maximum height is 'u'.

3) Change in its velocity when it returns to the ground is 'u'.

4) all the above are true.

PRACTICE QUESTIONS

168. A boy throws a ball with a velocity of $20ms^{-1}$ such that its horizontal range is maximum. If g = $10m/s^2$, range of the ball is

1) 20 m 2) 25 m 3) 30 m 4) 40 m

169. A ball thrown with a velocity of 49 m/s got the maximum range measured in the atmosphere as 225m. The decrease in range due to atmosphere is

1) 0 m 2) 245 m 3) 225 m 4) 20 m

TWO ANGLES OF PROJECTION FOR THE SAME RANGE

MODEL QUESTIONS

170. Two particles are projected with the same velocity but at angles of projection $(45^0-\theta)$ and $(45^0+\theta)$ to have maximum range. Then their horizontal ranges are in the ratio of

1) 1:2 2) 2:1 3) 1:1 4) 1:4

PRACTICE QUESTIONS

171. A body is projected with a certain speed at angles of projection of θ and $90-\theta$. The maximum height attained in the two cases are 20 m and 10 m respectively. The maximum possible range is

1) 60 m 2) 30 m 3) 20 m 4) 80 m

172. Two bodies are thrown from the same point with the same velocity of $50ms^{-1}$. If their angles of projection are complimentary to each other and the difference of maximum heights is 30m, the maximum heights are (g=10 m/s^2)

1) 50 m & 80 m 2) 47.5 m & 77.5 m 3) 30 m & 60 m 4) 25 m & 55 m

HORIZONTAL PROJECTILE

MODEL QUESTIONS

173. A body projected horizontally with a velocity 'v' from a height 'h' has a range 'R'. With

what velocity a body is to be projected horizontally from a height h/2 to have the same range ?

1) $\sqrt{2}$ v 2) 2v 3) 6v 4) 8v

174. A bomb is dropped from an aeroplane flying horizontally with a velocity of 720 kmph at an altitude of 980m. Time taken by the bomb to hit the ground is

1) 1 s 2) 7.2 s 3) 14.14 s 4) 0.15 s

175. A gun with a muzzle velocity of 500 m/s shoots a bullet at a bird 50m away. To hit the bird, the gun should be aimed (g = 10 m/s^2)

1) directly towards the bird along the line joining the gun and bird.

2) 10 cm high above the bird. 3) 5 cm high above the bird

4) 5 cm below the bird

176. In between two hills of heights 100m and 92m, there is a valley of breadth 16m. If a vehicle jumps from the first hill to the second one, the minimum velocity of the vehicle is (assume g = 9 m/s^2)

1) 16 m/s 2) 12 m/s 3) 9 m/s 4) 10 m/s

177. From certain height 'h' two bodies are projected horizontally each with velocity v. One body is projected towards North and the other body is projected towards east. Their seperation on reaching the ground

1) $\sqrt{\frac{2v^2h}{g}}$ 2) $\sqrt{\frac{4v^2h}{g}}$ 3) $\sqrt{\frac{v^2h}{g}}$ 4) $\sqrt{\frac{8v^2h}{g}}$

PRACTICE QUESTIONS

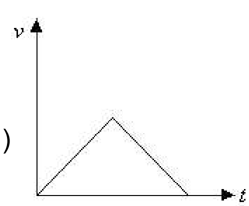
178. A ball is projected horizontally with a speed 'v' from the top of a plane inclined at an angle 45^0 with the horizontal. How far from the point of projection will be ball strike the plane?

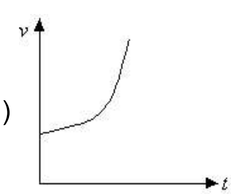
1) $\frac{v^2}{g}$ 2) $\sqrt{2}\frac{v^2}{g}$ 3) $\frac{2v^2}{g}$ 4) $\sqrt{2}\left[\frac{2v^2}{g}\right]$

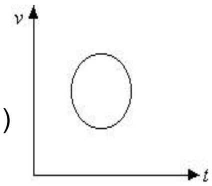
GRAPHS

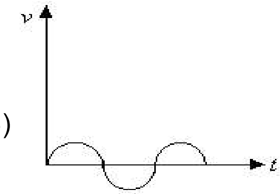
MODEL QUESTIONS

179. Which of the following curves do not represent motion in one dimensions?

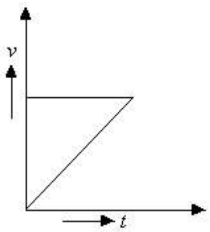
1)


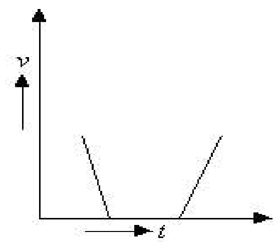
2)


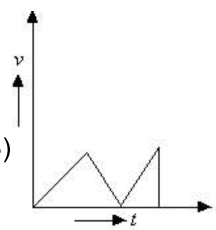
3) 

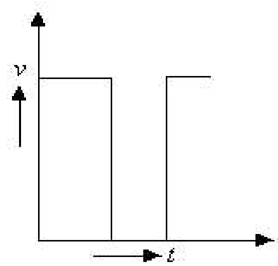
4) 

180. Which of the following velocity time graphs is NOT possible

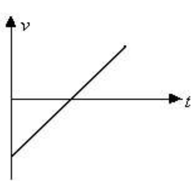
1) 

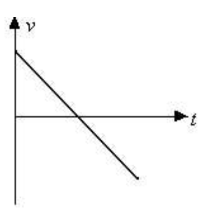
2) 

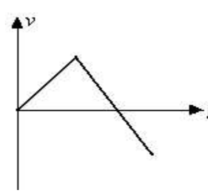
3) 

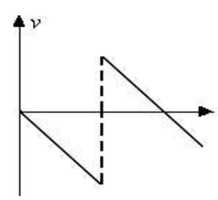
4) 

181. A particle falls from a height h and rebounds to $h_1 < h$, then which of the graph represents the motion correct?

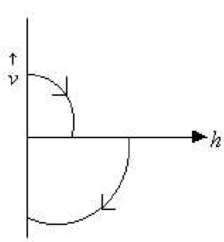
1) 

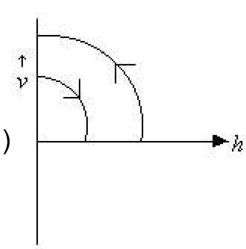
2) 

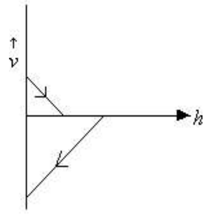
3) 

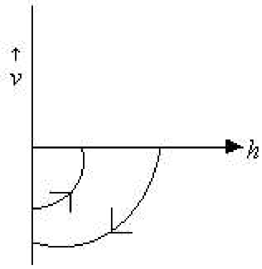
4) 

182. A ball is dropped vertically from a height h above the ground. It hits the ground and bounces up vertically to a height h/2. Neglecting subsequent motion and air resistance, its velocity v varies with the height h as

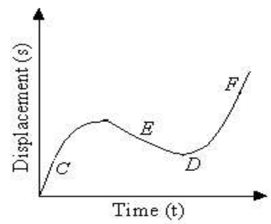
1) 

2) 

3) 

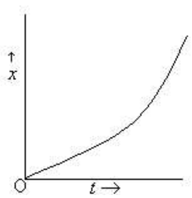
4) 

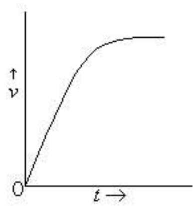
183. The displacement time graph of a moving particle is shown in the figure. The instantaneous velocity of the particle is negative at the point

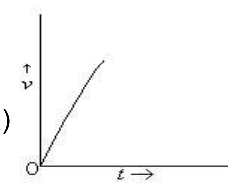


1) D 2) F 3) C 4) E

184. Which of the velocity-time graphs shown figure can posibly represent one-diemnsional motion of a particle?

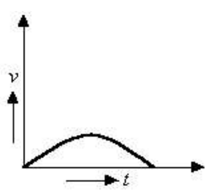
1) 

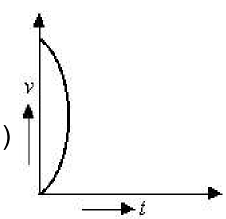
2) 

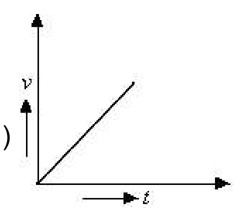
3) Both (1) & (2)
4) 

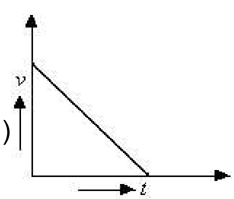
PRACTICE QUESTIONS

185. Which of the following cannot be the speed time graph

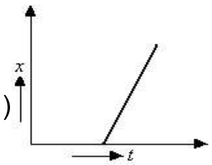
1) 

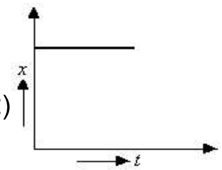
2) 

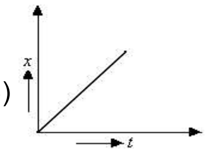
3) 

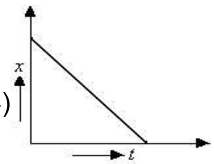
4) 

186. Which of the following cannot be the distance time graph?

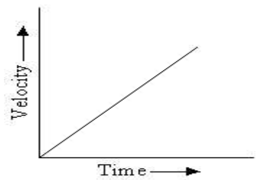
1) 

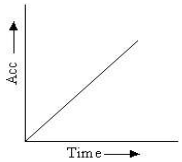
2) 

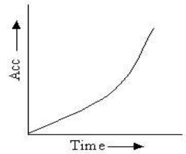
3) 

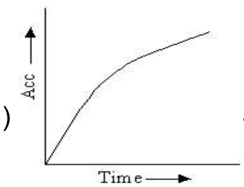
4) 

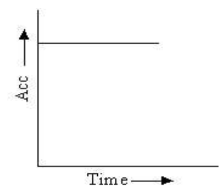
187. Figure shows the velocity-time graph of a car moving on a straight road. Which one of the diagrams shown in figure. Will be the corresponding acceleration time graph.



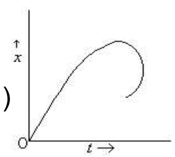
1) 

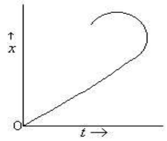
2) 

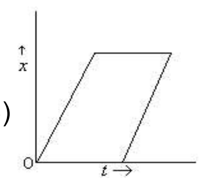
3) 

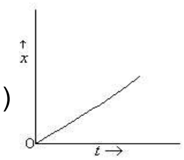
4) 

188. Which of the displacement -time $(x-t)$ graphs shown in figure cannot possibly represent one dimensional motion of a particle?

1) 

2) 

3) 

4) 

LEVEL -II

VELOCITY

MODEL QUESTIONS

189. A body moving with uniform acceleration travels a distance $s_n = (0.4n + 9.8)$m in n^{th} second. Initial velocity of the body is (in m/s)

1) 0.4 2) 10 3) 3.5 4) 4

190. A particle moving with velocity equal to 0.4 m/s is subjected to an acceleration of 0.15 m/s^2 for 2s in a direction at right angle to its direction of motion. The magnitude of resultant velocity is

1) 0.3 m/s 2) 0.5 m/s 3) 0.27 m/s 4) 0.55 m/s

191. Two cars are travelling in the same direction with a velocity of 60 kmph. They are separated by a distance of 5 km. A truck moving in opposite direction meets the two

cars in a time interval of 3 minute. The velocity of the truck is (in kmph)

1) 20 2) 30 3) 40 4) 60

PRACTICE QUESTIONS

192. When two bodies approach each other with different uniform speeds, the distance between them decreases by 120m per every 1 minute. If they move in the same direction, the distance between them increases by 90m per every 1 minute. The speeds of the bodies are respectively.

1) 2 m/s, 0.5 m/s 2) 3 m/s, 2 m/s

3) 1.75 m/s, 0.25 m/s 4) 2.5 m/s, 0.5 m/s

ACCELERATION

MODEL QUESTIONS

193. A train accelerates from rest at a constant rate a_1 for distance S_1 and time t_1. After that it retards to rest at a constant rate a_2 for distance S_2 at time t_2.Then the correct relation among the following is

1) $\frac{S_1}{S_2}=\frac{a_1}{a_2}=\frac{t_1}{t_2}$ 2) $\frac{S_1}{S_2}=\frac{a_2}{a_1}=\frac{t_1}{t_2}$ 3) $\frac{S_1}{S_2}=\frac{a_1}{a_2}=\frac{t_2}{t_1}$ 4) $\frac{S_1}{S_2}=\frac{a_2}{a_1}=\frac{t_2}{t_1}$

PRACTICE QUESTIONS

194. The relation between time t and distance x is $t = ax^2 + bx$, where a and b are constants. The acceleration is : **(2005 A)**

1) $-2abv^2$ 2) $2bv^3$ 3) $-2av^3$ 4) $2av^2$

195. A particle is moving eastwards with a velocity of $5ms^{-1}$. In 10 seconds the velocity changes to $5ms^{-1}$ northwards. The average acceleration in this time is : **(2005 A)**

1) $\frac{1}{\sqrt{2}}ms^{-2}$ N-W 2) $\frac{1}{2}ms^{-2}$ North 3) zero 4) $\frac{1}{2}ms^{-2}$ N-E

196. The average velocity of a body moving with uniform acceleration after travelling a distance of 3.06 m is 0.34 m/s. If the change in velocity of the body is 0.18 ms^{-1} during this time, its uniform acceleration is **(2000 E)**

1) 0.01 ms^{-2} 2) 0.02 ms^{-2} 3) 0.03 ms^{-2} 4) 0.04 ms^{-2}

FORMULAE FOR MOTION WITH CONSTANT ACCELERATION

MODEL QUESTIONS

197. The position of a particle moving in the XY-plane at any time 't' is given by x = $(3t^2 - 6t)$m; y = $(t^2 - 2t)$m. Select the correct statement about the moving particle from the following

a) The acceleration of the particle is zero at t = 0 second

b) The velocity of the particle is zero at t = 0 second

c) The velocity of the particle is zero at t = 1 second

d) The velocity and acceleration of the particle are never zero

198. A train is running at full speed when brakes are applied. In the first minute it travels 8 km, and in the next minute it travels 3 km. Initial speed of the train is

1) 150 m/s 2) 175 m/s 3) 200 m/s 4) 225 m/s

199. A car travelling at 60 kmph overtakes another car travelling at 42 kmph. Assuming each car to be 5.0m long, the time taken for the over taking is

1) 6 s 2) 4 s 3) 3 s 4) 2 s

200. Two particles move along x-axis in the same direction with uniform velocities 8 m/s and 4 m/s. Initially the first particle is 21m to the left of the origin and the second one is 7m to the right of the origin. The two particles meet from the origin at a distance of

1) 35 m 2) 32 m 3) 28 m 4) 56 m

201. A particle is moving with uniform acceleration along a straight line ABC. Its velocity at 'A' and 'B' are 6 m/s and 9 m/s respectively. If AB:BC = 5:16 then its velocity at 'C' is

1) 9.6 m/s 2) 12 m/s 3) 15 m/s 4) 21.5 m/s

202. A body starts with velocity 'u' and moves on a straight path with constant acceleration. When its velocity becomes '5u' the acceleration is reversed in direction without change in magnitude. When it returns to starting point its velocity becomes.

1) -u 2) -3u 3) -7u 4) -5u

203. A bus starts from rest and moves with a uniform acceleration of $1ms^{-2}$. A boy 10m behind the bus at the start runs at a constant speed and catches the bus in 10s. Speed of the boy is

1) 10 m/s 2) 1 m/s 3) 6 m/s 4) 4 m/s

204. A car starts from rest and travels with uniform acceleration α for some time and then with uniform retardation β and comes to rest. If the total time of travel of the car is 't', the maximum velocity attained by it is given by (**1998 E)**

1) $\frac{\alpha\beta}{(\alpha+\beta)}t$ 2) $\frac{1}{2}\frac{\alpha\beta}{(\alpha+\beta)}t^2$ 3) $\frac{\alpha\beta}{(\alpha-\beta)}t$ 4) $\frac{1}{2}\frac{\alpha\beta}{(\alpha-\beta)}t^2$

205. A starts from rest and moves with acceleration a_1. Two seconds later, B starts from rest and moves with an acceleration a_2. If the displacement of A in the 5^{th} second is the same as that of B in the same interval, the ratio of a_1 to a_2 is**(1994 M)**

1) 9:5 2) 5:9 3) 1:1 4) 1:3

PRACTICE QUESITONS

206. A body covers 30m and 40m during 10^{th} and 15^{th} second respectively. The acceleration and initial velocity of the body are respectively

1) $2 m/s^2$, 35 m/s 2) $2 m/s^2$, 11 m/s 3) $11 m/s^2$, 2 m/s 4) $1 m/s^2$, 10 m/s

KINEMATICS

207. A body travels 200m in the first two second and 220m in the next four second. The velocity at the end of the seventh second from the start will be

1) 10 m/s 2) 15 m/s 3) 220 m/s 4) 5 m/s

208. While moving with uniform acceleration, a body has covered 550m in 10 second and attained a velocity of 105 m/s. Its initial velocity 'u' and acceleration 'a' respectively are

1) 10 ms^{-1}, 5 ms^{-2} 2) 10 ms^{-1}, -5 ms^{-2} 3) 5 ms^{-1}, 10 ms^{-2} 4) 10 ms^{-1}, 0 ms^{-2}

209. While moving with uniform acceleration, a body has covered 100m in 10^{th} second and attained a velocity of 105 m/s. Its initial velocity 'u' and acceleration 'a' respectively are

1) 10 ms^{-1}, 5 ms^{-2} 2) 10 ms^{-1}, -5 ms^{-2} 3) 5 ms^{-1}, 10 ms^{-2} 4) 10 ms^{-1}, 0 ms^{-2}

210. A car moving with a constant acceleration covers the distance between two points 180m apart in 6s. If its speed as it passes the second point is 45 m/s, its speed at the first point is

1) 10 m/s 2) 15 m/s 3) 30 m/s 4) 45 m/s

211. A body travels 200cm in the first two seconds and 220cm in the next 4 seconds with deceleration. The velocity of the body at the end of the 7^{th} second is **(1994 E)**

1) 20 cm/s 2) 15 cm/s 3) 10 cm/s 4) 0 cm/s

212. A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a certain distance with velocity of 30 kmph and 40 kmph respectively. Velocity of the car exactly midway between P and Q is

1) 33.3 kmph 2) 20 kmph 3) 25 kmph 4) 35 kmph

213. If a body looses half of its velocity on penetrating 3cm in a wooden block, then how much will it penetrate more before coming to rest **(2002 A)**

1) 1 cm 2) 2cm 3) 3cm 4) 4cm

214. A car moving with a speed of 50km/hr can be stopped by brakes after atleast 6m. If the same car is moving at a speed of 100km/hr, the minimum stopping distance is **(2003 A)**

1) 12m 2) 18m 3) 24m 4) 6m

215. An automobile travelling with a speed of 60km/h. can brake to stop with in a distance of 20m. If the car is going twice as fast i.e., 120km/h the stopping distance will be **(2004 A)**

1) 20 m 2) 40 m 3) 60 m 4) 80 m

MOTION UNDER GRAVITY

MODEL QUESTIONS

216. A ball is dropped from a bridge 122.5m above a river. After 2s, a second ball is thrown down after it. What must its initial velocity be so that both hit the water at the same time ?

1) 49 m/s 2) 55.5 m/s 3) 26.1 m/s 4) 9.8 m/s

217. A ball dropped from a height of 10m, rebounds to a height of 2.5m. If the ball is in contact with the floor for 0.01 second, its acceleration during contact is (g = 9.8m/s^2)

1) 20 m/s^2 2) 21 m/s^2 3) 210 m/s^2 4)2100 m/s^2

218. A sharp stone of mass 2kg falls from a height of 10m on sand and buries into the sand.

It comes to rest in a time of 0.029 second. The depth through which it buries into sand is

1) 0.2 m   2) 0.15 m   3) 0.25 m   4) 0.30 m

219. The splash of sound was heard 5.35s after dropping a stone into a well 122.5m deep. Velocity of sound in air is

1) 350 cm/s   2) 350 m/s   3) 392 cm/s   4) 0 cm/s

220. Two stones are thrown vertically upwards with the same velocity of 49m/s. If they are thrown one after the other with a time lapse of 3 second, height at which they collide is

1) 58.8 m   2) 111.5 m   3) 117.6 m   4) 122.5 m

221. In the above problem, the time at which they collide after the projection of the first ball is

1) 3.5 s   2) 6.5 s   3) 4.5 s   4) 4.0 s

222. A body released from a height falls freely towards the earth. Another body is released from the same height exactly a second later. Then the separation between the two bodies two second after the release of the second body is

1) 4.9 m   2) 9.8 m   3) 19.6 m   3) 24.5 m

223. A freely falling body takes 't' second to travel first $(1/x)^{th}$ distance. Then, time of descent is

1) $\frac{t}{\sqrt{x}}$ 2) $t\sqrt{x}$ 3) $\frac{\sqrt{x}}{t}$ 4) $\frac{1}{t\sqrt{x}}$

224. A body released from the top of a tower of height 'h' takes 'T' second to reach the ground. At (T/2) s it is

1) at $\frac{h}{16}$ from the ground   2) at $\frac{h}{4}$ below the top of the tower

3) at $\frac{15h}{16}$ from the ground   4) at $\frac{3h}{16}$ below the top of the tower

225. The distance travelled by a body during last second of its upward journey is 'd', when the body is projected with certain velocity vertically up. If the velocity of projection is doubled, the distance travelled by the body during the last second of its upward journey is

1) 2d   2) 4d   3) d/2   4) d

226. A stone thrown vertically up with a velocity v reaches three points A, B and C with velocities $\frac{v}{2}, \frac{v}{4}, \frac{v}{8}$ respectively. Then AB : BC is

1) 1:1   2) 2:1   3) 4:1   4) 1:4

227. From an elevated point 'P', a stone is projected vertically upwards. When it reaches a distance 'd' below P, its velocity is doubled. The greatest height reached by it above 'P' is

1) d/3   2) 3d   3) 2d   4) d/2

228. A stone projected upwards with a velocity 'u' reaches two points 'P' and 'Q' separated by a distance 'h' with velocities u/2 and u/3. The maximum height reached by it is

1) $\frac{9h}{5}$ 2) $\frac{18h}{5}$ 3) $\frac{36h}{5}$ 4) $\frac{72h}{5}$

229. A body is thrown vertically up with certain velocity. If 'h' is the maximum height reached by it, its position when its velocity reduces to $(1/3)^{rd}$ of its velocity of projection is at

1) 8h/9 from the ground 2) 8h/9 below the top-most point

3) 4h/9 from the ground 4) h/3 below the top-most point

230. A stone of mass 200g is thrown up with certain velocity reaches a maximum height of 30m. Another body of double the mass is thrown up with half the velocity of the first. Maximum height reached by it is

1) 30 m 2) 15 m 3) 7.5 m 4) 3.5 m

231. A ball is dropped from the top of a building. The ball takes 0.5s to fall past the 3m length of a window at certain distance from the top of the building. Speed fo the ball as it crosses the top edge of the window is ($g=10m/s^2$)

1) 3.5 ms^{-1} 2) 8.5 ms^{-1} 3) 5 ms^{-1} 4) 12 ms^{-1}

232. In the above problem, how fast was the ball going as it passed the bottom of the window ?

1) 3.5 m/s 2) 8.5 m/s 3) 5 m/s 4) 12 m/s

233. In the above problem, how far is the top of the window from the point at which the ball was dropped ?

1) 0.5 m 2) 0.5225m 3) 0.6125m 4) 0 m

234. In the above problem, time of travel above the window is

1) 0.5 s 2) 0.25 s 3) 0.35 s 4) 0.75 s

235. A shot fired vertically upwards is known to be at 'P' at the end of two second and also again after six more second. Height of 'P' above the point of projection.

1) 44.1 m 2) 78.4 m 3) 122.5 m 4) 19.6 m

236. A body thrown vertically up with a velocity 'u' reaches the maximum height 'h'after'T' second. Correct statement among the following is

1) at a height h/2 from the ground its velocity is u/2

2) at a time 'T' its velocity is 'u' 3) at a time '2T' its velocity is '-u'

4) at a time '2T' its velocity is '-6u'

237. A stone projected vertically up with a velocity of 10m/s reaches the highest point after 2s. If it is thrown with a velocity of 20 m/s, it reaches the highest point after a time of

1) 2 s 2) 4 s 3) 6 s 4) 1s

238. A stone is dropped from the 16th store of a multistoried building reaches the ground in 4 seconds. The no. of stores travelled by the stone in 2nd second is

1) 4 2) 3 3) 5 4) 2

239. If the ratio of distances travelled by freely falling body in the last and last but one second of its motion is 7:5 The velocity with which the body strikes the ground is ______

1) 29.4 ms^{-1} 2) 39.2 ms^{-1} 3) 19.6 ms^{-1} 4) 49 ms^{-1}

240. A balloon starts rising from the ground with an acceleration of 1.25 ms^{-2}, After 8 seconds, a stone is released from the balloon, The stone will (g=10 ms^{-2})

1) cover a distance of 40 m 2) having a displaceent of 50 m

3) reach the ground in 4 s 4) begin to move down after being released

241. A ball is projected vertically upwards with a velocity of 25 ms^{-1} from the bottom of a tower. A boy who is standing at the top of a tower is unable to catch the ball when it passes him in the upward direction. But the ball again reaches him after 3 sec when it is falling. Now the boy catches it Then the height of the tower is (g=10ms^{-2})

1) 5 m 2) 10 m 3) 15 m 4) 20 m

242. A body is thrown verticaly upwards with an initial velocity u reaches maximum height in 6 seconds. The ratio of the distance travelled by body in the first second and the eleventh second is______

1) 1:1 2) 11:9 3) 1:2 4) 9:11

243. A ball is thrown straight upward with a speed v from a point h meters above the ground.

The time taken for the ball to strike the grounds is

1) $\frac{v}{g}\left[1+\sqrt{1+\frac{2hg}{v^2}}\right]$ 2) $\frac{v}{g}\left[1-\sqrt{1-\frac{2hg}{v^2}}\right]$ 3) $\frac{v}{g}\left[1-\sqrt{1+\frac{2hg}{v^2}}\right]$ 4) $\frac{v}{g}\left[2+\frac{2hg}{v^2}\right]$

244. A body falls from a height of 200m. If gravitational attraction ceases after 2s, further time taken by it to reach the ground is(g=10 ms^{-2})

1) 5s 2) 9s 3) 13s 4) 17s

245. A ball after having fallen from rest under the influence of gravity for 6s, crashes through a horizontal glass plate, thereby losing two-third of its velocity. If it then reaches the ground in 2s, height of the plate above the ground is

1) 19.6m 2) 39.2m 3) 58.8m 4) 78.4m

246. A juggler throws up balls at regular intervals of time. Each ball takes 2s to reach the highest position. If the first ball is in the highest position by the time the fifth one starts, then the separation between the first and the second balls is

1) 1.225m 2) 2.45m 3) 4.9m 4) 3.8m

247. A person sitting on the top of a tall building is dropping balls at regular intervals of one second. When the 6th ball is being dropped, the positions of the 3rd, 4th, 5th balls from the top of the building are respectively

1) 4.9m, 19.6m, 44.1m 2) 4.9m, 14.7m, 24.5m

3) 44.1m, 19.6m, 4.9m 4) 24.5m, 14.7m, 4.9m

248. A rocket is fired and ascends with constant vertical acceleration of 10m/s^2 for 1 minute. Its fuel is exhausted and it continues as a free particle. The maximum altitude reached is (g=10m/s^2)

1) 18 km 2) 36 km 3) 72 km 4) 108km

249. A body thrown up with a velocity of 98 m/s reaches a point ‘P’ in its path 7 second after projection. Since its projection it comes back to the same position after

1) 13s 2) 14s 3) 6s 4) 22s

250. A stone projected vertically up from the top of a cliff reaches the foot of the cliff in 8s. If it is projected vertically downwards with the same speed, it reaches the foot of the cliff in 2s. Then its time of free fall from the cliff is

1) 16s 2) 8s 3) 2s 4) 4s

251. A person in lift which ascends up with acceleration $10ms^{-2}$ drops a stone from a height 10 m. The time of descent is ($g = 10\ ms^{-2}$)

1) 1 s 2) 2 s 3) 1.5 s 4) 0.5 s

252. A stone is projected vertically up from the ground with velocity $40\ ms^{-1}$. The interval of time between the two instants at which the stone is at a height of 60 m above the ground is ($g = 10\ ms^{-2}$)

1) 4 s 2) 6 s 3) 8 s 4) 12 s

253. Two balls are dropped to the ground from different heights. One ball is dropped 2s after the other. But both of them strike the ground simultaneously 5s after the first is dropped. The difference in the heights, when they are dropped is

1) 80 m 2) 45 m 3) 95m 4) 100 m

254. A stone projected vertically up from the ground reaches a height y in its path at t_1 seconds and after further t_2 seconds reaches the ground. The height y is equal to

1) $\frac{1}{2}g(t_1 + t_2)$ 2) $\frac{1}{2}g(t_1 + t_2)^2$ 3) $\frac{1}{2}g\ t_1 t_2$ 4) $g\ t_1 t_2$

255. A person standing on the edge of a well throws a stone vertically upwards with an initial velocity 5 ms^{-1}. The stone gone up, comes down and falls in the well making a sound. If the person hears the sound 3 second after throwing, then the depth of water (neglect time travel for the sound and take g = 10ms^{-2}) **(1998 M)**

1) 1.25 m 2) 21.25 m 3) 30m 4) 32.5 m

256. A body throws balls vertically upwards. He throws one, while the previous one is at its highest point. Maximum height reached by a ball if he throws one ball each per second at uniform speed is

1) 19.6m 2) 9.8m 3) 4.9m 4) 2.45m

257. A parachutist after bailig out falls 50m without friction. When parachute opens, it decelerates at $2m/s^2$. He reaches the ground with a speed of $3m/s^2$. At what height, did he bail out ? **(2005 A)**

1) 91m 2) 182m 3) 293m 4) 111m

258. A body projected up with a speed 'u' took 'T' seconds to reach the maximum height 'H'. Pick out the correct statement

1) It reaches H/2 in (T/2)s 2) It acquires velocity u/2 in (T/2)s

3) Its velocity is u/2 at H/2 4) Same velocity at 2Ts

PRACTICE QUESTIONS

259. A stone dropped from the top of a tower covers 24.5m in the last second of its fall. Height of the tower is

1) 24.5 m 2) 44.1 m 3) 78.4 m 4) 122.5 m

260. A body dropped freely has covered half of he total distance in the last second. The total journey time is

1) $\left(2+\sqrt{2}\right)$ s 2) $\left(2-\sqrt{2}\right)$ s 3) 2 s 4) $\left(2+\sqrt{3}\right)$ s

261. A body dropped freely has covered $(16/25)^{th}$ of the total distance in the last second. Its total time of fall is

1) 2.5 s 2) 5 s 3) 7.5 s 4) 1 s

262. A particle is projected vertically up and another is let fall to meet at the same instant. If they have velocities equal in magnitude when they meet, the distances travelled by them are in the ratio

1) 1:1 2) 1:2 3) 3:1 4) 2:2

263. A body released from the top of a tower of height 'h' takes 'T' second to reach the ground. The position of the body at (T/4) second is

1) at $\frac{h}{16}$ from the ground 2) at $\frac{3h}{4}$ above the ground

3) at $\frac{15h}{16}$ from the ground 4) at $\frac{3h}{16}$ below the top of the tower

264. A stone is dropped from a balloon at an altitude of 280m. If the balloon ascends with a velocity of 5m/s and descends with a velocity of 5 m/s, times taken by the stone to reach the ground in the two cases respectively are ($g=10m/s^2$)

1) 8 s and 9 s 2) 9 s and 8 s 3) 3 s and 4 s 4) 8 s and 7 s

265. A ball is thrown vertically upwards with a speed of 10 m/s from the top of a tower 200m height and another is thrown vertically downwards with the same speed simultaneously. The time difference between them on reaching the ground is ($g=10m/s^2$)

1) 12s 2) 6s 3) 2s 4) 1s

266. Two balls, A and B are thrown simultaneously. A, vertically upwards at a speed of $15ms^{-1}$ from the ground and B, vertically downwards from a height of 30m at the same speed along the same line of motion. They meet after a time of

1) 1 s. 2) 2 s 3) 3 s 4) 4 s

267. If a body projected up with a velocity 'u' rises to a height 'h', a body of double the mass projected with a double the velocity rises to a height of

1) 8h 2) 4h 3) 2h 4) h

268. A balloon is rising vertically with a velocity of 9.8 m/s. A packet is dropped from it when it is a height of 39.2 m. Time taken by the packet to reach the ground is

1) 1s 2) 2s 3) 3s 4) 4s

269. A bag is dropped from a helicopter rising vertically at a constant speed of 2m/s. The

distance between the two after 2s is

1) 4.9m 2) 19.6m 3) 29.4m 4) 39.2m

270. In the above problem the velocity of bag after 2s is

1) 17.6 m/s 2) -17.6 m/s 3) 19.6 m/s 4) -19.6 m/s

271. A stone is dropped from a rising balloon at a height of 300m above the ground and it reaches the ground in 10s. The velocity of the balloon when it was dropped is

1) 19 m/s 2) 19.6 m/s 3) 29 m/s 4) 0 m/s

272. From the top of a tower 36 m high, a body is dropped and at the same time another body is projected vertically upward from the ground. If they meet midway find the initial velocity of the projected body and its velocity when the two bodies come together.

1) $5\sqrt{6}m, 0$ 2) $\frac{42}{\sqrt{5}}m, 0$ 3) $6\sqrt{6}m, 2m/s$ 4) $8\sqrt{6}m, 4.5m/s$

273. A paper weight is dropped from the roof of a block of multistorey flats each storey being 3 meters high. It passes the ceiling of the 20th storey at 30m/s. If (g = 10 m/s^2), how many storey does the flat have?

1) 25 2) 30 3) 35 4) 40

274. A ball of mass 100 gm is projected vertically upwards from the ground with a velocity of 49 m/s. At the same time another identical ball is dropped from a height of 98 m. After some time the two bodies collide. When they collide, their velocities are

1) 29.4 m/s upwards; 29.4 m/s downwards 2) 29.4 m/s upwards; 19.6 m/s downwards.

3) 19.6 m/s upwards; 19.6 m/s downwards 4) None

275. A stone is dropped from a height h. Simultaneously another stone is thrown up from the ground which reaches the height 4h. The two stones cross each other after a time.

1) $\sqrt{\frac{h}{2g}}$ 2) $\sqrt{\frac{h}{8g}}$ 3) $\sqrt{8}hg$ 4) $\sqrt{2}hg$

276. An objective falls from a bridge that is 45 m above the water. It falls directly into a small row-boat moving with constant velocity that was 12m from the point of impact when the object was released. The speed of the boat is

1) 3 ms^{-1} 2) 4 ms^{-1} 3) 5 ms^{-1} 4) 6 ms^{-1}

277. A body is thrown vertically upwards with an initial velocity 'u' reaches a maximum height in 6s. The ratio of the distance travelled by the body in the first second to the seventh second is **(2000 E)**

1) 1:1 2) 11:1 3) 1:2 4) 1:11

278. A stone is dropped from the top of a tower of height 49m. Another stone is thrown up vertically with velocity of 24.5 m/s from the foot of the tower at the same instant. They will meet in a time of

1) 1s 2) 2s 3) 0.5s 4) 0.25s

279. A ball is dropped from the top of a tower. Another ball thrown up vertically with a velocity

of 20 m/s from the ground level at the same instant meets the first after 1.5s. Height of the tower is

1) 20m 2) 30m 3) 40m 4) 50m

280. A ball is dropped from the top of a building. The ball takes 0.2s to fall past the 3m length of a window some distance from the top of the building. Speed of the ball as it crosses the top edge of the window is (g = $10ms^{-2}$)

1) 3.5 m/s 2) 8.5 m/s 3) 5 m/s 4) 14 m/s

281. A ball is projected vertically upwards with a velocity of 100 m/s. After 2 second, a second ball is projected vertically upwards from the same point with a velocity 110 m/s. When they meet, time taken by the first ball to meet the second one is (g = $10ms^{-2}$)

1) 6s 2) 8s 3) 10s 4) 12s

282. Two bodies are projected vertically upwards with a velocity of 49 m/s. They are projected with a time gap of 2s. After the projection of the first body, they will meet in a time of

1) 5s 2) 3s 3) 6s 4) 7s

283. A loose nut from a bolt on the bottom of an elevator which is moving up the shaft at 3m/s falls freely. The nut strikes the bottom of the shaft in 2s. Distance of the elevator from the bottom of the shaft when the nut fell off is

1) 19.6m 2) 13.6m 3) 9.8m 4) 3.8m

284. A ball is thrown vertically up with a velocity of 14.7 m/s from the top of a tower of height 49m. On its return, it misses the tower and finally strikes the ground. The time that elapsed from the instant the ball was thrown until it passes the edge of the tower is

1) 1.5s 2) 3s 3) 6s 4) 0.5s

285. A body projected up reaches a point A in its path at the end of 4th second and reaches the ground after 5 seconds from the start. The height of A above the ground is

1) 19.6 m 2) 30.6 m 3) 11 m 4) 20 m

286. If the distance travelled by a freely falling body in the last second of its journey is equal to the distance travelled in the first 2s, the time of descent of the body is

1) 5 s 2) 1.5 s 3) 2.5 s 4) 3 s

287. From an elevated point *P* a stone is projected vertically upward. When it reaches a distance y below the point of projection its velocity is double the velocity when it was at a height y above P. The greatest height reached by it above P is

1) $\frac{2y}{3}$ 2) $\frac{5y}{3}$ 3) $\frac{y}{3}$ 4) 2 y

288. A ball dropped from a point P crosses a point Q in t seconds. The time taken by it to travel from Q to R, if PQ = QR

1) t 2) $\sqrt{2}\ t$ 3) 2 t 4) $\left(\sqrt{2}-1\right)t$

289. In the above problem if S is a point such that $PQ = QR = RS,$ the time taken by the ball to travel from R to S is

1) $\left(\sqrt{2}-1\right)t$ 2) $\left(\sqrt{3}-\sqrt{2}\right)t$ 3) $\sqrt{3}\ t$ 4) $\left(\sqrt{3}-1\right)t$

290. A body projected vertically up travels a height 'h' in the nth second. The distance travelled by it in the next two seconds is

1) h + 2g 2) 2h + g 3) 2h + 2g 4)2h + 3g

291. A ball is thrown vertically upwards with a speed of $10\ ms^{-1}$ from the ground at the bottom of a tower 200 m high. Another is dropped vertically downward simultaneously, from the top of a tower. If $g = 10ms^{-2}$ the time interval after which the projected body will be at the same level as the dropped body is

1) 20 s 2) 25 s 3) $2\sqrt{10}$ s 4) 5 s

292. A body is thrown vertically up to reach its maximum height in seconds. The total time from the time of projection to reach a point at half of its maximum height while returning(in seconds) is **(2008 E)**

1. $\sqrt{2}\ t$ 2. $\left(1+\frac{1}{\sqrt{2}}\right)t$ 3. $\frac{3t}{2}$ 4. $\frac{t}{\sqrt{2}}$

293. A body is projected vertically upwards with a velocity 'u' . It crosses a point in its journey at a height 'h' twice , just after 1 and 7 seciinds .The value of u in $ms^{-1} is \left(g = 10ms^{-2}\right)$ **(2006 E)**

1. 50 2.40 3. 30 4. 20

294. A body projected vertically upwards crosses a proint twice its journey at a height '*h*' just after t_1 and t_2 seconds. Maximum height reached by the body is **(2005 E)**

1) $\frac{g}{4}\left(t_1+t_2\right)^2$ 2) $g\left(\frac{t_1+t_2}{4}\right)^2$ 3) $2g\left(\frac{t_1+t_2}{4}\right)^2$ 4) $\frac{g}{4}\left(t_1 t_2\right)$

295. Water drops fall from a tap on to the floor 5.0m below at regular intervals of time. The first drop strikes the floor when the fifth drop beings to fall. The height at which the third drop will be from ground, at the instant when the first drop strikes the ground is (Take g = $10ms^{-2}$) **(1999 E)**

1) 1.25m 2) 2.15m 3) 2.75m 4) 3.75m

296. A stone thrown vertically up from the ground reaches a maximum height of 50m in 10s. Time taken by the stone to reach the ground from maximum height is **(1996 M)**

1) 5s 2) 10s 3) 20s 4) 25s

297. A ball is thrown vertically upwards with a speed of 10 m/s from the top of the tower 200m high and another is thrown vertically downwards with the same speed simultaneously. The time difference between them in reaching the ground is (g=10 m/s^2) **(1994 E)**

1) 12s 2) 6s 3) 2s 4) 1s

298. A body freely falling from rest has a velocity 'v' after it falls through a distance 'h'. The distance it has to fall down further, for its velocity to become double ...... is times h. **(1992 E)**

1) 4h 2) 3h 3) h 4) 16h

299. A stone is dropped from the top of tall tower and after 1 second another stone is dropped from a balcony 20m below the top. If both the stones reach the ground at the same instant, then height of the tower is

1) 51.25m 2) 21.25m 3) 31.25m 4) 3.125m

300. A wooden block of mass 10 gm is dropped from the top of a cliff 100 m high. Simultaneously a bullet of mass 10 gm is fired from the foot of the cliff upward with a velocity 100 m/s. The bullet and the wooden block will meet each other after a time of **(1991 M)**

1) 10s 2) 0.5s 3) 1s 4) 7s

301. A ball is projected vertically up with a velocity of 40m/s. At the same time another ball is dropped from a height of 100m. The magnitudes of their velocities are equal after a time of (g = 10 m/s^2)

1) 2 sec 2) 1 sec 3) 3 sec 4) 4 sec

302. A stone is dropped into a lake from a lower 500m high. The sound of the splash will be heard by a man on the tower after a time of (velocity of sound in air=350 m/s)

1) 21s 2) 10s 3) 11.4s 4) 1s

303. A ball is released from the top of a tower of height h metre. It takes T seconds to reach the ground. What is the position of the ball in T/3 seconds. **(2004 A)**

1) h/9 metres from the ground 2) 7h/9 metres from the ground

3) 8h/9 metres from the ground 4) 17h/18 metres from the ground

PROJECTILES

MODEL QUESTIONS

304. A ball is thrown with a velocity of 'u' making an angle 'θ' with the horizontal. Its velocity vector is normal to initial velocity vector (u) after a time interval of

1) $\frac{u\sin\theta}{g}$ 2) $\frac{u}{g\cos\theta}$ 3) $\frac{u}{g\sin\theta}$ 4) $\frac{u\cos\theta}{g}$

305. A particle projected from the level ground just clears in its ascent a wall 30 m high and $120\sqrt{3}$ away measured horizontally. The time since projection to clear the wall is two second. It will strike the ground in the same horizontal plane from the wall on the other side at a distance of

1) $150\sqrt{3}$ m 2) $180\sqrt{3}$ m 3) $120\sqrt{3}$ m 4) $210\sqrt{3}$ m

306. A stone is projected from the top of a tower with velocity 20 m/s making an angle of elivigation of 30^0 with the horizontal. If the total time of flight is 5s and g = 10 ms^{-2}, then

1) the height of the tower is 75m

2) the maximum height of the stone from the ground is 80m

3) both the above are true

4) the height of the tower is 120m

307. A stone is projected with velocity 80 m/s making an angle of 30^0 with the horizontal. The horizontal component of its velocity after 2 second is($g=10\ ms^{-2}$)

1) 40 m/s   2) $40\sqrt{3}$ m/s   3) 20 m/s   4) $20\sqrt{3}$ m/s

308. A grass hopper can jump a maximum horizontal distance of 0.3 m. If it spends negligible time on the ground, its horizontal component of velocity is ($g=10\ m/s^2$)

1) 3/2 m/s   2) $\sqrt{\frac{3}{2}}$ m/s   3) 1/2 m/s   4) $\sqrt{\frac{2}{3}}$ m/s

309. A body is projected with a velocity u at an angle of 60^0 to the horizontal. The time interval after which it will be moving in a direction of 30^0 to the horizontal is

1) $\frac{1}{\sqrt{3}}\frac{u}{g}$ 2) $\frac{\sqrt{3}u}{g}$ 3) $\frac{\sqrt{3}u}{2g}$ 4) $\frac{2u}{\sqrt{3}g}$

310. A gun mounted on the top of a moving truck is aimed in the backward direction at angle of 30^0 to the vertical. If the muzzle velocity of the gun is 4 m/s, the speed of the truck to send the bullet vertically up is

1) 1 m/s   2) $\frac{\sqrt{3}}{2}$ m/s   3) 0.5 m/s   4) 2 m/s

311. Two second after projection, a projectile is moving at 30^0 above the horizontal. After one more second it is moving horizontally. Angle of projection is ($g = 10\ m/s^2$)

1) 0^0 2) 45^0 3) 60^0 4) 90^0

312. A particle of mass 1 kg is projected at an angle 45^0 to the horizontal with an initial velocity of 20 m/s. Change in momentum during its time of flight is

1) $10\sqrt{2}$ kg m/s   2) $20\sqrt{2}$ kg m/s   3) $30\sqrt{2}$ kg m/s   4) $40\sqrt{2}$ kg m/s

313. A player kicks a foot ball obliquely at a speed of 20 m/s so that its range is maximum. Another player at a distance of 24m away in the direction of kick starts running at that instant to catch the ball. Before the ball hits the ground to catch it, the speed with which the second player has to run is ($g=10\ ms^{-2}$)

1) $4\ m/s^{-1}$ 2) $4\sqrt{2}\ m/s^{-1}$ 3) $8\sqrt{2}\ m/s^{-1}$ 4) $8\ m/s^{-1}$

314. A bullet fired at an angle of 15^0 with the horizontal hits the ground 6 km away. Keeping the same velocity of projection for the bullet to attain a range of 12 km, the angle of projection is

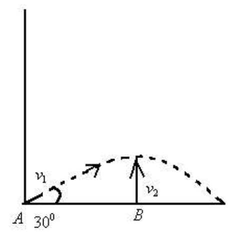
1) 15^0 2) 30^0 3) 45^0 4) 60^0

315. If 4 seconds be the time in which a projectile reaches a point P of its path and 5 seconds the time from P till it reaches the horizontal plane through the point of projection. The

height of P from the horizontal plane is

1) 78.4 m   2) 98 m   3) 122.5m   4) 220.5 m

316. A body is projected with velocity v_1 from the point A as shown in Fig. 3.39. At the same time another body is thrown vertically upward from with velocity v_2. The point B lies vertically below the highest point. For both the bodies to collide, $\frac{v_2}{v_1}$ should be



1) $\frac{1}{2}$ 2) $\sqrt{\frac{3}{2}}$ 3) 2   4) 1

317. If the velocity of a particle at greatest height is $\sqrt{2/5}$ times of its velocity when it is at half of the greatest height. The angle of projection is

1) 30^0 2) 37^0 3) 60^0 4) 45^0

318. A projectile has initial the same horizontal velocity as it would acquired if it had moved from rest with uniform acceleration of $3ms^{-2}$ of 0.5 min. If the minimum height reached by it is 80m, then the angle of projection is $\left(g = 10ms^{-2}\right)$

1) $\tan^{-1}(3)$ 2) $\tan^{-1}(3/2)$ 3) $\tan^{-1}(4/9)$ 4) $\sin^{-1}(4/9)$

319. A body is thrown with a velocity of $\left(4\hat{i}+3\hat{j}\right)$ m/s. The maximum height attained by the body is (g = 10ms^{-2})

1) 2.5m   2) 0.8m   3) 0.9m   4) 0.45m

320. A body projected obliquely with velocity 19.6 m/s has its kinetic energy at the maximum height equal to 3 times its potential energy. Since projection from the ground, its position after 1s is (h = maximum height)

1) $\frac{h}{2}$ 2) $\frac{h}{4}$ 3) $\frac{h}{3}$ 4) h

321. A ball is thrown with velocity $8\ ms^{-1}$ making an angle 60° with the horizontal. Its velocity will be perpendicular to the direction of initial velocity of projection after a time of

$(g = 10 \ ms^{-2})$

1) $\frac{1.6}{\sqrt{3}}$ s 2) $\frac{4}{\sqrt{3}}$ s 3) 0.6 s 4) $1.6\sqrt{3}$ s

322. When a body is projected from a level ground the ratio of its speed in the vertical and horizontal direction is 4 : 3. If the velocity of projection is u, the time after which, the ratio of the velocities in the vertical and horizontal directions are reversed is

1) $\frac{7u}{20g}$ 2) $\frac{35u}{10g}$ 3) $\frac{9u}{g}$ 4) $\frac{10u}{g}$

323. A ball is thrown from a point with a speed V_0 at an angle of projection θ. From the same point and at the same instant a person starts running with a constant speed $V_0/2$ to catch the ball . Will the person be able to catch the ball ? If yes, what should be the angle of projection ?**(2004 A)**

1) $yes, 60^0$ 2) $yes, 30^0$ 3) no 4) $yes, 45^0$

324. A projectile is fired with a speed 'u' at an angle 'θ' with the horizontal. Its speed when its direction of motion makes an angle 'α' with the horizontal is

1) $u\cos\theta$ 2) $u\cos\theta \sec\alpha$ 3) $u\cos\theta \sin\alpha$ 4) $u\cos\theta \cos\alpha$

325. A body is projected with velocity 'u' making an angle α with the horizontal. Its velocity when it is perpendicular to the initial velocity vector 'u' is

1) $u\sin\alpha$ 2) $u\cot\alpha$ 3) $u\tan\alpha$ 4) $u\cos\alpha$

326. A stone of mass 'm' is projected with a velocity 'u' at an angle 45^0 to the horizontal. It angular momentum about the point of projection when it is at its highest point

1) $\frac{mu^3}{4\sqrt{2}g}$ 2) $\frac{mu^2}{4g}$ 3) $\frac{mu}{\sqrt{2}}$ 4) $\frac{2mu^3}{g}$

327. The maximum height reached by projectile is 4 metres. The horizontal range is 12m. Velocity of projection in m/s is (g - acceleration due to gravity)
(2004 M)

1) $5\sqrt{\frac{g}{2}}$ 2) $3\sqrt{\frac{g}{2}}$ 3) $\frac{1}{3}\sqrt{\frac{g}{2}}$ 4) $\frac{1}{5}\sqrt{\frac{g}{2}}$

PRACTICE QUESTIONS

328. A ball of mass 'm' is thrown vertically upwards. Another ball of mass '2m' is thrown up making an angle 'θ' with the vertical. Both of them stay in air for the same time. Their maximum heights are in the ratio

1) 2:1 2) 1:1 3) 1: $\cos\theta$ 4) 1: $\sec\theta$

329. A particle having a mass of 0.5kg is projected with a speed of 98 ms^{-1} at an angle of 60^0. The magnitude of change of momentum of th particle after 10 seconds in N-S is

1) 0.5 2) 49 3) 98 4) 490

330. A javelin thrown into air at an angle with the horizontal has range of 200m. If the time of flight is 5 second, then the horizontal component of velocity of the projectile at the highest point of the trajectory is

1) 40 m/s 2) 0 m/s 3) 9.8 m/s 4) infinite

331. A boy playing on the roof a of a 10m high building thrown a ball with a speed of 10m/s at an angle 30^0 with horizontal. How far from the throwing piont will the ball be at the height of 10m from the ground $\left(g = 10m/s^2\right)$ **(2003 A)**

1) 5.20m 2) 4.33m 3) 2.60m 4) 8.66m

332. A projectile shot at an angle of 45^0 above the horizontal strikes the wall of a building 30m away at a point 15m above the point of projection. Initial velocity of the projectile is

1) 14 m/s 2) $14\sqrt{2}$ m/s 3) $14\sqrt{3}$ m/s 4) $14\sqrt{5}$ m/s

333. The equation of trajectory of a projectile is $y = 10x - \left(\frac{5}{9}\right)x^2$ (m) , The maximum height reached is **(2005 E)**

1) 36m 2) 24m 3) 18m 4) 9m

334. Two bodies are projected with the same velocity. One body is projected at an angle of 30^0 and the other at an angle of 60^0 to the horizontal. The ratio of the maximum heights reached is**(1995E)**

1) 3:1 2) 1:3 3) 1:2 4) 2:1

335. The maximum height reached is

1) $\frac{2A^2}{B}$ 2) $\frac{A^2}{2B}$ 3) $\frac{A^2}{4B}$ 4) $\frac{2A^2}{3B}$

336. Four projectiles are projected with the same speed at angles 20^0, 35^0, 60^0 and 75^0 with the horizontal. The range will be the longest for the projectile whose angle of projection is

1) 20^0 2) 35^0 3) 60^0 4) 75^0

TRAJECTORY OF AN OBNLIQUE PROJECTILE

MODEL QUESTIONS

337. The variation of horizontal and vertical distances with time are given by $y = 8t - 4.9t^2$, $x = 6t$ with MKS units. Then, the velocity of projection is

1) 8 m/s 2) 6 m/s 3) 10 m/s 4) 14 m/s

338. In the above problem, angle of projection is

1) $\tan^{-1}(3/4)$ 2) $\tan^{-1}(4/3)$ 3) $\sin^{-1}(3/4)$ 4) $\cos^{-1}(3/4)$

339. If the angle of projection is 60^0, the height of the projectile when it has travelled a distance $\frac{3R}{4}$ Where R is the range

1) $\frac{3\sqrt{3}R}{16}$ 2) $\frac{2}{3}R$ 3) $\frac{\sqrt{3}R}{16}$ 4) $\frac{4}{5}R$

340. In the same problem, the total time of flight is

1) $\sqrt{\frac{A}{Bg}}$ 2) $\sqrt{\frac{AB}{g}}$ 3) $A\sqrt{\frac{2}{Bg}}$ 4) $B\sqrt{\frac{2}{Ag}}$

PRACTICE QUESTIONS

341. The parabolic path of a projectile is represented by $y = \frac{x}{\sqrt{3}} - \frac{x^2}{60}$ in MKS units : Its angle of projection is ($g = 10ms^{-2}$)

1) 30^0 2) 45^0 3) 60^0 4) 90^0

342. A body is projected with a velocity of 20 m/s making an angle 45^0 with the horizontal. Its path is represented by ($g = 10ms^{-2}$)

1) $y = x - \frac{x^2}{20}$ (m) 2) $y = x - \frac{x^2}{40}$ (m) 3) $\sqrt{3}x - \frac{x^2}{40}$ (m) 4) $\frac{x}{\sqrt{3}} - \frac{x^2}{40}$ (m)

343. An object is projected with a velocity of $20ms^{-1}$ making an angle 45° with the horizontal. The equation of the trajectory is $y = Ax - Bx^2$, where y is height and x is horizontal distance. Then $A^2/4B$ is ($g = 10\ m\ s^{-2}$)

1) 10m 2) 5m 3) 40m 4) 1m

344. The horizontal and vertical displacements of a projectile at a time 't' are x = 36t, y = 48t - $4.9t^2$ respectively. Initial velocity of the projectile is (in m/s)
(2002M)

1) 15 2) 30 3) 45 4) 60

345. An object is projected with a velocity of 20 ms^{-1} making an angle of 45^0 with horizontal. The equation of the trajectory is $h = Ax-Bx^2$(m) where 'h' is the height, 'x' is the horizontal distance, A and B are constants. The ratio A to B is ($g = 10m/s^2$) **(2001E)**

1) 1:5 2) 5:1 3) 1:40 4) 40:1

346. The distances covered by a particle thrown in a vertical plane, in horizontal and vertical directions at any instant of time 't' are x = 3t and $y = 4t - 4t^2$. The range of the particle

1) 3 m 2) 4 m 3) 2.4 m 4) 5 m

347. In the above problem, acceleration due to gravity is

1) -10 m/s^2 2) 5 m/s^2 3) 20 m/s^2 4) 2.5 m/s^2

TIME OF FLIGHT (OBLIQUE PROJECTILE)

MODEL QUESTIONS

348. A body is projected with a velocity 'u' making an angle 'θ' with horizontal. The time after which its vertical component of velocity is equal to horizontal component is

1) $\frac{u}{g\sin\theta}$ 2) $\frac{u}{g}(\sin\theta - \cos\theta)$ 3) $\frac{u}{g\cos\theta}$ 4) $\frac{u}{g}(\cos\theta - \sin\theta)$

PRACTICE QUESTIONS

349. The maximum height reached by a projectile is 'h'. Its time of flight is

1) $\sqrt{\frac{4h}{g}}$ 2) $\frac{8h}{g}$ 3) $\sqrt{\frac{8h}{g}}$ 4) $\sqrt{\frac{16h}{g}}$

350. A ball is projected at an angle of 30^0 and 60^0 to the horizontal with the same initial velocity in each case. Ratio of their times of flight is

1) 1:1 2) 1:3 3) 1:$\sqrt{3}$ 4) 2:$\sqrt{3}$

MAXIMUM HEIGHT (OBLIQUE PROJECTILE)

MODEL QUESTIONS

351. Two stones are projected with the same speed but making different angles with the horizontal. Their horizontal ranges are equal. The angle of projection of one is $\pi/3$ and the maximum height reached by it is 102m. Then the maximum height reached by the other in metres is **(2003M)**

1) 336 2) 224 3) 56 4) 34

PRACTICE QUESTIONS

352. In the above problem, ratio of maximum height is

1) 1:1 2) 1:3 3) 1:$\sqrt{3}$ 4) 2:$\sqrt{3}$

353. For a projectile, the ratio of maximum height reached to the square of flight time is ($g=10ms^{-2}$) **(2000 E)**

1) 5:4 2) 5:2 3) 5:1 4) 10:1

HORIZONTAL RANGE

MODEL QUESTIONS

354. In the above problem, ratio of ranges is

1) 1:1 2) 1:3 3) 1:$\sqrt{3}$ 4) 2:$\sqrt{3}$

355. The horizontal range of a projectile is $4\sqrt{3}$ times the maximum height achieved by it, then the angle of projection is

1) 30^0 2) 45^0 3) 60^0 4) 90^0

356. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the time of flights in the two cases, then the product of the two time of flights is directely proportional to **(2004 A)**

1) $1/R^2$ 2) $1/R$ 3) R 4) R^2

357. If the range and maximum height of a projectile are respectively 'R' and 'H', the maximum range that could be obtained with the same velocity of projection is

1) 4H 2) 2R 3) $2H+\frac{R^2}{8H}$ 4) $2R+\frac{H^2}{8R}$

PRACTICE QUESTIONS

358. The speed of a projectile at the maximum height is half of its initial speed. Its horizontal range is

1) $\frac{u^2}{\sqrt{3}g}$ 2) $\frac{2u^2}{\sqrt{3}g}$ 3) $\frac{\sqrt{3}}{2}.\frac{u^2}{g}$ 4) $\frac{\sqrt{3}u^2}{g}$

359. The horizontal and vertical displacements x and y of a projectile at given time *t* are given by $x=6t$ (m) and $y=8t-5t^2$ (m). The range projectile in metres is **(2004 E)**

1) 9.6 2) 10.6 3) 19.2 4) 38.4

360. It is possible to project a particle with a given speed in two possible ways so that it has the same horizontal range R. The product of the times taken by it in the two possible ways is**(2001M)**

1) $\frac{R}{g}$ 2) $\frac{2R}{g}$ 3) $\frac{3R}{g}$ 4) $\frac{4R}{g}$

TWO ANGLES OF PROJECTION FOR THE SAME RANGE

MODEL QUESTIONS

361 A body is projected with the same speed at two different angles such that the horizontal range is same in both the cases. If the maximum height attained are 20m and 80m respectively in the above two cases, then the range is

1) 120 m 2) 20 m 3) 160 m 4) 40 m

HORIZONTAL PROJECTILE

MODEL QUESTIONS

362. Two paper screens A and B are separated by a distance of 100 m. A bullet pierces A and then B. The hole in B is 10 cm below the hole in A. If the bullet is travelling horizontally at A, velocity of the bullet at A is (g=9.8 m/s^2)

1) 500 m/s 2) 700 m/s 3) 800 m/s 4) 900 m/s

363. A particle is projected horizontally with a speed 10 ms^{-1} at time t = 0 from the top of a tower of height 100m. What is the magnitude of tangential acceleration of the particle at time t =1 sec ? (g = 10 ms^{-2})

1) 10 ms^{-2} 2) $10\sqrt{2}ms^{-2}$ 3) $5\sqrt{2}ms^{-2}$ 4) 5 ms^{-2}

364. From the top of a building 80 m high, a ball is thrown horizontally which hits the ground at a distance. The line joining the top of the building to the point where it hits the ground makes an angle of 45^0 with the ground. Initial velocity of projection of the ball is(g=10 m/s^2)

1) 10 m/s 2) 15 m/s 3) 20 m/s 4) 30 m/s

365. A stone is thrown horizontally from the top of the tower of height 'h' such that the line joining the point of projection and the point of striking makes an angle 60^0 with the horizontal. The velocity of projection of the stone is

1) $\sqrt{\frac{gh}{6}}$ 2) $\sqrt{\frac{2gh}{3}}$ 3) $\sqrt{\frac{gh}{2}}$ 4) $\sqrt{3gh}$

366. A ball rolling off the top of a staircase of each step with height H and width W, with an initial velocity U will just hit n^{th} step. Then n =

1) $\frac{2U^2H^2}{gW}$ 2) $\frac{2U^2H^2}{gW^2}$ 3) $\frac{2U^2H}{gW^2}$ 4) $\frac{2UH^2}{W^2}$

367. In the above problem, if H = 20cm, W = 30cm, U = 18 kmph, then n = (g = 10 m/s^2)

1) 11.1 2) 6.5 3) 8.3 4) 12.8

368. A body of mass 'm' is projected horizontally with a velocity 'v' from the top of a tower of height 'h' and it reaches ground at a distance 'x' from the top of a tower. If a second body of mass '2m' is projected horizontally from the top of a tower of height 2h, it reaches the ground at a distance '2x' from the tower. The horizontal velocity of second body is

1) v 2) 2v 3) $\sqrt{2v}$ 4) $v/2$

369. A fighter plane flying horizontally at an attitude of 2 km with speed of 540 kmph passes directly over head an anti aircraft gun. If the gun can fire a bullet at the muzzles speed of 500 ms^{-1}. at what angle with the vertical the gun should fire the bullet so that the bullet hits the plane ?

1) $\cos^{-1}\left(\frac{3}{10}\right)$ 2) $\sin^{-1}\left(\frac{3}{10}\right)$ 3) $\tan^{-1}\left(\frac{3}{10}\right)$ 4) 45°

370. Two thin wood screens A and B are separated by 200 m. A bullet travelling horizontally at a spped of 600ms^{-1} hits the screen A, penetrates through it and finally emerges out from B making holes in A and B. If the resistance of air and wood are negligible, the difference of heights of the holes in A and B is

1) 5 m 2) $\frac{49}{90}$ m 3) $\frac{7}{\sqrt{90}}$ m 4) zero

371. A body is projected horizontally from the top of a hill with a velocity of 9.8m/s. What time elapses before the vertical velocity is twice the horizontal velocity ?

1) 0.5sec 2) 1 sec 3) 2 sec 4) 1.5 sec

372. A ball is rolled off along the edge of table(horizontal) with velocity 3m/s. It hits the ground after time 0.4s. Which one of the following is wrong ?

1) The height of the table is0.8 m

2) It hits the ground at an angle of 60^0 with the verticle.

3) It covers a horizontal distance 1.2m from the table.

4) It hits the ground with verticle velocity 4m/s.

PRACTICE QUESTIONS

373. Two tall buildings are 80 m apart. The velocity with which a ball should be thrown horizontally from a window 95 m above the ground in one building so that it will enter a window 15 m above the ground in the second building is (g=10 m/s^2)

1) 15 m/s 2) 5 m/s 3) 10 m/s 4) 20 m/s

374. A marble travelling at 100 cm/s rolls of the edge of a level table. It hits the floor 30 cm away from the spot directly below the edge of the table. Height of the table is

1) 44 cm 2) 100cm 3) 30 cm 4) 70 cm

375. A body is projected downwards at an angle of 30^0 with the horizontal from the top of a building of height 300m. Its initial speed is 40 m/s. Time taken by it to hit the ground is (g = 10 m/s^2)

1) 2s 2) 4s 3) 6s 4) 8s

376. From the top of a tower of height 78.4 m two stones are projected horizontally with 10 m/s and 20 m/s in opposite directions. On reaching the ground, their separation is

1) 120 m 2) 100 m 3) 200 m 4) 150 m

377. An aeroplane is flying horizontally at a height of 980 m with velocity 100 ms^{-1} drops a food packet. A person on the ground is 414 m ahead horizontally from the dropping point. At what velocity should he move so that he can catch the food packet.

1) $50\sqrt{2}ms^{-1}$ 2) $\frac{50}{\sqrt{2}}ms^{-1}$ 3) $100ms^{-1}$ 4) $200ms^{-1}$

378. A body is projected horizontally from the top of a high tower with a speed of 20ms^{-1}. After 4 seconds, the displacement of the body is (g = 10 ms^{-2})

1) 40m 2)80m 3) $80\sqrt{2}$ m4) $\frac{80}{\sqrt{2}}m$

379. At a certain height a shell at rest explodes into two equal fragments. One of the fragments receives a horizontal velocity u. The time interval after which, the velocity vectors will

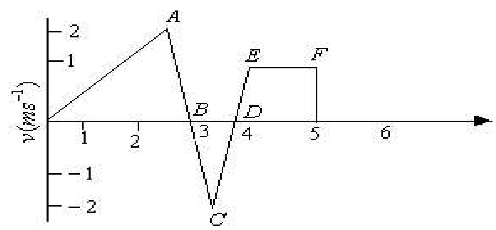
be inclined at 120° to each other is

1) $\frac{u}{\sqrt{3}g}$ 2) $\frac{\sqrt{3}u}{g}$ 3) $\frac{2u}{\sqrt{3}g}$ 4) $\frac{u}{2\sqrt{3}g}$

GRAPHS

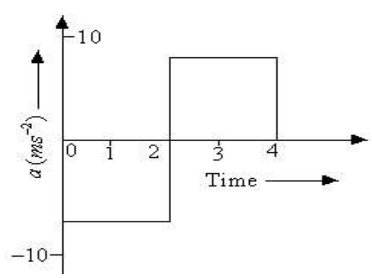
MODEL QUESTIONS

380. The velocity time graph of a body is as follows. What is the displacement in 5 sec?



1) 2m 2) 3m 3) 4m 4) 5m

381. A particle starts from rest at t = 0 and moves on a straight line with acceleration as shown graphically. The speed will be maximum after

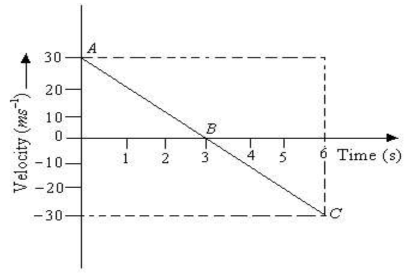


1) 1 sec 2) 2 sec 3) 3 sec 4) 4 sec

382. The distance time graph of a particle t makes an angle of 45^0 with time axis. After 1 second it makes an angle of 60^0 with time axis, what is the acceleration of the particle?

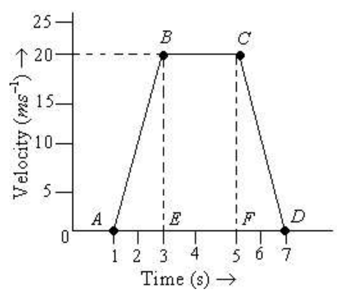
1) $\sqrt{3}-1$ 2) $\sqrt{3}+1$ 3) $\sqrt{3}$ 4) 1.

383. The velocity-time graph of a stone thrown vertically upward with an initial velocity of $30ms^{-1}$ is shown in the figure. The velocity in the upward direction is taken as positive and that in the downward direction as negative. What is the maximum height to which the stone rises?



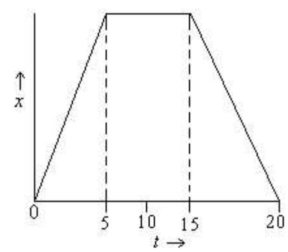
1) 30 m 2) 45 m 3) 60 m 4) 90 m

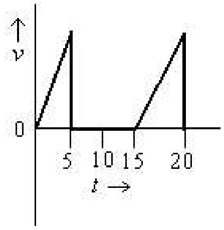
384. For the velocity-time graphs shown in figure, the total distance covered by the particle in the last two seconds of its motion is what fraction of the total distance convered by it in all the seven seconds?

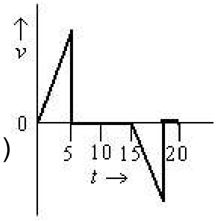


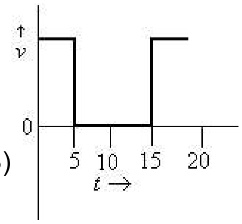
1) 1/8 2) 1/6 3) 1/4 4) 1/2

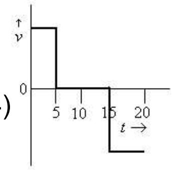
385. Figure shows the displacement-time $(x-t)$ graph of a body moving in a straight line. Which one of the graphs shown in figure represents the velocity-time $(v-t)$ graph of the motion of the body.



1) 

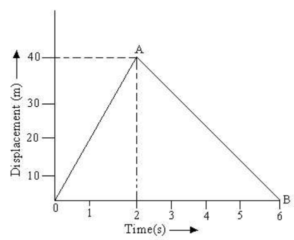
2) 

3) 

4) 

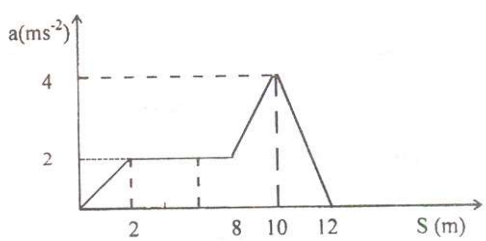
MODEL QUESTIONS

386. The displacement-time graph of a motion is shown in Fig. The ratio of the magnitudes of the speeds during the first two seconds and the next four seconds is



1) 1 : 1 2) 1 : 2 3) 2 : 1 4) $1:\sqrt{2}$

387. The acceleration - displacement graph of a particle moving in a straight line is given below. The initial velcoity of the particle is zero. When displacement of the particles is s = 12m, then the velocity of the particle is



1) $4\sqrt{3}\,m\,s^{-1}$ 2) $4\,m\,s^{-1}$ 3) $\sqrt{3}\,m\,s^{-1}$ 4) $12\,m\,s^{-1}$.

388. The position of a particle moving on a stright line path is given by $x = 12 + 18t + 9t^2$ metre. Its acceleration at any instant is

1) $18\,ms^{-2}$ 2) $45\,ms^{-2}$ 3) $9\,ms^{-2}$ 4) $12\,ms^{-2}$

389. A car moves along a straight line whose equation of motion is given by $s = 12t + 3t^2 - 2t^3$, where s is in meters and t in seconds. The velocity of car at start will be

1) 7 m/s 2) 9 m/s 3) 12 m/s 4) 16 m/s

LEVEL -III

MODEL QUESTIONS

390. Three persons A, B and C at the corners of an equilateral triangle of side 'x' move at a constant speed 'v'. Each person maintains a direction towards the person at the next corner. The time, the persons will take to meet each other is

1) $\frac{2x}{3v}$ 2) $\frac{2x}{v}$ 3) $\frac{x}{v}$ 4) $\frac{4x}{3v}$

391. In the above problem if it is a square with four persons A,B,C and D at the corners, their time of meeting is

1) $\frac{2x}{3v}$ 2) $\frac{2x}{v}$ 3) $\frac{x}{v}$ 4) $\frac{3x}{4v}$

392. In the above problem, if six persons are at the corners of a regular hexagon, the time of meeting is

1) $\frac{2x}{3v}$ 2) $\frac{2x}{v}$ 3) $\frac{x}{v}$ 4) $\frac{5x}{6v}$

393. A motor boat going down stream crosses a float at a point A . 60 minutes later it turned back and after some time passed the float at a distance of 12 km from the point A. The velocity of stream

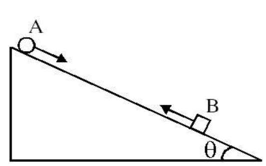
1) 8 kmph 2) 4 kmph 3) 6 kmph 4)10 kmph

394. Two cars start in a race with velocities u_1 and u_2 and travel in a straight line with acceleration 'α' and β. If both reach the finish line at the same time, the range of the race is

1) $\frac{2(u_1-u_2)}{(\beta-\alpha)^2}(u_1\beta-u_2\alpha)$ 2) $\frac{2(u_1-u_2)}{\beta+\alpha}(u_1\alpha-u_2\beta)$

3) $\frac{2(u_1-u_2)^2}{(\beta-\alpha)^2}$ 4) $\frac{2u_1u_2}{\beta\alpha}$

395. A mass 'A' is released from the top of a frictionless inclined plane 18m long and reaches the bottom 3 sec. later. At the instant when 'A' is released a second mass 'B' is projected upwards along the plane, from the bottom with a certain velocity. The mass travels a certain distance up the plane, stops and returns to the bottom so that it arrives simultaneously with 'A'. The two masses do not collide with each other. The initial velocity of 'B' is



1) 7 ms^{-1} 2) 2.25 ms^{-1} 3) 6 ms^{-1} 4) 3 ms^{-1}

396. The initial velocity of a particle $\vec{u} = 4\vec{i} + 3\vec{j}$. It is moving with uniform acceleration $\vec{a} = 0.4\vec{i} + 0.3\vec{j}$. Its velocity after 10 seconds is

1) 3 units 2) 4 units 3) 5 units 4) 10 units

397. A body is at A, B, C, D after successive equal intervals of time. If 'O' is a point in the same line ABCD and distances of A, B, C, D from 'O' are respectively a, b, c, d then (a – d) is equal to (the body is moving with uniform acceleration)

1) (b – c) 2) 2 (b – c) 3) 3 (b – c) 4) 4 (b – c)

398. A point moves with uniform acceleration v_1, v_2 and v_3 denote the average velocities in three successive intervals of time t_1, t_2 and t_3. Correct relation among the following is

1) $(v_1 - v_2) : (v_2 - v_3) = (t_1 - t_2) : (t_2 - t_3)$
2) $(v_1 - v_2) : (v_2 - v_3) = (t_1 + t_2) : (t_2 + t_3)$
3) $(v_1 - v_2) : (v_2 - v_3) = (t_1 - t_2) : (t_2 + t_3)$
4) $(v_1 - v_2) : (v_2 - v_3) = (t_1 + t_2) : (t_2 - t_3)$

399. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerate at the rate $\frac{f}{2}$ to come to rest. If the total distance travelled is 15S, then

1) $S = ft$ 2) $S = \frac{1}{6}ft^2$ 3) $S = \frac{1}{72}ft^2$ 4) $S = \frac{1}{4}ft^2$

400. Two balls of equal masses are thrown upwards along the same vertical line at an interval of 2 seconds with the same initial velocity of $39.2\ \text{ms}^{-1}$. The total time of flight of each ball, if they collide at a certain height, inelastically will be

1) 5s and 3s
2) 10 s and 6 s
3) $5\sqrt{15}$ s and $3\sqrt{15}$ s
4) $(5+\sqrt{15})$s and $(3+\sqrt{15})$s

401. A man in a lift ascending with an upward acceleration throws a ball vertically upwards and catches it after t_1 second. Later when the lift is descending with the same acceleration, the man throws the ball up again with same velocity and catches it after t_2 second.

1) the acceleration of the elevator is $g\frac{(t_2 - t_1)}{(t_1 + t_2)}$

2) the velocity of projection of the ball relative to elevator is $\frac{t_2 t_1 g}{t_1 + t_2}$. We can conclude that.

1) only A is true
2) only B is true
3) Both A and B is true
4) Both A and B are false

KINEMATICS

402. A ball is projected from the bottom of a tower and is found to go above the tower and is caught by the thrower at the bottom of the tower after a time interval t_1. An observer at the top of the tower finds the same ball go up above him and then come back to his level in a time interval t_2. The height of the tower is

1) $\frac{1}{2}gt_1t_2$ 2) $\frac{gt_1t_2}{8}$ 3) $\frac{g}{8}\left(t_1^2-t_2^2\right)$ 4) $\frac{g}{2}\left(t_1-t_2\right)^2$

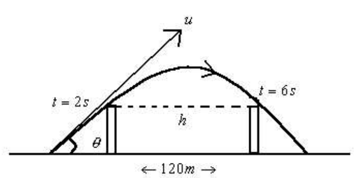
403. An elevator ascends with an upward acceleration of 0.2 ms^{-2} At the instant its upward speed is $2\ m/s$, a loose bolt 5 m high from the floor drops from the ceiling of the elevator. The time taken by the bolt to strike the floor and the distance it has fallen are

1) 1 s, 1.9 m 2) 1 s, 2.9 m 3) 1 s, 4.9 m 4) 1s, 3.9 m

404. The friction of the air causes a vertical retardation equal to 10% of the acceleration due to gravity. Take $g=10m/s^2$. The maximum height and time to reach the maximum height will be dereased by

1) 9%, 9% 2) 11%, 11% 3) 9%, 10% 4) 11%, 9%

405. If a prjectile crosses two wallls of equal height h symmetrically as shown in the fig. Choose the correct statement (s) $\left(g=10m/s^2\right)$



1) The time of flight is 8 sec

2) The height of each wall is 60 m

3) The maximum height of projectile is 80m

4) All the above

406. In the above problem the direction of velocity of projection with respect to x-axis is

1) $\tan^{-1}(3/4)$ 2) $\tan^{-1}(4/3)$ 3) $\sin^{-1}(3/4)$ 4) $\cos^{-1}(3/4)$

407. A car is moving horizontally along a straight line with constant speed $30m/s$. A projectile is to be fired from the moving car in such a way that it will return to the car after the car has moved through $60\sqrt{3}m$. The speed and angle at which the projectile must be projected are respectively

1. $20\sqrt{3}m/s;45^0$ 2. $20m/s;30^0$ 3. $20\sqrt{3}m/s;30^0$ 4. $20\sqrt{3}m/s;60^0$

PRACTICE QUESTIONS

408. An election starting from rest has a velocity that increases linearly with time that is v=kt

where k=2m/s^2. Distance covered in first 3s will be

1) 9m 2) 16m 3) 27m 4) 36m

409. The driver of an express train travelling at a speed of v_1 sees on the same track at distance 'd' in front of him a goods train travelling in the same direction at a speed v_2. Immediately he applies brakes to his express train producing retardation 'a' to avoid collision. Then

1) $a < \frac{v_1^2 - v_2^2}{2d}$ 2) $a < \frac{(v_1 - v_2)^2}{2d}$ 3) $a > \frac{(v_1 - v_2)^2}{2d}$ 4) $a > \frac{v_1^2 - v_2^2}{2d}$

410. A particle starts with a velocity 200 cm/s and moves in a straight line with a retardation of 10 cm/s^2. Its displacement will be 1500 cm

1) Only once after 30s from start 2) Only once after 10s

3) Twice after 10s and 30s 4) Always

411. The position of a body is given as a function of time by the relation, $x = 2t^3 - 6t^2 + 12t + 6$. The acceleration of the body is zero after a time

1) 1s 2) 2s 3) $2\sqrt{2}$ s 4) 3s

412. Velocity of a body in time 't' is according to the equation ($v=20+0.1t^2$). The body is undergoing

1) Uniform acceleration 2) Uniform retardation

3) Non uniform acceleration 4) Zero acceleration

413. A parachutist after bailing out falls for 10s without friction. When the parachute opens he descends with an acceleration of 2 m/s^2 against his direction and reached the ground with 4 m/s. From what height he has dropped himself? (g = 10m/s^2)

1) 500m 2) 2496m 3) 2996m 4) 4296m

414. In the above problem the total journey time is

1) 10s 2) 48s 3) 38s 4) 58s

415. A boy standing on an open car throws a ball vertically upwards with a velocity of 9.8 m/s, while moving horizontally with uniform acceleration of 1 m/s^2 starting from rest. The ball will fall behind the boy on the car at a distance of

1) 1m 2) 2m 3) 3m 4) 4m

416. A particle is projected with velocity $2\sqrt{gh}$ so that it just clears two walls of equal height h which are distance 2h from each other. The time interval for which the particle travels between the two walls is

1) $2\sqrt{\frac{h}{g}}$ 2) $\sqrt{\frac{h}{g}}$ 3) $\sqrt{\frac{2h}{g}}$ 4) $\sqrt{\frac{h}{2g}}$

417. A projectile is thrown in to space so as to have the maximum possible horizontal range equal to 400m. Taking the point of projection as the origin, the co-ordinate of the point where the velocity of the projectile is minimum are

1) (400, 200) 2) (200, 200) 3) (400, 100) 4) (200, 100)

KINEMATICS

418. Two coordinates of moving particle at any time t are given by $x = at^2$ and $y = bt^2$. The velocity magnitude of the particle

1) $2t(a+b)$ 2) $2t\sqrt{a^2-b^2}$ 3) $2t\sqrt{a^2+b^2}$ 4) $\sqrt{a^2+b^2}$

419. A body has an initial velocity of 3m/s and has an acceleration of 1m/sec^2 normal to the direction of the initial velocity. Then its velocity 4 seconds after the start is

1) 7 m/sec along the direction of initial velocity

2) 7 m/sec along the normal to the direction of initial velocity

3) 7m/sec mid-way between the two directions

4) 5m/sec at an angle of $\tan^{-}\left(\frac{4}{3}\right)$ with the direction of initial velocity

420. A body moves with velocity v, 2v and 3v in the first second and third, one-third distance of the path every time travelled. Its average velocity is

1) $(36/11)\ v$ 2) $(18/11)\ v$ 3) $(6/11)\ v$ 4) $(12/11)\ v$

421. A car starts from rest and accelerates at uniform rate of $5m/s^2$ for some time, then moves with contant speed for some time and retards at the same uniform rate and comes to rest. Total time for the journey is 25 sec and average speed for the journey is 20 m/s. How long does the car move with constant speed?

1) 10 sec 2) 12 sec 3) 15 sec 4) 18 sec

422. The motors of an electric train can give it an acceleration of $1ms^{-2}$ and the brakes can give a negative acceleration of $3ms^{-2}$. The shortest time in which the train can make a trip between two stations 1350 m apart is

1) $113.6s$ 2) $60.0s$ 3) $245.4s$ 4) $14.2s$

423. A body moves in a straight line along Y-axis. Its distance y (in metre) from the origin is given by $y = 8t - 3t^2$. The average speed in the time interval from t = 0 second to t = 1 second is

1) $-4ms^{-1}$ 2) zero 3) $5ms^{-1}$ 4) $6ms^{-1}$

424. A body is dropped from the roof of a muit-storeyed building. It passes the ceiling of the 15th storey at a speed of $20ms^{-1}$. If the height of each storey is 4m, the number of storeys in the building is (take $g = 10ms^{-2}$ and neglect air resistance)

1) 20 2) 25 3) 30 4) 35

425. The velocity acquired by a body when it falls through a height h is v. If it further falls through a height $x(x << h)$, the increase in velocity is approximately

1) $\frac{vx}{2h}$ 2) $\frac{2v}{xh}$ 3) $\frac{2vx}{h}$ 4) $\frac{v}{2xh}$

426. A ball is thrown vertically upwards. It was observed at a height h twice with a time interval Δt . The initial velocity of the ball is

1) $\sqrt{8gh+g^2(\Delta t)^2}$ 2) $\sqrt{8gh+\left(\frac{g^2\Delta t}{2}\right)^2}$

3) $\frac{1}{2}\sqrt{8gh+g^2(\Delta t)^2}$ 4) $\sqrt{8gh+4g^2(\Delta t)^2}$

427. A body is projected with a velocity u. It passes through a certain point above the gound after t_1 sec. The time after which the body passes through the same point during the return journey is

1) $\left(\frac{u}{g}-t_1^2\right)$ 2) $2\left(\frac{u}{g}-t_1\right)$ 3) $3\left(\frac{u^2}{g}-t_1\right)$ 4) $3\left(\frac{u^2}{g^2}-t_1\right)$

428. Let A, B, C, D be points on a vertical line such that AB = BC = CD. If a body is released from position A, the times of descent through AB, BC and CD are in the ratio

1) $1:\sqrt{3}-\sqrt{2}:\sqrt{3}+\sqrt{2}$ 2) $1:\sqrt{2}-1:\sqrt{3}-\sqrt{2}$

3) $1:\sqrt{2}-1:\sqrt{3}$ 4) $1:\sqrt{2}:\sqrt{3}-1$

429. A ball is thrown vertically upward with a velocity 'u' from the balloon descending with velocity v. The ball will pass by the balloon after time

1) $\frac{u-v}{2g}$ 2) $\frac{u+v}{2g}$ 3) $\frac{2(u-v)}{g}$ 4) $\frac{2(u+v)}{g}$

430. Two bodies begin a free fall from the same height at a time interval of Ns. If vertical separation between the two bodies is 1 after n second from the start of the first body, then n is equal to

1) $\sqrt{nN}$ 2) $\frac{1}{gN}$ 3) $\frac{1}{gN}+\frac{N}{2}$ 4) $\frac{1}{gN}-\frac{N}{4}$

431. The maximum height attained by a projectile is increased by 10%. Keeping the angle of projection constant, what is the increase in the time flight?

1) 5% 2) 20% 3) 10% 4) 40%

432. A particle moves according to the equation $x=5t^2+2t+5$ where x is displacement and t is time. Its average velocity in first 3 seconds is

1) $17\,ms^{-1}$ 2) $32\,ms^{-1}$ 3) $16\,ms^{-1}$ 4) None of these

433. A monkey standing on the ground wants to climb to the top of a vertical pole 13 m tall. He climbs 5m in 1s and then slips downwards 3m in the next second. He again climbs 5 m in 1s and slips by 3m in the next second as so on. How much time will the monket take to reacch the top of the pole?

1) 7s 2) 9s 3) 11s 4) 13 s

434. The position x of a particle varies with time (t) as $x = at^2 - bt^3$. The acceleration at time t of the particle will be equal to zero, where t is equal to

1) $\frac{2a}{3b}$ 2) $\frac{a}{b}$ 3) $\frac{a}{3b}$ 4) zero

435. The displacement x of a particle varies with time according to the relation $x = \frac{a}{b}\left(1 - e^{-bt}\right)$. Then

1) At t = 1/b, the displacement of the particle in nearly (2/3) (a/b)

2) The velocity and acceleration of the particle at t = 0 are a and $-ab$ respectively

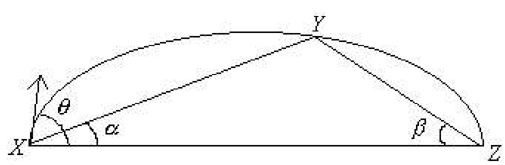
3) The particle cannot reach a point at a distance x' from its starting position if $x' > a/b$

4) All the above

436. Displacement (x) of a particle is related to time (t) as $x = at + bt^2 - ct^3$ where a, b and c constants of motion. The velocity of the particle when its acceleratin is zero is given by

1) $a + \frac{b^2}{c}$ 2) $a + \frac{b^2}{2c}$ 3) $a + \frac{b^2}{3c}$ 4) $a + \frac{b^2}{4c}$

437. A particle is projected with a velocity u making an angle θ with the horizontal such that the trajectory just grazes the vertices of the triangle then



1) $\tan\theta = \cos\alpha + \cos\beta$ 2) $\cot\theta = \cos\alpha + \cos\beta$

3) $\sin\theta = \sin\alpha + \sin\beta$ 4) $\tan\theta = \tan\alpha + \tan\beta$

438. An armoured car 2m long and 3 m wide is moving at $10\,ms^{-1}$ when a bullet hits it in a direction making an angle $\tan^{-1}\left(\frac{3}{4}\right)$ with the length of the car as seen by a stationary observer. The bullet enters one edge of the car at the corner and passes out at the diagonally opposite corner. Neglecting any interaction between the car and the bullet, the time for the bullet to cros the car is

1) 0.20 s 2) 0.15 s 3) 0.10 s 4) 0.50 s

439. If a body looses half of its velocity on penetrating 3 cm in a wooden block, then how much will it penetrate more before coming to rest?

[AIEEE-2002]

1) 1 cm 2) 2 cm 3) 3 cm 4) 4 cm

440. From a building two balls A and B are thrown such that A is thrown upwards and B downwards (both vertically with same speed). If v_A and v_B are their respectively velocities on reaching the ground, then **[AIEEE-2002]**

1) $v_B > v_A$ 2) $v_A = v_B$ 3) $v_A > v_B$

4) their velocities depends on their masses

441. The coordinates of a moving [article at any time 't' are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time 't' is given by **[AIEEE-2003]**

1) $\sqrt{\alpha^2 + \beta^2}$ 2) $3t\sqrt{\alpha^2 + \beta^2}$ 3) $3t^2\sqrt{\alpha^2 + \beta^2}$ 4) $t^2\sqrt{\alpha^2 + \beta^2}$

442. A ball is released from the top of a tower of height h metres. It takes T seconds to reach the ground. What is the position of the ball in T/3 seconds? **[AIEEE-2004]**

1) h/9 metres from the ground 2) 7h/9 metres from the ground

3) 8h/9 metres from the ground 4) 17h/18 meters from the ground

443. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the time of flights in the two cases, then the product of the two time of flights is directly proportional to **[AIEEE-2004]**

1) $1/R^2$ 2) 1/R 3) R 4) R^2

444. The relation between time t and distance x is $t = ax^2 + bx$ where a and b are constants. The acceleration is **[AIEEE-2005]**

1) $-2av^3$ 2) $2av^2$ 3) $-2abv^2$ 4) $2bv^3$

445. A particle located at x = 0 at time t = 0, starts moving along the positive x-direction with a velocity v that varies as $v = \alpha\sqrt{x}$. The displacement of the particle varies with time as **[AIEEE-2006]**

1) t^3 2) t^2 3) t 4) $t^{1/2}$

446. A particle is projected at 60^0 to the horizontal witha kinetic energy K. The kinetic energy at the highest point is **[AIEEE-2007]**

1) K/2 2) K 3) zero 4) K/4

LEVEL-IV

447. An inclined plane is making an angle β with horizontal. A projectile is projected from the bottom of the plane with a speed u at an angle α with horizontal then its range on the inclined plane is

1) $R = \frac{2u^2 \sin(\alpha - \beta)\cos\alpha}{g\cos^2\beta}$ 2) $R = \frac{u^2 \sin(\alpha - \beta)\cos\alpha}{g\cos^2\beta}$

3) $R = \frac{2u^2 \sin(\alpha + \beta)\cos\alpha}{g\cos^2\beta}$ 4) $R = \frac{u^2 \sin(\alpha + \beta)\cos\alpha}{g\cos^2\beta}$

448 In the above question, the time of flight is

1) $T = \frac{2u\sin(\alpha - \beta)}{g\cos\beta}$ 2) $T = \frac{u\sin(\alpha - \beta)}{g\cos\beta}$

3) $T = \frac{2u\sin(\alpha + \beta)}{g\cos\beta}$ 4) $T = \frac{u\sin(\alpha + \beta)}{g\cos\beta}$

449. In the above question, maximum range is

1) $R_{\max} = \frac{u^2}{g(1-\sin\beta)}$ 2) $R_{\max} = \frac{u^2}{g(1+\sin\beta)}$

3) $R_{\max} = \frac{u}{g(1-\sin\beta)}$ 4) $R_{\max} = \frac{u}{g(1+\sin\beta)}$

450. There is a regular bus service between towns A and B, with a bus leaving towns A and B every T minutes. A cyclist moving with a speed of $20\ km\ h^{-1}$ in the direction A to B notices that a bus goes past him every 18 minutes in the direction of his and every 6 minutes in the opposite direction. What is the period T of bus service?

1) 9 minutes 2) 12 minutes 3) 15 minutes 4) 18 minutes

451. In the previous question, what is the speed with which buses ply between towns A and B? (Assume the speeds to be constant.)

1) $30\ km\ h^{-1}$ 2) $40\ km\ h^{-1}$ 3) $50\ km\ h^{-1}$ 4) $60\ km\ h^{-1}$

452. An aircraft is flying at a uniform speed $v\ ms^{-1}$. If the angle substend at an observation point on the ground by two positions of the aircraft t seocnds apart is θ, the height of the aircraft above the ground is given by

1) $\frac{vt}{2\tan\theta}$ 2) $\frac{2vt}{\tan\theta}$ 3) $\frac{vt}{\tan\left(\frac{\theta}{2}\right)}$ 4) $\frac{vt}{2\tan\left(\frac{\theta}{2}\right)}$

453. Two particles one with constant velocity 50 m/s and the other with uniform acceleration $10\,m/s^2$, start moving simultaneously from the same place in the same direction. They will be at a distance of 125m from each other after

1) 5 sec 2) $5(1+\sqrt{2})\,\sec$ 3) 10 sec 4) $10(\sqrt{2+1})\,\sec$

454. A point traversed half of the distance with a valocity v_0. The half of remaining part of the distance was convered with velocity v_1 and second half of remaining part by v_2 velocity. The mean velocity of the point, averaged over the whole time of motion is

1) $\frac{v_0+v_1+v_2}{3}$ 2) $\frac{2v_0+v_1+v_2}{3}$

3) $\frac{v_0+2v_1+2v_2}{3}$ 4) $\frac{4v_0v_1v_2}{v_0\left(v_1+v_2\right)+2v_1v_2}$

455. A particle is projected with certain velocity at an angle α above hte horizontal from the foot of an inclied plane of inclination 30^0. If the particle strikes the plane normally then α is

1) $30^0+Tan^{-1}\left(\frac{1}{2\sqrt{3}}\right)$ 2) 45^0

3) 60^0 4) $30^0+Tan^{-1}\left(2\sqrt{3}\right)$

456. A particle is projected with some velocity u making an angle 60^0 with horizontal on to an inlcined plane making an angle 30^0 with horizontal its range on the inclined plane is

1) $\frac{ut}{\sqrt{3}}$ 2) $\frac{\sqrt{3}\,ut}{2}$ 3) $\sqrt{3}ut$ 4) $2ut$

457. Between the two stations, a train accelerates uniformly at first, then moves with constant velocity and finally retards uniformly. If the ratio of the time, taken by 1 : 8 :1 and the maximum speed attained be 60 km/h, then what is the average speed over the whole journey?

1) 52 km/h 2) 48 km/h 3) 54 km/h 4) 56 km/h

458. Two roads cross at right angles at O. A person A walking along one of them at 3 m/s sees another person B walking at 4 m/s along the other road at O, when he is 10 m off. The nearest distance between the two persons is

1) 10 m 2) 9 m 3) 8 m 4) 7.2 m

459. A body dropped from a height H above the ground strikes an inclined plane at a height h above the ground. As a result of the impact, the velocity of the body becomes horizontal. The body will take the maximum time to reach the ground if

1) $h=\frac{H}{4}$ 2) $h=\frac{H}{2\sqrt{2}}$ 3) $h=\frac{H}{2}$ 4) $h=\frac{H}{\sqrt{2}}$

460 Two Cannons installed at the top of a cliff 10m high fire a shot each with speed $5\sqrt{3}\,ms^{-1}$ at some interval. One cannon fires at 60^0 with horizontal whereas the second fires horizontally. The coordinates of point of collision of the shots are

1) $\frac{1}{3}m$, $\frac{1}{3\sqrt{5}}m$ 2) $5\sqrt{3}m$, 5m 3) $3\sqrt{5}\,m$, 3m 4) $\frac{1}{5\sqrt{3}}m$, $\frac{1}{5}m$

461. A tank moves uniformly along x-axis. It fires a shot from origin at an angle of 30^0 with horizontal while moving along positive x-axis and the second shot is also fired similarly except that the tank moves along negative x-axis. If the respective range of the shot are 250m and 200m along x-axis, the velocity of tank is

1) $3.9\,ms^{-1}$ 2) $4.9\,ms^{-1}$ 4) $5.9\,ms^{-1}$ 4) $9.4\,ms^{-1}$

462. A ball is thrown from a point with a speed 'v_0' at an elevation angle of θ. From the same point and at the same instant, a person starts running with a constant speed $\frac{'v_0'}{2}$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angel of projection θ?

1) No 2) Yes, 30^0 3) Yes, 60^0 4) Yes, 45^0

463. A boy playing on the roof of a 10m high building throws a ball with a speed of 10 m/s at an angle of 30^0 with the horizontal. How far from the throwing point will the ball be at the height of 10m from the ground? **[AIEEE-2003]**

$$\left[g = 10\ m/s^2, \sin 30^0 = \frac{1}{2}, \cos 30^0 = \frac{\sqrt{3}}{2}\right]$$

1) 8.66 m 2) 5.20 m 3) 4.33 m 4) 2.60 m

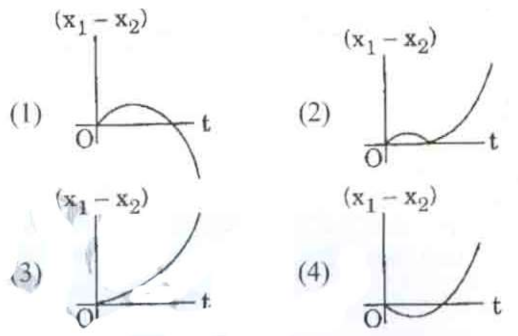
464. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then deceleates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S, then **[AIEEE-2005]**

1) $S = \frac{1}{72}\mathrm{ft}^2$ 2) $S = \frac{1}{4}\mathrm{ft}^2$ 3) $S = \mathrm{ft}$ 4) $S = \frac{1}{6}\mathrm{ft}^2$

465. The velocity of a particle is $v = v_0 + gt + ft^2$. If its postion is x = 0 at t = 0, then its displacement after unit time (t = 1) is

1) $v_0 + g/2 + f$ 2) $v_0 + 2g + 3f$ 3) $v_0 + g/2 + f/3$ 4) $v_0 + g + f$

466. A body is at rest at x = 0. At t = 0, it starts moving in the positive x-direction with a constant acceleration. At the same instant another body passes through x = 0 moving in the positive x-direction with a constant speed. The position of the first body is given by $x_1(t)$ after time 't' and that of the second body by $x_2(t)$ after the same time interval. Which of the following graphs correctly describes $(x_1 - x_2)$ as a function of time 't' ? **[AIEEE - 2008]**



LEVEL-V

MORE THAN ONE ANSWER TYPE QUESTIONS

467. The position of a particle travelling along x axis is given by $x_1 = t^3 - 9t^2 + 6t$ where x_t is in cm and t is in second. Then

1) the body comes to rest firstly at $(3-\sqrt{7})$ s and then at $(3+\sqrt{7})$ s

2) the total displacement of the particle in travelling from the first zero of velocity to the second zero of velocity is zero

3) the total displacement of the particle in travelling from the first zero of velocity to the second zero of velocity is -74cm.

4) the particle reverses its velocity at $(3-\sqrt{7})$ s and then at $(3+\sqrt{7})$ s and has a negative velocity for $(3-\sqrt{7}) < t < (3+\sqrt{7})$

468 The velocity of a particle moving along a straight line increases according to the linear law $v = v_0 + kx$, where k is a constant. Then

1) the acceleration of the particle is $k(v_0 + kx)$

2) the particle takes a time $\frac{1}{k}\log_e\left(\frac{v_1}{v_0}\right)$ to attain a velocity v_1

3) velocity varies linearly with displacement with slope of velocity displacement curve equal to *k*

4) data is insufficient to arrive at a conclusion

469. A car starts moving rectilinearly(inital velocity zero) first with an acceleration of $5ms^{-2}$ then uniformly and finally decelerating at the same rate till it stops. Total time of journey is 25s and average velocity during the journey is $72kmh^{-1}$.Then

1) total distance travelleed by the car is 500m.

2) maximum speed attained during the journey is $25ms^{-1}$

3) car travels with uniform speed for 15s

4) car accelerates for 5s and decelerates also for 5s

470. Two particles P and Q move in a straight line AB towards each other. P starts from A with velocity u_1, and an acceleration a_1, Q starts from B with velocity u_2 and acceleration a_2. They pass each other at the midpoint of AB and arrive at the other ends of AB with equal velocities

1) They meet at midpoint at time $t = \frac{2(u_2 - u_1)}{(a_1 - a_2)}$

2) The length of path specified i.e. AB is $l = \frac{4(u_2 - u_1)(a_1u_2 - a_2u_1)}{(a_1 - a_2)^2}$

3) They reach the other ends of AB with equal velocities if $(u_2 + u_1)(a_1 - a_2) = 8(a_1u_2 - a_2u_1)$

4) They reach the other ends of AB with equal velocities if $(u_2 - u_1)(a_1 + a_2) = 8(a_2u_1 - a_1u_2)$

471. A body is moving along a straight line. Its distance x_1 from a point on its path at a time t after passing that point is given by $x_t = 8t^2 - 3t^3$, where x_t is in metre and t is in second

1) Average speed during the interval $t = 0$ s to $t = 4$ s is $20.21ms^{-1}$

2) Average velocity during the interval $t = 0s$ to $t = 4s$ is $-16ms^{-1}$

3) The body starts from rest and at $t = \frac{16}{9}$ s it reverses its direction of motion at $x_t = 8.43m$ from the start

1) It has an acceleration of $-56ms^{-2}$ at $t = 4s$

472. Two particles projected from the same point with same speed u at angles of projection α and β strike the horizontal ground at the same point. If h_1 and h_2 are the maximum heights attained by porjectiles, R be the range for both and t_1 and t_2 be their time of flights respectively then

1) $\alpha+\beta=\frac{\pi}{2}$ 2) $R=4\sqrt{h_1h_2}$ 3) $\frac{t_1}{t_2}=\tan\alpha$ 4) $\tan\alpha=\sqrt{\frac{h_1}{h_2}}$

473. Two shells are fired from a cannon successively with speed u each at angles of projection α and β respectively. If the time interval between the firing of shots is t and they collide in mid air after a time T from the firing of the first shot. Then

1) $T\cos\alpha=(T-t)\cos\beta$ 2) $\alpha>\beta$

3) $(T-t)\cos\alpha=t\cos\beta$

4) $(u\sin\alpha)t\frac{1}{2}gt^2=(u\sin\beta)(T-t)-\frac{1}{2}g(T-t)^2$

474. Two guns situated at the top of a hill of height 10m, fire one shot each with the same speed of $5\sqrt{3}ms^{-1}$ at some interval of time. One gun fores horizontally and other fires upwards at an angle of 60^0 with the horizontal. The shots collide in mid ait at the point P. Taking the origin of the coordinate system at the foot of the hill right below the muzzle, trajectories in x-y plane and $g=10ms^{-2}$ then

1) the first shell reaches the point P at $t_1=1$ s from the start

2) the second shell reaches the point P at $t_2=2$ s from the start

3) the first shell is fired 1 s after the firing of the second shell.

4) they collide at P whose coordinates are given by $(5\sqrt{3},5)m$.

475. A boat is moving directly away from a cannon on the shore with a speed v_1. the cannon fires a shell with a speed v_2 at an angle α and the shell hits the boat. Then

1) the shell hits the boat when the time equal to $\frac{2v_2\sin\alpha}{g}$ is lapsed

2) the boat travels a distance $\frac{2v_1v_2\sin\alpha}{g}$ from its original position

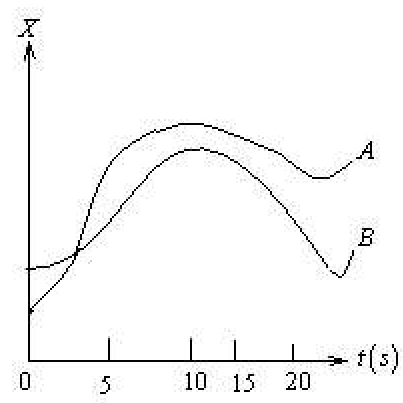
3) the distance of the boat from the cannon at the instant the shell is fired is $\frac{2}{g}(v_2\sin\alpha)(v_2\cos\alpha-v_1)$

4) the distance of the boat from the cannon when the shell hits the boat is

$$\frac{2}{g}(v_2 \sin\alpha)(v_2 \cos\alpha)$$

LINKED -COMPREHENSION TYPE

Two particles A and B are moving along x-axis whose position -time graphs are as shown in the figure below.



476. For the time interval 0 to5s

1) the particle A is speeding up while B is slowing down

2) both the particles are initially speeding up and then slowing down

3) both the particles are initially slowing down and then speeding up

4) Particle A is speeding up first and then slowing down while B is slowing down first and then speeding up

477. Mark the correct statement(s)

1) Initial velocity of A is less than that of B

2) There is exactly one instant when both the particles have the same velocity

3) There is no instant when both the particles have same velocity

4) For time interval, 5 to 15s average velocity of both the particles are same.

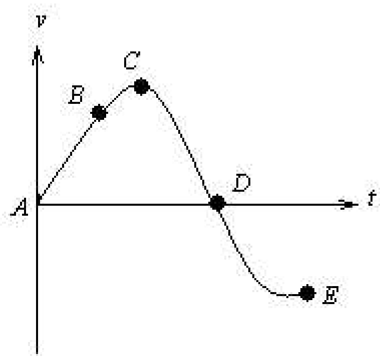
Matrix-Match Type

478. For a particle moving along X-axis if acceleration (constant) is acting along -ve X-axis, then match the entries of Column-I with entries of Column II

Column-I	**Column-II**
A. Initial velocity >0	P. Particle may move in +ve X-direction with increasing speed

B. Initial velocity < 0	Q. Particle may move in +ve X-direction with decreasing speed
C. x > 0	R. Particle may move in -ve X-direction with increasing speed
D. $x < 0$	S. Particle may move in -ve X-direction with decreasing speed

479. The velocity-time graph of a particle moving along X-axis is shown in the figure below. Match the entries of Column-I with entries of Column -II



Column-I	**Column-II**
A. For AB, particle is	P. moving in +ve X- direction with an increasing speed.
B. For Bc, Prticle is	Q. moving in +ve X-direction with an decreasing speed.
C. For CD, particle is	R.moving in -ve X-direction with an increasing speed.
D. For DE, particle is	S. moving in -ve X-direction with an decreasing speed.

Assertion & Reason

In the questions that follows two statements are given. STatement II is purported to be the explanation for STatement I. Study both the statements and then mark your answers. Statements and then mark your answers according to the codes given below.

Mark your answer as

1) If Statement I is true, Statement II is true, Statement II is a correct explanation for Statement I

2) If Statement I is true, Statement II is true, Statement II is not a correct explanation for Statement I

3) If Statement I is true, Statement II is false

4) If Statement I is false, Statement II is true

480. Statement I : Accleration of a body can change its direction without any change in direction of velocity

Statement II: Direction of acceleration is same as that of direction of change in velocity vector

481. Statement I: The v-t graph peprpendicular to time axis is not possible in practice.

Statement II : Infinite acceleration can't be realised in practice.

482. Statement I: Magnitude of average velocity is equal to average speed, if velocity is constant.

Statement II : If velocity is constant, then there is no change in the direction.

KEY

01. 1	2. 4	3. 3	4. 1	5. 1	6. 3	7. 1	8. 4	9. 4	10. 2
11. 1	12. 2	13. 1	14. 1	15. 1	16. 1	17. 2	18. 4	19. 2	20. 1
21. 2	22. 3	23. 1	24. 1	25. 3	26. 3	27. 2	28. 3	29. 2	30. 3
31. 3	32. 3	33. 1	34. 1	35. 2	36. 2	37.1	38. 2	39. 3	40. 4
41. 2	42. 1	43. 1	44. 4	45. 1	46. 1	47. 1	48. 3	49. 3	50. 3
51. 3	52. 2	53. 3	54. 1	55. 3	56. 3	57. 1	58. 1	59. 2	60. 2
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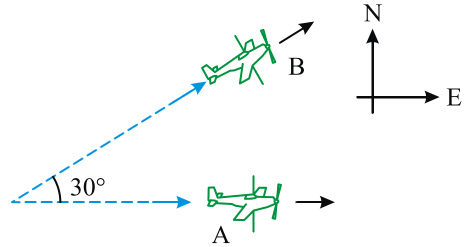
451.2 452.4 453.2 454.4 455.1 456.1 457.3 458.3 459.3 460.2
461.2 462.3 463.2 464.4 465.4
466.3 467.1,3,4 468.1,2,3 469.1,2,3,4 470.1,2,3
471.1,2,3,4 472.1,2,3,4 473.1,2,4 474.1,2,3,4 475.1,2,3,4
476.2 477.3 478. A-Q, R : B = R: C =Q,R: D= Q, R
479. A=P: B = P : C = Q; D = R 480.2
481.1 482.1

EXCERCISE 1

SINGLE CORRECT ANSWERS QUESTIONS

A) RELATIVE MOTION

1. **An aeroplane A is flying horizontally due east at a speed of 400 km/hr. Passengers in A, observe another aeroplane B moving perpendicular to direction of motion at A. Aeroplane B is actually moving in a direction 30^0 north of east in the same horizontal plane as shown in the figure. Determine the velocity of B**



A) $400\sqrt{3}i + 400\sqrt{3}j$ B) $400\hat{i} + \frac{400}{\sqrt{3}}\hat{j}$

C) $400i + \frac{400}{\sqrt{3}}j$ D) $\frac{400}{\sqrt{3}}i + 400j$

2. **A boat moves relative to water with a velocity which is n times less than the river flow velocity. At what angle to the stream direction must the boat move to minimize drifting? (u is velocity of water, v is velocity of boat)**

a) $\theta = \sin^{-1}\left(\frac{v}{u}\right)$ from normal direction

b) $\theta = \cos^{-1}\left(\frac{v}{u}\right)$ from normal direction

c) $\theta = \tan^{-1}\left(\frac{v}{u}\right)$ from normal direction

d) $\theta = \sin^{-1}\left(\frac{u}{v}\right)$ from normal direction

3. **A man wishes to cross a river flowing with velocity u jumps at an angle θ with the river flow. If the man swims with speed v and if the width of the river is d, then the drift travelled by him is**

a) $(u + v\cos\theta)\frac{d}{v\sin\theta}$ b) $(u - v\cos\theta)\frac{d}{v\sin\theta}$

c) $(u - v\cos\theta)\frac{d}{v\cos\theta}$ d) $(u + v\cos\theta)\frac{d}{v\cos\theta}$

4. **A boat moves relative to water with a velocity which is 1/2 times the river flow velocity. At what angle to the stream direction must the boat move to minimize drifting.**

a) 45^0 b) 60^0 c) 120^0 d) 90^0

5. **Two bodies were thrown simultaneously from the same point one straight up and the other at an angle of $\theta=60^0$ to the horizontal. The initial velocity of**

each body is equal to $v_0 = 25 m/s$. **Neglecting the air drag, find the distance between the bodies t =1.70 s later.**

a) 20m b) 18m c) 22m d) 24m

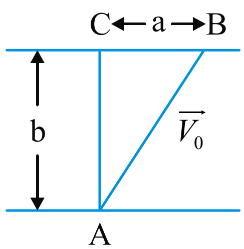
6. **A sailor in a boat, which is going due east with a speed of 8m/s observes that a submarine is heading towards north at a speed of 12 m/s and sinking at a rate of 2 m/s. The commander of submarine observes a helicopter ascending at a rate of 5 m/s and heading towards west with 4 m/s. Find the speed of the helicopter with respect to boat.**

a) 10m/s b) 11m/s c) 12m/s d) 13m/s

7. **Consider a collection of a large number of particles each with speed v in a plane.**
The direction of velocity is randomly distributed in the collection. The magnitude of the average relative velocity of a particle with velocities of all other particles is

a) > v b) < v c) = v d) none of these

8. **A man in a row boat must get from point A to point B on the opposite bank of the river (see figure). The distance BC=a. The width of the river AC=b. At what minimum speed u relative to the still water should the boat travel to reach the point B? The velocity of flow of the river is** v_0.



a) $\frac{v_0 b}{\sqrt{a^2+b^2}}$ b) $\frac{v_0 a}{\sqrt{a^2+b^2}}$

c) $\frac{v_0 b}{\sqrt{2a}}$ d) $\frac{v_0 a}{\sqrt{2b}}$

9. **A man standing on a road has to hold his umbrella at 53^0 with vertical to keep the rain away. He throws the umbrella and starts running at 12 km/h. He finds that rain drops are falling on his head vertically. Find the speed (in km/hr) of raindrops w.r.t the moving man**

a) 12km/hr b) 14 km/hr c) 16km/hr d) 18 km/hr

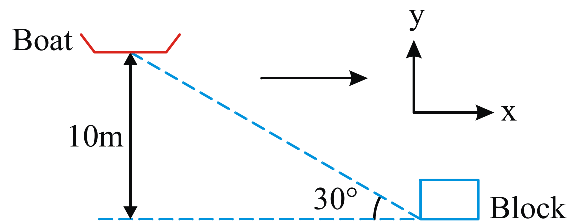
10. **A motor boat has a speed of 5 m/s. At time t =0, its position vector relative to a origin is** $\left(-11\hat{i}+16\hat{j}\right)$ **m, having the aim of getting as close as possible to a steamer. At time t =0, the steamer is at the point** $\left(4\hat{i}+36\hat{j}\right)$**m and is moving with constant velocity** $\left(10\hat{i}-5\hat{j}\right)$ **m/s. Find the direction in which the motorboat must steer**

a) 3i+3j b) 3i+4j c) 4i+3j d) 4i+4j

11. **A river 400 m wide is flowing at a rate 2.0 m/s. A boat is sailing at a velocity of 10.0 m/s repect to the water, in a direction perpendicular to the river.**
(a) Find the time taken by the boat ot reach the opposite bank.
(b) How far from the point directly opposite to the starting point does the boat reach the opposite bank?

a) 40 sec, 80 m b) 30 sec, 40 m c) 20 sec, 20 m d) 35 sec, 80 m

12. **A block of mass m is floating in a river flowing with a velocity of 2m/s. A boat is moving behind the block with a velocity of 5 m/s with respect to the block as shown. From the boat a stone is thrown with a velocity $\bar{v} = v_1\hat{i} - v_2\hat{j} + v_3\hat{k}$ with respect to the river such that it hits the block. If $v_1 : v_2 : v_3 = 2\sqrt{3} : 2 : 3$ then the velocity of the stone with respect to the ground is(g=10m/s²)**

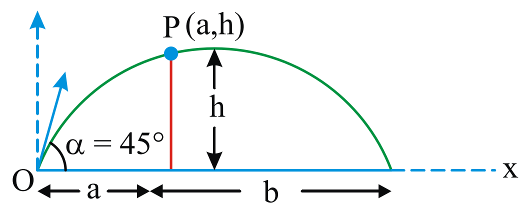


a) $10\hat{i} - \frac{10}{\sqrt{3}}\hat{j} + 5\sqrt{3}\hat{k}$ b) $12\hat{i} - \frac{10}{\sqrt{3}}\hat{j} + 5\sqrt{3}\hat{k}$

c) $10\hat{i} - 10\hat{j} + 5\sqrt{3}\hat{k}$ d) $10\sqrt{3}\hat{i} - \frac{10}{\sqrt{3}}\hat{j} + 5\sqrt{3}\hat{k}$

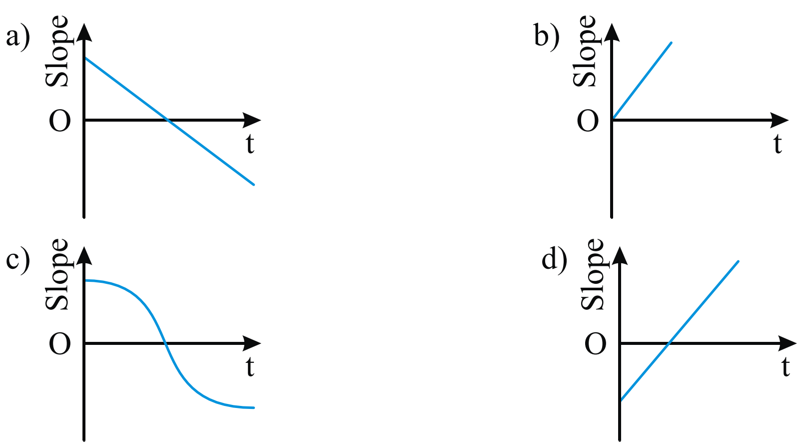
B) BODY PROJECTED FROM THE GROUND

13. **From a point on the ground at a distance a from the foot of a pole, a ball is thrown at an angle of 45⁰, which just touches the top of the pole and strikes the ground at a distance of b, on the other side of it.Find the height of the pole.**



a) $\frac{ab}{a-b}$ b) $\frac{ab}{a+b}$ c) $\frac{2ab}{a+b}$ d) $\frac{ab}{a+2b}$

14. **A heavy particle is projected with a velocity at an angle with the horizontal into the uniform gravitional field. The slope of the trajectory of the particle varies as**



15. **A fixed mortar fires a bomb at an angle of 53⁰ above the horizontal with a muzzle velocity of 80m/s⁻¹. A tank is advancing directly towards the mortar on**

level ground at a constant speed of 5m/s. The initial separation (at the instant mortar is fired) between the mortar and tank, so that the tank would hit is [Take g=10ms^{-2}]

a) 662.4 m b) 526.3 m c) 486.6 m d) 678.4 m

16. **The angular elevation of an enemy's position on a hill 'h' ft high is α. What should be the minimum velocity of the projectile in order to hit the enemy?**

a) $u = \sqrt{gh(\cos\alpha + 1)}$ b) $u = \sqrt{gh(\sin\alpha + 1)}$

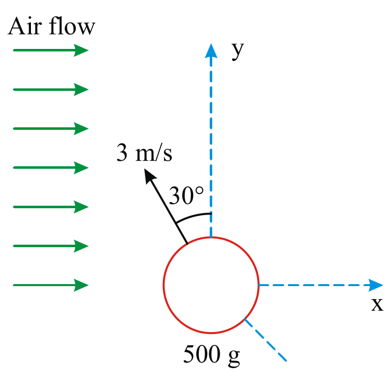
c) $u = \sqrt{gh(\text{cosec}\alpha + 1)}$ d) $u = \sqrt{gh(\sec\alpha + 1)}$

17. **Two particles are projected simultaneously with the same speed v in the same vertical plane with angles of elevation θ, and 2θ, where θ<45^0. At what time will their velocities be parallel?**

a) $t = \frac{v}{g}\tan\frac{\theta}{2}\text{cosec}\frac{3\theta}{2}$ b) $t = \frac{v}{g}\cos\frac{\theta}{2}\cot\frac{3\theta}{2}$

c) $t = \frac{v}{g}\cos\frac{\theta}{2}\tan\frac{3\theta}{2}$ d) $t = \frac{v}{g}\cos\frac{\theta}{2}\text{cosec}\frac{3\theta}{2}$

18. **Figure shows a sphere moving in a steady flow of air in the x-direction on a horizontal plane . The air stream exerts an essentially constant acceleration 1.8 m/sec^2 on the sphere in the x-direction. If at t = 0 the sphere is moving as shown in figure, determine the time t required for the sphere to cross the y-axis again.**



a) 1/3 sec

b) 2/3 sec

c) 4/3 sec

d) 5/3 sec

19. **A very broad elevator is going up vertically with a constant acceleration of $2\text{m}/\text{s}^2$. At the instant when the velocity is $4\text{m}/\text{s}$ a ball is projected from the floor of the lift with a speed of $4\text{m}/\text{s}$ relative to the floor at an elevation of 30°. The time taken by the ball to return the floor is** $(g = 10\text{m}/\text{s}^2)$

(a) $\frac{1}{2}$s (b) $\frac{1}{3}$s (c) $\frac{1}{4}$s (d) 1s

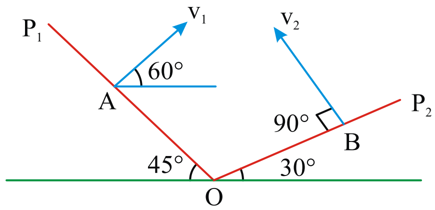
20. **A boy throws a ball with velocity $v_0 = 20m/s$ The wind impart horizontal acceleration of 4m/s^2 to the left. The angle θ (with vertical)at which the ball must be thrown so that the ball returns to the boy's hand is (g=10m/s^2) :**

a) $\tan^{-1}(1.2)$ b) $\tan^{-1}(0.2)$ c) $\tan^{-1}(2)$ d) $\tan^{-1}(0.4)$

C) PROJECTILE MOTION ON INCLINED PLANE

21. **A particle is projected from an inclined plane OP$_1$ from A with velocity v_1=8ms$^-$**

^{1} at an angle 60^0 with horizontal. An another particle is projected at the same instant from B with velocity v_2=16ms^{-1} and perpendicular to the plane OP$_2$ as shown in the figure. After time $10\sqrt{3}$ sec there separation was minimim and found to be 70m. Then find distance AB.



a) 250 m

b) 500 m

c) 750 m

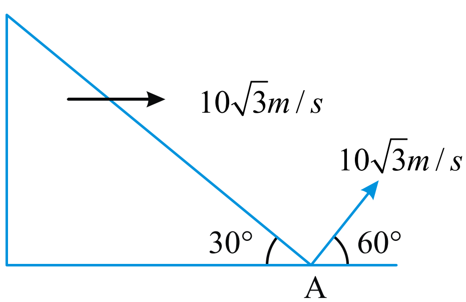
d) 1000 m

22. **A particle is projected with a certain velocity at an angle α above the horizontal from foot of an inclined plane of inclination 30°. If the particle strikes the plane normally then α is equal to**

(a) $30^\circ + \tan^{-1}\left(\frac{1}{2\sqrt{3}}\right)$ (b) $30^\circ + \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(c) 60° (d) $30^\circ + \tan^{-1}\left(2\sqrt{3}\right)$

23. **A particle is projected at an angle 60^0 with speed $10\sqrt{3}$ m/s from the point A, as shown in the figure. At the same time the wedge is made to move with speed $10\sqrt{3}$ m/s towards right as shown in the figure. Then the time after which particle will strike with wedge is**



a) 2s

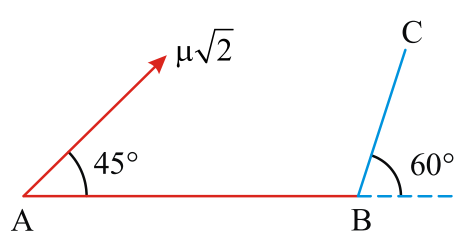
b) $2\sqrt{3}s$

c) $\frac{4}{\sqrt{3}}s$

d) None of these

D) COLLISIONS BETWEEN PROJECTILES

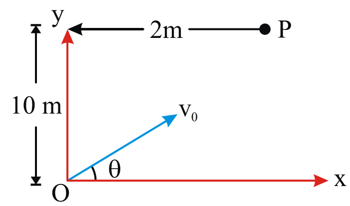
24. **A particle is projected from a point A withvelocity u $\sqrt{2}$ at an angle of 45° with horizontal as shown in figure. It strikes the plane BC at right angles. The velocity of the particle at the time of collision is**



(a) $\frac{\sqrt{3}u}{2}$ (b) $\frac{u}{2}$ (c) $\frac{2u}{\sqrt{3}}$ (d) u

25. **A particle is dropped from point P at time t = 0. At the same time another**

particle is thrown from point O as shown in the figure and it collides with the particle P. Acceleration due to gravity is along the negative y-axis. If the two particles collide 2s after they start, find the initial v_0 of the particle which was projected from O. Point O is not necessarily on ground.



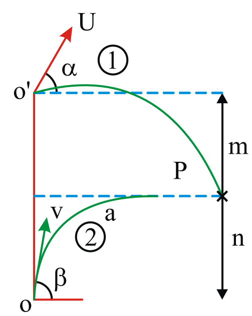
a) $\sqrt{6} m/s^{-1}$, $\theta = tan^{-1}(1)$ $with\ X-axis$

b) $\sqrt{26} m/s^{-1}$, $\theta = tan^{-1}(5)$ $with\ X-axis$

c) $\sqrt{2} m/s^{-1}$, $\theta = tan^{-1}(2)$ $with\ X-axis$

d) $\sqrt{13} m/s^{-1}$, $\theta = tan^{-1}(4)$ $with\ X-axis$

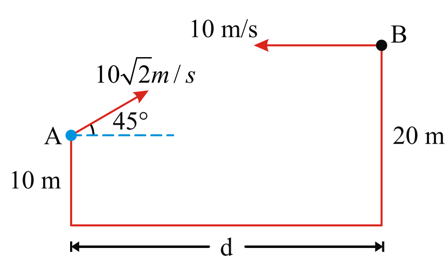
26. **Shots are fired simultaneously from the top and bottom of a vertical cliff at angles α and β and they strike an object simultaneously at the same point. If the horizontal distance of the object from the cliff is a, the height of the cliff is**



(a) $\dfrac{a(\cot\alpha - \cot\beta)}{\cot\alpha\cot\beta}$ (b) $a(\sin\beta - \tan\alpha)$

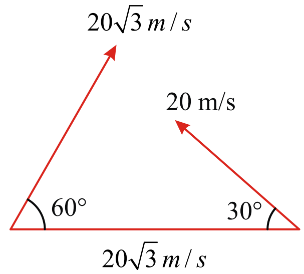
(c) $\dfrac{a\tan\alpha}{\tan\beta}$ (d) $a(\cot\alpha - \cot\beta)$

27. **Two particles A and B are projected simultaneously from the two towers of height 10m and 20m respectively. Particle A is projected with an initial speed of $10\sqrt{2}m/s$ at an angle of 45^0 with horizontal, while particle B is projected horizontally with speed 10m/s. If they collide in air, what is the distane d between the towers?**



a) 10 m b) 20 m c) 30 m d) 40 m

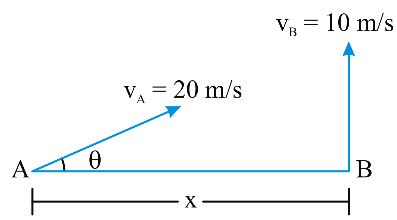
28. **In the figure shown, the two projectiles are fired simultaneously. The minimum distance between them during their flight is**



a) 20 m b) $10\sqrt{3}\, m$ c) 10 m d) zero

29. **In the direction shown in figure with velocities** $v_A = 20m/s$ **and** $v_B = 10m/s$ **respectively.**

They collide in air after $\frac{1}{2}s$**. Find the distance x.**



a) $2\sqrt{3}$ m b) $3\sqrt{3}$ m c) $4\sqrt{3}$ m d) $5\sqrt{3}$ m

E) NON UNIFORM TWO DIMENTIONAL MOTION

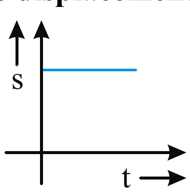
30. **A particle starts from origin of co-ordinates at time** $t = 0$ **and moves in the** xy **plane with a constnat acceleration** α **in the y direction .It's equation of motion is** $y = \beta x^2$**. It's velocity component in the** x **direction is**

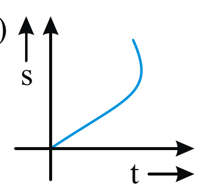
(A) Variable (B) $\sqrt{\frac{2\alpha}{\beta}}$ (C) $\frac{\alpha}{2\beta}$ (D) $\sqrt{\frac{\alpha}{2\beta}}$

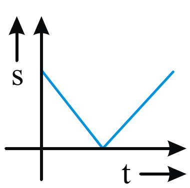
31. **Motion of a particle is governed by following relations**

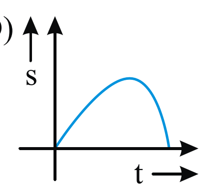
$y = \frac{x}{\alpha}; V_x = b - ct. (\alpha, b, c \text{ are} + ve \text{ const})$

The displacement (S) verson from (t) graph os

(A)


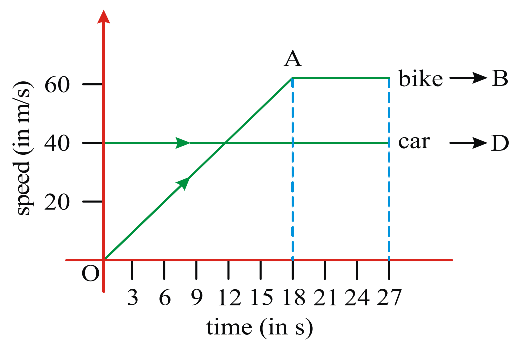
(B)


(C)


(D)


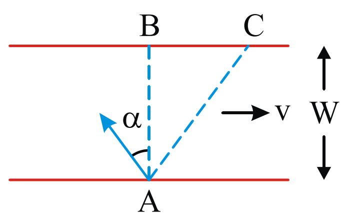
MULTIPLE ANSWER QUESTIONS

32. At the instant a motor bike starts from rest in a given direction, a car overtakes the motor bike, both moving in the same direction. The speed time graphs for motor bike and car are represented by OAB and CD respectively. Then



a) at t=18s the motor bike and car are 180m apart.
b) at t=18s the motor bike and car are 720m apart.
c) the relative distance between motor bike and car reduce to zero at t =27 s and both are 1080m far from origin
d) the relative distance between motor bike and car always remains same.

33. A man in a boat crosses a river from point A. If he rows perpendicular to the bank he reaches point C(BC=120m) in 10 minutes. If the man heads at a certain angle α to the straight line AB (AB is perpendicular to the banks)against the current he reaches point B in 12.5 minutes.



a) The width of the river is 300m
b) The width of the river is 200m
c) The rowing velocity is 20m/min
d) The rowing velocity is 30m/min

34. A motor boat is to reach at a point 30° upstream on other side of a river flowing with velocity 5 m/s. Velocity of motor boat with respect to water is $5\sqrt{3}$ m/sec. The driver should steer the boat at an angle of

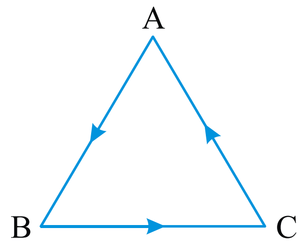
(A) 30° up w.r.t. the line of destination from the starting point
(B) 60° up w.r.t. normal to the bank
(C) 150° w.r.t. stream direction
(D) none of these

35. A car is moving rectilinearly on a horizontal path with acceleration a_0. A person sitting inside the car observes that an insect S is crawling up the screen with an acceleration a. If θ is the inclination of the wind screen with the horizontal, then the acceleration of the insect.

a) perpendicular to screen is $a_0 \tan\theta$
b) perpendicular to screen is $a_0 \sin\theta$
c) along the horizontal is $a_0 - a\cos\theta$
d) parallel to screen is $a + a_0\cos\theta$

36. Three particles A, B and C and situated at the vertices of an equilateral triangle ABC of side of length l at time $t=0$, Each of the particles move with constant

speed u. A always has its velocity along AB, B along BC and C along CA.



a) The time after which they meet is $\frac{2l}{3u}$

b) Total distance travelled by each particle before they meet is $\frac{2l}{3}$

c) Average velocity during the motion is $\frac{\sqrt{3}u}{2}$

d) Relative velocity of approach between any two particles is

37. **A man crosses a river in a boat. If he crosses the river in minimum time he takes 10 minutes with a drift 120 m. If he crosses the river taking shortest path, he takes 12.5 minute:(Assume $v_{b/r} > v_r$)**

(a) width of the river is 200 m

(b) velocity of the boat with respect to water 12 m/min

(c) speed of the current 20 m/min

(d) velocity of the boat with respect to water 20 m/min

MULTIPLE ANSWER QUESTIONS

38. **The co-ordinates of a particle moving in a plane are given by $x(t) = a\cos(\pi t)$ and $y(t) = b\sin(\omega t)$ where $a, b(< a)$ and ω are positive constant of appropriate dimensions. Then**

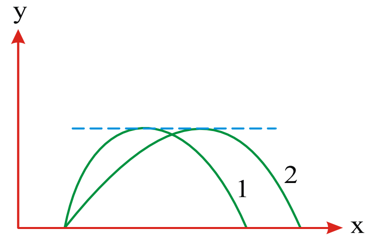
(A) The path of the particle is an ellipse.

(B) The velocity and acceleration of the particle are normal to each other at $t = \frac{\pi}{2\omega}$

(C) The acceleration of the particle is always directed towards a fixed position

(D) The distance travelled by the particle in time internal $t = 0$ to $t = \frac{\pi}{2\omega}$ is a

39. **Trajectories of two projectiles are shown in figure. Let T_1 and T_2 be the time periods and u_1 and u_2 their speeds of projection. Then**



(a) $T_2 > T_1$ (b) $T_1 = T_2$ (c) $u_1 > u_2$ (d) $u_1 < u_2$

40. In a projectile motion let v_x and v_y are the horizontal and vertical components of velocity at any time t and x and y are displacements along horizontal and vertical from the point of projection at any time t. Then

(a) $v_y - t$ graph is a straight line with negative slope and positive intercept

(b) x-t graph is a straight line passing through origin

(c) y-t graph is a straight line passing through origin

d) $v_x - t$ graph is a straight line

41. Two particles are projected from ground with same intial velocities at angles 60^0 and 30^0 (with horizontal). Let R_1 and R_2 be their horizontal ranges, H_1 and H_2 their maximum heights and T_1 and T_2 are the time of flights. Then

(a) $\frac{H_1}{R_1} > \frac{H_2}{R_2}$ (b) $\frac{H_1}{R_1} < \frac{H_2}{R_2}$ (c) $\frac{H_1}{T_1} > \frac{H_2}{T_2}$ (d) $\frac{H_1}{T_1} < \frac{H_2}{T_2}$

42. A particle is projected from the ground with velocity u at angle θ with horizontal. The horizontal range, maximum height and time of flight are R, H and T respectively. Now keeping u as fixed, θ is varied from 30° to 60°. Then

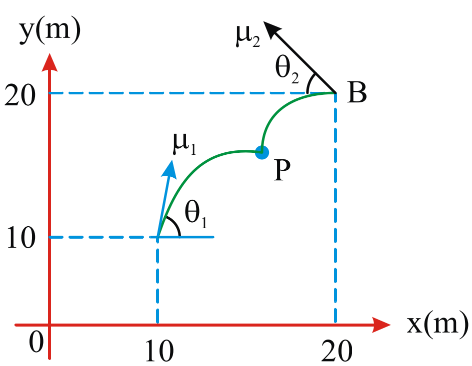
(a) R will first increase. H will increase and T will decrease

(b) R will first increase then dcrease while H and T both will increase

(c) R will decrease while H and T will increase

(d) R will increase while H and T will decrease

43. Two projectiles A and B are fired simultaneously as shown in figure. They collide in air at point at time t. Then

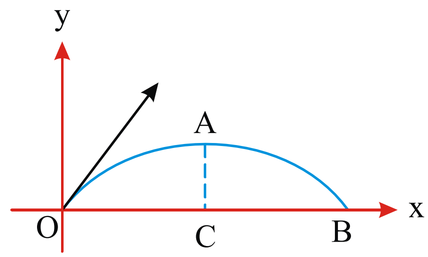


(a) $t(u_1 \cos\theta_1 - u_2 \cos\theta_2) = 20$ (b) $t(u_1 \sin\theta_1 - u_2 \sin\theta_2) = 10$

(c) Both (a) and (b) are correct (d) Both (a) and (b) are wrong

44. Suppose in the abscence of air resistance, $R = OB$, $H = AC$, $t_1 = t_{OA}$ and

$t_2 = t_{AB}$. **If air resisitance is taken into consideration and the corresponding values are** R', H', t_1' **and** t_2' **then**



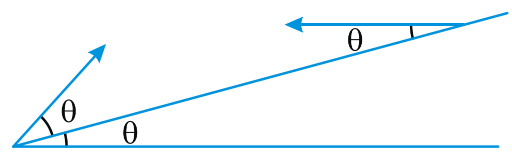
(a) $R' < R, H' < H, t_1' > t_1$ and $t_2' > t_2$

(b) $R' < R, H' < H, t_1' > t_1$ and $t_2' < t_2$

(c) $R' < R, H' > H, t_1' > t_1$ and $t_2' < t_2$

(d) $R' < R, H' < H, t_1' < t_1$ and $t_2' > t_2$

45. From an inclined plane two particles are projected with same speed at same angle θ, one up and other down the plane as shown in figure. Which of the following statement(s) is/are correct ?



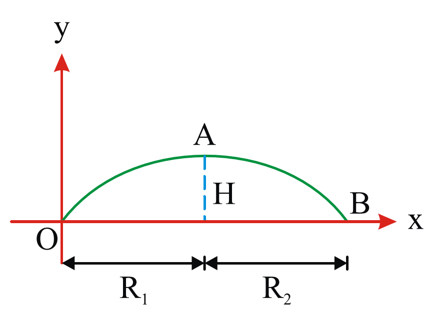
(a)The particles will collide the plane with same speed

(b) The times of flight of each particle are same

(c) Both particles strike the plane perpendicularly

(d) The particles will collide in mid air if projected simultaneuosly and time of flight of each particle is less than the time of collision

46. In a projectile motion let $t_{OA} = t_1$ and $t_{AB} = t_2$. The horizontal displacement from O to A is R_1 and from A to B is R_2. Maximum height isH and time of flight is T. If air drag is to be considered, then choose the correct alternative(s).



(a) t_1 will decrease while t_2 will increase

(b) H will increase

(c) R_1 will decrease while R_2 will increase

(d) T may increase or decrease

47. A projectile is projected from the ground making an angle of $30°$ with the horizontal. Air exerts a drag which is proportional to the velocity of the projectile

(a) at highest point velocity will be horizontal
(b) the time of ascent will be equal to the time of descent
(c) the time of descent will be greater than the time of ascent
(d) the time of ascent will be greater than the time of descent

48. A particle is fired from a point on the ground with speed u making an angle θ with the horizontal. Then

(a) the radius of curvature of the projectile at the highest point is $\frac{u^2 \cos^2 \theta}{g}$
(b) the radius of curvature of the projectile at the highest point is $\frac{u^2 \sin^2 \theta}{g}$
(c) at the point of projection magnitude of tangential acceleration is $g \sin \theta$
(d) at the point of projection magnitude of tangential acceleration is $g \cos \theta$

49. A particle is projected from ground with velocity $40\sqrt{2}\ m/s$ at 45^o. At time t = 2 s

(a) displacement of particle is 100 m
(b) vertical component of velocity is 20 m/s
(c) velocity makes an angle of $\tan^{-1}(2)$ with vertical
d) particle is at height of 60 m from ground

COMPREHENSION TYPE QUESTIONS

Comprehension - I

A motor cyclist is riding North in still air at $36\ kmh^{-1}$. The wind starts blowing West ward with a velocity $18\ kmh^{-1}$

50. The direction of apparent velocity is

a) $\tan^{-1}(1/2)$ West of North
b) $\tan^{-1}(1/2)$ North of West
c) $\tan^{-1}(1/2)$ East of North
d) $\tan^{-1}(1/2)$ North of East

51. If the wind velocity becomes $36\ kmh^{-1}$ due West, then how much more distance the motor cyclist would cover in 10 min

a) 10 km
b) 1.8 km
c) 3.6 km
d) 8.5 km

Comprehension-II

A river of width 'a' with straight parallel banks flows due north with speed u. The points O and A are on opposite banks and A is due east of O. Coordinate axes OX and OY are taken in the east and north directions respectively. A boat, whose speed is v relative to water, starts from O and crosses the river. If the boat is steered due east and u varies with x as $u = x(a-x)\frac{v}{a^2}$ find

52. equation of trajectory of the boat

a) $y = \frac{x}{a} - \frac{x^2}{2a}$
b) $y = \frac{x^2}{2a} - \frac{x^3}{3a^2}$
c) $y = \frac{x^2}{a} - \frac{x^3}{a^2}$
d) $y = \frac{x^2}{a} - \frac{x^3}{3a^2}$

53. Time taken to cross the river

a) $\frac{a}{v}$ b) $\frac{v}{a}$ c) $\frac{2a}{v}$ d) $\frac{2v}{a}$

54. The direction of absolute velocity of boat man when he reaches the opposite bank

a) west b)south c)east d) north

Comprehension-III

A car is moving towards south with a speed of 20 ms^{-1}. A motorcyclist is moving towards east with a speed of 15 ms^{-1}. At a certain instant, the motorcyclist is due south of the car and is at a distance of 50m from the car.

55. The shortest distance between the motorcyclist and the car is

a) 10m b) 20m c) 30m d) 40m

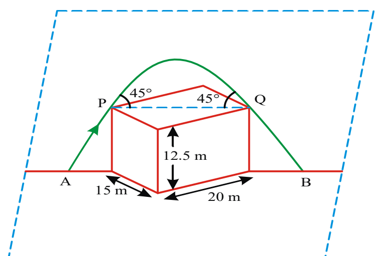
56. The time after which they are closest to each other

a) 1/3s b) 8/3s c) 1/5s d) 8/5s

COMPREHENSION TYPE QUESTIONS

Passage:1

A particle is fired from 'A' in the diagonal plane of a building of dimension 20m (length) x 15m(breadth) x 12.5m (height), just clears the roof diagonally & falls on the other side of the building at B. It is observed that the particle is traveling at an angle 45^0 with the horizontal when it clears the edges P and Q of the diagonal. Take g=10m/s².



57. The speed of the particle at point P will be :

a) $5\sqrt{10}m/s$ b) $10\sqrt{5}m/s$ c) $5\sqrt{15}m/s$ d) $5\sqrt{5}m/s$

58. The speed of projection of the particle at A will be :

a) $5\sqrt{10}m/s$ b) $10\sqrt{5}m/s$ c) $5\sqrt{15}m/s$ d) $5\sqrt{5}m/s$

59. The range that is AB will be :

a) $5\sqrt{10}m$ b) $25\sqrt{3}m$ c) $5\sqrt{15}m$ d) $25\sqrt{5}m$

Passage: 3

Two projectiles are projected simultaneously from the top and bottom of a vertical tower of height h at angles 45^0 and 60^0 above horizontal respectively. Body strike at the same point on ground at distance 20m from the foot of the tower after same time.

60. The speed of projectile projected from the bottom is

a) 40 m/s b) $\frac{20}{\sqrt{3}}m/s$ c) $40\sqrt{3}m/s$ d) $\frac{20}{\sqrt{\sqrt{3}}}m/s$

61. The ratio of the speed of the projectile projected from the top and the speed of the projectile projected from the bottom of tower is

a) $1:\sqrt{2}$ b) $1:\sqrt{3}$ c) $\sqrt{5}:1$ d) $\sqrt{7}:1$

62. The time of flight of projectiles is

a) $(3)^{\frac{1}{4}}$ b) $2(3)^{\frac{1}{4}}$ c) $3(3)^{\frac{1}{4}}$ d) $4(3)^{\frac{1}{4}}$

Passage:4 (IIT JEE 1996)

Two guns situated on top of a hill of height 10m fire one shot each with the same speed $5\sqrt{3}$ m/s at some interval of time. One gun fires horizontally and the other fires upwards at an angle of 60^0 with the horizontal. The shots collide in air at a point P. Find

63. The time interval between the firings and

a) 1 s b) 2s c) 3 s d) 4s

64. the coordinates of point P. Take the origin of coordinate system at the foot of the hill right below the muzzle and trajectories in the xy-plane.

a) $(5m, 5m)$ b) $(5\sqrt{3}m, 5\sqrt{3}m)$ c) $(5\sqrt{3}m, 5m)$ d) $(5m, 5\sqrt{3}m)$

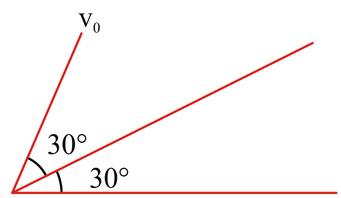
MATRIX MATCHING TYPE

65. V_r, V_w, V_m are the velocities of rain, wind and man are given in Column-I V_{rm} in Column-II match Column-I withColumn-II

Column-I	Column-II
a) $\overline{V}_r = -5j, \overline{V}_w = 5i, \overline{V}_m = 0$	p) $\overline{V}_{rm} = -10j$
b) $\overline{V}_r = -5j, \overline{V}_w = 5i, \overline{V}_m = 5i$	q) $\overline{V}_{rm} = 5i - 5j$
c) $\overline{V}_r = -5j, \overline{V}_w = 5i - 5j, \overline{V}_m = 5i$	r) $\overline{V}_{rm} = -5j$
d) $\overline{V}_r = -5j, \overline{V}_w = -5i - 5j, \overline{V}_m = 5i$	s) $\overline{V}_{rm} = -10i - 10j$

MATRIX MATCHING TYPE QUESTIONS

66. A particle is projected on an inclined plane which is inclined at 30^0 with the horizontal as shown in fig. Initial speed of the particle is v_0, and inclined plane is sufficiently large. Match the Column – I and Column – II



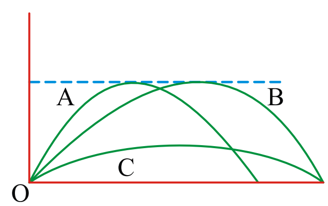
Column – I	Column – II
a) Range on the inclined plane	p) $\frac{v_0}{g\sqrt{3}}$
b) Velocity of the particle is parallel to the inclined plane at time	q) $\frac{2v_0}{g\sqrt{3}}$
c) Time after which particle strikes the plane is	r) $\frac{4v_0}{3g}$

d) For the given velocity maximum range on the inclined plane (angle of projection changing) — s) $\frac{2v_0^2}{3g}$

67. A ball is thrown at an angle 75^0 with the horizontal at a speed of 20 m/s towards a high wall at a distance d. If the ball strikes the wall, its horizontal velocity component reverses the direction without change in magnitude and the vertical velocity component remains same. Ball stops after hitting the ground.Match the statement of column I with the distance of the wall from the point of throw in column II.

Column-I	**Column-II**
a) Ball strikes the wall directly	**p)** d = 8m
b) Ball strikes the ground at x = 12 m from the wall	**q)** d = 10 m
c) Ball strikes the ground at x = 10 m from the wall	**r)** d = 15 m
d) Ball strikes the ground at x = 5 m from the wall	**s)** d = 25 m

68. Trajectories are shown in figure for three kicked footballs. Initial vertical and horizontal velocity components are u_y *and* u_x respectively. Ignoring air resistance, choose the correct statement from column-2 for the value of variable in column-1.



Column-1	**Column-2**
A) Time of flight	**P)** greatest for A only
B) u_y / u_x	**Q)** greatest for C only
C) u_x	**R)** equal for A and B
D) $u_x u_y$	**S)** equal for B and C

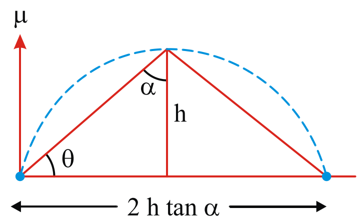
INTEGER ANSWER TYPE QUESTIONS

69. Three points are located at the vertices of an equilateral triangle whose sides equal to a =3m. They all start moving simultaneously with speed v =1 m/s, with the first point heading continually for the second, the second for the third, and the third for the first. How soon will the ponits meet?

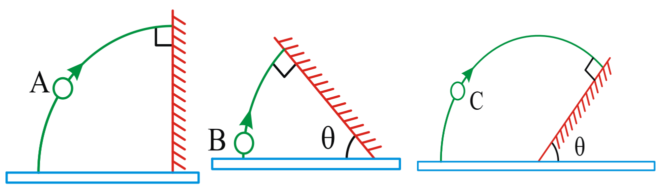
70. The slopes of wind screen of two cars are $\alpha_1 = 30^0$ and $\alpha_2 = 15^0$ respectively. At what ratio of $\frac{v_1}{v_2}$ of the velocities of the cars will their drivers see the hail stones bounced back by the wind screen on their cars in vertical direction assume hail stones fall vertically downwards and collisions to be elastic

71. **A heavy particle is projected from a point at the foot of a fixed plane, inclined at an angle 45^0 to the horizontal, in the vertical plane containing the line of greatest slope through the point. If $\phi(> 45^0)$ is the inclination to the horizontal of the initial direction of projection, for what value of $\tan\phi$ will the particle strike the plane horizontal.**

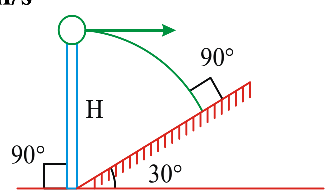
72. **A projectile is fired from the base of cone-shaped hill. The projectile grazes the vertex and strikes the hill again at the base. If α be the half - angle of the cone, h its height, u the initial velocity of projection and θ angle of projection, then $\tan\theta\tan\alpha$ is**



73. **Three balls A,B and C are projected from ground with same speed at same angle with the horizontal. The balls A, B and C collide with the wall during a flight in air and all three collide perpendicularly and elastically with the wall as shown in figure. If the time taken by the ball A to fall back on ground is 4 seconds and that by ball B is 2 seconds. Then the time taken by the ball C to reach the ground after projection will be ....**



74. **In the given figure, the angle of inclination of the inclined plane is 30^0. A particle is projected with horizontal velocity V_0 from height H. Find the horizontal velocity V_0(in m/s) so that the particle hits the inclined plane perpendicularly. Given, H = 4m, g =10 m/s^2**



EXERCISE - I - KEY

SINGLE ANSWER TYPE

1)B	2)A	3)A	4)C	5)C	6)D	7)A
8)A	9) C	10) C	11)A	12) B	13) b	14) a
15) d	16)c	17) d	18) d	19) b	20) d	21) a
22) b	23) a	24) c	25) b	26) a	27) b	28) b
29) d	30) d	31) d				

MULTI ANSWER TYPE

32)AC 33)BC 34) ABC 35)BC
36)A,B,C,D 37)A,D 38) a,b,c 39) b,d
40) a,b,d 41) a,c 42) b 43) b

44) b 45) b,d 46) a,d 47) a,d
48) a,c 49) a,b,c,d

COMPREHENSION TYPE

50) A 51) B 52)B 53)A 54)C 55)C 56)D
57) a 58) b 59) b 60) d 61) a 62) b 63) a 64)c

MATRIX MATCH TYPE

65) a-q,b-r,c-p,d-s

66) $a \to s, b \to p, c \to q, d \to s$

67) $A \to p,q,r; B \to p; C \to q; D \to r,s$

68) a-r b-p c-q d-s

INTEGER TYPE

69) 2 70)3 71) 2 72) 2 73) 6 74) 4

EXERCISE - II

SINGLE ANSWER QUESTIONS

A) RELATIVE MOTION

1. An open merry go round rotates at an angular velocity ω. A person stands in it at a distance r from the rotational axis. It is raining and the rain drops falls vertically at a velocity v_0. How should the person hold an umbrella to prorect himself from the rain in the best way. Angle made by umbrella with the vertical is

a) $\cot\alpha = \frac{v_0}{r\omega}$ b) $\tan\alpha = \frac{v_0}{r\omega}$ c) $\cot\alpha = \frac{r\omega}{v_0}$ d) $\tan\alpha = \frac{v_0}{r\omega}$

2. A man standing, observes rain falling with velocity of 20 m/s at an angle of 30^0 with the vertical. Find out velocity of man so that rain again appears to fall at 30^0 with the vertical.

a) 20 m/s b) 30 m/s c) 40 m/s d) 10 m/s

3. A person standing on a road has to hold his umbrella at 60^0 with the vertical to keep the rain away. He throws the umbrella and starts running at 20 ms^{-1}. He finds that rain drops are falling on him vertically. Find the speed of the rain drops with respect to

1. The road 2. The moving person

a) $\frac{40}{3}$ m/s, $\frac{20}{3}$ m/s b) $\frac{40}{3}$ m/s, $\frac{22}{3}$ m/s

c) $\frac{40\sqrt{3}}{3}$ m/s, $\frac{20\sqrt{3}}{3}$ m/s d) $\frac{40\sqrt{3}}{3}$ m/s, $\frac{20}{3}$ m/s

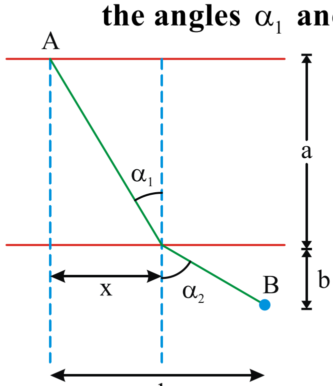
4. Two swimmers leave point A on one bank of the river to reach point B lying right across on the other bank. One of them crosses the river along the straight line AB while the other swims at right angles to the stream and the walks the distance that he has been carried away by the stream to get to point B. What was the velocity u of his walking if both swimmers reached the destination sumultaneously The stream velocity v_0 = 2.0 km/hour and the velocity v^1 of each swimmer with respect to water equals 2.5km per hour.

a) 3km/hr b) 3.5km/hr c) 4km/hr d) 5km/hr

5. A ball is thrown vertically upward from the 12m level in an elevator shaft with an initial velocity of 18m/s. At the same instant an open platform elevator passes the 5m level, moving upward with a constant velocity of 2 m/s. Determine (a) when and where the ball will hit the elevator, (b) the relative velocity of the ball with respect to the elevator when the ball hits the elevator.

a) 10.2m 9.8m/s b) 12.3m 19.8m/s c) 12m 10.2m/s d) 12.5m 22m/s

6. From a point A on bank of a channel with still water a person must get to a point B on the opposite bank. All the distances are shown in figure. The person uses a boat to travel across the channel and then walks along the bank to point B. The velocity of the boat is v_1 and the velocity of the walking person is v_2. Prove that the fastest way for the person to get from A to B is to select the angles α_1 and α_2 in such a manner that



a) $\dfrac{\sin\alpha_1}{\sin\alpha_2} = \dfrac{v_2}{v_1}$

b) $\dfrac{\sin\alpha_1}{\sin\alpha_2} = \dfrac{v_1}{v_2}$

c) $\dfrac{\cos\alpha_1}{\cos\alpha_2} = \dfrac{v_2}{v_1}$

d) $\dfrac{\cos\alpha_2}{\cos\alpha_1} = \dfrac{v_1}{v_2}$

7. On morning Joy was walking on a grass-way in a garden. Wind was also blowing in the direction of his walking with speed u. He suddenly saw his friend Kim walking on the parallel grass-way at a distance x away. Both stopped as they saw each other when they were directly opposite on their ways at a distance x. Joy shouted "Hi Kim". Find the time after which Kim would have heard his greeting. Sound speed in still air is v.

a) $\dfrac{x}{\sqrt{v^2-u^2}}$ b) $\dfrac{2x}{\sqrt{v^2-u^2}}$ c) $\dfrac{x}{2\sqrt{v^2-u^2}}$ d) $\dfrac{x}{4\sqrt{v^2-u^2}}$

B) BODY PROJECTED FROM THE GROUND

8. A projectile is fired with velocity v_0 from a gun adjusted for a maximum range. It passes through two points P and Q whose heights above the horizontal are h each. The separation of the two points is

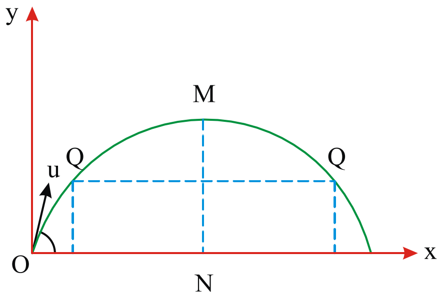
a) $\dfrac{v_0}{g}\sqrt{v_0^2-4gh}$ b) $\dfrac{v_0}{g}\sqrt{v_0^2+4gh}$ c) $2\dfrac{v_0}{g}\sqrt{v_0^2-4gh}$ d) $\dfrac{v_0}{g}\sqrt{v_0^2-gh}$

9. A shot is fired with a velocity u at a very high vertical wall whose distance from the point of projection is x. The greatest height above the level of the point of projection at which the bullet can hit the wall is .

a) $\dfrac{u^4+g^2x^2}{2gu^2}$ b) $\dfrac{u^4-g^2x^2}{gu^2}$ c) $\dfrac{u^4-g^2x^2}{4gu^2}$ d) $\dfrac{u^4-g^2x^2}{2gu^2}$

10. A stone is projected from the point of a ground in such a direction so as to hit a bird on the top of a telegraph post of height h and then attain the maximum

height 2h above the ground. If at the instant of projection, the bird were to fly away horizontally with a uniform speed. Find the ratio between the horizontal velocities of the bird and the stone, if the stone still hits bird while decending.



a) $\frac{2}{\sqrt{2}+1}$

b) $\frac{1}{\sqrt{2}+1}$

c) $\frac{2}{\sqrt{2}-1}$

d) $\frac{1}{\sqrt{2}-1}$

11. The benches of a gallery in a cricket stadium are 1 m high and 1 m wide. A batsman strikes the ball at a level 1 m about the ground and hits a ball. The ball starts at 35 m/s at an angle of 53° with the horizontal. The benches are perpendicular to the plane of motion and the first bench is 110 m from the batsman. On which bench will the ball hit.

a) 4th step b) 5th step c) 6th step d) 7 th step

12. If R is the horizontal range for θ inclination and h is the maximum height reached by the projectile, Then maximum range is

a) $\frac{R^2}{h}+2h$ b) $\frac{R^2}{8h}+2h$ c) $\frac{R^2}{8h}+8h$ d) $\frac{R^2}{h}+h$

13. The acceleration of gravity can be measured by projecting a body upward and measuring the time it takes to pass two given points in both directions. Show that if the time the body takes to pass a horizontal line a in both directions is t_A antime to go by a second line B in both direction is t_B, then assuming that the acceleration is constant, its magnitude is $g =$ (where h is the height of the line B above line A.)

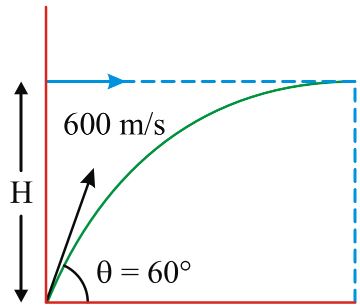
a) $\frac{h}{t_A^2 - t_B^2}$ b) $\frac{8h}{t_A^2 - t_B^2}$ c) $\frac{8h}{t_A^2 + t_B^2}$ d) $\frac{4h}{t_A^2 + t_B^2}$

C) BODY PROJECTED FROM TOP OF A TOWER

14. A particle is released from a certain height H = 400 m. Due to the wind the particle gathers the horizontal velocity component $v_x = ay$ where $a = \sqrt{5}\,s^{-1}$ and y is the vertical displacement of the particle from point of release, then find the horizontal drift of the particle when it strikes the ground

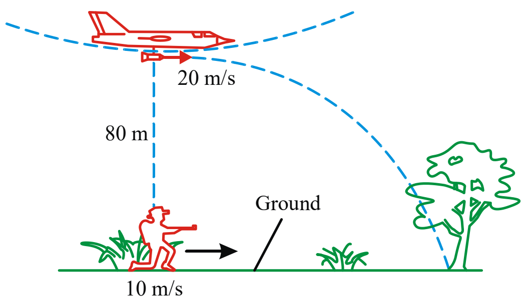
a) 2.67 km b) 5.67 km c) 12.67 km d) 4.97 km

14. A fighter plane enters inside the enemy territory, at time t = 0, with velocity $\upsilon_o = 250\,m/s$ a moves horizontally with constant acceleration $a = 20\,m/s^2$ (see figure). An enemy tank at theborder, spot the plane and fire shots at an angle $\theta = 60^\circ$ with the horizontal and with velocity u = 600 m/s. At what altitude H of the plane it can be hit by the shot?



a) 1500 m b) 2473 m c) 1650 m d) 1800 m

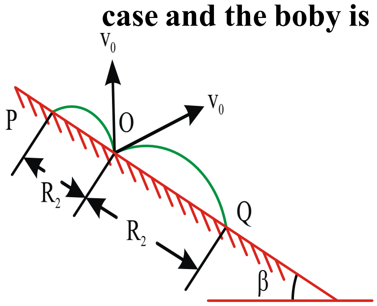
15. **A bomber plane moving at a horizontal speed of 20 m/s releases a bomb at a height of 80 m above ground as shown. At the same instant a Hunter starts running from a point below it, to catch the bomb at 10 m/s. After two seconds he realized that he cannot make it, he stops running and immediately hold his gun and fires in such direction so that just before bomb hits the ground, bullet will hit it. What should be the firing speed of bullet. (Take g = 10 m/s²)**



a) 10 m/s b) $20\sqrt{10}m/s$ c) $10\sqrt{10}m/s$ d) None of these

D) PROJECTILE MOTION ON INCLINED PLANE

16. **A body has maximum range R_1 when projected up the inclined plane. The same boby when projected down the inclined plane. it has maximum range R_2. Find its maximum horizontal range. Assume the equal speed of projection in each case and the boby is projected onto the e greatest slope.**



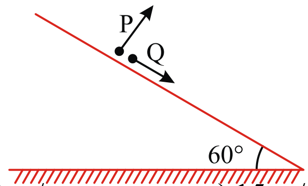
a) $R = \dfrac{2R_1R_2}{R_1 - R_2}$

b) $R = \dfrac{2R_1R_2}{R_1 + R_2}$

c) $R = \dfrac{R_1R_2}{R_1 - R_2}$

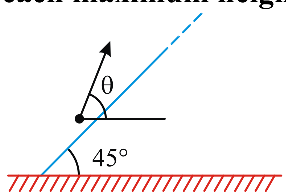
d) $R = \dfrac{4R_1R_2}{R_1 + R_2}$

17. **A particle P is projected from a point on the surface of smooth inclined plane. Simultaneously another particle Q is released on the smooth inclined plane from the same position. P and Q collide on the inclined plane after t = 4 second. The speed of projection of P is (Take g = 10 m/s²)**



a) 5 m/s b) 10 m/s c) 15 m/s d) 20 m/s

18. **A particle is projected from surface of the inclined plane with speed u and at an angle θ with the horizontal. After some time the particle collides elastically with the smooth fixed inclined plane for the first time and subsequently moves in vertical direction. Starting from projection, find the time taken by the particle to reach maximum height. (Neglect time of collision)**

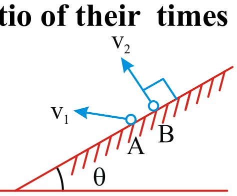


a) $\frac{2u\cos\theta}{g}$ b) $\frac{2u\sin\theta}{g}$ c) $\frac{u(\sin\theta+\cos\theta)}{g}$ d) $\frac{2u}{g}$

19. **A perfectly elastic particle is projected with a velocity v on a vertical plane through the line of greatest slope of an inclined plane of elevation α. If after striking the plane, the particle rebounds vertically, show that it will return to the point of projection at the end of time equal to**

a) $\frac{6v}{g\sqrt{1+8\sin^2\alpha}}$ **b)** $\frac{6v}{g\sqrt{1+\sin^2\alpha}}$ **c)** $\frac{v}{g\sqrt{1+8\sin^2\alpha}}$ **d)** $\frac{v}{g\sqrt{1+\sin^2\alpha}}$

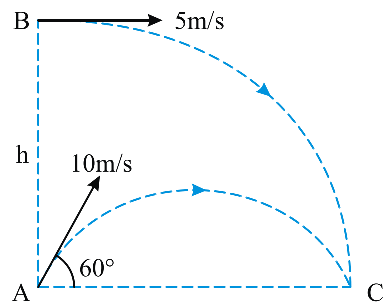
20. **Two bodies A and B are projected from the same place in same vertical plane with velocities v_1 *and* v_2. From a long inclined plane as shown Find the ratio of their times of flight**



a) $\frac{v_1\sin\theta}{v_2}$ **b)** $\frac{2v_1\sin\theta}{v_2}$ **c)** $\frac{v_1\sin\theta}{2v_2}$ **d)** $\frac{v_1\cos\theta}{v_2}$

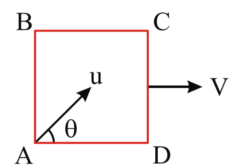
E) COLLISIONS BETWEENPROJECTILES

21. **A particle A is projected from the ground with an initial velocity of 10 m/s at an angle of 60° with horizontal. From what height should an another particle B be projected horizontally with velocity 5 m/s so that both the particles collide in ground at point C if both are projected simultaneously g = 10 m/s².**



(A) 10 m (B) 15 m (C) 20 m (D) 30 m

22. **A smooth square platform $ABCD$ is moving towards right with a uniform speed v. At what angle θ must a particle be projected from A with speed u so that it strikes the point B?**



(a) $\sin^{-1}\left(\frac{u}{v}\right)$ (b) $\cos^{-1}\left(\frac{v}{u}\right)$ (c) $\cos^{-1}\left(\frac{u}{v}\right)$ (d) $\sin^{-1}\left(\frac{v}{u}\right)$

23. **Two particles are projected from the same point on ground simultaneously with speeds and $20\,m/s$ and $20/\sqrt{3}\,m/s$ at angles 30° and 60° with the horizontal in the same direction. The maximum distance between them till both of them strike the ground is approximately (g = 10m/s^2)**

(a) 23.1 m (b) 16.4 m (c) 30.2 m (d) 10.4 m

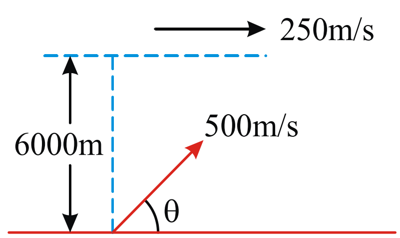
24. **Two particles A and B are projected simultaneously from a point situated on a horizontal plane.The particle A is projected vertically up with a velocity v_A while the particle B is projected up at an angle of 30° with horizontal with a velocity v_B . After 5 s the particles were observed moving mutually perpendicular to each other. The velocity of projection of the particle v_A and v_B respectively are**

(a) $5ms^{-1}, 100\,ms^{-1}$ (b) $100\,ms^{-1}, 50\,ms^{-1}$

(c) v_A can have any value grater than $25\,ms^{-1}, 100\,ms^{-1}$

(d) $20ms^{-1}, 25\,ms^{-1}$

25. **An aircraft moving with a speed of 250 m/s is at a height of 6000m, just overhead of an antiaircraft gun. If the muzzle velocity is 500 m/s, the firing angle θ should be:**

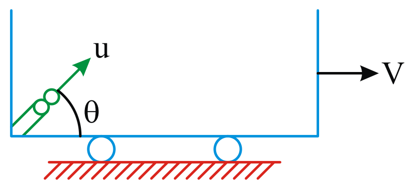


(a) 30^0 (b) 45^0 (c) 60^0 (d) none of these.

26. **A cannon fires successively two shells with velocity v_0 =250 m/s, the first at an angle $\theta_1 = 60^0$ and the second at an angle $\theta_2 = 45^0$ to the horizontal, the azimuth being the same. Neglecting the air drag, find the time interval between firings leading to the collision of the shells**

a) 4 sec b) 7 sec c) 17 sec d) 11 sec

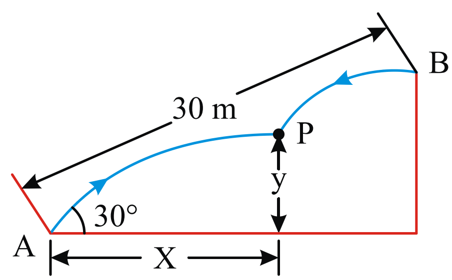
27. **A shell is projected from a gun with a muzzle velocity v. The gun is fitted with a trolley car at an angle θ as shown in the fig. if the trolley car is made to move with constant velocity v towards right, find the horizontal range of the shell relative to ground.**



a) $R = \dfrac{2u\sin\theta(u\cos\theta + v)}{g}$ b) $R = \dfrac{2u\sin\theta(u\cos\theta - v)}{g}$

c) $R = \dfrac{u\sin\theta(u\cos\theta + v)}{2g}$ d) $R = \dfrac{u\sin\theta(u\cos\theta + v)}{g}$

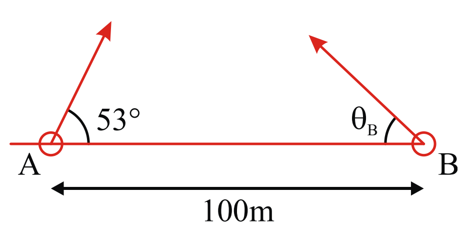
28. **Two guns are projected at each other, one upward at an angle of $30^0$and the other at the same of depression, the muzzles being 30m apart as shown in the figure. If the guns are shot with velocities of 350m/s upward and 300 m/s downward respectively. where the bullets may meet.**



a) x = 14m,y = 8.07m b) x = 4m,y = 4.07m
c) x = 10m,y = 10.07m d) x=5m,y = 1 8.07m

29. **Two particles A and B are projected in same vertical plane as shown in the figure. Their initial positions (t = 0), initial speed and angle of projections are indicated in the diagram. If initial angle of projection $q_B = 37^0$, what should be initial speed of projection of particle B, so that it hits particle A.**

$U_A = 60m/s$



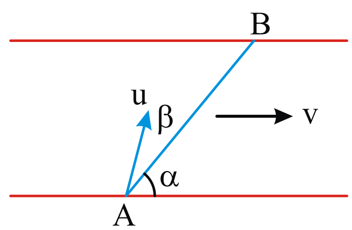
1) 80 m/s 2) 75 m/s 3) 40 m/s 4) 45 m/s

MULTI ANSWER QUESTIONS

30. A child in danger of drowing in a river is being carried downstream by a current that flows uniformly at a speed of 2.5km/h. The child is 0.6km from shore and 0.8km upstream of a boat landing when a rescue boat sets out. If the boat proceeds at its maximum speed of 20km/h with respect to the water, what angle does the boat velocity v make with the shore? How long will it take boat to reach the child.

a) The angle made by the boat with the shore is 53^0
b) The angle made by the boat with the shore is 37^0
c) The time taken by boat to reach the child is 4 min
d) The time taken by boat to reach the child is 3 min

31. A launch plies between two points A and B on the opposite banks of a river always following the line AB. The distance S between points A and B is 1,200m. The velocity of the river current v =1.9m/s is constant over the entire width of the river. The line AB makes an angle $\alpha = 60^0$ with the direction of the current. With what velocity u and at what angle β to the line AB should the launch move to cover the distance AB and back in a time t =5 min? The angle β remains the same during the passage from A to B and from B to A.



a) The velocity of the boat is 8m/s
b) The velocity of the boat is 6m/s
c) The angle made by u with the line AB is 12^0
d) The angle made by u with line AB is 10^0

32. The current velocity of river grows in proportion to the distance from its bank and reaches the maximum value v_0 in the middle. Near the banks the velocity is zero. A boat is moving along the river in such a manner that it always perpendicular to the current. The speed of the boat in still water is u. Find the distance through which the boat crossing the river will be carried away by the current if the width of the river is c. Also determine the trajectory of the boat.

a) The distance carried by the boat is $X_{max} = \frac{2cu}{v_0}$

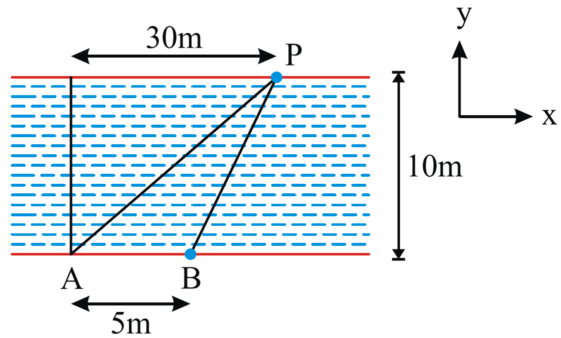
b) The distance carried by the boat is $x_{max} = \frac{cv_0}{2u}$

c) The trajectary of the boat is $y^2 = \frac{v_0 c}{u} x$

d) The trajectary of the boat is $y^2 = \frac{uc}{v_0} x$

33 Two swimmers A and B start swimming from different positions on the same bank as shown in figure. The swimmer A swims at angle 90^0 with respect to the

river to reach point P. He takes 120 seconds to cross the river of width 10m. The swimmer B also takes the same time to reach the point P

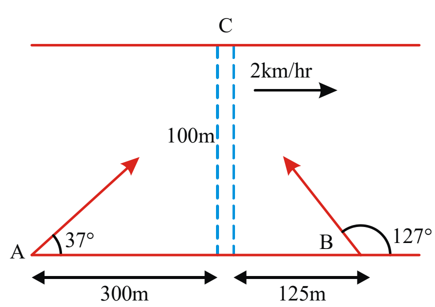


a) velocity of A with respect to river is 1/6 m/s
b) river flow velocity is ¼ m/s.
c) Velocity of B along y-axis with respect to earth is 1/3 m/s.
d) velocity of B along x-axis with respect to earth is 5/24 m/s.

34. **Two frames of reference P and Q are moving relative to each other at constant velocity. Let $\vec{v}_{OP}$ and $\vec{a}_{OP}$ represent the velocity and the acceleration respectively of a moving particle O as measured by an observer in frame P and $\vec{v}_{OQ}$ and $\vec{a}_{OQ}$ represent the velocity and the acceleration respectively of the moving particle O as measured by an observer in frame Q, then**

(A) $\vec{v}_{OP} = \vec{v}_{OQ}$ (B) $\vec{v}_{OP} = \vec{v}_{OQ} + \vec{v}_{QP}$
(C) $\vec{a}_{OP} = \vec{a}_{OQ}$ (D) $\vec{a}_{OP} = \vec{a}_{OQ} + \vec{a}_{QP}$

35. **Two swimmers start a race. One who reaches the point C first on the other bank wins the race. A makes his strokes in a direction of 37^0 to the river flow with velocity 5km/hr relative to water. B makes his strokes in a direction 127^0 to the river flow with same relative velocity. River is flowing with speed of 2km/hr and is 100m wide. speeds of A and B on the ground are 8km/hr and 6km/hr respectively.**



(A) A will win the race (B) B will win the race
(C) the time taken by A to reach the point C is 165 sec
(D) the time taken by B to reach the point C is 150 sec

36. **Two trains A and B are moving with same speed of 100km/hr. Train 'A' moves towards east and train B moves towards west. At an instant when the trains are moving side by side, an aeroplane files above the trains horizontally. For the passengers in the train A, the plane appears to fly from North to South direction. For the passengers in the train B, the plane appears to fly in a direction making an angle 60^0 to North – South direction.**

(A) The speed of the plane with respect to ground is $100\sqrt{\frac{7}{3}}km/hr$

(B) The speed of the plane with respect to ground is $100\sqrt{3}\,km/hr$

(C) The plane moves in a direction at an angle of $\tan^{-1}\frac{\sqrt{3}}{2}$ to North-South direction (with respect to ground)

(D) The plane moves in a direction at an angle of $\tan^{-1}\frac{\sqrt{5}}{2}$ to North-South direction (with respect to ground)

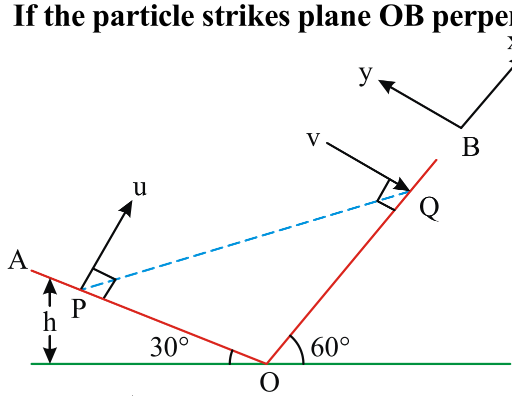
37. **Two shells are fired from cannon with speed u each, at angles of α and β respectively with the horizontal. The time interval between the shots is T. They collide in mid air after time t from the first shot. Which of the following conditions must be satisfied?**

a) $\alpha > \beta$ b) $t\cos\alpha = (t-T)\cos\beta$

c) $(t-T)\cos\alpha = t\cos\beta$

d) $(u\sin\alpha)t - \frac{1}{2}gt^2 = (u\sin\beta)(t-T) - \frac{1}{2}g(t-T)^2$

38. **Two inclined panes OA and OB having inclina tion 30^0 and 60^0 with the horizontal respectively intersect each other at O, as shown in figure. A particle is projected from point P with a velocity $u = 10\sqrt{3}m/s$ along a direction perpendicular to plane OA. If the particle strikes plane OB perpendicular at Q**



Which of the following is/are correct

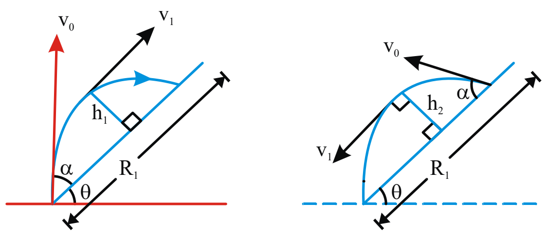
(a) The time of flight 2s

(b) The velocity with which the particle strikes the plane OB=10 m/s

(c) The height of the point P from point O is 5m

(d) The distance PQ = 20m

39. **Two balls are thrown from an inclined plane at angle of projection α with the plane, one up the incline and other down the incline as shown in figure (T stands for total time of flight) :**



a) $h_1 = h_2 = \dfrac{v_0^2 \sin^2 \alpha}{2g \cos\theta}$ b) $T_1 = T_2 = \dfrac{2v_0 \sin\alpha}{g \cos\theta}$

c) $R_2 = R_1 = g(\sin\theta)T_1^2$ d) $v_{t_2} = v_{t_1}$

40. An aeroplane at a constant speed releases a bomb. As the bomb drops away from the aeroplane,

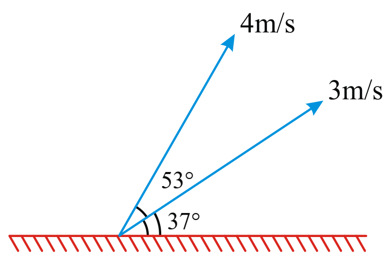
a) It will always be vertically below the aeroplane

b) It will always be vertically below the aeroplane only if the aeroplane was flying horizontallly.

c) It will always be vertically below the aeroplane only if the aeroplane was flying at an angle of 45^0 to the horizontal

d) It will gradually fall behind the aeroplane if the aeroplane was flying horizontally.

41. Two particles are projected with speed 4 m/s and 3 m/s simultaneously from same point as shown in the figure. Then :

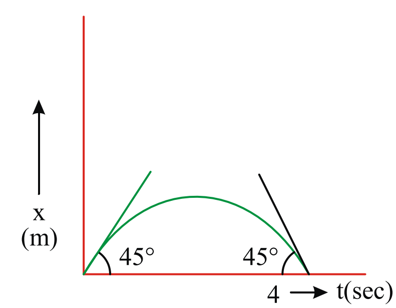


a) Their relative velocity is along vertical direction b) Their relative acceleration is non-zero and it is along vertical direction

c) They will hit the surface simultaneously

d) Their relative velocity is constant and has magnitude 1.4 m/s

42. A particle moves along x-axis with constant acceleration and its x-position depend on time 't' as shown in the following graph (parabola); then in interval 0 to 4 sec.



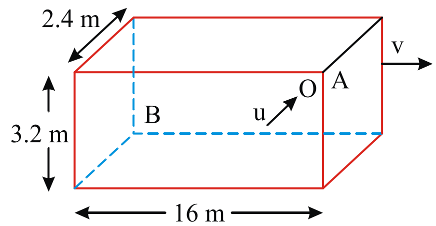
a) relation between x- coordinate & time is $x = t - t^2/4$.

b) maximum x-coordinate is 1m

c) total distance traveled is 2m

d) average speed is 0.5 m/s

43. A railway compartment is 16 m long, 2.4 m wide and 3.2 m high. It is moving with a velocity 'v'. A particle moving horizontally with a speed 'u', perpendicular to the direction of 'v' enters through a hole at an upper corner A and strikes the diagonally opposite corner B. Assume g = 10 m/s^2.



a) v = 20 m/s   b) u = 3 m/s

c) To an observer inside the compartment, the path of the particle is a parabola

d) To a stationary observer outside the compartment, the path of the particle is parabola

44. Two particles A and B are projected from the same point with the same speed but at different angles α and β with the horizontal, such that the maximum height of A is two–third of the horizontal range of B. Then which of the following relations are true ?

a) range of A = maximum height of B

b) $3(1 - \cos 2\alpha) = 8 \sin 2\beta$

c) maximum value of β is $\sin^{-1}(3/4)$

d) maximum horizontal range of A = u^2/g and this occurs when $\beta = \frac{1}{2}\sin^{-1}\left(\frac{3}{8}\right)$

45. Two particles are projected from the same point , with the same speed, in the same vertical plane, at different angles with the horizontal. A frame of reference is fixed to one particle. The position vector of the other particle as observed from this frame is $\vec{r}$. Which of the follwing satements are correct?

a) direction of $\vec{r}$ does not change

b) $\vec{r}$ changes in magnitude and direction with time

c) The magnitude of $\vec{r}$ increases linearly with time

d) The direction of $\vec{r}$ changes with time; its magnitude may or may not change, depending on the angles of projection

COMPREHENSION TYPE QUESTIONS

Passage-1

A river of width w is flowing such that the stream velocity varies with y as $v_R = v_0\left[1 + \frac{\sqrt{3}-1}{w}y\right]$; where y is the perpendicular distance from one bank. A boat starts rowing from the bank with constant velocity v =2v_0 in such a way that it always moves along a straight line perpendicular to the banks.

46. At what time will he reach the other bank

a) $t = \frac{w\pi}{6v_0}$ b) $\frac{w\pi}{6\left(\sqrt{2}-1\right)v_0}$ c) $\frac{w\pi}{6\left(\sqrt{3}-1\right)v_0}$ d) $\frac{w\pi}{\left(\sqrt{3}-1\right)v_0}$

47. What will be the velocity of the boat along the straight line when he reaches the other bank

a) v_0 b) $\sqrt{2}v_0$ c) $\frac{v_0}{\sqrt{2}}$ d) $2c_0$

Passage-2

A man is riding on a flat car travelling with a constant speed of 10m/s. He wishes to throw a ball through a stationary hoop 15 m above the height of his hands in such a manner that the ball will move horizontally as it passes through the hoop. He throws the ball with a speed of 12.5 m/s w.r.t. himself.

48. How many seconds after he release the ball will it pass through the hoop ?

a) 1 sec b) 2 sec c) 3 sec d) 4 sec

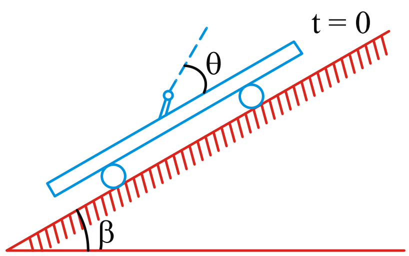
49. At what horizontal distance in front of the hoop must he release the ball ?

a) 12.5 m b) 15.5 m c) 17.5 m d) 20 m

Passage-3

A cannon is fixed with a smooth massive trolley car at an angle θ as shown in the figure. The trolley car slides from rest down the inclined plane of angle of inclination β.

The muzzle velocity of the shell fired at $t = t_0$ from the cannon is u, such that the shell moves perpendicular to the inclined plane just after the firing.



50. The value of t_0 is:

(a) $\frac{u\cos\theta}{g}$ (b) $\frac{u\cos\theta}{g\cos\beta}$ (c) $\frac{u\cos\theta}{g\sin\beta}$ (d) $\frac{u\sin\theta}{g\cos\beta}$

51. the time of flight of the shell is:

(a) $\frac{u\cos\theta}{g\sin\beta}$ (b) $\frac{2u\sin\theta}{g\cos\beta}$ (c) $\frac{u}{g}$ (d) $\frac{u\sin\theta}{g\sin\beta}$

52. the difference in range of the shell relative to the trolley car and ground is:

(a) $\frac{u^2\sin 2\theta}{g\cos\beta}$ (b) $\frac{u^2\cos^2\theta}{2g\sin\beta}$

(c) $\frac{u^2\sin\theta\sin\beta}{2g}$ (d) $\frac{2U^2\sin\theta\cos(\theta-\beta)}{g\cos^2\beta}$

53. after what time should the shell be fired such that it will go vertically up?

(a) $\frac{u\cos\theta}{g\sin\beta}$ (b) $\frac{u\sin(\theta+\beta)}{g\cos\theta\sin\beta}$ (c) $\frac{u\cos(\theta+\beta)}{g\cos\beta}$ (d) $\frac{u\cos(\theta+\beta)}{g\sin\beta\cos\beta}$

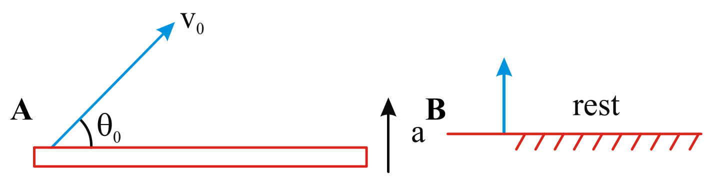
Passage: 4

When we analyse the projectile motion from any acccelerated frame O as

$\overrightarrow{r_O}, \overrightarrow{u_O}$ and $\overrightarrow{a_O}$ respectively, express the following terms; $\vec{r}_{pO} = \vec{r}_p - \vec{r}_O, \vec{u}_{pO} = \vec{u}_p - \vec{u}_O$ and $\vec{a}_{pO} = \vec{a}_p - \vec{a}_O$, where P stands for projectile. Then using the following kinematical equations of the projectile (For constant acceleration) relative to the accelerating frame, we have $\vec{s}_{pO} = \vec{u}_{pO}t + \frac{1}{2}\vec{a}_{pO}t^2, \vec{v}_{pO}$

$= \vec{u}_{pO} + \vec{a}_{pO}t$ and $v_{pO}^2 = u_{pO}^2 + 2\vec{a}.\vec{s}_{pO}$

Using the above expressions, answer the following question: A projectile has initial velocity v_0 relative to the large plate which is moving with a constant upward accelertion a.



54. Which of the following remain/s equal for the observers A and B ?

(a) Maximum height (b) Range
(c) Time of flight (d) Angle of projection

55. Refering to Q.1, velocity of the projectile relative to B ofter some time

(a) $< v_0$ at an angle $\theta < \theta_0$ (b) $> v_0$ at an angle $\theta > \theta_0$
(c) $> v_0$ at an angle $\theta = \theta_0$ (d) v_0 at an angle $\theta = \theta_0$

Passage - 5:

A point moves in the plane xy according to the law, $x = a\sin\omega t$, $y = a(1 - \cos\omega t)$

Answer the following question taking a and ω as positive constant

56. The distance travelled by the point during the time T is

(A) $2a\omega T$ (B) $3a\omega T$ (C) $4a\omega T$ (D) $a\omega T$

57. The equation of the trajectory of the particle is

(A) $y = x - \frac{x^2\alpha}{a}$ (B) $y = 2x - \frac{x^2\alpha}{a}$ (C) $y = x - \frac{x^2\alpha}{2a}$ (D) $y = x - \frac{2x^2\alpha}{a}$

58. The magnitude of the velocity of the point as a function of time is

(A) $a\sqrt{1+(1-\alpha t)^2}$ (B) $a\sqrt{1+(1-2\alpha t)^2}$
(C) $2a\sqrt{1+(1-\alpha t)^2}$ (D) $2a\sqrt{1+(1-2\alpha t)^2}$

Passage - 6:

At time $t = 0$, the position vector of a particle moving in the $x - y$ plane is $5\hat{i}$ m. By time $t = 0.62$ sec, it's position vector has become $(5.1\hat{i} + 0.4\hat{j})m$. with this data answer the following questions.

59. The magnitude of the average velocity during the above time interval.

(A) $.0206\, m/\sec$ (B) $0.206\, m/\sec$ (C) $20.6\, m/\sec$ (D) $2.06\, m/\sec$

60. The angle θ made by the average velocity with the positive x axis

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}(3)$ (C) $\tan^{-1}(1)$ (D) $\tan^{-1}(4)$

Passage - 7:

The position vector of a particle at time t is given by $\vec{r} = 2t\hat{i} + 5t\hat{j} + 4\sin\omega t\,\hat{k}$ where ω is a constant . Answer the following questions

61. Velocity vector of the particle is

(A) Constant in magnitude but with variable direction
(B) constant in direction must variable with magnitude
(C) constant
(D) varying with magnitude an well as direction

62. Velocity vector is perpendicular to ...... vector

(A) $2\hat{i} + 4\hat{j}$ (B) $3\hat{i} + 2\hat{j}$ (C) $5\hat{i} - 2\hat{j}$ (D) None

63. Acceleration of the particle is

(A) Constant in magnitude but variable with direction
(B) constant
(C) Constant in direction but variable with magnitude
(D) Varying with magnitude as well as direction

MATRIX MATCHING TYPE QUESTIONS

64. Two particles A and B moving in x-y plane are at origin at t=0sec. The initial velocity vectors of A and B are $\overline{v}_A = 8i\ m/s$ and $\overline{v}_B = 8j\ m/s$. The acceleration of A and B are constant and are $\overline{a}_A = -2i\,m/s^2$ and $\overline{a}_B = -2j\ m/s^2$. Column-I given certain statements regarding particle A and B Column-II given corresponding results. Match the statements in Column-I with corresponding results in Column-II.

Column-I	Column-II
(a) The time (in secs) at which velocity of A relative to B is zero	(p) $16\sqrt{2}$
(b) The distance (in m) between A and B when their relative velocity is zero	(q) $8\sqrt{2}$
(c) The time (in sec) after t =0 at which A and B are at same position	(r) 8
(d) The magnitude of relative velocity of A and B at the instant they are at same position	(s) 4

65. Consider 5 different situations a man M moving and rain as observed by him. $\vec{V}_R \rightarrow$ velocity of rain, $\vec{V}_{R/M} \rightarrow$ velocity of rain relative to man, $\vec{V}_M \rightarrow$ velocity of man The situations are shown on right hand column

Column - I

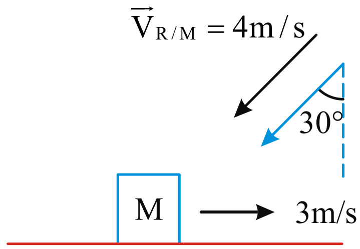
a) V_R lies in which of the following ranges $3.3\ m/s \le V_R \le 4.3\ m/s$

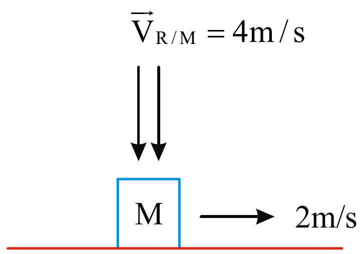
b) $4.3\ m/s < V_R \le 5.3\ m/s$

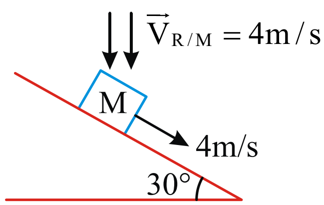
c) $5.3\ m/s < V_R \le 6.3\ m/s$

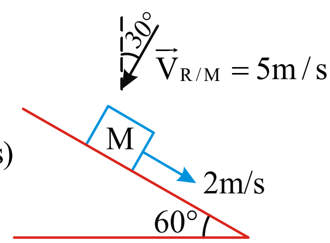
d) $6.3\ m/s < V_R \leq 7.3\ m/s$

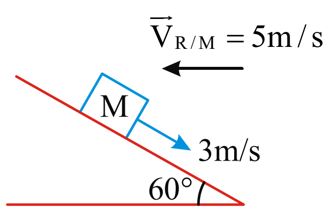
Column - II

p) 

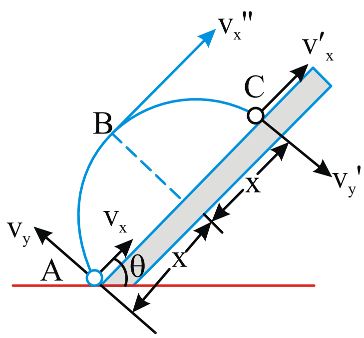
q) 

r) 

s) 

t) 

66. A particle projected onto an inclined plane:



Column-I | **Column-II**

(a) $\frac{v'_y}{v_y}$ (p) > 1

(b) t_{AC} (q) $\frac{2v_y}{g\cos\theta}$

(c) $\frac{x}{x'}$ (r) $\frac{v_x - v'_x}{g\sin\theta}$

(d) $\frac{t_{AB}}{t_{BC}}$ (s) 1

67. A projectile is thrown at an angle θ with the horizontal with a initial velocity v_0. If the magnitude of velocity of the projectile and time are related as $\frac{v^2}{a^2} - \left(t - \frac{b}{a}\right)^2 = \frac{c^2}{a^2}$, then

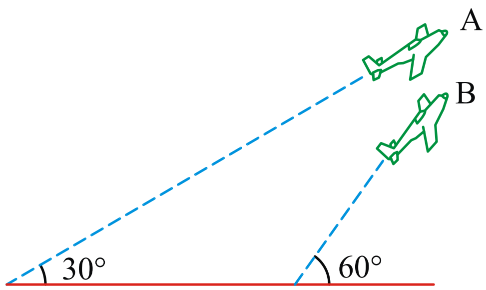
Column-I	**Column-II**
(a) Range is	(p) c
(b) Height	(q) $\frac{2b}{a}$
(c) Time of flight is	(r) $\frac{2bc}{a}$
(d) Velocity at highest point	(s) $\frac{b^2}{2a}$

INTEGER ANSWER TYPE QUESTIONS

68. The distance between two moving particles at any time is a= 32m. If v be their relative velocity and $v_1 = 4$ m/s and v_2 =8m/s be the components of v along and perpendicular to a. The time when they are closest to each other is (in meter)

69. Airplanes A and B are flying with constant velocity in the same vertical plane

at angles 30^0 and 60^0 with respect to the horizontal respectively as shown in figure. The speed of A is $100\sqrt{3}m/s$. At time t=0 s, an observer in A finds B at a distance of 500 m. The observer sees B moving with a constant velocity perpendicular to the line of motion of A. If at $t = t_0$, A just escapes being hit by B, t_0 in seconds is (adv 2014)



70. **A rock is launched upward at 45^0. A bee moves along the trajectory of the rock at a constant speed equal to the initial speed of the rock. The magnitude of acceleration of the bee at the top point of the trajectory is xg ? For the rock, neglect the air resistance. Find the value of x .**

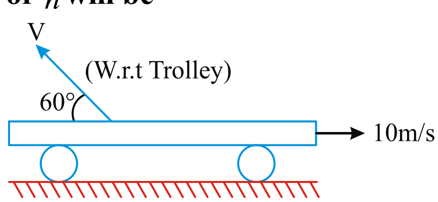
71. **A balll is thrown horizontally from a height of 20 m. If hits the ground with a velocity of '3' times the velocity of projection. The velocity of projection is 3.5x m/s, then x is**

72. **A body is projected up from the bottom an inclined plane with a velocity $3\sqrt{3}$ m/sec which makes an angle 60^0 if the horizontal. The angle of projection is 30^0 with the plane then the time of flight when it strikes the same plane is $0.1x$. Then the value of x is**

73. **A ball is thrown with a velocity whose horizontal component is $12ms^{-1}$ from a vertical wall 18.75m high in such away that it just clears the wall. At what time will it reach the ground ? ($g = 10ms^{-2}$)**

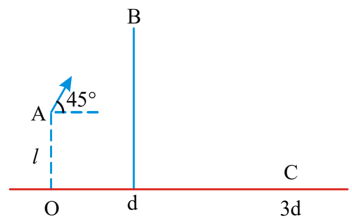
74. **A golfer standing on level ground hits a ball with a velocity of $u = 50ms^{-1}$ at an angle α above the horizontal. If $\tan\alpha = \frac{5}{12}$, then the time for which the ball is at least 15 m above the ground will be** (take g $g = 10ms^{-2}$)

75. **A particle is projected from a stationary trolley. After projection, the trolly moves with velocity $2\sqrt{15}m/s$. For an observer on the trolley, the direction of the particle is as shown in the figure while for the observer on the ground, the ball rises vertically. The maximum height reached by the ball from the trolley is h metre. The value of h will be**



76. **A projectile is launched at time t = 0 from point A which is at height 1m above**

the floor with speed v m/sec and at an angle $\theta = 45^0$ with the floor. It passes through a hoop at B which is 1 m above A and B is the highest point of the trajectory. The horizontal distance between A and B is d metres. The projectile then falls into a basket, hitting the floor at C a horizontal distance 3d metres from A. Find *l* (in m).



EXERCISE -II - KEY

SINGLE ANSWER TYPE

1) A 2)A 3) C 4) A 5) B 6) A 7)A
8) a 9) d 10) a 11) c 12) b 13) b 14) a
15) b 16) c 17) d 18) 19) c 20) a 21) a
22) b 23) b 24) a 25) c 26) c 27) d
28) a 29) a 30) a

MULTIPLE TYPE

31)BD 32)AC 33)BD 34)B,D
35)B,C,D 35) A,D 36) A,C 37) a,b,d
38) a,b,c,d 39) a,b,c,d 40) a 41) a,d
42)a,b,c,d 43) a,b,c,d 44) b,d 45) a,c

COMPREHENSION TYPE

46)C 47)A 48) b 49) c 50) c 51) b 52) d
53) d 54) d 55) b 56) d 57) a 58) b 59) c
60) d 61) d 62) c 63) d

MATRIX MATCH

64)a-s,b-p,c-r,d-q 65) A – p, B – q,t, C – s, D – r
66) a-s b-q,r c- p d-s 67) a-r b-s c- q d-p

INTEGER TYPE

68)3 69)5 70) 2 71) 4 72) 6 73) 3 74) 9 75) 3

A. MOTION ALONG HORIZONTAL AXIS :

EXERCISE - III

SINGLEANSWER TYPE

1. **A body moving along a straight line traversed one third of the total distance with a velocity 4 m/sec in the first stretch. In the second stretch the remaining distance is covered with a velocity 2 m/sec for some time t_0 and with $4m/s$ for the remaining time. if the average velocity is 3 m/sec, find the time for which body moves with velocity 4 m/sec in second stretch:**

a) $\frac{3}{2}t_0$ b) t_0 c) $2t_0$ d) $\frac{t_0}{2}$

2. **For motion of an object along the x-axis, the velocity v depends on the displacement x as $v = 3x^2 - 2x$, then what is the acceleration at x = 2 m?**

A) $48\ ms^{-2}$ B) $80\ ms^{-2}$ C) $18\ ms^{-2}$ D) $10\ ms^{-2}$

3. **A police party is chasing a dacoit in a jeep which is moving at a constant speed v. The dacoit is on a motorcycle. When he is at a distance x from the jeep, he accelerates from rest at a constant rate α ? Which of the following relations is true if the police is able to catch the dacoit ?**

A) $v^2 \le \alpha x$ B) $v^2 \le 2\alpha x$ C) $v^2 \ge 2\alpha x$ D) $v^2 \ge \alpha x$

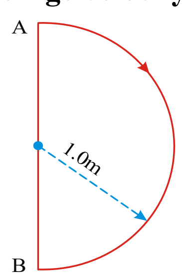
4. **A point moves in a straight line so that its displacement x metre time t second is given by $x^2 = 1 + t^2$. Its acceleration in ms^{-2} at time t second is**

A) $\frac{1}{x^{3/2}}$ B) $\frac{-t}{x^3}$ C) $\frac{1}{x} - \frac{t^2}{x^3}$ D) $\frac{1}{x} - \frac{1}{x^2}$

5. **A 2m wide truck is moving with a uniform speed $v_0 = 8\ ms^{-1}$ along a straight horizontal road. A pedestrain strarts to cross the road with a uniform speed v when the truck is 4 m away from him. The minimum value of v so that he can cross the road safely is**

A) $2.62\ ms^{-1}$ B) $4.6\ ms^{-1}$ C) $3.57\ ms^{-1}$ D) $1.414\ ms^{-1}$

6. **In 1.0 s, a particle goes from point *A* to point *B*, moving in a semicircle (see figure). The magnitude of the average velocity is**



(A) 3.14 m/s (B) 2.0 m/s (C) 1.0 m/s (D) zero

MULTIPLE ANSWER QUESTIONS

7. **The velocity of a particle along a straight line increases according to the linear law $v = v_0 + kx$, where k is a constant. Then**

a) the acceleration of the particle is $k(v_0 + kx)$

b) the particle takes a time $\frac{1}{k}\log_e\left(\frac{v_1}{v_0}\right)$ to attain a velocity v_1

c) velocity varies linearly with displacement with slope of velocity displacement curve equal to k.

d) data is insufficient to arrive at a conclusion.

8. **Two particles P and Q move in a straight line AB towards each other. P starts from A with velocity u_1 and an acceleration a_1. Q starts from B with velocity u_2 and acceleration a_2. They pass each other at the midpoint of AB and arrive at the other ends of AB with equal velocities.**

a) They meet at midpoint at time $t = \frac{2(u_2 - u_1)}{(a_1 - a_2)}$

b) The length of path specified i.e., AB is $l = \frac{4(u_2 - u_1)(a_1 u_2 - a_2 u_1)}{(a_1 - a_2)^2}$

c) They reach the other ends of AB with equal velocities if $(u_2 + u_1)(a_1 - a_2) = 8(a_1 u_2 - a_2 u_1)$

d) They reach the other ends of AB with equal velocities if $(u_2 - u_1)(a_1 + a_2) = 8(a_2 u_1 - a_1 u_2)$

9. **Which of the following statements is/ are correct ?**

A) If the velocity of a body changes, it must have some acceleration.
B) If the speed of a body changes, it must have some acceleration
C) If the body has acceleration, its speed must change
D) If the body has acceleration, its speed may change.

10. **A particle moves along a straight line so that its velocity depends on time as $v = 4t - t^2$. Then for first 5s.**

A) Average velocity is $25/3\ ms^{-1}$ B) Average speed is $10\ ms^{-1}$

C) Average velocity is $5/3\ ms^{-1}$ D) Acceleration is $4\ ms^{-2}$ at $t = 0$

11. **A particle moves with an initial velocity v_0 and retardation αv, where v is velocity at any time t.**

(A) The particle will cover a total distance $\frac{v_0}{\alpha}$

(B) The particle will come to rest after time $\frac{1}{\alpha}$

(C) The particle will continue to move for a long time.

(D) The velocity of particle will become $\frac{v_0}{e}$ after time $\frac{1}{\alpha}$

12. A particle is moving along X–axis whose position is given by $x = 4 - 9t + \frac{t^3}{3}$ **. Mark the correct statement(s) in relation to its motion.**

(A) direction of motion is not changing at any of the instants
(B) direction of motion is changing at t = 3 s
(C) for 0 < t < 3 s, the particle is slowing down
(D) for 0 < t < 3 s, the particle is speeding up.

13. A particle of mass *m* moves on the *x*-axis as follows : it starts from rest at *t* = 0 from the point *x* = 0, and comes to rest at *t* = 1 at the point *x* = 1. No other information is available about its motion at intermediate times $(0 < t < 1)$ **. If a denotes the instantaneous acceleration of the particle, then [1993]**

(A) a cannot remain positive for all *t* in the interval $0 \le t \le 1$
(B) |a| cannot exceed 2 at any point in its path
(C) |a| must be $\ge$ 4 at some point or points in its path
(D) a must change sing during the motion, but no other assertion can be made with the information given.

PASSAGE TYPE QUESTIONS

PASSAGE-1

A train starts from rest with constant acceleration, $a = 1 m/s^2$ **. A passenger at a distance 'S' from the train runs at his maximum velocity of 10 m/s to catch the train at the same moment at which the train starts.**

14. If S=25.5 m and passenger keeps running, find the time in which he will catch the train:

a) 5 sec b) 4 sec c) 3 sec d) $2\sqrt{2}$ sec.

15. Find the critical distance 'S_c' for whcih passenger will take the ten seconds time to catch the train:

a) 50m b) 35m c) 30m d) 25m

16. Find the speed of the train when the passenger catches it for the critical distacne:

a) 8 m/s b) 10 m/s c) 12 m/s d) 15m/s

PASSAGE-2

A body is moving with uniform velocity of $8\ ms^{-1}$ **. When the body just crossed another body, the second one starts and moves with uniform acceleration of** $4\ ms^{-2}$ **.**

17. The time after which two bodies meet will be

A) 2 s B) 4 s C) 6 s D) 8 s

18. The distance covered by the second body when they meet is

A) 8 m B) 16 m C) 24 m D) 32 m

MARTIX MATCHING QUESTION

19. A particle moves along a straight line such that its displacement S varies with time as $S = \alpha + \beta t + \gamma t^2$ **.**

Column-I

i. Acceleration at t= 2 s
ii. Average velocity during 3^{rd} sec

iii. Velocity at $t = 1\,s$
iv. Initial displacement
Column-II
a. $\beta + 5\gamma$ b. 2γ c. α d. $\beta + 2\gamma$

INTEGER TYPE QUESTIONS

20. In a car race, car A takes 4 s less than car B at the finish and passes the finishing point with a velocity v more than the car B. Assuming that the cars start from rest and travel with constant accelerations $a_1 = 4\,ms^{-2}$ and $a_2 = 1\,ms^{-2}$ respectively, find the velocity of v in ms^{-1}.

21. A police jeep is chasing a culprit going on a motorbike. The motorbike crosses a turning at a speed of $72\,kmh^{-1}$. The jeep follows it at a speed of $90\,kmh^{-1}$, crossing the turning 10 s later than the bike.
Assuming that they travel at constant speeds, how far from the turning will the jeep catch up with the bike ? (in km)

22. A particle moves in a straight line such that the displacement x at any time 't' is given by $x = 6t^2 - t^3 - 3t - 4$. x is in m and t is in second calculate the maximum velocity (In ms^{-1}) of the particle.

B. MOTION UNDER GRAVITY

SINGLE ANSWER QUESTIONS

23. A ball is thrown upwards with speed v from the top of a tower and it reaches the ground with speed $3v$. What is the height of the tower ?

A) $\frac{v^2}{g}$ B) $\frac{2v^2}{g}$ C) $\frac{4v^2}{g}$ D) $\frac{8v^2}{g}$

24. An elevator in which a man is standing is moving upwards with a speed of $10\,ms^{-1}$. If the man drops a coin from a height of 2.45 m from the floor of elevator, it reaches the floor of the elevator after time ($g = 9.8\,ms^{-2}$)

A) $\sqrt{2}\ s$ B) $1/\sqrt{2}\ s$ C) 2 s D) $1/2\,s$

25. A body is thrown vertically upwards from A, the top of a tower. It reaches the ground in time t_1. If it is thrown vertically downward from A with the same speed, it reaches the ground in time t_2. If it is allowed to fall freely from A, then the time it takes to reach the ground is given by

A) $t = \frac{t_1 + t_2}{2}$ B) $t = \frac{t_1 - t_2}{2}$ C) $t = \sqrt{t_1 t_2}$ D) $t = \sqrt{\frac{t_1}{t_2}}$

26. A stone is dropped from the 25^{th} storey of a multistoried building and it reaches the ground in 5s. In the first second, it passes through how many storeys of the building

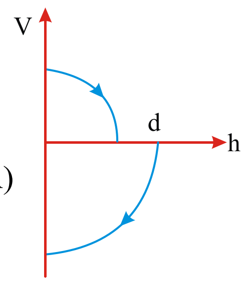
(g= $10\,ms^{-2}$)

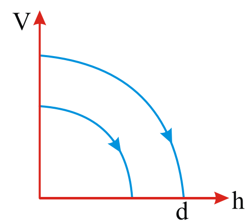
A) 1 B) 2 C) 3 D) None

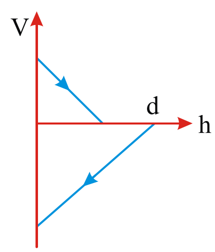
27. **A body is projected upwards with a velocity u, It passes through a certain point above the ground after t_1. The time after which the body passes through the same point during the return journey is**

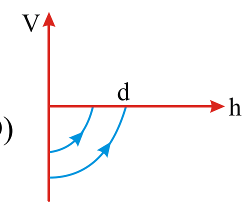
A) $\left(\frac{u}{g}-t_1^2\right)$ B) $2\left(\frac{u}{g}\right)-t_1$ C) $3\left(\frac{u^2}{g}-t_1\right)$ D) $3\left(\frac{u^2}{g^2}-t_1\right)$

28. A ball is dropped vertically from a height ***d*** **above the ground. It hits the ground and bounces up vertically to a height $\frac{d}{2}$. Neglecting subsequent motion and air resistance, its velocity *v* varies with height *h* above the ground as: [2004]**

A)


B)


C)


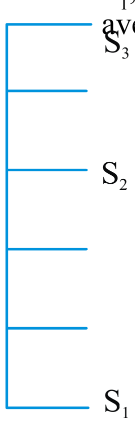
D)


29. **A small block slides without friction down an inclined plane starting from rest. Let s_n be the distance traveled from $t = n - 1$ to $t = n$. Then $\frac{s_n}{s_{n+1}}$ is : [2005]**

(A) $\frac{2n-1}{2n}$ (B) $\frac{2n+1}{2n-1}$ (C) $\frac{2n-1}{2n+1}$ (D) $\frac{2n}{2n+1}$

MULTIPLE ANSWER QUESTIONS

30. S_1,S_2 and S_3 are the different sizes of windows 1,2 and 3 respectively, placed in a vertical plane. A particle is thrown up in that vertical plane. Find the correct options:



a) average speed of the particle passing the windows may be equal if $s_1 < s_2 < s_3$

b) average speed of the particle passing the windows may be equal if $S_1 > S_2 > S_3$

c) If $S_1 = S_2 = S_3$, the change in speed of the particle while crossing the windows will satisfy $\Delta V_1 < \Delta V_2 < \Delta V_3$.

d) If $S_1 = S_2 = S_3$, the time taken by particle to cross the windows will satisfy $t_1 < t_2 < t_3$.

31. **At $t=0$, an bullet is fired vertically upward with a speed of $100\ ms^{-1}$. A second bullet is fired vertically upwards with the same speed at $t=5\ s$. Then**

A) The two bullets will be at the same height above the ground at $t=12.5\ s$

B) The two bullets will reach back their strarting points at $t=20\ s$ and at $t=25\ s$

C) The ratio of the speeds of the first and second bulletsat $t=20\ s$ will be 2: 1

D) The maximum height attained by either bullet will be 1000 m

32. **From the top of a tower of height 200 m, a ball A is projected up with $10\ ms^{-1}$, and 2 s later another ball B is projected vertically down with the same speed Then**

A) Both A and B will reach the ground simultaneously

B) Ball A will hit the ground 2 s later than B hitting the ground.

C) Both the balls will hit the ground with the same velocity

D) Both the balls will hit the ground with the different velocity

MATRIX MATCH QUESTIONS

33. **A particle moves such that, $t=\sqrt{x}+3$, where x is in metre, t is in second. Based on this information, match the value in Column-I (in SI units) to their respective quantities for the particles motion given in Column-II**

Column-I	Column-II
a) 0	p) Acceleration at t= 5 s
b) 2	q) Average speed from t =0 to t =6s
c) 3	r) Velocity at the point of reversal of motion
d) 18	s) Total distance travelled from t =0 to t=6s
	t) Displacement from t =0 to t=6s

34. **For a body projected vertically up with a velocity v_0 from the ground, match the following**

Column-I

A. $\vec{V}_{av}$ (Average velocity)

B. U_{av} (Average speed)

C. T_{ascent}

D. $T_{descent}$

Column-II

i. Zero for round trip

ii. $\frac{\vec{v}_1+\vec{v}_2}{2}$ over any time interval where $\vec{v}_1$ & $\vec{v}_2$ are the intial and final velocities in the time interval

iii. $\frac{v_0}{2}$ over the total timeof its flight

iv. $\frac{v_0}{g}$

INTEGER TYPE QUESTIONS

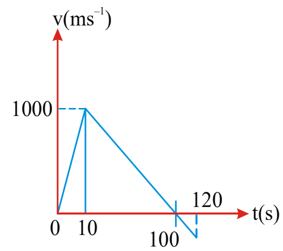
35. From a lift moving upwards with a uniform acceleration $a = 2ms^{-2}$, a man throws a ball vertically upwards with a velocity $v = 12\ ms^{-1}$ relative to the lift. The ball comes back to the man after a time t. Find the value of t in second (g=10ms^{-2}).

36. A body is thrown up with a velocity $100\ ms^{-1}$. It travels 5 m in the last second of upword journey. If the same body is thrown up with a velocity $200\ ms^{-1}$, how much distance (in metre) will it travel in the last second of its opward journey $\left(g = 10ms^{-2}\right)$

C. GRAPHS

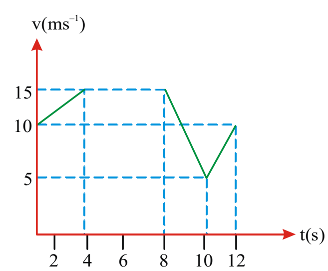
SINGLE ANSWER QUESTIONS

37. **The following graph shows the variation of velocity of a rocket with time. Then the maximum height attained by the rocket is**



A) 1.1 km B) 5 km C) 55 km D) None

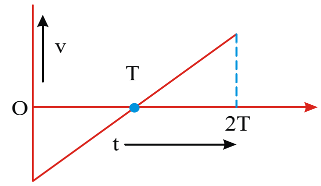
38. **The velocity-time graph of a particle moving in a straight line is shown in figure. The acceleration of the particle at $t = 9$ is**



A) Zero B) $5\ ms^{-2}$ C) $-5\ ms^{-2}$ D) $-2\ ms^{-2}$

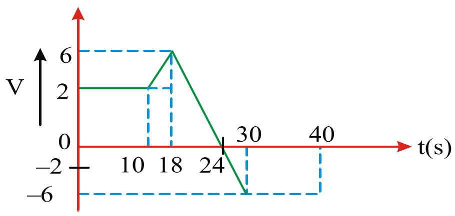
MULTIPLE ANSWER QUESTIONS

39. **Figure shows the velocity(v) of a particle plotted against time (t).**



A) The particle changes its direction of motion at some point
B) The acceleration of the particle remains constant .
C) The displacement of the particle is zero
D) The initial and final speeds of the particle are the same.

40. A particle moves in astraight with the velocity as shown in figure. At $t = 0, x = -16\,m$.



A) The maximum value of the position coordinate of the particle is 54 m.
B) The maximum value of the position coordinate of the particle is 36 m.
C) The particle is at the position of 36 m at $t = 18\,s$.
D) The particle is at the position of 36 m at $t = 30\,s$

EXERCISE - III - KEY

1. D 2. B 3. C 4. C 5. C 6. B 7.A,B,C 8.A,B,C 9. A,B,D 10. C,D 11. A,C,D 12. B,C 13. A,C 14.C 15. A 16. B 17. B 18. D
19. i - b, ii - a, iii - d, iv - c
20. 8 21. 1 22. 9 23. C 24. B 25. C 26. A 27. B 28. A 29. C 30. B,C,D 31. A,B,C 32. A,C
33. a- (r,t) b-(p) c-(q) d-(s)
34. A - i,ii B - iii, C - iv, D - iv
35. 2 36. 5 37. C 38. C 39. A,B,C,D 40. A,C,D

A. MOTION ALONG HORIZONTAL AXIS

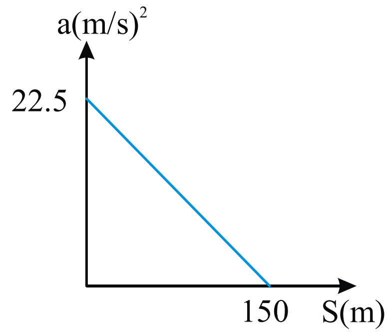
EXERCISE - IV

SINGLE QUESTION TYPE

1. The deceleration experienced by a moving motor boat, after its engine is cut-off is given by $\frac{dv}{dt} = -kv^3$, where k is constant.If v_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time t after the cut-off is

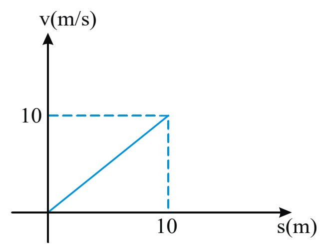
a) $v_0/2$ b) v c) v_0e^{-kt} d) $\frac{v_0}{\sqrt{2v_0^2kt+1}}$

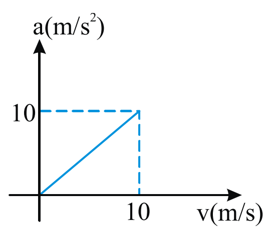
2. **A jet plane starts from rest at S = 0 and is subjected to the acceleration shown. Determine the speed of the plane when it has travelled 60 m.**

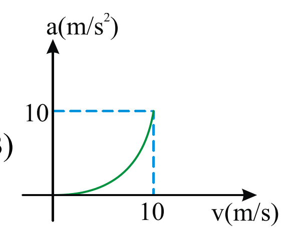


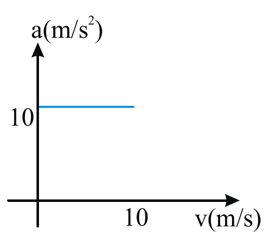
A) 46.47 m/s B) 36.47 m/s C) 26.47 m/s D) 16.47 m/s

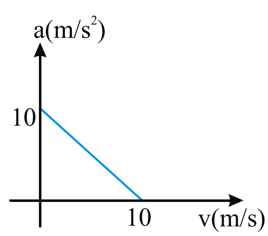
3. **Velocity versus displacement graph of a particle moving in a straight line is shown in figure. Corresponding acceleration versus velocity graph will be :**



A)


B)


C)


D)


4. **The relation between time** t **and distance** x **is** $t = ax^2 + bx$ **. Where** a *and* b **are constants. The retardation is**

a) $2av^3$ b) $2bv^3$ c) $2abv^3$ d) $2b^3v^3$

5. **The motion of a body falling from rest in a resisting medium is described by the equation** $\frac{dv}{dt} = a - bv$ **where** a *and* b **are constants. The velocity at any time** t **is given by**

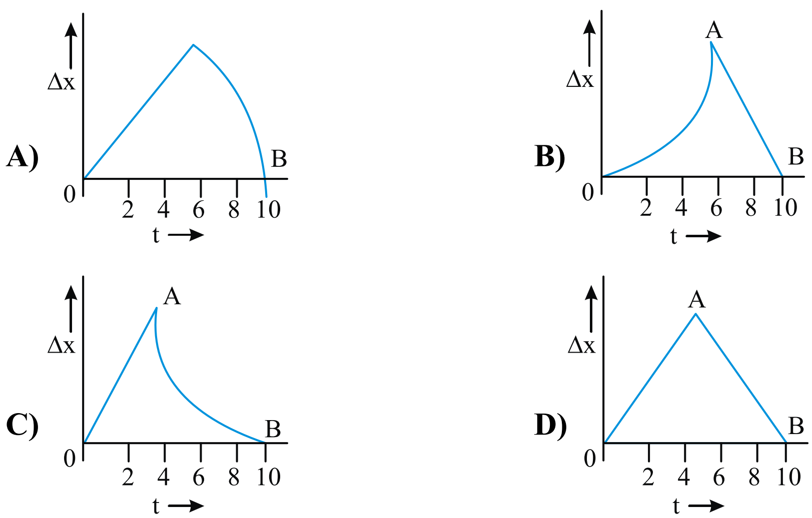
(a) $v = \frac{a}{b}\left(1 - e^{-bt}\right)$ **(b)** $v = \frac{b}{a}\left(e^{-bt}\right)$

(c) $v = \frac{a}{b}\left(1+e^{-bt}\right)$ **(d)** $v = \frac{b}{a}e^{bt}$

6. **A train stops at two stations *s* distance apart and takes time t on the journey from one station to the other. Its motion is first of uniform acceleration a and then immediately of uniform retardation *b*, then**

a) $\frac{1}{a} - \frac{1}{b} = \frac{t^2}{s}$ b) $\frac{1}{a} + \frac{1}{b} = \frac{t^2}{s}$ c) $\frac{1}{a} + \frac{1}{b} = \frac{t^2}{2s}$ d) $\frac{1}{a} - \frac{1}{b} = \frac{t^2}{2s}$

7. **Two stones are thrown up simultaneously with initial speeds of u_1 and u_2 ($u_2 > u_1$). They hit the ground after 6 s and 10 s respectively. Which graph in fig.correctly represents the time variation of $\Delta x = (x_2 - x_1)$, the relative position of the second stone with respect to the first upto t=10 s? Assume that the stones do not rebound after hitting the ground.**



8. **A particle moving along x - axis has acceleration a at time t given by $a = a_0\left(1 - \frac{t}{T}\right)$ where a_0 and T are constants. The particle at $t = 0$ has zero velocity. The particles velocity when acceleration reduces to zero.**

a) $\frac{1}{2}a_0T^2$ b) a_0T^2 c) $\frac{1}{2}a_0T$ d) a_0T

9. **A cone falling with a speed v_0 strikes and penetrates the block of a packing material. The accelertation of the cone after impact is $a = g - cx^2$. Where c is a positive constant and x is the penetration distance. If maximum penetration depth is x_m then c equals**

a) $\frac{2gx_m + v_0^2}{x_m^2}$ b) $\frac{2gx_m - v_0^2}{x_m^2}$ c) $\frac{6gx_m - 3v_0^2}{2x_m^3}$ d) $\frac{6gx_m + 3v_0^2}{2x_m^3}$

MULTIPLE ANSWER QUESTIONS

10 **If the velocity of the particle is given by $v = \sqrt{x}$ and intially particle was at x=4m, then which of the following are correct.**
(A) at t=2 sec, the position of the particle is x= 9 m
(B) Particle acceleration at t= 2 sec. is 1 m/s^2.
(C) Particle acceleration is ½ m/s^2 through out the motion
(D) Particle will never go in negative direction from its starting position.

11. **Starting from rest a particle is first accelerated for time t_1 with constant acceleration a_1 and then stops in time t_2 with constant retardation a_2. Let v_1 be the average velocity in this case and s_1 the total displacment. In the second case, it is accelerated for the same time t_1 with constant acceleration $2a_1$ and comes to rest with constant retardation a_2 in time t_3. If v_2 is the average velocity in this case and s_2 the total displacement. Then**
(a) $v_2 = 2v_1$ (b) $2v_1 < v_2 < 4v_1$ (c) $s_2 = 2s_1$ (d) $2s_1 < s_2 < 4s_1$

PASSAGE TYPE QUESTIONS

Comprehension - 1

Two particles A and B start from rest at the origin x=0 and move along a straight line such that **$a_A=(6t-3)ms^{-2}$ and $a_B=(12t^2-8)ms^{-2}$, where t is in seconds. Based on the above facts, answer the following questions.**

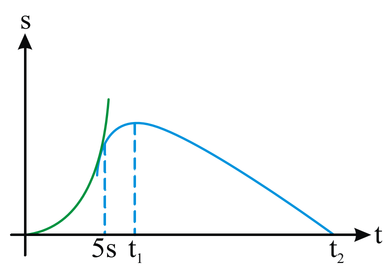
12. **Total distance travelled by A at t=4 s is**
A) 40m B) 41m C) 42m D) 43m

13. **Total distance travelled by B at t=4 s is**
A) 192m B) 184m C) 196m D) 200m

14.. **Total distance between them at t = 4 s is**
A) 144m B) 148m C) 152m D) 156m

Comprehension - 2

A balloon is start rising with constant acceleration 2m/s² from ground at t=0s. A stone is dropped at t=5s. s-t graph for the given situation is shown in figure. Answer the following.



15. The maximum hight reached by the stone is
A) 30m B) 40m C) 45m D) 28m

16. **t_1 is**
A) 4s B) 6s C) 2s D) 1s

17. **t_2 is**
A) 4s B) 4.45s C) 3.45s D) 9.45s

MATRIX MATCHING QUESTIONS

18. Study the following.

List - I

a) A body covers first half of distance with a speed v_1 and second half of distance with a speed v_2

b) A body covers first half of a time with a speed v_1 and second half of time with a speed v_2

c) A body is projected vertically up from ground with a speed $\sqrt{gh}$ .Considering its total motion

d) A body freely released from a height h

List - II

i) Average speed is $\sqrt{\frac{gh}{2}}$

ii) Average speed is $\frac{v_1 + v_2}{2}$

iii) Average speed is $\frac{2v_1v_2}{v_1 + v_2}$

iv) Average speed is $\frac{\sqrt{gh}}{2}$

19. For a particle moving along X - axis if acceleration (constant) is acting along -ve X-axis, then match the entires of Column I with entires of Column II.

Column -I

(A) Initial velocity > 0
(B) Initial velocity < 0
(C) x > 0
(D) x < 0

Column -II

i) Particle may move in +ve X - direction with increasing speed.
ii) Particle may move in +ve X-direction with decreasing speed.
iii) Particle may move in -ve X - direction with increasing speed.
iv) Particle may move in -ve X - direction with decreasing speed.

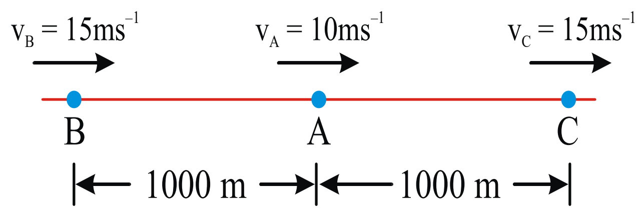
INTEGER TYPE QUESTIONS

20. A train starts from station A with uniform acceleration a_1 for some distance and then goes with uniform retardation a_2 for some more distance to come to rest at station B. The distance between stations A and B is 4 km and the train takes 1/15 h to complete this journey. Acceleration are in km/min^2 unit. If

$\frac{1}{a_1}+\frac{1}{a_2}=x$, **find the value of x.**

21. A cat, on seeing a rat a distance $d=5\,m$, starts with velocity $u=5\,ms^{-1}$ and moves with acceleration $\alpha=2.5\,ms^{-2}$ in order to catch it, while the rat with acceleration β starts from rest. For what value of β will the cat overtake the rat ? (in ms^{-2})

22. On a two-lane road, car A is travelling with a speed of $36\,kmh^{-1}$. Two cars B and C approach car A In opposite directions with a speed of $54\,kmh^{-1}$ each. At a certain instant, when the distance AB is equal to AC, both being 1 km, B decides to overtakes A before C does. What minimum acceleration of car B (in m/s^2) is required to avoid an accident ?



23. The accelerator of a train can produce a uniform acceleration of 0.25 ms^{-2} **and its brake can produce a retardation of 0.5 ms^{-2}. The shortest time in which the train can travel between two stations 8 km apart is x minutes and 10 s, if it stops at both stations. The value of x is.**

24. A body starts from rest with uniform acceleration. Its velocity after 2n second is v_0. the displacement of the body in last n second is $\frac{3v_0 n}{\beta}$. Determine the value of β?

B. MOTION ALONG VERTICAL AXIS :

SINGLE ANSWER QUESTIONS

25. A ball is thrown from the top of a tower in vertically upward direction. Velocity at apoint h metre below the point of projection is twice of the velocity at a point h metre above the point of projection. find the maximum height reached by the ball above the top of tower.

a) $2h$ b) $3h$ c) $(5/3)h$ d) $(4/3)h$

26. A parachutist drops first freely from an aeroplane for 10 s and then his parachute opens out. Now he descends with a net retardation of $2.5\,ms^{-2}$. If he bails out of the plane at a height of 2495 m and $g=10\,ms^{-2}$, his velocity on reaching the ground will be

a) $5\,ms^{-1}$ b) $10\,ms^{-1}$ c) $15\,ms^{-1}$ d) $20\,ms^{-1}$

MORE THAN ONE QUESTION TYPE

27. A particle is projected vertically upward with velocity u from a point A, when it returns to point of projection

a) Its average speed is $u/2$

b) Its average velocity is zero

c) Its displacement is zero

d) Its average speed is u

28. A particle is thrown vertically in upward direction and passes three equally spaced windows of equal heights then

(A) average speed of the particle while passing the windows satisfies the relation $u_{av_1} > u_{av_2} > u_{av_3}$

(B) the time taken by the particle to cross the windows satisfies the relation $t_1 < t_2 < t_3$

(C) the magnitude of the acceleration of the particle while crossing the windows satisfies the relation $a_1 = a_2 \neq a_3$

(D) the change in the speed of the particle while crossing the windows would satisfy the relation $\Delta u_1 < \Delta u_2 < \Delta u_3$.

COMPREHENSION QUESTION

An elevator car whose floor to ceiling distance in equal to 2.7 m starts ascending with constant acceleration 1.2m/s^2, 2 sec. after the starts a bolt begins falling from the ceiling of the car. Answer the following questions. (g=9.8 m/s^2)

29. The bolt's free fall time

(A) 0.3 s (B) 0.5 s (C) 0.7 s (D) 0.9 s

30. The velocity of bolt at instant it loses contact is

(A) 1.2 m/s (B) 2.4 m/s (C) 4 m/s (D) 10 m/s

31. Distance moved by elevator car w.r.t. ground frame during the free fall time of the bolt.

(A) 1.44 m (B) 1.63 m (C) 1.68 m (D) 1.97 m

32. Distance covered by the bolt during the free fall time w.r.t. ground frame.

(A) 0.7 m (B) 0.9 m (C) 1.1 m (D) 1.3m

33. The displacement by the bolt during its free fall time w.r.t. ground frame

(A) 0.3 m (B) 0.7 m (C) 0.9 m (D) 1 m

INTEGER TYPE QUESTIONS

34. A stone is dropped from a height h. Simultaneously another stone is thrown up from the ground with such a velocity that it can reach a height of 4h. The time when two stones cross each other is $\sqrt{\left(\frac{h}{kg}\right)}$ where k = ______

35. A particle moves along x-axis satisfying the equation $x = \left[(t-1)(t-2)\right]$ (t is in seconds and 'x' is in meters). Find the magnitude of initial velocity of the particle in m/s.

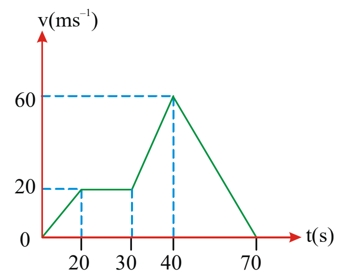
36. The position vector of a particle varies with time as $\vec{r} = \vec{r_0}t(1-\alpha t)$ where $\vec{r_0}$ is

a constant vector and α is a positive constant. The distance travelled by particle in a time interval in which particle returns to its initial position is $\frac{Kr_0}{16\alpha}$. Determine the value of K?

C. GRAPHS:

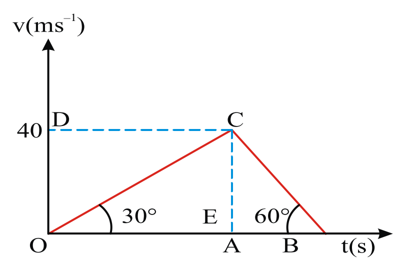
SINGLE ANSWER TYPE

37. **The velocity-time graph of abody is given in figure. The maximum accceleration in ms^{-2} is**



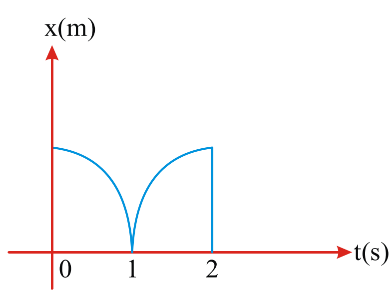
a) 4 b) 3 c) 2 d) 1

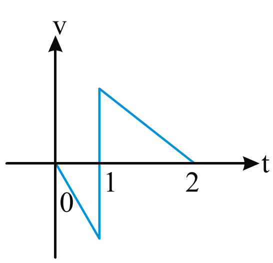
38. **The velocity-time graph of a body is shown in figure. The ratio of magnitude of average acceleration during the intervals OA and AB is**

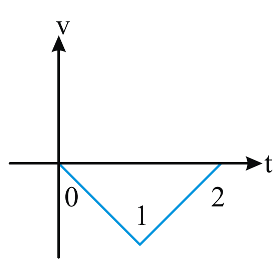


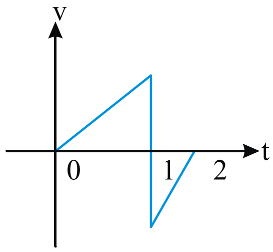
a) 1 b) 1/2 c) 1/3 d) 3

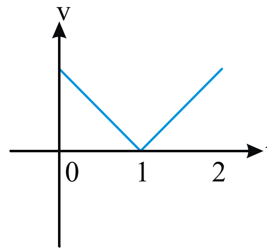
39. **The displacement-time graph of a moving particle with constant acceleration is shown in the figure. The velocity time graph is given by**



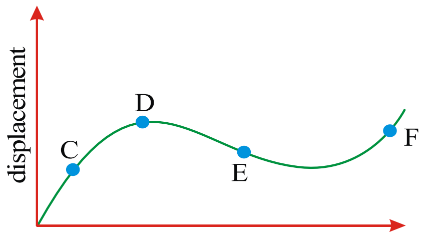
A) 

B) 

C) 

D) 

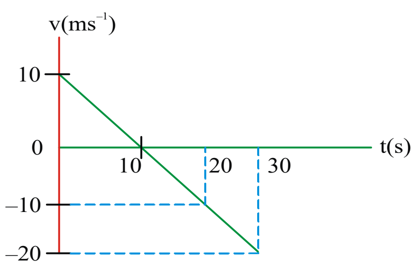
40. **The displacement-time graph of a moving particle is shown in figure. The instantaneous velocity of the particle is negative at the point.**



a) D b) F c) C d) E

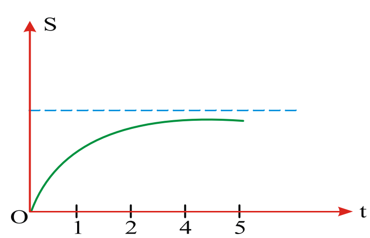
MULTIPLE ANSWER QUESTIONS

41. **The velocity-time plot a particle moving on a straight line is shown in figure.**



a) The particle has a constant acceletration
b) The particle has never tuned around
c) The particle has zero displacement
d) The average speed in the interval 0 to 10 s is the same as the average speed in the interval 10 s to 20 s

42. **The displacement of a particle as a function of time is shown in figure. It indicates**

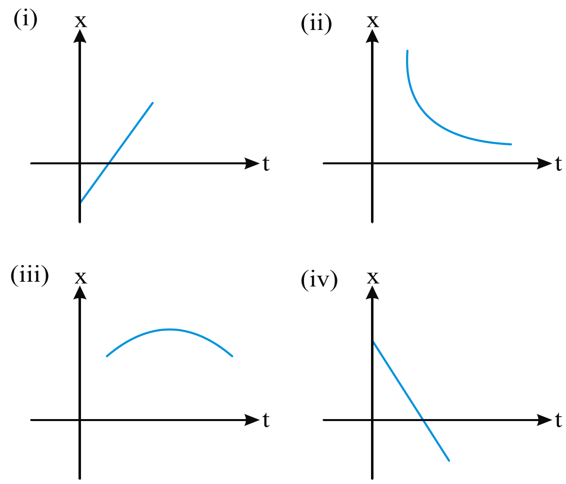


a) The particle starts with a certain velocity, but the motion is retarded and finally the particle stops
b) The velocity of the particle decreases
c) The acceleration of the particle is in opposite direction to the velocity
d) The particle starts with a constant velocity, the motion is accelerated and finally the particle moves with another constant velocity.

PASSAGE TYPE QUESTION

PASSAGE-1:

Study the following graphs:



43. The particle is moving with constant speed

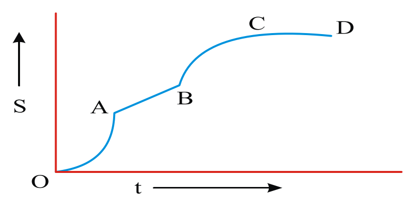
a) In graphs(i) and (iii) b) In graphs (i) and (iv)
c) In graphs (i) and (ii) d) In graphs (i)

44. The particle has negative acceleration

a) In graph (i) b) In graph (ii) c) In graph (iii) d) In graph (i v)

MATRIX MATCHING QUESTION

45. The displacement versus time is given figure. Sections OA and BC are parabolic. CD is parallel to the time axis.



Column-I

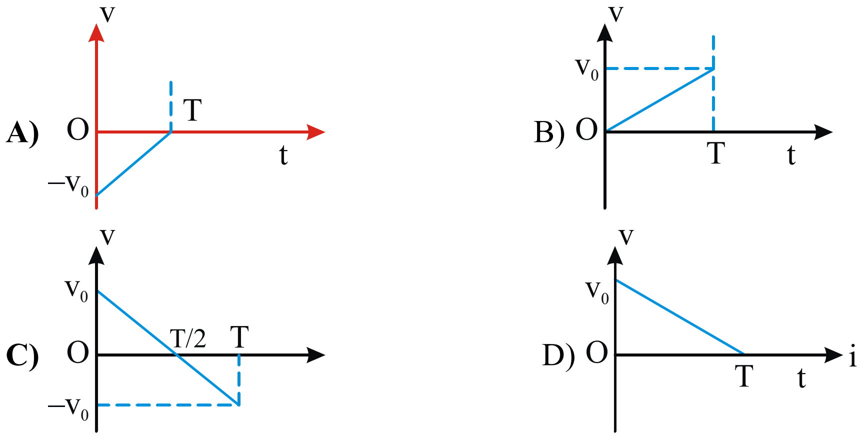
A. OA
B. AB
C. BC
D. CD

Column-II

i. Velocity increases with time linearly
ii. Velocity decreases with time
iii. Velocity is independent of time
iv. Velocity is zero

46. Study the following $v-t$ graphs in Column I carefully and match appropriately with the statements given in Column II. Assume that motion takes place from time $0\ to\ T$.

Column-I



Column-II

i. Net displacement is positive, but not zero
ii. Net displacement is negative, but not zero
iii.Particle returns to its initial position again
iv. Acceleration is positive.

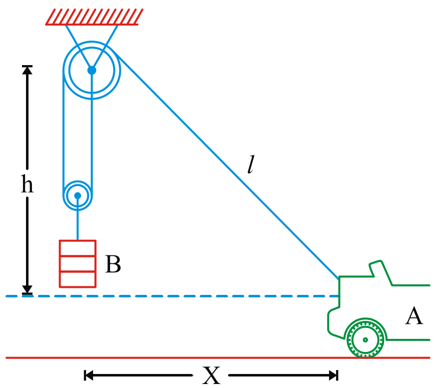
EXERCISE - IV - KEY

1. D 2. A 3. A 4. A 5. A 6. C 7. A
8. C 9. D 10. A,C,D 11.A,D 12) B 13) D
14) C 15) A 16) B 17) D 18. A-iii, B- ii, C-iv, D-i
19. A-ii, B-iii, C-ii, D- ii,iii 20. 2 21. 5 22. 1 23. 5
24. 4 25. C 26. A 27. ABC 28. ABD 29. C 3 0. B
31. D 32. D 33. B 34. 8 35. 2 36. 8 37. A
38. C 39. A 40. D 41. AD 42. ABC 43. B 44. C
45. A - i, B - iii, C - ii, D - iv 46. A - ii,iv, B - i,iv C - iii, D - i

EXERCISE - V

SINGLE ANSWER QUESTIONS

1. **The car A is used to pull a load B with the pulley arrangement shown. If A has a forward velocity v_A determine an expression for the upward velocity v_B, of the load in terms of V_A and θ. θ is angle between string and horizontal**



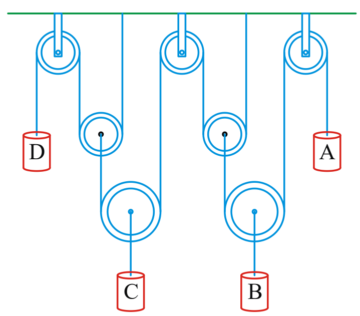
A) $\frac{1}{2}V_A \cos\theta$

B) $V_A \sin\theta$

C) $V_A \cos\theta$

D) $\frac{1}{2}V_A \tan\theta$

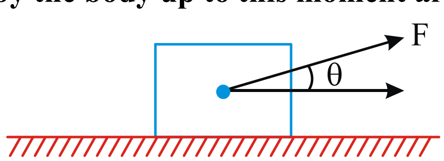
2. **Determine the relationship which governs the velocities of the four cylinders. Express all velocities as positive down. How many degrees of freedom are there?**



A) $3v_A + 6v_B + 4v_C + v_D = 0$ **B)** $4v_A + 8v_B + 4v_C + v_D = 0$

C) $3v_A + 6v_B + 2v_C + v_D = 0$ **D)** $3v_A + 10v_B + 2v_C + v_D = 0$

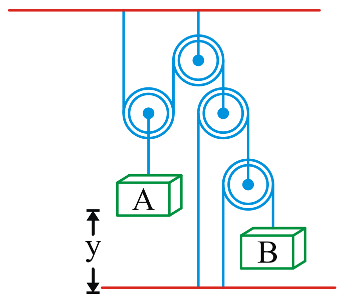
3. **At t = 0, force F = ct is applied to a small body of mass m resting on a smooth horizontal plane (c is a constant). The force is at an angle θ with the horizontal .The velocity of the body at the moment of its breaking off the plane and the distance travelled by the body up to this moment are**



A) $\left(\frac{mg^2 \cos\theta}{2c\sin^2\theta}\right) m/s, \left(\frac{mg^3 con\theta}{6c^2\sin^3\theta}\right) m$ B) $\left(\frac{mg^2\cos\theta}{2c\sin^2\theta}\right) m/s, \left(\frac{m^2g^3\cos\theta}{6c^2\sin^3\theta}\right) m$

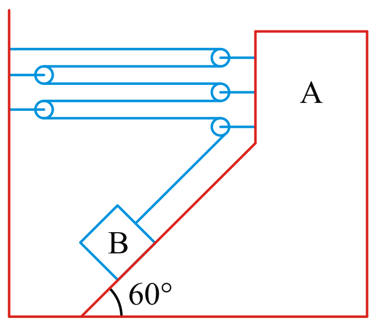
C) $\left(\frac{mg\cos\theta}{2c\sin^2\theta}\right)m/s,\ \left(\frac{m^2g^3\sin\theta}{6c^2\cos^3\theta}\right)m$ D) $\left(\frac{mg^2\cos\theta}{2c\sin^2\theta}\right)m/s,\ \left(\frac{m^2g^3\sin\theta}{6c^2\cos^3\theta}\right)m$

4. The vertical displacement of block A in meter is given by y = $\frac{t^2}{4}$ where t is in second. Calculate the downward acceleration a_B of block B.



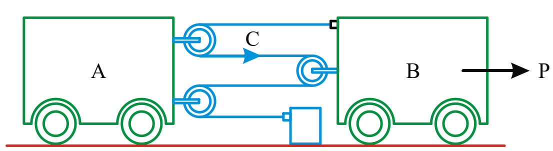
A) $2ms^2$ B) $1ms^2$ C) $4ms^2$ D) $9ms^2$

5. Find the acceleration of block B relative to the block A and realtive to the ground, if the blcok A moves to the left with an acceleration a_0



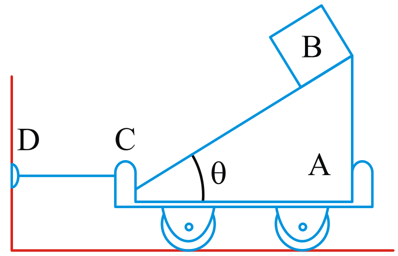
A) $\sqrt{31}a_0$ B) $\sqrt{25}a_0$ C) $\sqrt{30}a_0$ D) $30a_0$

6. Under the action of force P, the constant acceleration of block B is $3ms^{-2}$ to the right. At the instant when the velocity of B is $2ms^{-1}$ to the right, determine the velocity of B relative to A, the acceleration of B relative to A and the absolute velocity of point C of the cable



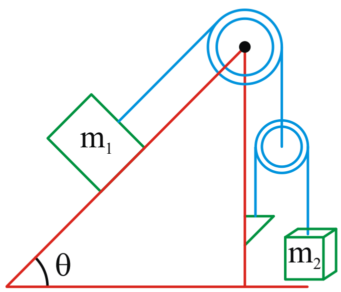
A) 2 B) 1 C) 3 D) 4

7. Block B has a mass m and is released from rest when it is on top of wedge A, which has a mass 3m. Determine the tension in cord CD required to hold the wedge from moving while B is sliding down A. Neglect friction



A) $\frac{mg}{2}\sin(2\theta)$ B) $\frac{mg}{2}\sin(3\theta)$ C) $\frac{mg}{3}\sin(3\theta)$ D) $\frac{mg}{2}\sin(2\theta)$

8. Find the acceleration of the body of mass m_2 in teh arrangement shown in figure. If the mass m_2 is η times great as the mass m_1 and the angle that the inclined plane forms with the horizontal is equal to θ. The masses of the pulleys and threads, as well as the friction, are assumed to be negligible.



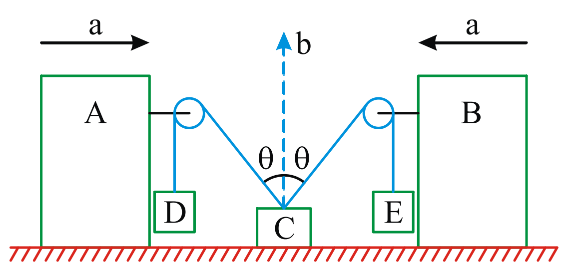
A) $\frac{2g(2\eta-\sin\theta)}{2\eta+1}$

B) $\frac{2g(2\eta-\sin\theta)}{4\eta+1}$

C) $\frac{2g(2\eta-\sin\theta)}{3\eta+1}$

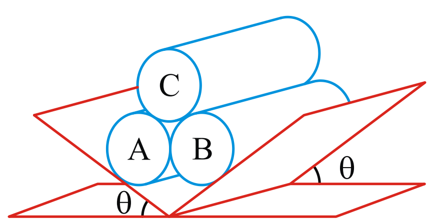
D) $\frac{4g(2\eta-\sin\theta)}{3\eta+1}$

9. If A and B moves with acceleration a. block c moves up with acceleration b. calculate acceleration of D with respective A.



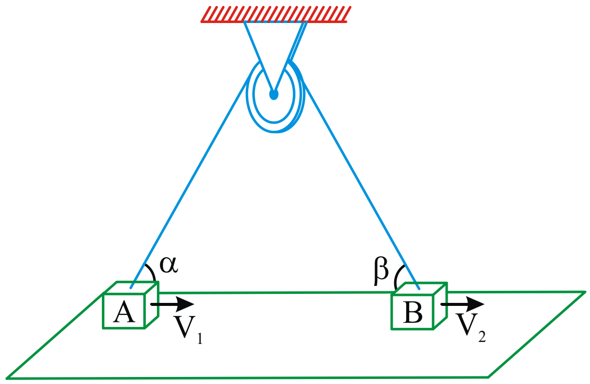
A) 2a+b B) $2a+b\cos\theta$ C) $b\cos\theta+a\sin\theta$ D) $b\sin\theta+a\cos\theta$

10. Three identical rigid circular cylinders A,B and C arranged on smooth inclined surfaces as shown in figure. The least value of θ that prevents the arrangement from collapsing is



A) $\tan^{-1}\left(\frac{1}{2}\right)$ B) $\tan^{-1}\left(\frac{1}{2\sqrt{3}}\right)$ C) $\tan^{-1}\left(\frac{1}{3\sqrt{3}}\right)$ D) $\tan^{-1}\left(\frac{1}{4\sqrt{3}}\right)$

11. In the arrangement shown, blocks A and B connected with an inextensible string move with velocities v_1 and v_2 along horizontal direction. The ratio of $\frac{v_2}{v_1}$ is



A) $\frac{\sin\alpha}{\sin\beta}$ B) $\frac{\sin\beta}{\sin\alpha}$ C) $\frac{\cos\beta}{\cos\alpha}$ D) $\frac{\cos\alpha}{\cos\beta}$

12. In the arrangements shown, the pulleys, strings and springs are weightless and the systems can move freely without friction. The extension of spring in figure 1 is x_1 and that in figure 2 is x_2. Then

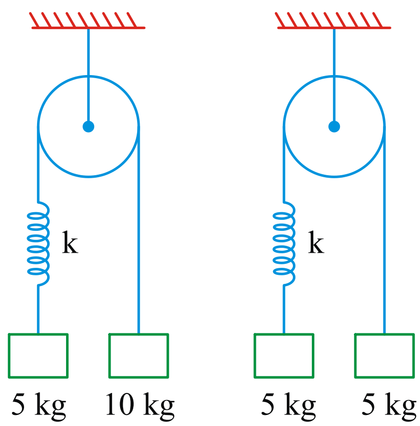
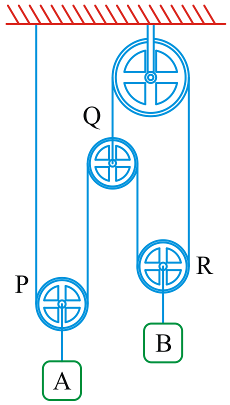


Fig 1 Fig 2

A) $x_1=x_2$ B) $x_2>x_1>0$ C) $x_1>x_2=0$ D) $x_1>x_2>0$

13. Figure shows a system of four pulleys with two masses $m_A = 3$ kg and $m_B = 4$ kg. At an instant, force acting on block A, if block B is going up at an acceleration of 3 m/s^2 and pulley Q is going down at an acceleration of 1 m/s^2 is



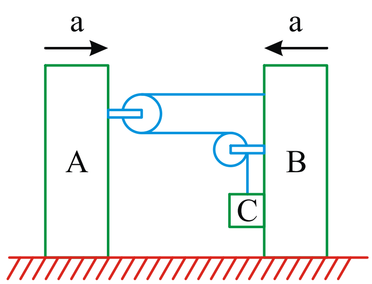
(A) 7 N acting upward

(B) 7 N acting downward

(C) 10.5 N acting upward

(D) 10.5 N acting downward.

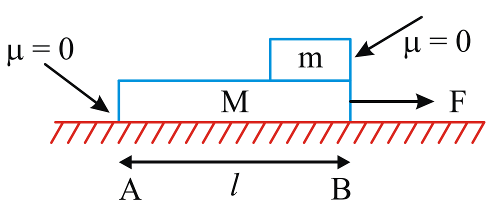
14. If A and B moves with acceleration a as shown in diagram calculate acceleration of C with respect to B



(A) 2a (B) $a\sqrt{2}$ (C) 3a (D) 4a

MULTIPLE ANSWER QUESTIONS

15. In the figure small block m is kept on planck of mass M and a force F is applied on planck as shown in diagram then which of the following statements is /are correct.



(A) the acceleration of m w.r.t. ground is $\frac{F}{m}$.

(B) the acceleration of m w.r.t. ground is zero

(C) the time taken by m to separate from M is $\sqrt{\frac{2\ell m}{F}}$

(D) the time taken by m to separate from M is $\sqrt{\frac{2\ell M}{F}}$

16. A particle of mass m starts moving at t = 0 due to a force $F = F_0 \sin \omega t$ where F_0

and ω are constant. Then correct statement is/are

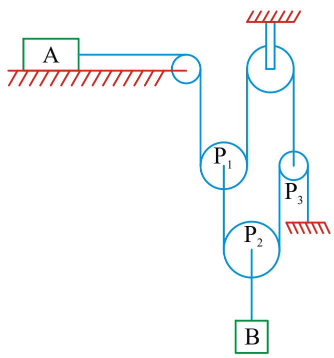
(A) it will stop first time at $\frac{\pi}{\omega}$

(B) It will travel distance $S = \frac{F_0}{m\omega^2}$ during this time

(C) During this distance maximum velocity of particle is $v_{max} = \frac{F_0}{m\omega}$

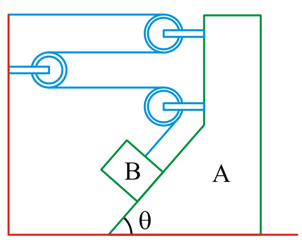
(D) it will stop for first time at $2\pi / \omega$

17. From the given diagram, choose the correct option



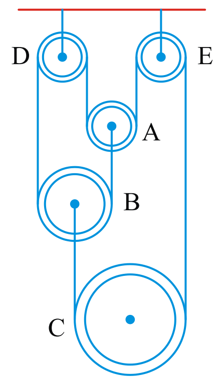
(A) acceleration of block A is zero
(B) acceleration of B is g
(C) acceleration of block A is non zero
(D) tension in the string connecting A is zero

18. In the diagram shown, the acceleration of the block B as shown in figure relative to the block A and relative to ground is a_{BA} and a_{BG} respectively. If the block A is moving towards left with an acceleration a_0, then



A) $a_{BA} = 2a_0$ B) $a_{BG} = 3a_0$ C) $a_{BA} = 3a_0$ D) $a_{BG} = a_0\sqrt{10 + 6\cos\theta}$

19. In the pulley system shown the movable pulleys A,B and C have mass m each, D and E are fixed pulleys. The strings are vertical, light and inextensible. Then,



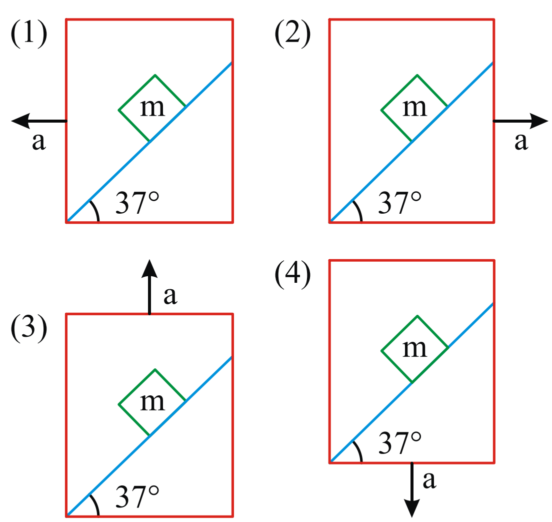
A) the tension throughout the string is the same and equals $T = \frac{2mg}{3}$

B) pulleys A and B have acceleration $\frac{g}{3}$ each in downward direction and pulley C has acceleration $\frac{g}{3}$ in upward direction

C) pulleys A,B and C all have acceleration $\frac{g}{3}$ in downward direction

D) pulley A has acceleration $\frac{g}{3}$ in downward direction and pulleys B and C have acceleration $\frac{g}{3}$ each in upward direction.

20. A block of mass m is placed on a wedge. The wedge can be accelerated in four manners marked as (1), (2), (3) and (4) as shown. If the normal reactions in situation (1), (2), (3) and (4) are N_1, N_2, N_3 and N_4 respectively and acceleration with which the block slides on the wedge in situation are b_1, b_2, b_3 and b_4 respectively then :

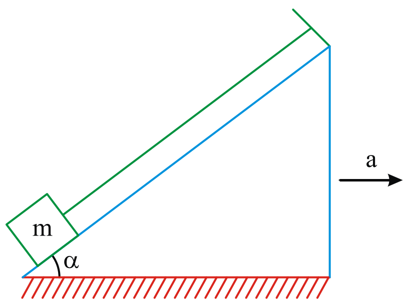


(A) $N_3 > N_1 > N_2 > N_4$ (B) $N_4 > N_3 > N_1 > N_2$
(C) $b_2 > b_3 > b_4 > b_1$ (D) $b_2 > b_3 > b_1 > b_4$

PASSAGE TYPE QUESTIONS

PASSAGE : 1

A body of mass $m = 1.8\ kg$ is placed on an inclined plane, the angle of inclination is $\alpha = 37^0$, and is attached to the top end of the slope with a thread which is parallel to the slope. Then the plane slope is moved with a horizontal acceleration of a. Friction is negligible.



21. The acceleration, if the body pushes the plane with a force of $\frac{3}{4}mg$ is :

A) $\frac{5}{43} m/s^2$ B) $0.5 m/s^2$ C) $0.75 m/s^2$ D) $\frac{5}{6} m/s^2$

22. The tension in thread in the above question is :

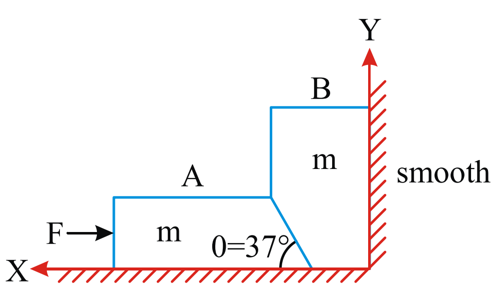
A) 12 N B) 10 N C) 8 N D) 4 N

23. At what acceleration will the body lose contact with plane :

A) $\frac{40}{3} m/s^2$ B) $7.5\ m/s^2$ C) $10 m/s^2$ D) $5 m/s^2$

PASSAGE-2

Two smooth blocks are placed at a smooth corner as shown. Both the blocks are having mass m. We apply a force F on the small block m. Block A presses the block B in the normal direction, due to which pressing force on vertical wall will increase, and pressing force on the horizontal wall decrease, as we increase F. (q = 37° with horizontal). As soon as the pressing force on the horizontal wall by block B becomes zero, it will lookse the contact with the ground. If the value of F is further increase, the block B will accelerate in upward direction and simultaneously the block A will move toward right



24. What is minimum value of F, to lift block B from ground :

(A) $\frac{25}{12}$ mg (B) $\frac{5}{4}$ mg (C) $\frac{3}{4}$ mg (D) $\frac{4}{3}$ mg

25. If both the blocks are stationary, the force exerted by ground on block A is :

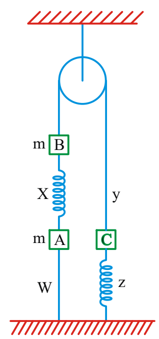
(A) $mg + \frac{3F}{4}$ (B) $mg - \frac{3F}{4}$ (C) $mg + \frac{4F}{3}$ (D) $mg - \frac{4F}{3}$

26. If acceleration of block A is a rightward, then acceleration of block B will be :

(A) $\frac{3a}{4}$ upwards (B) $\frac{4a}{3}$ upwards (C) $\frac{3a}{5}$ upwards (D) $\frac{4a}{5}$ upwards

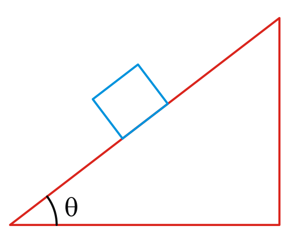
MATRIX MATCHING QUESTIONS

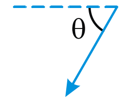
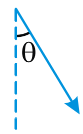
27. In the diagram strings, springs and the pulley are light and ideal. The system is in equilibrium with the strings taut (T>0), match the column. Masses are equal.



Column - 1	**Column- 2**
A) Just after string W breaks	P) $a_A = 0$
B) Just after spring X breaks	Q) $a_B = 0$
C) Just after string Y breaks	R) $a_C = 0$
D) Just after spring Z breaks	S) $a_B = a_C$

28. In the situation shown, all surfaces are frictionless and triangular wedge is free to move, In column-2, the direction of certain vectors are shown. Match the direction of quantities in Column-1 with possible vector in Column-2.

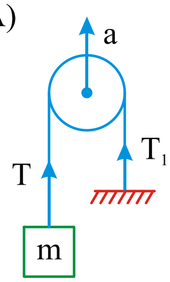


Column - 1	**Column-2**
A) acceleration of the block X relative to ground	(P) 
B) acceleration of block X relative to wedge	(Q) 
C) normal force by block on wedge	(R) 
D) net force on the wedge	(S) 

29. **See the diagrams carefully in Column-1 and match each with the obeying relation(S) in column-2, The string is massless, inextensible and pulley is frictionless in each case.** $a = g/3, m = mass$ **of block** $T =$ **tension in a given string,** a_{pulley} = **acceleration of movable pulley in each** case, **acceleration due to gravity is g.**

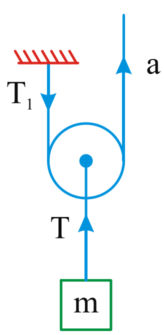
Column -1 **Column -2**

(A)



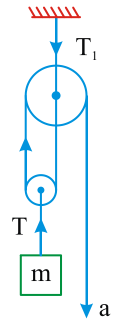
P) $a_{block} \leq a$

(B)



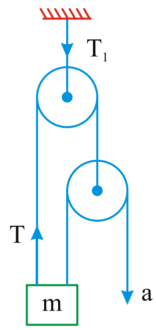
Q) $a_{pulley \leq} a$

(C)



R) $T > mg$

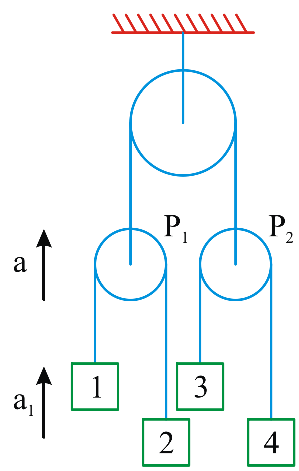
(D)



S)Force on fixed

support $T_1 > (3/2)mg$

30. **In the system shown in figure, masses of the blocks are such that when system is released, acceleration of pulley P_1 is a upwards and acceleration of block 1 is a_1 upwards. It is found that acceleration of block 3 is same as that of 1 both in magnitude and direction.**

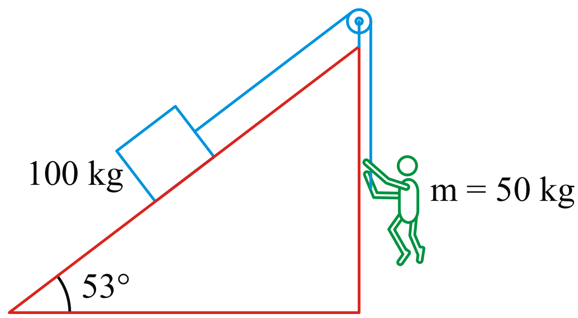


Column - I	**Column - II**
A) Acceleration of 2	P) $2a + a_1$
B) Acceleration of 4	Q) $2a - a_1$
C) Acceleration of 2 w.r.t. 3	R) upwards
D) Acceleration of 2 w.r.t. 4	S) downwards

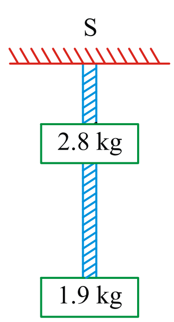
INTEGER TYPE QUESTIONS

31. **Under the action of a constant force F = 10 N, a body moves in a straight line so that the relation between the distance S moved by the body and the time t is described by the equation $S = A - Bt + Ct^2$. Find the mass of the body if $C = 1 m/s^2$.**

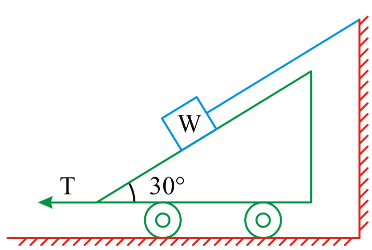
32. **In the arrangement shown, by what acceleration (in ms^{-2}) the boy of mass 50 kg must go up so that 100 kg block remains stationary on the wedge. The wedge is fixed and friction is absent everywhere. Take $g = 10 m/s^2$.**



33. Two blocks of mass 2.9 kg and 1.9 kg are suspended from a rigid support ***S*** **by two inextensible wires each of length 1 m (see Fig.) The upper wire has negligible mass and the lower wire has a uniform mass of 0.2 kg/m. The whole system of blocks, wires and support have an upward acceleration of $0.2 m/s^2$. The acceleration due to gravity is $9.8 m/s^2$. If tension at the midpoint of upper wire is 10x . Find x.**

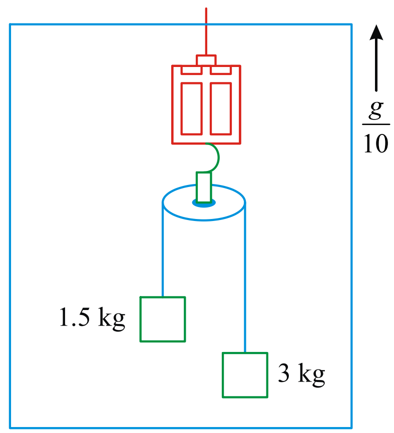


34. **If the tension T needed to hold the cart equilibrium is $\frac{\sqrt{3}W}{x}$, there is no friction. Find value of x**

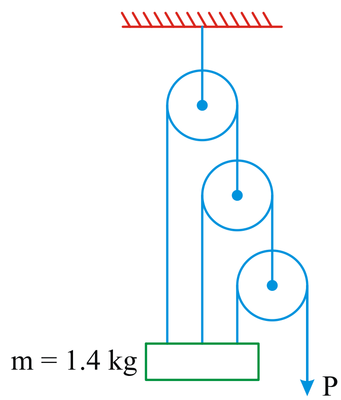


35. **The elevator is going up with an acceleration of *g*/10, the pulley and the sting are light and the pulley is smooth.If reading of spring balance shown is 0.8x.**

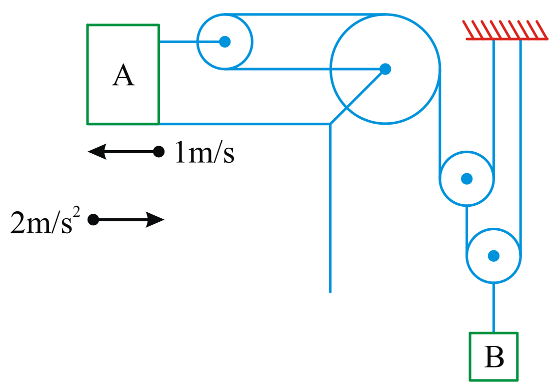
Calculate x $\left(\text{take } g = 10 m/s^2\right)$



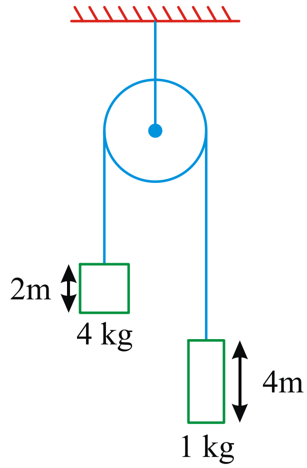
36. **The pull P is just sufficient to keep the 14 N block in equilibrium as shown. Pulleys are ideal. Find the tension (in N) in the cable connected with ceiling.**



37. **In the given figure find the and acceleration of B, if instantaneous velocity and acceleration of A are as shown in the Fig.**



38. **In Fig. shown, both blocks are released room rest. Length of 4 kg block is 2 m and of 1 kg is 4 m. Find the time they take to cross each other ? Assume pulley to be light and string to be light and inelastic.**



EXERCISE -V - KEY

SINGLE ANSWER

1) A	2) D	3)B	4) C	5) A	6) B	7) A
8) B	9) C	10) C	11)D	12) D	13)D	14) C

MULTI ANSWER

15) A,C	16) C,D	17)A,B,D	18) C,D
19) A,B	20) A,C		

PASSAGE TYPE

21) D	22) A	23) A	24) C	25) C	26) A

MATCHING

27. A-q,r,s, B-s, C-p, D-p,s
28. A-q, B-p, C-r, D-s
29. A-q,r,s; B-p, q, r; C-p,q,r,s; D-p,q
30. A **- qr;** B **- ps;** C **- s;** D **-r**

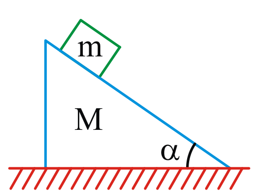
INTEGER

31) 5 32) 6 33) 5 3 4) 4 35) 6 36) 2 37) 1 38) 1

EXERCISE - VI

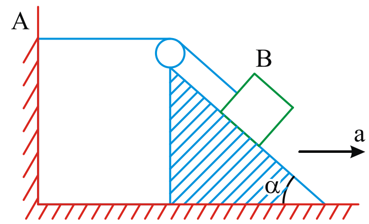
SINGLE ANSWER QUESTIONS

1. **In the figure the heavy mass m moves down the smooth surface of a wedge making an angle α with the horizontal. The wedge at rest $t = 0$ is on a smooth surface. The mass of the wedge is M. The direction of motion of the mass m makes an angle β with the horizontal, then '$Tan\beta$' is**



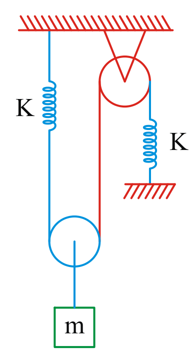
A) $\frac{m}{M}\tan\alpha$ B) $\frac{M}{m}\tan\alpha$ C) $\left(1+\frac{m}{M}\right)\tan\alpha$ D) $\left(1+\frac{M}{m}\right)\tan\alpha$

2. A weightless inextensible rope rests on a stationary wedge forming an angle α with a horizontal. One end of the rope is fixed to the wall at point A. A small load is attached to the rope at point B. The wedge starts moving to the right with a constant acceleration a. The acceleration of the load is given by :



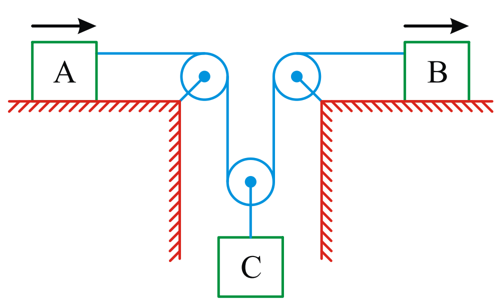
A) a B) $2a\sin\left(\alpha/2\right)$ C) a sin α D) $\sin\left(\alpha/2\right)$

3. Block is attached to system of springs. Calculate equivalent spring constant.



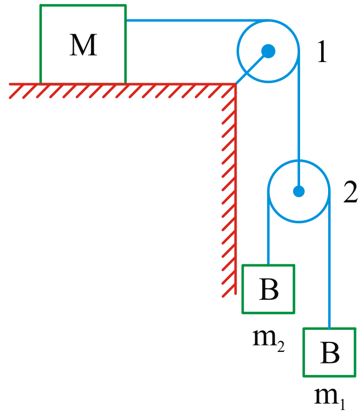
A) K B) 2K C) 3K D) 4K

4. Block A and C start from rest and move to the right with acceleration $a_A = 12t\ m/s^2$ and $a_C = 3m/s^2$. Here t is in seconds. The time when block B attain comes to rest is



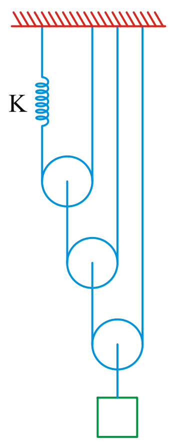
(A) 2 s (B) 1 s (C) 3/2 s (D) 1/2 s

5. In the arrangement shown in fig. $m_1 = 1kg$, $m_2 = 2kg$. Pulleys are massless and string are light. For what value of M the mass m_1 moves with constant velocity (neglect friction)



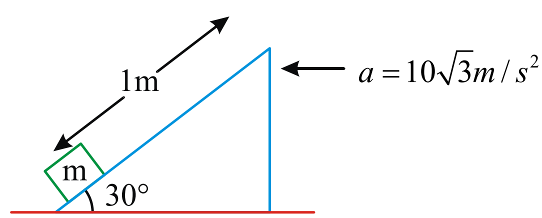
(A) 6 kg (B) 4 kg (C) 8 kg (D) 10 kg

6. Find equivalent spring constant for the system



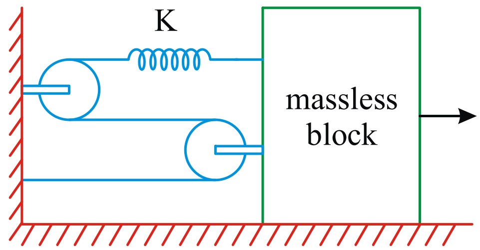
A) k B) 2K C) 64K D) 8K

7. In the figure , the wedge is pushed with an acceleration of $10\sqrt{3}\ m/s^2$. It is seen that the block starts climbing upon the smooth inclined face of wedge. What will be the time taken by the block to reach the top?



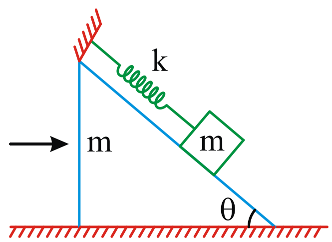
(A) $\frac{2}{\sqrt{5}}s$ (B) $\frac{1}{\sqrt{5}}s$ (C) $\sqrt{5}s$ (D) $\frac{\sqrt{5}}{2}s$

8. In the above diagram system is in equilibrium. If applied force F is doubled how much mass less block will more towards right before new equilibrium is achieved.



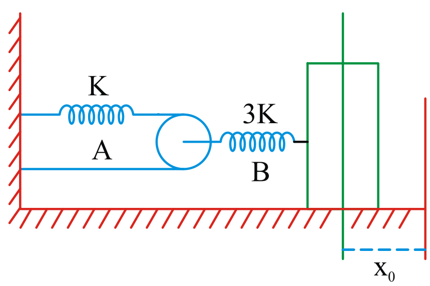
A) $\frac{F}{K}$ B) $\frac{2F}{K}$ C) $\frac{F}{3K}$ D) $\frac{F}{9K}$

9. **In the above diagram all surface friction less what horizontal force has to be applied on wedge such that in equilibrium steady state sping is compressed by $\frac{mg\sin\theta}{K}$**



A) $2mg\tan\theta$ B) $2mg\sin\theta$ C) $4mg\tan\theta$ D) $2mg\tan\theta$

10. **If the above diagram initially there is not elongation in spring if the block is displaced towards right by x_0. Calculate the elongation of spring A.**



A) $\frac{3}{7}x_0$ B) $\frac{x_0}{4}$ C) $\frac{x_0}{7}$ D) $\frac{x_0}{3}$

MULTIPLE ANSWER QUESTIONS

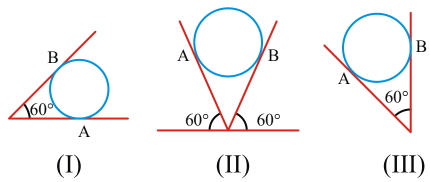
11. **A book leans against a crate on a table. Neither is moving. Which of the following statements concerning this situation is/are incorrect ?**

A) The force of the book on the crate is lessthan that of crate on the book
B) Although there is no friction acting on the crate, there must be friction acting on the book or else it will fall

C) The net force acting on the book is zero

D) The direction of the frictional force acting on the book is in the same direction as the frictional acting on the crate.

12. An iron sphere weighing 10 N rests in a V shaped smooth trough whose sides form an angle of 60^0 as shown in the figure. Then the reaction forces are :



A) $R_A = 10N and\ R_B = 0$ in case (i) B) $R_A = 10N\ and\ R_3 = 10N\ in\ case$ (ii)

C) $R_A = \frac{20}{\sqrt{3}} N\ and\ R_B = \frac{10}{\sqrt{3}} N$ in case (iii)

D) $R_A = 10N\ and\ R_B = 10N$ in all the 3 cases

13. In the above situation all surface are frictionless system is released from rest. Then which of the following statements is/are correct.

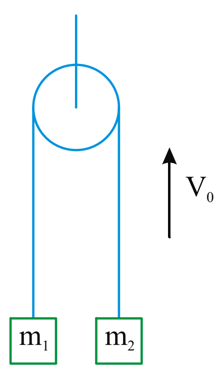
A) acceleration of wedges are zero

B) wedges accelerate towards right

C) Normal force exerted by ground on A is more than normal force exerted by ground on B

D) Tension in connecting string is nonzero.

14. Two blocks of masses m_1 and m_{-2} ($m_1 > m_2$) are connected by a massless threads, that passes over a massless smooth pulley. The pulley is suspended from the ceiling of an elevator. Now the elevator moves up with uniform velocity V_0. Now, select the correct options.



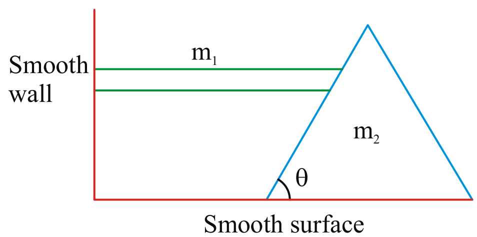
A) Magnitude of acceleration of m_1 with respect to ground is greater than $\frac{(m_1 - m_2)g}{m_1 + m_2}$

B) Magnitude of acceleration of m_1 with respect to ground is qual to $\frac{(m_1 - m_2)g}{m_1 + m_2}$

C) Tension in the thread that connects m_1 and m_2 is equal to $\frac{2m_1 m_2 g}{m_1 + m_2}$

D) Tension in the thread that connects m_1 and m_2 is greater than $\frac{2m_1 m_2 g}{m_1 + m_2}$

15. **A horizontal bar of mass m_1 and Prism of mass m_2 can move as shown. There is no friction at any contact point. During the motion, the length of the rod is always horizontal. Now, magnitude values of**



A) Acceleration of m_1 is $g/(1+\eta \cot^2\theta)$, where $\eta = m_2/m_1$

B) Acceleration of m_1 is $\frac{g\tan\theta}{\eta[1+\tan^2\theta]}$, where $\eta = m_2/m_1$

C) Acceleration of m_2 is $g/(\tan\theta + \eta\cot\theta)$, where $\eta = m_2/m_1$

D) Acceleration of m_2 is $\frac{g\tan^2\theta}{\eta[1+\tan^2\theta]}$, where $\eta = m_2/m_1$

16. **Which of the following regarding frame of reference is correct**

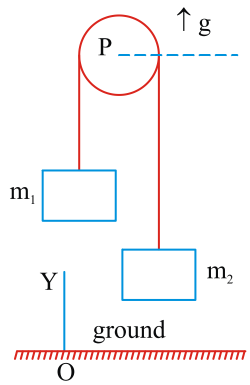
A) Newton's third law is valid from both inertial and non inertial frame.

B) Natural forces like tension, normal force are same from all inertial frame

C) sun can be considered perfectly inertial frame

D) Acceleration of a body measured from different inerital frames are different.

17. **Two masses m_1 and m_2 are connected by light inextensible string passing over a smooth pulley. P. If the pulley moves vertically upwards with an acceleration equal to g then.**



A) Tension on the string is $\dfrac{4m_1m_2g}{m_1+m_2}$

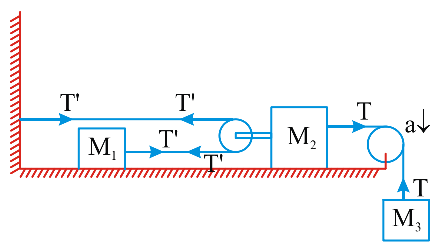
B) Tension on the string is $\dfrac{2m_1m_2g}{m_1+m_2}$

C) The acceleration of mass m_1 with respect to ground is $\dfrac{3m_2-m_1}{m_1+m_2}g$

D) The acceleration of mass m_1 with respect to ground is $\dfrac{2(m_2-m_1)}{m_1+m_2}g$

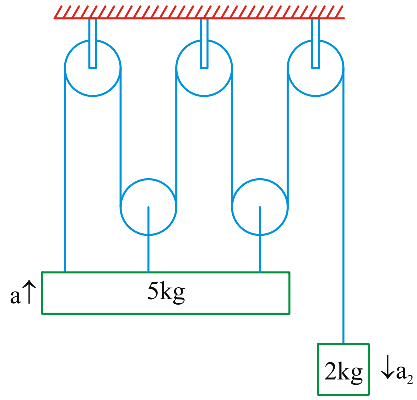
18. In the arrangement shown in the figure all contact surfaces are smooth strings and pulleys are massless.

Given $M_1=1\text{kg}, M_2=2\text{kg}, M_3=4\text{kg}$ **and g=10ms^{-2}**



A) The acceleration of block of mass M_3 is 4ms^{-2}
B) The acceleration of block os mass M_1 is 4ms^{-2}
C) The tension (T) in the string connecting blocks of masses M_3 and M_2 is 24N.
D) The tension (T) in the string connecting block of mass M_1 and M_2 is 24N

19. In the figure shown, two blocks, one of mass 5kg and the other of mass 2kg are connected by light and inextensible string. Pulleys are light an d frictionless. Choose the correct statement



A) The acceleration of 5kg mass is $\frac{5g}{11}ms^{-2}$

B) The acceleration of 2kg mass is $\frac{5g}{11}ms^{-2}$

C) Tension in the string is $\frac{12g}{11}N$

D) Tension in the string is $\frac{10g}{11}$

PASSAGE TYPE QUESTION

PASSAGE : I

A shot putter with a mass of 80 kg pushes the iron ball of mass of 6 kg from a standing position accelerating it uniformly form rest at an angle of 45^0 with the horizontal during a time interval of 0.1 seconds. The ball leaves his hand when it is 2m high above the level ground and hits the ground 2 seconds later. $(g = 10m/s^2)$

20. The accleration of the ball in shot putter's hand:

A) $11\sqrt{2}\,m/s^2$ B) $100\sqrt{2}\,m/s^2$

C) $90\sqrt{2}\,m/s^2$ D) $9\sqrt{2}\,m/s^2$

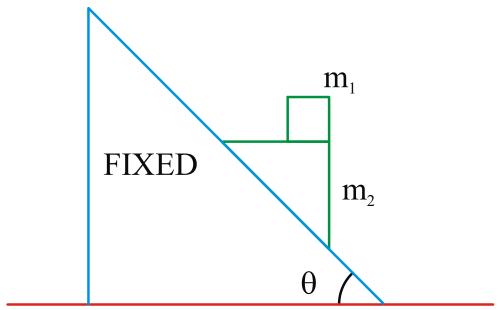
21 The horizontal distance between the point of release and the point where the ball hits the ground:

A) 16 m B) 18 m C) 20 m D) 22m

22. The minimum value of the static coefficient of friction if the shot putter does not slip during the shot is closest to :

A) 0.28 B) 0.40 C) 0.48 D) 0.58

PASSAGE : II



Two blocks m_1 and m_2 are allowed to move without friction. Block m_1 is on block m-$_2$ and m_2 slides on smooth fixed incline as shown. The angle of inclination of inclined plane is θ.

23. The acceleration of m_1 **with respect to ground is**

A) $\frac{(m_1+m_2)g\sin^2\theta}{m_2+m_1\sin^2\theta}$ B) $\frac{(m_1+m_2)g\sin^2\theta}{m_1+m_2\sin^2\theta}$

C) $\frac{(m_1+m_2)g\sin^2\theta}{m_2-m_1\sin^2\theta}$ D) $\frac{(m_1+m_2)g\sin^2\theta}{m_1-m_2\sin^2\theta}$

24. The acceleration of m_2 with respect to ground is

A) $\frac{(m_1+m_2)g\sin^2\theta}{m_2+m_1\sin^2\theta}$ B) $\frac{(m_1+m_2)g\sin\theta}{m_1+m_2\sin^2\theta}$

C) $\frac{(m_1+m_2)g\sin^2\theta}{m_2-m_1\sin^2\theta}$ D) $\frac{(m_1+m_2)g\sin^2\theta}{m_1-m_2\sin^2\theta}$

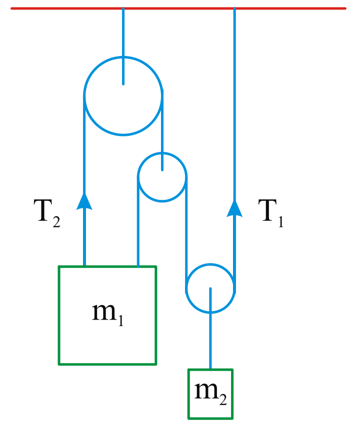
25. Normal reaction on m_1- is:

A) m_1g B) $(m_1+m_2)g$

C) $\frac{m_1m_2g\cos^2\theta}{m_2+m_1\sin^2\theta}$ D) $\frac{m_1g\left[1-(m_1+m_2)\sin^2\theta\right]}{m_1+m_2\sin^2\theta}$

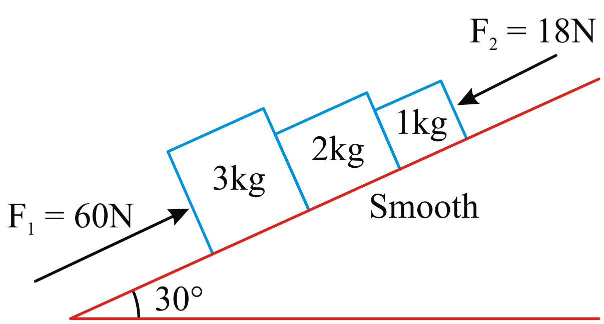
MATRIX MATCHING QUESTIONS

26. Two blocks of masses m_1=5kg and m_2= 2kg are connected by threads which pass over the pulleys as shown in the figure. The threads are mass less and the pulleys are mass less and smooth. The blocks can move only along the vertical direction. T_1 and T_2 are the tensions in the string as shown. Now match the following: [take g = 10m/s^2]



Column-I		Column-II	
A)	Magnitude value of acceleration of m_1 with respect to ground.	p)	$\frac{500}{19}$ SI units
B)	Magnitude value of acceleration of m_2 with respect to ground.	q)	$\frac{250}{19}$ SI units
C)	The value of tension T_1	r)	$\frac{60}{19}$ SI units
D)	The value of tension T_2	r)	$\frac{40}{19}$ SI units
		t)	None of these

27. In the diagram shown, match the following (g = 10m/s²)



Blocks are on smooth incline. F_1 and F_2 are parallel to the inclined plane. The motion of the blocks is along the incline the surface.

Column I	**Column II** **SI UNITS**
A) Acceleration of 2kg block	(p)39
B) Net force on 3kg block	(q)25
C) Normal reaction between 2kg and 1kg	(r) 2
D) Normal reaction between 3kg and 2kg	(s) 6

28. **Column - I**

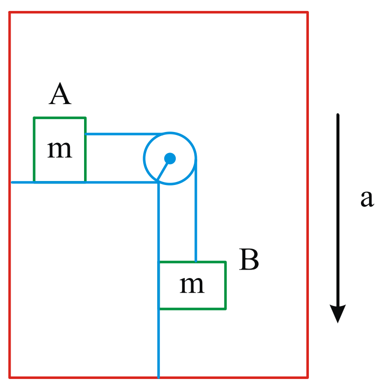
(A) When lift is accelerated up then apparent weight
(B) When lift is accelerated down, then apparent weight
(C) When lift is moving up or down constant velocity,
(D) When lift is free falling then apparent weight

Column - II

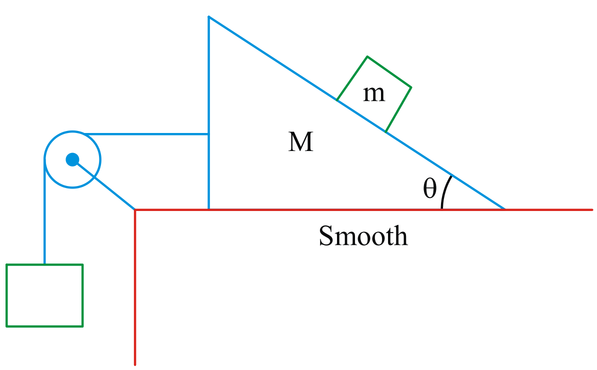
(P) Less than actual weight
(Q) Greater than actual weight
(R) Zero
(S) Equal to actual weight.
(T) Negative

INTEGER TYPE QUESTIONS

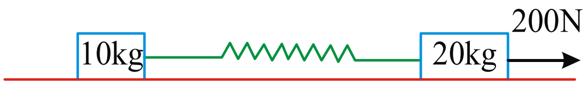
29. Two smooth blocks of same mass are connected by an inextensible and massless string which is passing over a smooth pulley are kept in a lift. The lift is going down with acceleration 'a' as shown in the figure. What should be the value of a (in m/s²) so that acceleration of block A w.r.t. ground will be minimum ? (g = 10 m/s²)



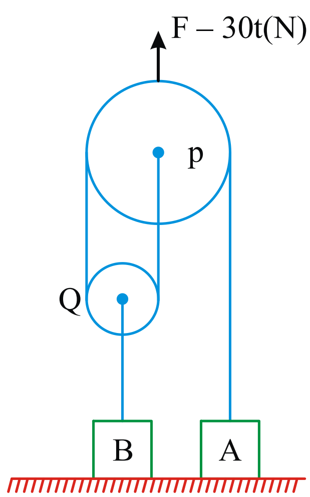
30. Fig. shows a block of mass 0.1 kg placed on a smooth wedge of mass $\frac{1}{5\sqrt{3}}kg$. **If the block of mass** m **will move vertically downward with acceleration 10 m/s². Then the value of tension (in newton) in the string is** $(q = 30^0)$.



31. **Two blocks of masses 10 kg and 20 kg are connected by a massless spring and are placed on a smooth horizontal surface. A force of 200 N is applied on 20 kg mass as shown in the diagram. At the instant, the acceleration of 10 kg mass is 12 ms^{-2}, the acceleration of 20kg mass is.**

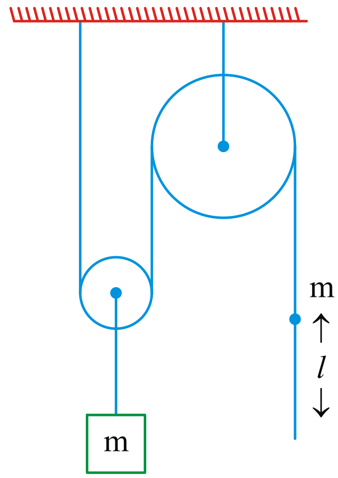


32. **Two block A and B having masses $m_1 = 1kg,\ m_2 = 4kg$ are arranged as shown in the figure. The pulleys P and Q are light and frictionless. All the blocks are resting on a horizontal floor and the pulleys are held such that strings remains just taut . At moment $t = 0\ a$ force $F = 30t(N)$ starts acting on the pulley P along vertically upward direction as shown in the figure. The time when the blocks A and B loose contact with ground is 4/x sec then x is**

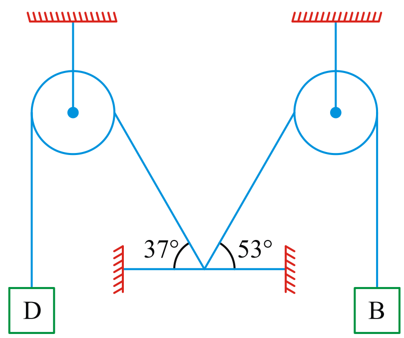


33. **In the figure shown, friction force between the bead and the light string is $\frac{mg}{4}$.**

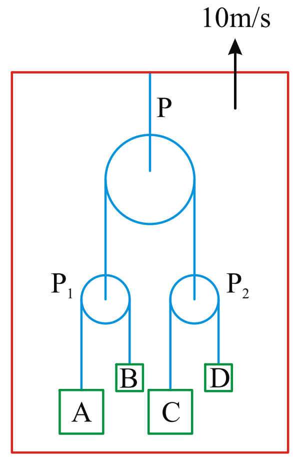
If $t = \sqrt{\frac{nl}{7g}}$ where t is the time in which the bead loose contact with the string after the system is released from rest, find n



34. **A bead C can move freely on a horizontal rod. The bead is connected by blocks B and D by a string as shown in the figure. If the velocity of B is v. The velocity of block D is 4v/x, find the value of x**

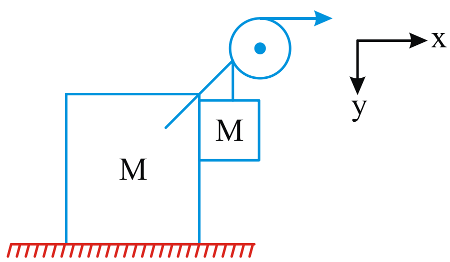


35. **A lift goes up with $10 m/s$. A pulley P is fixed to the celling of the lift. To this pulley other two pulley P_1 and P_2 are attached. P_1 moves up with velocity $30 m/s$. A moves up with velocity $10 m/s$. D is moving downwards with velocity $10 m/s$. at same instant of time. Assume that all velocities are relative to the ground. If velocity of v is 10x, calculate x**

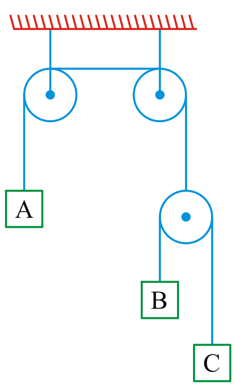


36. **In the situation given, all surfaces are frictionless. pulley is ideal and string is light if**

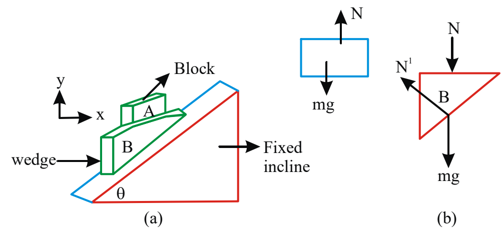
$F = Mg/2,$ **the acceleration of the big block is g/x then x is**



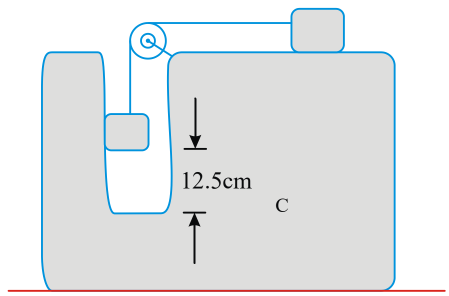
37. **Three blocks shown in figure, move vertically with constant velocities, The relative velocity of A w.r.t C is** $100 m/s$ **upward and the relative velocity of B w.r.t A is** $50 m/s$ **downward. All the string are ideal. The velocity of C with respect to ground is 125/x calcualte x**



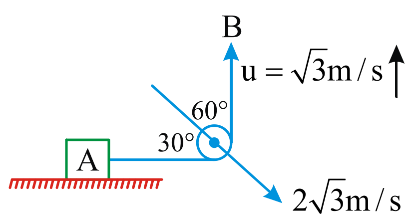
38. **Block A of mass m is placed over a wedge of same mass m. Both the block and wedge are placed on a fixed inclined plane. Assuming all surfaces to be smooth, the displacement of the block A in ground frame in 1s is** $\frac{g\sin^2\theta}{x+\sin^2\theta}$ **then the value of x is**



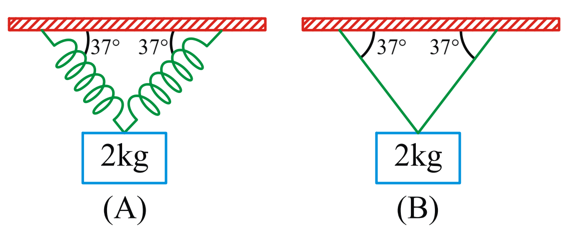
39. **A small , light pulley is attached with a block C of mass 4 kg as shown in Fig . A block B of mass 1.5 kg is placed on the top horizontal surface of C.Another block A of mass 2kg is hanging from a string , attached with B and passing over the pulley. Taking g = 10 ms^{-2} and neglecting friction, acceleration of block C when the system is released from rest is x/4 calculate x.**



40. **A system is shown in the figure. End B of string is moving upwards with $\sqrt{3}$ m/s. Pulley is moving with speed 2$\sqrt{3}$ m/s in direction shown in the figure. The velocity of the block A is $x+2\sqrt{3}$ (m/s) find x**

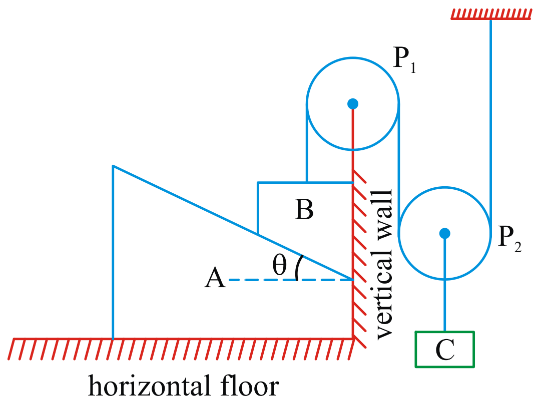


41. **If at t = 0 right spring in (A) and right string in (B) breaks. The ratio of magnitudes of instantaneous acceleration of blocks A & B is $\frac{5x}{24}$, calculate x**



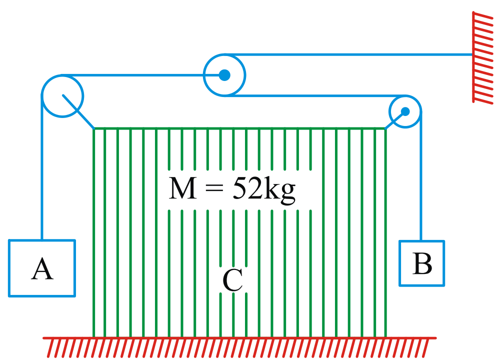
42. **In the figure shown P_1 and P_2 are massless pulleys. P_1 is fixed and P_2 can move. Masses of A,B and C are $\frac{9m}{64}$, 2m and m respectively. All contacts**

are smooth and the string is massless. $\theta = \tan^{-1}\left(\frac{3}{4}\right)$**. (Take g = 10m/s²)**



the tension in string connecting pulley P_2 and block C is $\frac{13}{x}$**, Calculate x (Take m = 1 kg)**

43. **In the arrangement shown in the figure, pulleys are light, small and smooth. Mass of blocks A, B and C is $m_1 = 14$ kg, $m_2 = 11$ kg and M = 52 kg respectively. The block A can slide freely along a vertical rail, fixed to left vertical face of block C. Assuming all the surfaces to be smooth, magnitude of resultant acceleration of blocks A is 20/x, calculate x.**



EXERCISE -VI - KEY

SINGLE ANSWER

1.C 2.B 3.B 4.D 5.C 6.C 7.B 8.D 9.C 10.A

MULTI ANSWER

11.A,B,D 12.A,B,C 13.A,C,D 14. B,C 15. A,C 16. ABD 17.A,D
18.A,C 19. B,C 20.C 21.B 22.B 23.A 24.B 25.C

MATCHING

26. A – s;B – r;C – q;D – p 27. A - r ; B - s; C - q ;D – p 28. A-q B-p C-s D-r

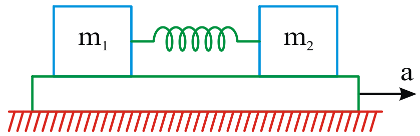
INTEGER TYPE

29.2 30. 2 31.4 32.2 33.8 34. 3 35.5 36.4
37.2 38. 1 39.5 40. 3 41.5 42.2 43.5

EXERCISE - VII

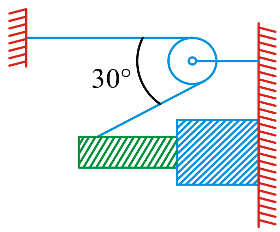
SINGLE ANSWER QUESTIONS

1. Two block of masses m1 and m2 are connected with a massless unstretched spring and placed over a plank moving with an acceleration 'a' as shown in figure. The coefficient of friction between the blocks and platform is μ



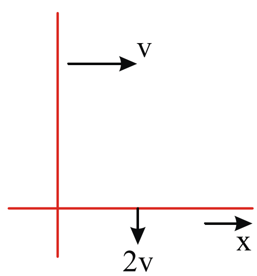
(A) spring will be stretched if $a > \mu g$
(B) spring will be commpressed if $a \le \mu g$
(C) spring will neither be compressed nor be stretched for $a \le \mu g$ only.
(D) spring will be in its natural length under all conditions.

2. Two blocks with masses M_1 and M_2 of 10 kg and 20 kg respectively are placed as in fig. $\mu_s = 0.2$ between all surfaces, then tension in string and acceleration of M_2 block will be :



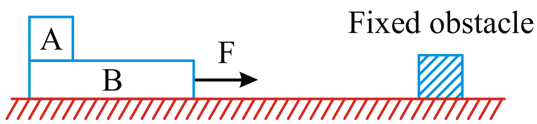
(A) 250 N, 3 m/s^2 (B) 200 N, 6 m/s^2 (C) 306 N, 4.7 m/s^2 (D) 400 N, 6.5 m/s^2

3. Two thin rods are moving perpendicularly as shown in the figure. If the friction acting between them is F_R then the unit vector in the direction of friction force acting on the rod lying along x-axis is



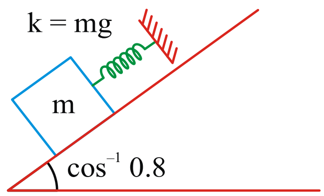
A) $\frac{\left(-\hat{i}-2\hat{j}\right)}{\sqrt{5}}$ B) $\frac{\left(\hat{i}+2\hat{j}\right)}{\sqrt{5}}$ C) $\frac{\left(3\hat{i}+2\hat{j}\right)}{\sqrt{13}}$ D) none of these

4. In the figure shown mass of A and B is equal to M each. Friction between B and lowermost surface is negligible. Initially both the blocks are at rest. The dimensions of the block A are very small. A constant horizontal force F is applied on the blocks B and both the blocks start moving together without any relative motion. Suddenly, the block B encounters a fixed obstacle and comes to rest. The block A continues to slide on the block B. The block A just manages to reach the opposite end of the block B. What is the coefficient of friction between the two blocks? (Required length are shown in the figure)



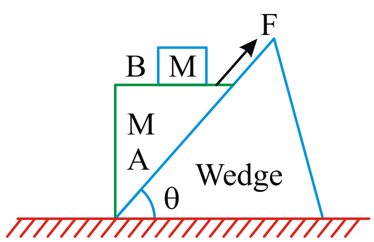
A) F/Mg B) 2F/Mg C) F/2Mg D) none

5. **A block of mass m is gradually released so that at position shown it is in equilibrium with spring extended by 10cm. The static and kinetic coefficients of friction differ by 0.1.When the spring is cut, m slides down with acceleration (in ms^{-2})**



A) 0.8 B) 1 C) 1.8 D) 2.1

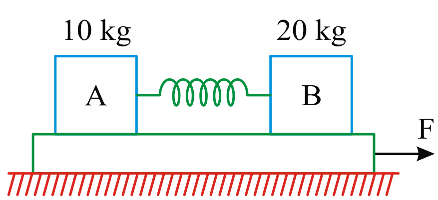
6. **Wedge is fixed on horizontal surface. Block A is pulled upward by applying a force F as shown in the figure and there is no friction between the wedge and the block A while coefficient of friction between A and B is μ. If there is no relative motion between the block A and B then frictional force developed between A and B is**



A) $\left[\frac{F+(m-M)g\sin\theta}{(m+M)}\right]m\cos\theta$ B) μmg

C) $\left[\frac{F-(m+M)g\sin\theta}{(m+M)}\right]m\cos\theta$ D) $\mu mg/2$

7. **Two blocks A & B attached to each other by a mass-less spring , are kept on a rough horizontal surface $\mu = 0.1$. A constant force $F = 200N$ is applied on block B horizon tally as shown below. If at some instant the acceleration of 10 kg mass is $12\ m/s^2$, then the acceleration of 20 kg mass is**

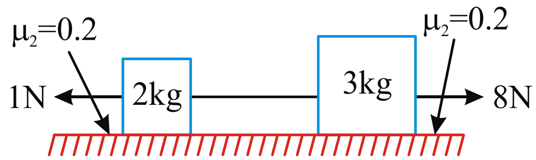


A) $2.5\ m/s^2\ \ or\ 15.5\ m/s^2$ B) $4\ m/s^2\ \ or\ 10\ m/s^2$

C) $3.6\ m/s^2\ \ or\ 4.1\ m/s^2$ D) $1.2\ m/s^2\ \ or\ 1.3\ m/s^2$

8. **In the shown arrangement if f_1, f_2 and T be the frictional forces on 2 kg block, 3**

kg block & tension in the string respectively, then their values are :

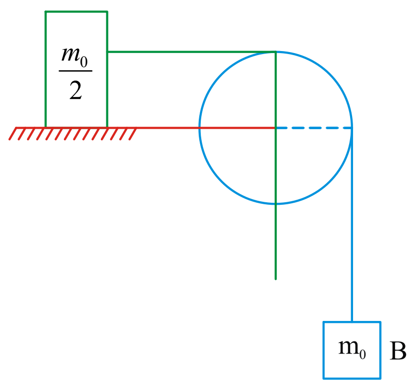


(A) 2N, 6N, 3.2 N (B) 2N, 6 N, 0 N

(C) 1N, 6 N, 2 N

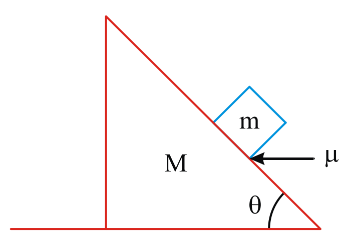
(D) data insufficient to calculate the required values.

9. **Coefficient of friction between pulley and light string is μ_1 . Calculate minimum coefficient of friction between block A and ground such that system can be in equilibrium.**



A) $\mu = 2$ B) $\mu = 2e^{\frac{-\mu_1\pi}{2}}$ C) $\mu = e^{\frac{\mu_1\pi}{2}}$ D) $\mu = \frac{3}{2}$

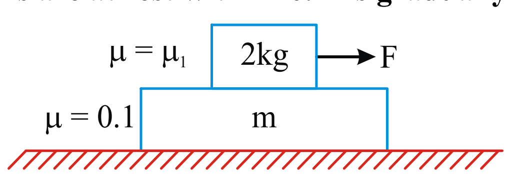
10. **Calculate angle of friction between wedge and block system is at rest M coefficient of fricion between wedge and block.**



A) $\tan^{-1}\mu$ B) 2θ C) θ D) $\frac{\theta}{2}$

MULTI ANSWER TYPE QUESTIONS

11. **Initially the blocks are at rest with F=0. F is gradually increased.**



From F=0 till $F=F_1$, no motion

From $F>F_1$ till $F=2F_1$, motion with relative acceleration =0

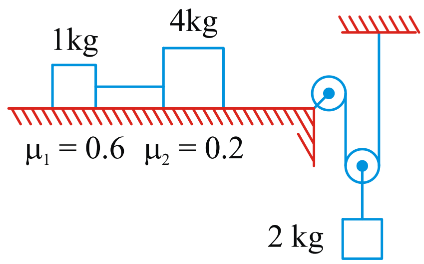
From $F>2F_1$, relative acceleration non-zero

At $F=3F_1$, relative acceleration $=2ms^{-2}$
Then,

A) m=2kg   B) $\mu_1 = 0.4$ C) F_1 =6N

D) At $F=4F_1$, relative acceleration is $4ms^{-2}$

12. 1kg and 4kg blocks lie on a rough horizontal surface. The coefficient of friction between 4kg block and surface is 0.2 while the coefficient of friction between 1kg block and the surface is 0.6. All the pulley shown in the figure are massless and frictionless and all strings are massless.



A) The frictional force acting on 1kg block is 2N.
B) The frictional force acting on 1kg block is 6N
C) The tension in the string connecting 4kg block and 1kg block is 1N
D) The tension in the string connecting 1kg block and 4kg block is zero.

13. The force F_1 that is necessary to move a body up an inclined plane is double the force F_2 that is necessary to just prevent it from sliding down, then :

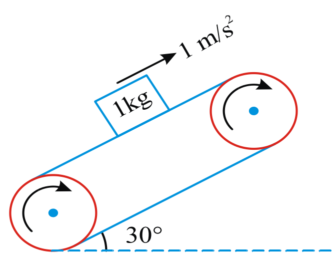
(A) $F_2 = w\sin(\theta - \phi)\sec\phi$ (B) $F_1 = w\sin(\theta - \phi)\sec\phi$

(C) $\tan\phi = 3\tan\theta$

(D) $\tan\theta = 3\tan\phi$ Where ϕ = angle of friction

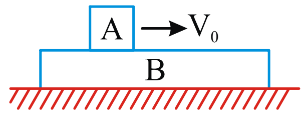
θ = angle of iclined plane w = weight of the body

14. A block of mass 1 kg is stationary with respect to a conveyer belt that is accelerating with 1 m/s² upwards at an angle of 30° as shown in figure. Which of the following is/are correct?



(A) Force of friction on block is 6N upwards.
(B) Force of friction on block is 1.5 N upwards.
(C) Contract force between the block & belt is 10.5 N.
(D) Contact force between the block & belt is $5\sqrt{3}$ N.

15. A block A of mass m is placed over a plank B of mass 2 m. Plank B is placed over a smooth horizontal surface. The coefficient of friction between A and B is $\frac{1}{2}$. Block A is given a velocity v_0 towards right. Then

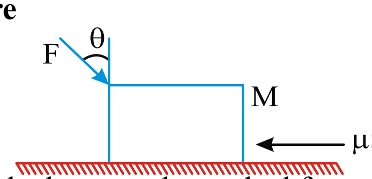


(A) Acceleration of A is $\frac{g}{2}$ (B) Acceleration of A is g

(C) Acceleration of B relative to A is $\frac{3}{4}g$

(D) Acceleration of A is zero

16. **In the situation shown in the figure the friction coefficient between M and the horizontal surface is μ. The force F is applied at an angle θ with vertical. The correct statements are**



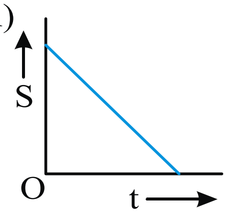
A) If $\theta > \tan^{-1}\mu$ the block cannot be pushed forward for any value of F

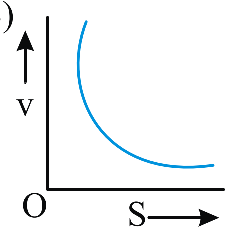
B) If $\theta < \tan^{-1}\mu$ the block cannot be pushed forward for any value of F

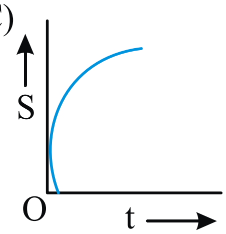
C) As θ decreases the magnitude of force needed to just push the block M forward increases

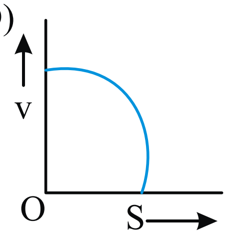
D) None of these

17. **A block is resting on a rough horizontal surface. A sharp horizontal impulse is applied on the block at t = 0.If at an instant t, its velocity be v and displacement up to this instant be s, then which of the following graphs is/are correct ?**

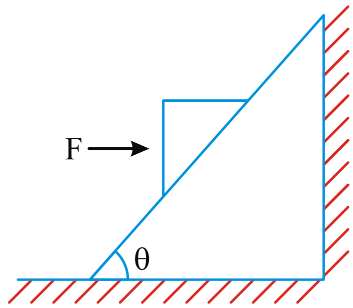
(A)


(B)


(C)


(D)


8. **A triangular block of mass m rests on a fixed rough inclined plane having friction coefficient μ with the block. A horizontal forces F is applied to it as shown in figure below, then the correct tatement is :**



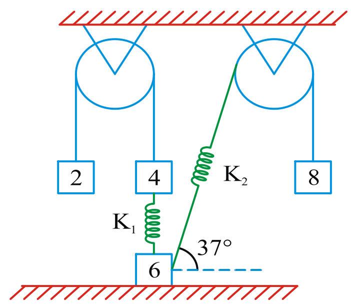
A) Friction force is zero when $F\cos\theta = mg\sin\theta$

B) The value of limiting friction is $\mu\left(mg\sin\theta + F\cos\theta\right)$

C) Normal reaction on the block is $F\sin\theta + mg\cos\theta$

D) The value of limiting friction is $\mu\left(mg\sin\theta - F\cos\theta\right)$

19. System is in equilibrium

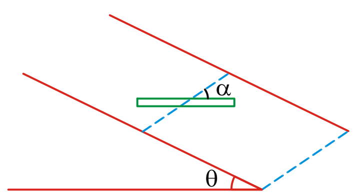


A) Minimum coefficent of friction required between 6kg block and ground $\mu = 2$ such that system is in equilibrium.

B) Compression of vertical spring is $\frac{2g}{K_1}$ C) Elongation of vertical spring is $\frac{6g}{K_1}$

D) for $\mu = 1$ system can be in equilibrium

20. A small object is kept on a groove on rough incline plane of inclination θ. Groove wakes an angle α as shown in diagram. μ coefficient of friction. Which of the following is correct



A) Normal force by incline plane. N=mg cos θ

B) Normal force by incline is $N = mg\sqrt{\cos^2\theta + \sin^2\theta\sin^2\alpha}$

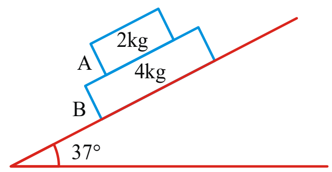
C) maximum frictional force that can develop is $f_{max} = \mu mg\cos\theta$

D) If $\mu = 0$ then acceleration of block is $g\sin\theta\cos\alpha$

PASSAGE TYPE QUESTIONS

PASSAGE - I

Consider the situation shown in figure in which a book 'A' of mass 2 kg is placed over a block 'B' of mass 4 kg. The combination of the blocks are placed on a inclined plane of inclination 37^0 with horizontal. The coefficient of friction between block B and inclined plane is μ_2 and in between the two blocks is μ_1, The system is released from rest. $\left(Take\, g = 10m/\sec^2\right)$



21. **If** $\mu_1 = 0.8, \mu_2 = 0.8$ **then :**

A) Both block will move together
B) Only block A will move and block B remains at rest
C) Only block B will move and block A remains at rest
D) None of the blocks will move

22. **In the previous question the frictional force between block B and plane is :**

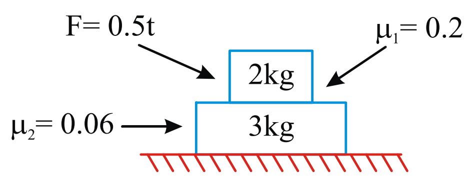
A) 36 N B) 24 N C) 12 N D) 48 N

23. **If** $\mu_1 = 0.5, \mu_2 = 0.5,$ **then :**

A) Both block will move but with different acceleerations
B) Both block will move together C) Only block A will move
D) Only block B will move

PASSEGE -II

In the given figure, the blocks of mass 2 kg and 3 kg are placed one over the other as shown. The surface are rough with coefficient of friction $\mu_1 = 0.2, \mu_2 = 0.06.$ **A force** $F = 0.5t$ **(where 't' in sec) is applied on upper block in the directoin shown. Based on above data answers the following questions.** $\left(g = 10m/\sec^2\right)$



24. **The motion of blocks 2 kg and 3 kg will begin at time** $t = -, -$ **respectively**

A) 8, 8 sec B) 6, 8 sec C) 8, 6 sec D) 6,6 sec

25. **The relative slipping between the blocks occurs at t =**

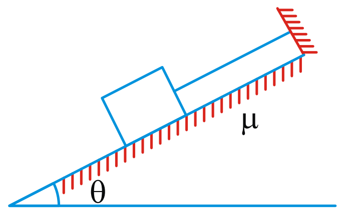
A) 6 sec B) 8 sec C) $\frac{28}{3}$ sec D) Never

26. **The frictional force acting between the two blocks at t = 8 sec.**

A) 4 N B) 3 N C) 3.6 N D) 3.2 N

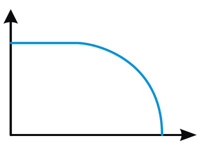
MATRIX MATCHING QUESTIONS

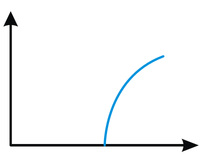
27. A block of mass m is put on a rough inclined plane of inclination θ, and is tied with a light thread shown. Inclination θ is increased gradually from θ = 0° to θ = 90°. Match the columns according to corresponding curve.

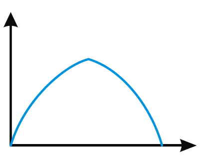


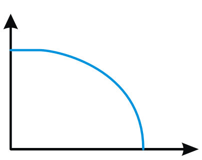
Column I

(A) Tension in the thread versus θ
(B) Normal reaction between the block and the incline versus θ
(C)Friction force between the block and the incline versus θ
(D) Net interaction force between the block and the incline versus θ

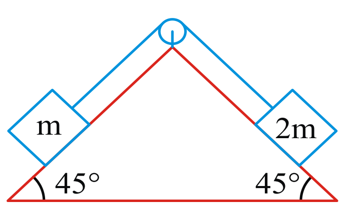
(p)


(q)


(r)


(s)


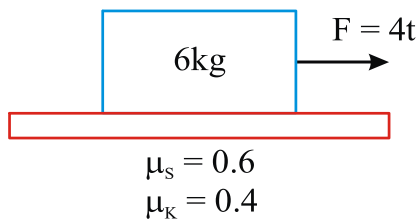
28. **Two blocks A and B of mass m and 2m are placed on a fixed triangular wedge and connected by light string as shown pulley is mass less and friction less coefficient of friction between block A and wedge is 2/3 and that between wedge is 1/3**
(Take m=1kg g=10ms^{-2})



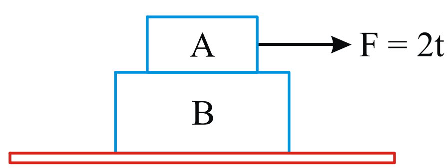
Column-I	Column-II
A) Friction force between block A and wedge	p) $\dfrac{5}{\sqrt{2}}$
B) Friction between block B and wedge	q) $\dfrac{10}{3\sqrt{2}}$
C) Tension in the string	r) $\dfrac{10\sqrt{2}}{3}$
D) Maximum friction force between block B and wedge.	s) $30\sqrt{2}$
	t) $\dfrac{20\sqrt{2}}{3}$.

INTEGER TYPE QUESTIONS

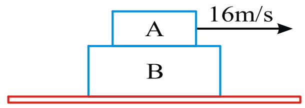
29. **A 6 kg block is kept over a rough surface with coefficients of friction** $\mu_s = 0.6$ and $\mu_k = 0.4$ **as shown in figure. A time varying force F = 4t (F in newton and t in second) is applied on the block as shown. Find the acceleration of block** at t = 5 sec. (Take g = 10 m/s^2)



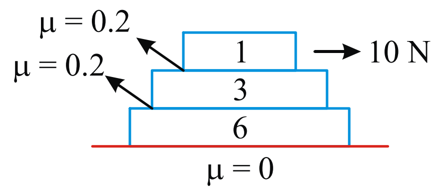
30. **Two blocks A and B of mass 2 kg and 4 kg are placed one over the other as shown in figure. A time varying horioznta1 force F = 2t is applied on the upper block as shown in figure. Here t is in second and F is in newton. Coefficient of friction between A and B is** $\mu = \dfrac{1}{2}$ **and the horizontal surface over which B is placed is smooth.** **(g = 10 m/s^2). If acceleration of block A as a function of time is given by a_A = t/c then find value of c.** $(t \le 7.5\,s)$



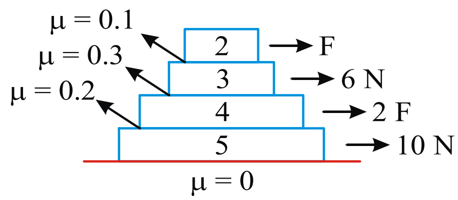
31. **Block B of mass 2kg is placed on smooth horizontal plane. Block A of mass 1kg is placed on block B. The coefficient of friction between A and B is 0.40. The block A is imparted a velocity 16 m/s at t =0. Find the time at which momentum of the twoblocks are equal (in seconds).** $\left(g = 10m/s^2\right)$.



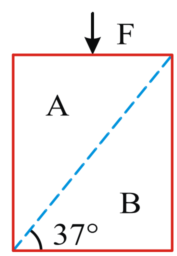
32. **In the above diagram calculate frictional force acting on 6kg block**



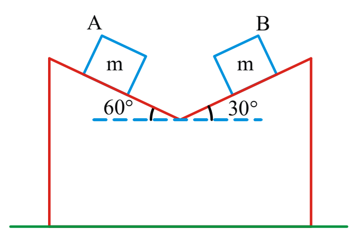
33. **Calculate F such that frictional force acting on all blocks zero.**



34. **Two plates A and B kept on horizontal surface. Force F is applied as shown. If minimum coefficient of friction between them is $\frac{n}{4}$ to keep them in equilibrium. Calculate n.**



35. **Two small blcok m=2kg each kept on wedge of mass 12kg. There is no friction between blocks and wedge coefficient of riction between wedge and ground is $\mu = 0.3$. Calculate frictional force by ground on wedge.**



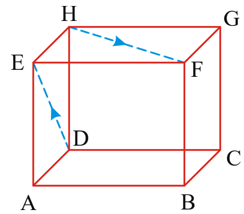
EXERCISE - VII - KEY

1) D 2) A 3) 4) A 5) B 6) C 7) A 8) C 9) B 10) C
11)A,D 12)C,D 13)A,D 14)A,C 15)A,C 16) A,C
17) B,C 18) C,D 19)A,B 20) B,D 21) D 22) A 23)B
24) D 25) C 26)C 27.(A) q, (B) s, (C) r, (D) p 28. A-q; B-r; C-t ; D-r
29) 0 30) 3 31)2 32) 6 33) 4 34) 3 35) 0

EXERCISE - VIII

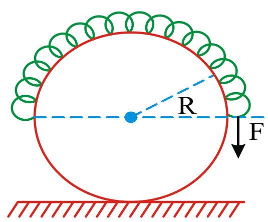
SINGLE ANSWER QUESTIONS

1. Cube of mass m kept on rough horizontal surface. Two insects each mass m. moving in the cube with equal acceleration. a_0 from D to E and H to F what is the frictional force by ground on the cube.



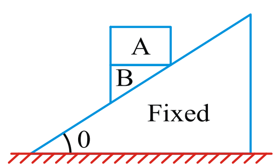
A) $(m+2m)a_0$ B) $\frac{\sqrt{5}}{\sqrt{2}}ma_0$ C) $2ma_0$ D) $ma_0\sqrt{2}$

2. Chain of mass M length L kept on rough sphere. μ is coefficient if friction between sphere and chain F is minimum force required to slide chain



A) $\frac{2\mu Mg}{\pi}$ B) μMg C) $>\frac{2\mu Mg}{\pi}$ D) $2\mu Mg$

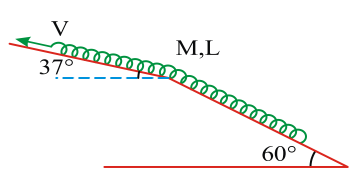
3. The coefficient of friction between the block A of mass m & blcok B of mass 2m is μ. There is no friction between block B & the inclined plane. If the system of blocks A & B is released from rest & there is no slipping between A & B then :



A) $2\theta \le \sin^{-1}(2\mu)$ B) $\theta \le \tan^{-1}(\mu)$

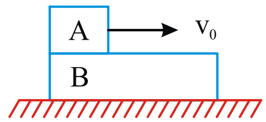
C) $2\theta \le \cos^{-1}(2\mu)$ D) $2\theta \le \tan^{-1}(\mu/2)$

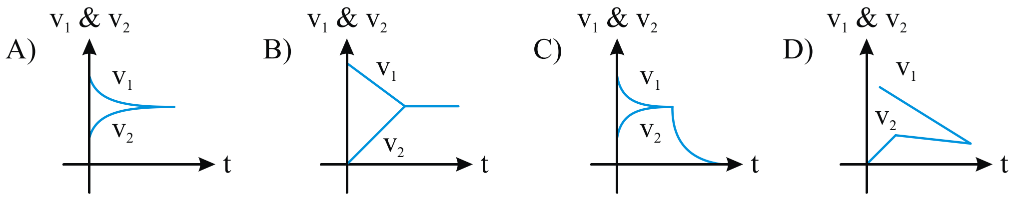
4. A long chain of mass of mass M length L is being pulled with constant velocity on a rough incline with coefficient of friction μ. What rate frictional force on chain is increasing.



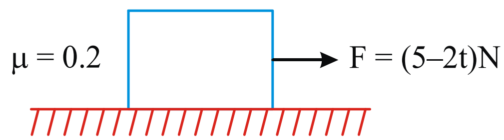
A) $\frac{3}{10}\mu\frac{M}{L}gv$ B) $\frac{5}{6}\mu\frac{M}{L}gv$ C) zero D) $\mu\frac{M}{L}gv$

5. **A block A is placed over a long rough plank B of same mass as shown below. The plank is placed over a smooth horizontal surface. At time $t=0$, block A is given a velocity v_o in horizontal direction. Let v_1 and v_2 be the velocity of A & B at time 't'. Then choose the correct graph between v_1 or v_2 and t :**





6. **The force acting on the block of mass 1 kg is given by $F=5-2t$. The frictional force acting on the block after time t = 2 seconds will be : $(\mu=0.2)$**



A) 2 N B) 3 N C) 1 N D) Zero

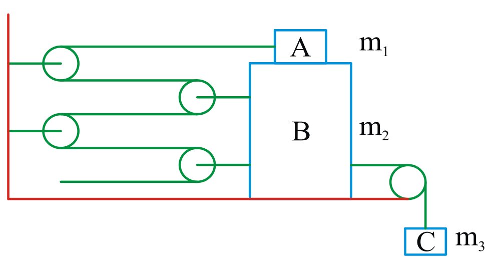
7. **A block of mass 2 kg is placed on the floor of an elevator. The elevator is moving with an acceleration of**

$6\hat{i}+7\hat{j}\ m/s^2$. **If** $m = 0.5,\ g = 10\ ms^{-2}$

and horizontal, vertically upward directions are taken as +ve x, y axes, find frictional force acting on the block.

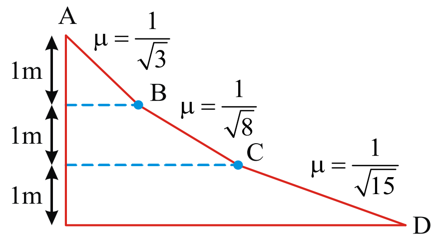
A) 12 N B) 16 N C) 10 N D) 17 N

8. **In the figure, $m_1 = m_2 = 10kg$. The co-efficients of friction between A, B and B, surface are 0.2. Find the maximum value of m_3 so that no block slips (All the pullies are ideal and strings are massless).**



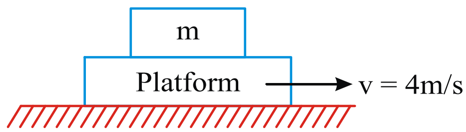
A) 16 kg B) 10 kg C) 18 kg D) 14 kg

9. **A composite inclined plane has three different inclined surfaces AB, BC and CD of heights 1m each and coefficients of friction $\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{8}}$ and $\frac{1}{\sqrt{15}}$ respectively. A particle given an initial velocity at A along AB transverses the inclined surfaces with uniform speed, reaches D in 5s. The initial speed given is (in m/s)**



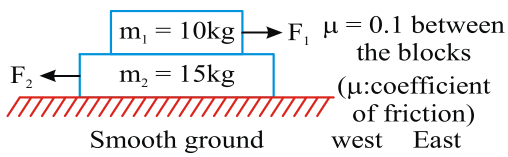
(A) 1.6 **(B)** 1.8 **(C)** 2.4 **(D)** 3

10. **A stationary body of mass m is slowly lowered onto a rough massive plat form moving at a constant velocity $v_o = 4m/s$. on smooth surface. The distance the body will slide with respect to the plat form ($\mu = 0.2$) is :**



A) $4m$ B) $6m$ C) $12m$ D) $8m$

11. **In the diagram shown the ground is smooth and F_1 & F_2 are both horizontal forces. The mass of the upper block is 10 kg while that of lower block is 15 kg. The correct statement is :**



A) m_1 experiences frictional force towards west only if $F_1 > F_2$

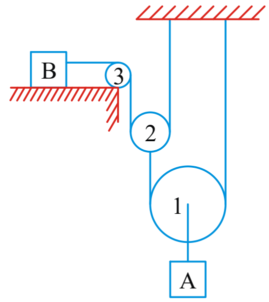
B) If $F_1 \neq F_2$ then it is possible to keep the system in equilibrium for certain suitable values of F_1 & F_2

C): If the system is to remain in equilibrium then F_1 must be equal to F_2 & $F_2 \leq 10N$

D) If $\frac{F_1}{m_1} = \frac{F_2}{m_2}$, then frictional force between the blocks is zero

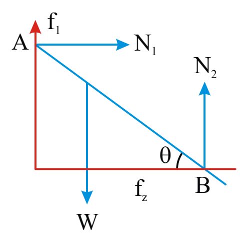
MULTIPLE ANSWER QUESTIONS

12. **As shown in figure, A and B are two blocks of mass 5kg and 10 kg connected by inextensible and massless strings. Pulleys 1,2,3 are massless; no friction exists between pulley and strings. The coefficient of friction between block B and the surface is $\mu = 0.1$ Take g =10m/s^2 . Choose the correct statements.**



A) The acceleration of block A is 0.06ms^{-2}
B) The acceleration of block B is 0.24ms^{-2}
C) The tension in the string connecting pulley 1 and block A is 24.7N
D) The tension in the string connecting pulley 3and block B is 6.175N

13. A uniform rod is made to lean between rough vertical wall and the ground. Friction coefficient between rod and wall is $\mu_1 = \frac{1}{2}$ and between the rod and the ground is $\mu_2 = \frac{1}{4}$.
The rod is about to slip at contact surfaces.
The correct options are:

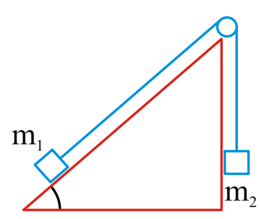


(A) The normal reaction between rod and wall is $\frac{\mu_2 W}{1+\mu_1\mu_2}$

(B) Normal reaction between rod and ground is $\frac{W}{1+\mu_1\mu_2}$

(C) $N_2 > N_1$ (D) $N_1 > N_2$

14. Two blocks of masses m_1 and m_2 are connected by a string of negligible mass which pass over a frictionless pulley fixed on the top of an inclined plane as shown in figure. The coefficient of friction between m_1 and plane is μ.



(A) If $m_1 = m_2$, the mass m_1 first begin to move up inclined plane when the angle of inclination θ, then $\mu = \sec\theta - \tan\theta$.

(B) If $m_1 = m_2$, then mass m_1 first begin to side down the plane if $\mu = \sec\theta - \tan\theta$.

(C) If $m_1 = 2m_2$, then mass m_1 first begins to slide down the plane if $\mu = 2\tan\theta$.

(D) If $m_1 = 2m_2$, then mass m_1 first begins to slide down the plane if $\mu = \tan\theta - \frac{1}{2}\sec\theta$.

15. A plank 1 m long is fixed with one end, 28 cm above the level of the other end. The top half of the plank is smooth and the bottom half is rough. When a small block of mass m is released at the top, it just reaches the bottom.

A) The coefficient of friction between the block and the part of plank is 1/2.

B) On the rough part, the normal reaction on the block is $\frac{24}{25}mg$

C) Coefficient of friction between the block and the rough part of plank is 7/12

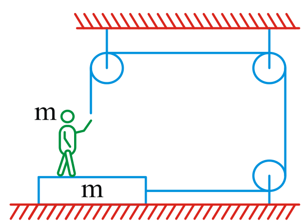
D) On the rough part, the retardation of the block is $\frac{28}{100}g$

16. Suppose F, F_N & f are the magnitudes of the contact force, normal force and the frictional force exerted by one surface on the other, kept in contact, if none of these is zero

A) $F > f$ B) $F_N > f$

C) $F > F_N$ D) $F_N - f < f < F_N + f$

17. The friction coefficient between plank and floor is μ. The man applies, the maximum possible force on the string and the system remains at rest. Then :



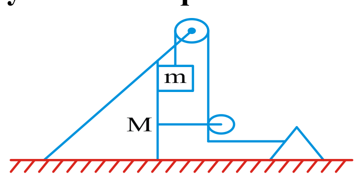
A) frictional force between plank and surface is $\frac{2\mu mg}{1+\mu}$

B) frictional force on man is zero

C) tension in the string is $\frac{2\mu mg}{1+\mu}$

D) net force on man is zero

18. In the figure shown , friction exists between wedge and block and also between wedge and floor. The system is in equilibrium in the shown position.



A) frictional force between wedge and surface is $\mu\left(M+m\right)g$

B) frictional force between wedge and surface is mg

C) frictional force between wedge and block is 0

D) minimum coefficient of friction required to hold the system in equilibrium is

$\frac{m}{M+m}$

19. **When person cycling on rough horizontal surface then which of the following are correct**

A) Friction on front wheel is towards left

B) Friction on front wheel is towards right

C) Friction on rear wheel towards right

D) Friction on rear wheel towards left

20. **A body is moving down a long inclined plane of inclination 45^0 with horizontal. The coefficient of friction between the body and the plane varies as $\mu = x/2$, where x is the distance moved down the plane. Initially $x = 0$ & $v = 0$.**

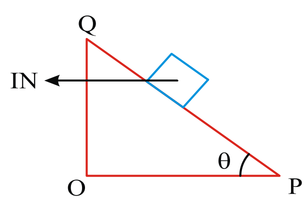
A) When $x = 2$ the velocity of the body is $\sqrt{g\sqrt{2}}\, m/s$

B) The velocity of the body increases all the time

C) At an instant when $v \neq 0$ the instantaneous acceleration of the body down the plane is $\frac{g(2-x)}{2\sqrt{2}}$

D) The body first accelerates and then decelerates

21. **A small block of mass of 0.1kg lies on a fixed inclined plane PQ which makes an angle θ with the horizontal.A horizontal force of 1N acts on the block through its centre of mass as shown in the figure. The block remains stationary if (take $g = 10 m/s^2$) *(JEE 2012)***



A) $\theta = 45^0$

B) $\theta > 45^0$ and frictional force acts on the block towards P.

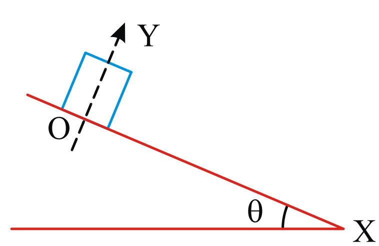
C) $\theta > 45^0$ and frictional force acts on the block towards Q.

D) $\theta < 45^0$ and frictional force acts on the block towards Q.

PASSAGE TYPE QUESTIONS

PASSEGE - I

In the adjacent figure, x-axis has been taken down the inclined plane. The coefficient of friction varies with x as $\mu = kx$, where k $= \tan\theta$. A block is released at O.



22. **The maximum velocity of block will be :**

A) $\sqrt{g}$ B) $\sqrt{g\sin\theta}$ C) $\sqrt{g\cos\theta}$ D) $\sqrt{g\tan\theta}$

23. **Maximum distance traveled by the block :**

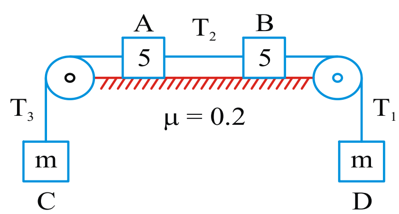
A) 1 m B) 2 m C) 3 m D) $\frac{1}{2}m$

24. **Frictional force acting on the block after it comes to rest :**

A) $mg\sin\theta$ B) $2mg\sin\theta$ C) $\frac{mg\sin\theta}{2}$ D) $2mg\cos\theta$

PASSAGE : II

In the shown figure, four blocks A,B,C and D are connected by three ideal strings. Coefficient of friction between A,B and surface is 0.2. The masses A, B and D are of 5 kg andC is of $m\ kg$. f_A and f_B are the frictional forces action on A and B respectively. The system is allowed to move. Based on the above data answer the following questions. $(Take\ g = 10m/s^2)$



25. **If** $m = 5\,kg$, **then :**

A) $T_2 = 50N, f_A = f_B = 10\,N$ B) $T_2 = 40N, f_A = f_B = 10\,N$

C) $T_2 = 50N, f_A = f_B = 0$ D) $T_2 = 40N, f_A = f_B = 0$

26. **If** $m = 6kg$, **then :**

A) $T_2 = 40N, f_A = 10N, f_B = 0$ B) $T_2 = 40N, f_A = 20N, f_B = 10N$

C) $T_2 = 40N, f_A = 20N, f_B = 10N$ D) $T_2 = 50N, f_A = 10N, f_B = 0$

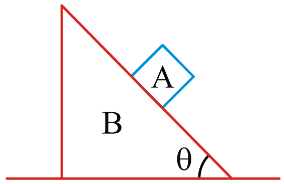
27. **If** $m = 4\,kg$ **then :**

A) $T_2 = 40N, f_A = 0, f_B = 10N$ B) $T_2 = 0, f_A = 10N, f_B = 10N$

C) $T_2 = 30N, f_A = 10N, f_B = 20N$ D) $T_2 = 30N, f_A = 10N, f_B = 10N$

MATRIX MATCHING QUESTIONS

28. **A block A is placed on wedge B, which is placed on horizontal surface. All the contact surfaces are rough but friction is not suficient to prevent sliding at any surface. Match Column I and II.. Column II indicates possible direction(s) of the physical quantities mentioned under Column I. X and Y axes are along the incline and perpendicular to the incline**



Column-I

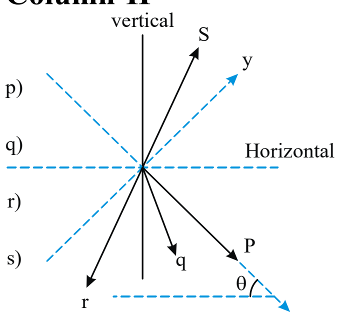
A) Acceleration of A

B) Net force applied by A on B

C) Acceleration of A relative to B

D) Net force applied by ground on B

Column-II



29. **Column-II gives certain situations involving two blocks of mass 2 kg and 4 kg. The 4kg block on a smooth horizontal table. There is sufficient friction between both the blocks and there is no relative motion between both the blocks in all situations. Horizontal force act on one or both blocks are shown.**

Column-I gives certain statement related to figures given in column II.

Match the statement in column-I with the figure in column-II

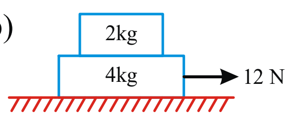
Column-I

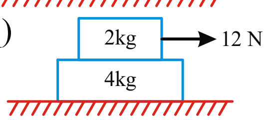
A)magnitude of frictional force is maximum

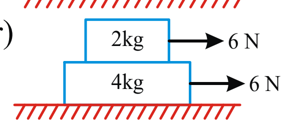
B) magnitude of frictional force is least

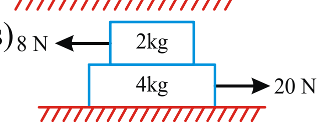
C) Frictional force on 2kg block is towards right

Column-II

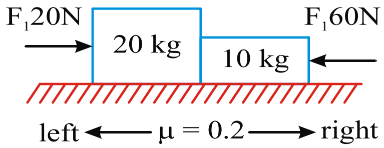
p) 

q) 

r) 

s) 

30. **Two blocks of masses 20kg and 10kg are kept on a rough horizontal floor. The coefficient of friction between both blocks and floor is $\mu = 0.2$. The surface of contact of both blocks are smooth. Horizontal forces of magnitude 20N and 60N are applied on both the blocks as shown in figure. Match the statements in column I with the statements in column II**



Column-I

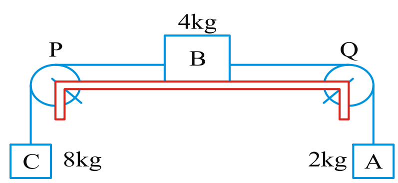
A) Frictional force acting on block of mass 10kg
B) Frictional force acting on block of mass 20kg
C) Normal reaction exerted by 20kg block
D) Net force on system consisting of 10kg

Column-II

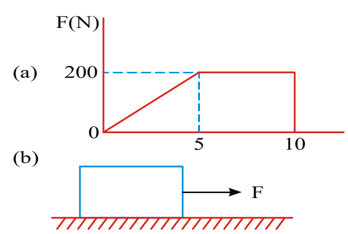
p) has magnitude 20N
q) has magnituide 40N
r) is zero
s) is towards right (in horizontal direction)

INTEGER TYPE QUESTIONS

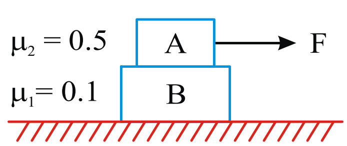
31. **In the figure, the distance BQ = 3 m, BP = 14 m at time t = 0. The system of blocks is released from rest at time t = 0. The string connecting B and C is suddenly cut at time t = 2 s. Calculate the velocity of B at the instant when it hits the pulley Q. The coefficient of friction between B and the horizontal surface is** $\mu_s = \mu_k = 0.25$. **Take g = 9.8 m/s².**



32. **A 20 kg block is originally at rest on a horizontal surface for which the coefficient of friction is 0.6. A horizontal force F is applied such that it varies with time as shown in the figure (a) & (b). If the speed of the block after 10 s is 8v then find v. (Take g =**$10 m/s^2$**)**

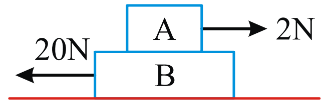


33. **A block A of mass 10 kg rests on a second block B of mass 8 kg. The coefficients of friction at various surfaces are shown in figure. A horizontal force of 100 N is applied on upper block at t = 0. Determine the velocity of block A relative to block B after 0.01 s of application of force. The system is initially at rest. Express your answer in cm/s. Take g = 10 m/s².**

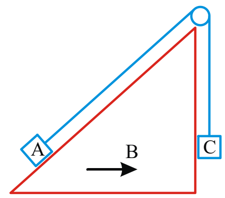


34. **Block B is placed on a smooth surface. Block A is placed on rough surface of block B with coefficient of friction 0.60 . The mass of A and B are 2 kg and 4 kg**

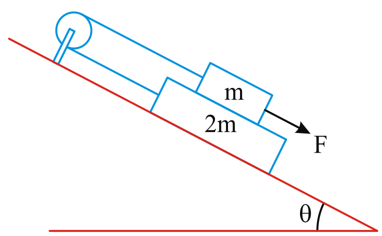
respectively. Find the frictional force between A and B (in N)



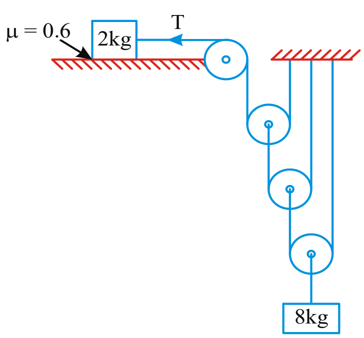
35. **In the fig. as shown, mass of each block is same. The surface are rough with coefficient of friction μ. The block B moves with acceleration a. The frictional force on the block C is $k \times \mu ma$. Calculate the value of k**



36. **μ is coefficient of friction between all surface. Block A is kept over block B on inclined plane. The minimum force required such that 'A' block can accelerate along applied force is $mg\sin\theta + n\mu g\cos\theta$ calculate n.**



37. **If friction develop between 2kg block and surface is k. Calculate the value of k**



EXERCISE - VIII - KEY

1.B 2) C 3) B 4)A 5)B 6) A 7)A 8)D 9)B 10) A
11) C 12) A,B,C 13) ABC 14) A,D 15)B,C,D 16) A,C 17) A,B,C,D
18) B,C,D 19) A,C 20) A,C,D 21) A,C 22) B 23) B 24)A 25) C
26) D 27)A 28) A- q B- r C- p D- s 29) A- sB- r C- p,s
30) A- p,s B- p,s C- q,s D- r 31) 7 32) 3 33)1 34)8 35)1
36) 5 37) 1

EXERCISE - I

SINGLE ANSWER TYPE QUESTIONS

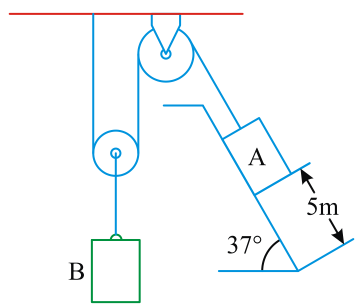
1. **A simple pendulum having a bob of mass m is suspended from the ceiling of a car used in a stunt film shooting. The car moves up along an inclined cliff at a speed v and makes a jump to leave the cliff and lands at some distance. Let R be the maximum height of the car from the top of the cliff. The tension in the string when the car is in air is**

(A) mg (B) $mg - \frac{mv^2}{R}$ (C) $mg + \frac{mv^2}{R}$ (D) zero

2. **A particle of mass m is projected at an angle α to the horizontal with an initial velocity u. the work done by gravity during the time it reaches its highest point is**

A) $u^2 \sin^2 \alpha$ B) $\frac{mu^2 \cos^2 \alpha}{2}$ C) $\frac{mu^2 \sin^2 \alpha}{2}$ D) $-\frac{mu^2 \sin^2 \alpha}{2}$

3. **The blocks A and B shown in the figure have masses M_A = 5 kg and M_B = 4 kg. The system is released from rest. The speed of B after A has travelled a distance 1 m along teh incline is**

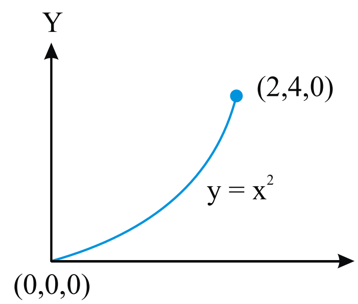


(A) $\frac{\sqrt{3}}{2}\sqrt{g}$ (B) $\frac{\sqrt{3}}{4}\sqrt{g}$ (C) $\frac{\sqrt{g}}{2\sqrt{3}}$ (D) $\frac{\sqrt{g}}{2}$

4. **A particle is projected along a horizontal surface whose coefficient of friction varies as $\mu = \frac{A}{r^2}$, where r is the distance from the origin in metres and A is a positive constant. The initial distance of the particle is 1m from the origin and its velocity is radially outwards. The minimum initial velocity at this point so the particle never stops is**

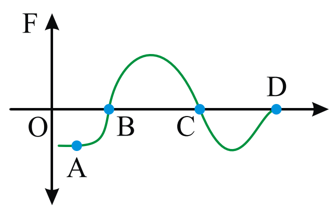
A) ∞ b) $2\sqrt{gA}$ c) $\sqrt{2gA}$ d) $4\sqrt{gA}$

5. **A force $\vec{F} = (3xy - 5z)\hat{j} + 4z\hat{i}$ is applied on a particle. The work done by the force when the particle moves from point $(0,0,0)$ to point $(2,4,0)$ as shown in fig. is**



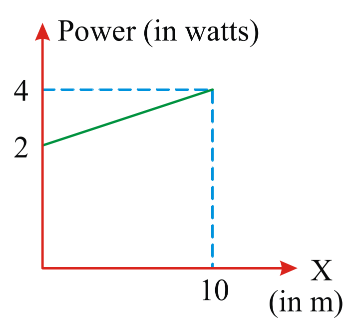
A) $\frac{280}{5}units$ B) $\frac{140}{5}units$ C) $\frac{232}{5}units$ D) $\frac{192}{5}units$

6. A particle is being acted upon by one dimensional conservative force. In the F–x curve shown, four points A, B, C, D are marked on the curve.State which type of equilibrium is the particle have at position c.



A) stable equilibrium B) unstable
C) Neutral D) No equilibrium

7. A particle of mass $\frac{10}{7}$ kg is moving in the positive direction of x. Its initial position is x = 0 & initial velocity is 1 m/s. The velocity at x = 10 is: (use the graph given)



A) 4 m/s B) 2 m/s C) $3\sqrt{2}$ m/s D) 100/3 m/s

8. The potential energy of a particle is determined by the expression $U = \alpha\left(x^2 + y^2\right)$, where α is a positive constant. The particle begins to move from a point with coordinates $(3,3)$, only under the action of potential field force. Then its kinetic energy T at the instant when the particle is at a point with the coordinates $(1,1)$ is

A) 8α B) 24α C) 16α D) Zero

WORK POWER ENERGY

9. An engine is pulling a train of mass m on a level track at a uniform speed u. The resistive force offered per unit mass is f.

A) Power expended by the engine is "mfu".

B) The extra power developed by the engine to maintain a speed u up a gradient of h in s is $\frac{mghu}{s}$

C) The frictional force exerting on the train is mf on the level track

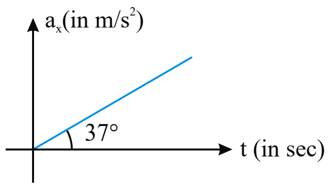
D) None of above is correct

10. A body of mass m slides downwards along a plane inclined at an angle α. The coefficient of friction is μ. The rate at which kinetic energy plus gravitational potential energy dissipates expressed as a function of time i

A) μ mtg^2 cosα B) μ mtg^2 cosα (sinα – m cosα)

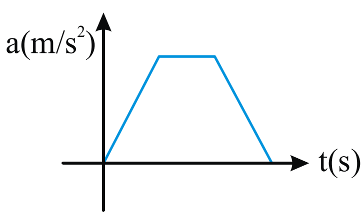
C) μ mtg^2 – sinα D) μ mtg^2 sinα (sinα – m cosα)

11. In the figure the variation of components of acceleration of a particle of mass is 1 kg is shown w.r.t. time. The initial velocity of the particle is $\vec{u} = (-3i + 4j)$ m/s. The total work done by the resultant force on the praticle in time from t = 0 to t = 4 seconds is :

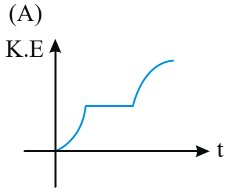


(A) 22.5 J (B) 10 J (C) 0 (D) None of these

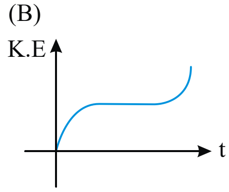
12. **For a particle moving on a straight lint the variation of acceleration with time is given by the graph as shown. Initially the particle was at rest. Then the corresponding kinetic energy of the particle versus time graph will be**



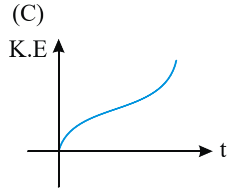
(A)



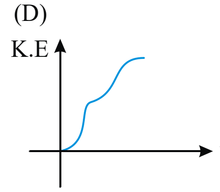
(B)



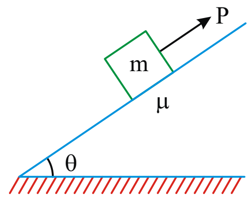
(C)



(D)



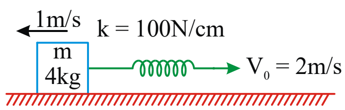
13. A block of mass m is being pulled up the rough inclined by an agent delivering constant power P. The coeficient of friction between the block and the inclined is μ. The maximum speed of the block during the course of ascent is



(A) $v = \dfrac{P}{mg\sin\theta + \mu mg\cos\theta}$ (B) $v = \dfrac{P}{mg\sin\theta - \mu mg\cos\theta}$

(C) $v = \dfrac{2P}{mg\sin\theta - \mu mg\cos\theta}$ (D) $v = \dfrac{3P}{mg\sin\theta - \mu mg\cos\theta}$

14. **The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed v_0 = 2m/s. At t = 0 sec, the spring of constant k = 100 N/ cm is unsttretched and the block has a speed 1 m/s to left. The maximum extension of the spring is**



(A) 2 cm (B) 4 cm (C) 6 cm (D) 8 cm

15. **Two equal masses are attached to the two ends of a spring of spring constant k. The masses are pulled a part symmetrically to stretch the spring by a length x over its natural length. The work done by the spring on each mass is**

(A) $\frac{1}{2}kx^2$ (B) $-\frac{1}{2}kx^2$ (C) $\frac{1}{4}kx^2$ (D) $-\frac{1}{4}kx^2$

16. **A block of mass m is allowed to slide down a fixed smooth inclined plane of angle q and length ℓ. The magnitude of power developed by the gravitational force when the block reaches the bottom is**

(A) $\sqrt{2m^2\ell(g\sin\theta)^3}$ (B) $(2/3)m^3\ell g^2\sin\theta$

(C) $\sqrt{(2/3)m^2\ell^2 g\cos\theta}$ (D) $(1/3)m^3\ell g^2\sin\theta$

17. **An object of mass (m) is located at the origin of a vertical plane . The body is projected at an angle θ with velocity u. The mean power developed by the gravitational force during the interval of time till it reaches maximum height**

(A) $mgu\sin\theta$ (B) $\dfrac{mgu\sin\theta}{2}$ (C) $\dfrac{mgu\sin\theta}{3}$ (D) $\dfrac{mgu\sin\theta}{4}$

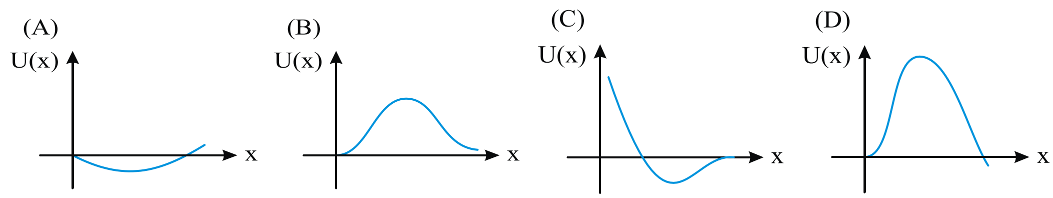
18. **The potential energy of a particle varies with position x according to the relation**

$U(x) = 2x^4 - 27x$ **the point** $x = \frac{3}{2}$ **is point of**

(A) unstable equilibrium   (B) stable equilibrium

(C) neutral equilibrium   (D) none of these.

19. **A particle, which is constrained to move along the x–axis, is subjected to a force from the origin as F (x) = – kx + ax^3. Here k and a are positive constants. For x=0, the functional form of the potential energy U (x) of particle is**



20. **A force $F = -K(y\hat{i} + x\hat{j})$, where k is a positive constant, acts on a particle moving in the xy plane. Starting from the origin, the particle is taken along the positive x-axis to the point (a, 0), and the parallel to the y-axis to the point (a, a). The total work done by the force on the particle is**

(A) $-2Ka^2$ (B) $2Ka^2$ (C) $-Ka^2$ (D) Ka^2

21. **A smooth sphere of radius R is made to translate in a straight line with a constant acceleration a = g. A particle kept on the top of the sphere is released from there at zero velocity with respect to the sphere. The speed of the particle with respect to sphere as a function of θ as it slides down is**

(A) $\sqrt{Rg(\sin\theta + \cos\theta)}$ (B) $\sqrt{Rg(1 + \cos\theta - \sin\theta)}$

(C) $\sqrt{4Rg\sin\theta}$ (D) $\sqrt{2Rg(1 + \sin\theta - \cos\theta)}$

22. **The potential energy of a 1 kg particle free to move along the x-axis is given by**

$U(x) = \left(\frac{x^4}{x} - \frac{x^2}{2}\right)J$. The total mechanical energy of the particle is 2J. Then, the maximum speed in (m/s) is

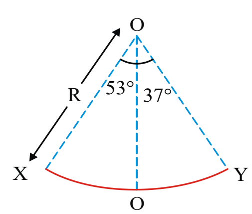
(A) $1/\sqrt{2}$ (B) 2 (C) $3/\sqrt{2}$ (D) $\sqrt{2}$

23. **A smooth sphere of radius R is made to translate in a straight line with a constant acceleration a = g. A particle kept on the top of the sphere is released from there at zero velocity with respect to the sphere. The speed of the particle with respect to sphere as a function of θ as it slides down is**

(A) $\sqrt{Rg(\sin\theta + \cos\theta)}$ (B) $\sqrt{Rg(1 + \cos\theta - \sin\theta)}$

(C) $\sqrt{4Rg\sin\theta}$ (D) $\sqrt{2Rg(1 + \sin\theta - \cos\theta)}$

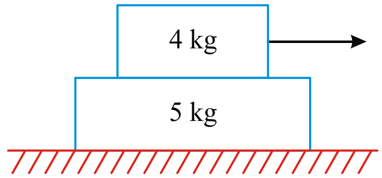
24. **A section of fixed smooth circular track of radius *r* in vertical plane is shown in the figure. A block is released from position *x* and leaves the track at *y*. The radius of curvature of its trajectory when it just leaves the track at *y* is**



(A) r (B) $\frac{r}{4}$ (C) $\frac{r}{2}$ (D) none of these

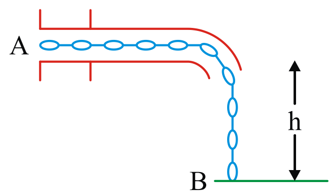
3. **A large slab of mass 5 kg lies on a smooth horizontal surface, with a block of mass 4 kg lying on the top of it. The coefficient of friction between the block and the slab is 0.25. If the block is pulled horizontally by a force of F = 6 N. The work done by the force of friction on the slab, between the instants t=2s to t=3s**

is $\left(g = 10\ ms^{-2}\right)$



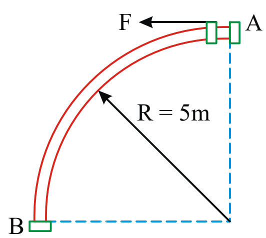
1) 2.4 J 2) 5.55 J 3) 4.44J 4) 10 J

10. A chain AB of length l is lying in a smooth horizontal tube so that a fraction h of its length l, hangs freely and touches the surface of the table with its end B. At a certain moment, the end A of the chain is set free. The velocity of end A of the chain, when it slips out of tube , is



1) $h\sqrt{\frac{2g}{lh}}$ 2) $\sqrt{2gh\log_e\left(\frac{l}{h}\right)}$ 3) $\sqrt{2gl\log_e\left(\frac{l}{h}\right)}$ 4) $\frac{1}{hl}\sqrt{2g}$

11. A bead of mass $\frac{1}{2}kg$ starts from rest from A to move in a vertical plane along a smooth fixed quarter ring of radius 5m, under the action of a constant horizontal force F = 5 N as shown. The speed of bead as it reaches point B is

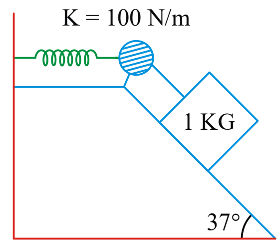


1) 14.14 m/s 2) 7.07 m/s 3) 5 m/s 4) 25 m/s

13. The bob of a pendulum is released from a horizontal position. If the length of the pendulum is 1.5 m, the speed with which the bob arrives at the lowermost point, given that it dissipated 5% of its initial energy against air resistance?

1) 3.14 m/s 2) 5.28 m/s 3) 1.54 m/s 4) 8.26 m/s

16. A 1 kg block situated on a rough inclined plane is connected to spring of a spring constant 100 N m^{-1} as shown in fig. The block is released from rest with the spring in the unstretched position. The block moves 10 cm down the incline before coming to rest. Find the coefficient of friction between the block and the incline. Assume that the spring has a negligible mass and the pulley is frictionless.



1) 0.115 2) 1.25 3) 5.2 4) 4.5

26. A nail is fixed at a point P vertically below the point of suspension 'O' of a simple pendulum of length 1m. The bob is released when the string of pendulum makes an angle 30^0 with horizontal. The bob reaches lowest point then describes vertical circle whose centre coincides with P. The least distance of P from O is

1) 0.4 m 2) 0.5 m 3) 0.6 4) 0.8 m

28. A block is freely sliding down from a vertical height 4 m on smooth inclined plane. The block reaches bottom of inclined plane then it describes vertical circle of radius 1 m along smooth track. The ratio of normal reactions on the block while it is crossing lowest point, highest point of vertical circle is

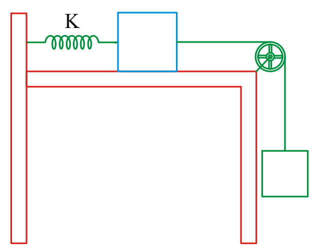
1) 6 : 1 2) 5 : 1 3) 3 : 1 4) 5 : 2

31. Mass of the bob of a simple pendulum of length L is m. If the bob is projected horizontally from its mean position with velocity $\sqrt{4gL}$, then the tension in the string becomes zero after a vertical displacement of

1) L/3 2) 3L/4 3) 4L/3 4) 5L/3

MULTIPLE ANSWER QUESTIONS

25. Two blocks, of masses M and 2M, are connected to a light spring of spring constanat K that has one end fixed, as shown in figure. The horizontal surface and the pulley are frictionless. The blocks are released from when the spring is non deformed. The string is light.



(A) Maximum extension in the spring is $\frac{4Mg}{K}$.

(B) Maximum kinetic energy of the system is $\frac{2M^2g^2}{K}$

(C) Maximum energy stored in the spring is four times that of maximum kinetic energy of the system.

(D) When kinetic energy of the system is maximum, energy stored in the spring is

$\frac{4M^2g^2}{K}$.

26. **Select the correct alternatives:**

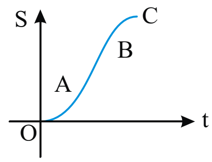
(A) Work done by static friction is always zero

(B) Work done by kinetic friction can be positive also

(C) Kinetic energy of a system can not be increased without applying any external force on the system

(D) Work energy theoram is valid in non-inerial frames also.

27. **Displacement time graph of a particle moving in a straight line is as shown in figure. select the correct alternative(s):**



(A) Work done by all the forces in region OA and BC is positive

(B) Work done by all the forces in region AB is zero

(C) Work done by all the forces in region BC is negative

(D) Work done by all the forces in region OA is negative.

28. **Which of the following is/are conservatve force(s)?**

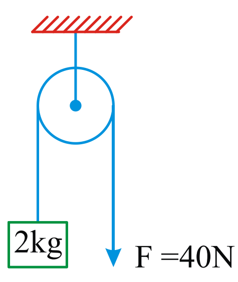
(A) $\vec{F} = 2r^3 r$

(B) $\vec{F} = \frac{5}{r} r$

(C) $\vec{F} = \frac{3(x\,i + y\,j)}{(x^2 + y^2)^{3/2}}$

(D) $\vec{F} = \frac{3(x\,i + y\,j)}{(x^2 + y^2)^{3/2}}$

29. **A block of mass 2 kg is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F = 40 N. The kinetic energy of the particle increase 40 J in a given interval of time. Then : (g = 10 m/s^2)**



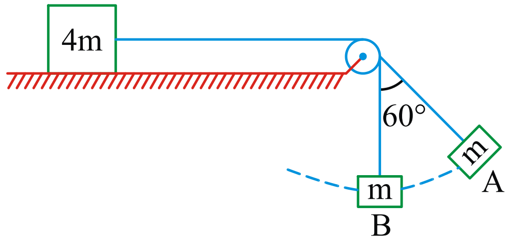
(A) tension in the string is 40 N

(B) displacement of the block in the given interval of time is 2 m

(C) work done by gravity is - 20 J

(D) work done by tension is 80 J

30. **In the system shown in the figure the mass m moves in a circular arc of angular amplitude 60°. Mass 4m is stationary . Then:**



(A) the minimum value of coefficient of friction between the same of mass 4m and the surface of the table is 0.50
(B) the work dine by gravitational force in the block m is positive when it moves from A to B
(C) the power delovered by the tention when m moves from A to B is zero
(D) The kinetic energy of m in position B equals the work done by gravitational force on the block when its moves from position A to B.

31. A strip of wood mass M and length l is placed on a smooth horizontal surface. An insect of mass m starts from rest at one end of the strip and walks to the other end in time t, moving with a constant speed.

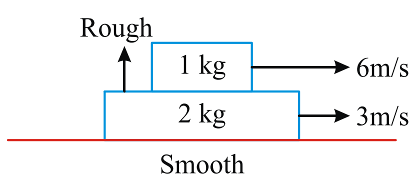
(A) The speed of the insect as seen from the ground is $< \frac{l}{t}$

(B) The speed of the strip as seen from the ground is $\frac{l}{t}\left(\frac{M}{M+m}\right)$

(C) The speed of the strip as seen from the ground is $\frac{l}{t}\left(\frac{m}{M+m}\right)$

(D) The total kinetic energy of the system is $\frac{1}{2}(m+M)\left(\frac{l}{t}\right)^2$

32. In the figure shown upper block is given a velocity of 6m/s and lower block 3 m/s. When relative motion between them is stopped.

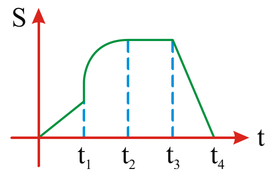


(A) Work done by friction on upper block is negative
(B) Work done by friction on both blocks is positive
(C) The magnitude of work done by friction on upper block is 10J
(D) Net work done by friction is zero.

33. The potential energy U in joule of a particle of mass 1kg moving in x-y plane obeys the law U = 3x + 4y, where (x, y) are the co-ordinates of the particle in metre. If the particle is at rest at (6, 4) at time t = 0 then:
(A) the particle has constant acceleration
(B) the particle has zero acceleration
(C) the speed of particle when it crosses the y-axis is 10m/s

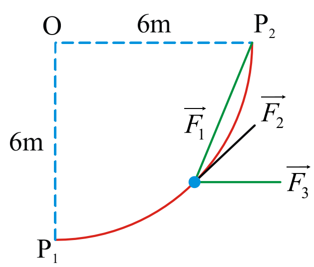
(D) co-ordinates of particle at t = 1s are (4.5, 2)

34. Displacement time graph of particle moving in a straight line is as shown in figure. From the graph we can conclude that work done on the block is :



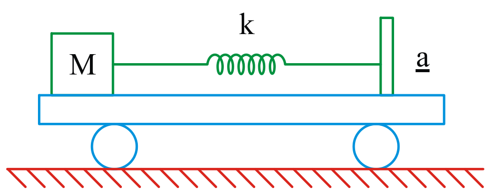
(A) positive from 0 to t_1 (B) negative from t_1 to t_2
(C) zero from t_2 to t_3 (D) negative from t_3 to t_4.

35. A smooth track in the form of a quarter circle of radius 6m lies in the vertical plane. A particle moves from P_1 to P_2 under the action of forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$. Force $\vec{F}_1$ is always toward P_2 and always 20N in magnitude. Force $\vec{F}_2$ is always acts horizontally and is always 30N in magnitude. Force $\vec{F}_3$ always acts tangentially to the track and is of magnitude 15N. Select the correct alternative(s):



(A) Work done by $\vec{F}_1$ is 120J (B) Work done by $\vec{F}_2$ is 180J
(C) Work done by $\vec{F}_3$ is 45π J (D) $\vec{F}_1$ is conservative in nature.

36. A block of mass M is attached with a spring constant k. The whole arrangement is placed on a vechile as shown in the figure. If the vehicle starts moving towards right with an acceleration a (there is no friction anywhere), then :



(A) maximum elongation in the spring is $\frac{Ma}{k}$

(B) maximum elongation in the spring is $\frac{2Ma}{k}$

(C) maximum compression in the spring $\frac{2ma}{k}$

(D) maximum compression in the spring is zero

37. A small ball of mass m is released from rest at a height h_1 above ground at time t = 0. At time t = t_0, the ball again comes to rest at a height h_2 above ground.

Consider the ground to be perfectly rigid and neglect air friction. In the time interval from t = 0 to t = t_0, pick up the correct statements.

(A) Work done by gravity on ball is mg (h_1 - h_2)

(B) Work done by ground on ball for duratin of contact is mg (h_1 - h_2).

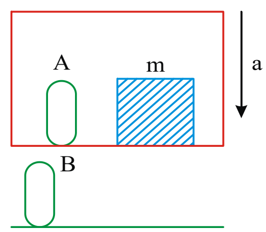
(C) Average acceleration of the ball is zero.

(D) Net work done on the ball by all forces except gravity is mg (h_1 - h_2).

COMPREHENSIVE TYPE QUESTIONS

Comprehension-1:

A block of mass m is kept in an elevation which starts moving downward with an acceleration a as shown in figure. The block is observed by two observers A and B for a time interval t_0.



38. **The observer B finds that the work done by gravity on the block is :**

1) $\frac{1}{2}mg^2t_0^2$ 2) $-\frac{1}{2}mg^2t_0^2$ 3) $\frac{1}{2}mgat_0^2$ 4) $-\frac{1}{2}mgat_0^2$

39 **The observer B finds that the woek done by pseudo-force on the block is**

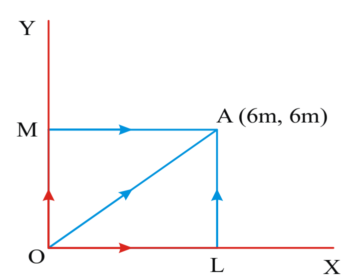
1) zero 2) $-ma^2t_0$ 3) $+ma^2t_0$ 4) $-mgat_0$

40. **According to observer B, the net work done on the block is :**

1) $-\frac{1}{2}ma^2t_0^2$ 2) $\frac{1}{2}ma^2t_0^2$ 3) $\frac{1}{2}mgat_0^2$ 4) $-\frac{1}{2}mgat_0^2$

Comprehensioni - 2 :

Force acting on a particle moving in the x-y plane is $\vec{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in fig, the particle moves from the origin O to point A(6m, 6m). the figure shows three paths, OLA, OMA and OA for the motion of the particle from O to A.



(A)

41. **Which of the following is correct?**

A) There is equal probability for the force being conservative or non-conservative.

B) Conservative or non-conservative nature of force cannot be predicted on the basis of given information.

C)The given force is non-conservative. D)The force is conservative.

42. Along which of the three paths is the work done maximum.

A)OA B) OMA C) OLA

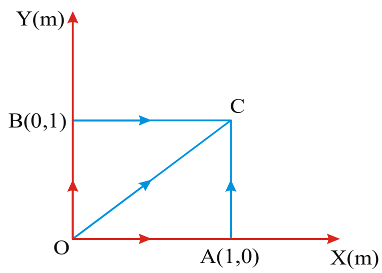
D) work done has the same value for all the three paths

43. Work done for motion along path OA is nearly

A) 383 J B) 90 J C) 180 J D) 1811 J

Comprehension - 3 :

One of the forces acting on a certain particle depends on the particle's position in the xy-plane. This force $\vec{F}$ expressed in newtons, is given by the expression $\vec{F} = (xy\hat{i} + xy\hat{j})$ where x and y are in metres. The particle is moved from O to C through three different paths :-



44. The work done by this force on path OC is

A) $\frac{1}{2}$J B) $-\frac{1}{2}$J C) $\frac{2}{3}$J D) $-\frac{2}{3}$J

45. The work done by this force on path OAC is

A) $\frac{1}{2}$J B) $-\frac{1}{2}$J C) $\frac{2}{3}$J D) $-\frac{2}{3}$J

46. The work done by this force on path OBC is

A) $\frac{1}{2}$J B) $-\frac{1}{2}$J C) $\frac{2}{3}$J D) $-\frac{2}{3}$J

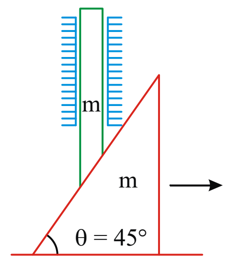
47. Which of the following can be negative ?

A) Kinetic energy B) Potential Energy

C) Chemical Energy D) All of these

Comprehension : 5

48. A smooth vertical rod is released from rest such that it is constrained to move vertically on a smooth wedge $\left(\theta = 45^0\right)$. When the wedge moves through a distance x, the speed of the rod is :



a) $\sqrt{2gx}$ b) $\sqrt{\frac{gx}{2}}$ c) $\sqrt{gx}$ d) none of these

49. The work done by the normal reaction on the rod is :

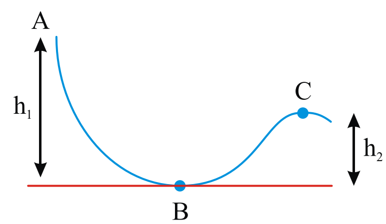
a) mgx b) $-\frac{mgx}{2}$ c) $-\frac{3}{2}mgx$ d) $-mgx$

50. The work done by the normal reaction on the wedge is :

a) mgx b) $-\frac{mgx}{2}$ c) $\frac{3}{2}mgx$ d) $\frac{mgx}{2}$

Comprehension – 5 :

A block of mass m = 1kg is released from point A along a smooth track as shown. Part AB is circular with radius r_1 = 4m and circular at C with radius r_2. Height of point A is h_1 = 2m and of c is h_2 = 1m.
($g = 10\ m/s^2$).



51. The force exerted by block on the track at B is

(A) 10 N (B) 20 N (C) 30 N (D) 40 N

52. The minimum safe value of r_2 so that the block does not fly off the track at C is

(A) 1 m (B) 2 m (C) 1.5 m (D) 3 m.

53. The work done by gravitational force from A to C is

(A) 10 J (B) 20 J (C) 30 J (D) 40 J

Comprehension : 6

A chain of length $l = \pi R/4$ is placed. On a smooth hemispherical surface of radius R with one of its ends fixed at the top of the sphere. Mass of chain is $\sqrt{2}\pi kg$ and R = 1m. ($g = 10\ m/s^2$).

54. The gravitational potential energy of the chain considering reference level at the base of hemisphere is

(A) 20J (B) $20\sqrt{2}$ J (C) 40 J (D) $40\sqrt{2}$ J.

55. If the chain sliped down the sphere, kinetic energy of the chain when it has sliped through an angle $\theta = \frac{\pi}{4}$

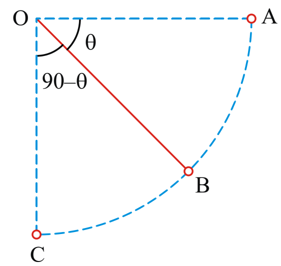
(A) 23.4 J (B) 63.44 J (C) 80 J (D) 97.4J.

56. The tangential acceleration of the chain when it starts sliding down.

(A) $\frac{40}{\pi}\left(1-\frac{1}{\sqrt{2}}\right)$ (B) $\frac{20}{\pi}\left(1-\frac{1}{\sqrt{2}}\right)$ (C) $10\left(1-\frac{1}{\sqrt{2}}\right)$ (D) zero.

PASSAGE-IV:

One end of a light string of length L is connected to a ball and the other end is connected to a fixed point O. The ball is released from rest at $t=0$ with string horizontal and just taut. The ball then moves in vetical circular path as shown. The time taken by ball to go from position A to B is t_1 and from B to lowest position C is t_2. Let the velocity of ball at B is $\vec{v}_B$ and at C is $\vec{v}_C$ respectively.



57. If $|\vec{v}_C| = 2|\vec{v}_B|$ then the value of θ as shown is

(A) $\cos^{-1}\frac{1}{2}$ (B) $\sin^{-1}\left(\frac{1}{4}\right)$ (C) $\cos^{-1}\frac{1}{2}$ (D) $\sin^{-1}\frac{1}{2}$

58. If $|\vec{v}_C| = 2|\vec{v}_B|$ then:

(A) $t_1 > t_2$ (B) $t_1 < t_2$ (C) $t_1 = t_2$

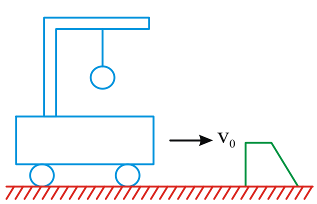
(D) Information is insufficient

59. If $|\vec{v}_C - \vec{v}_B| = |\vec{v}_B|$ then the value of θ as shown in the figure is

(A) $\cos^{-1}\left(\frac{1}{4}\right)^{1/3}$ (B) $\sin^{-1}\left(\frac{1}{4}\right)^{1/3}$ (C) $\cos^{-1}\left(\frac{1}{2}\right)^{1/3}$ (D) $\sin^{-1}\left(\frac{1}{2}\right)^{1/3}$

MATRIX MATCHING QUESTIONS

60. A bob of mass 2 kg is suspended from a vehicle by a rope of length l = 5m. the vehicle and the bob are moving at a constant speed v_0. The vehicle is suddenly stopped by a bumper and the bob the rope swings out a maximum angle of 60^0. Match the following.



COLUMN-I

A) Net force acting on the bob at lowest point just after the hitting

B) Acceleration of the bob at lowest point

C) Net force acting on the bob at its highest point

D) Acceleration of the bob at its highest point

COLUMN-II (all values in SI units)

p) $5\sqrt{3}$ vehicle is stopped

q) 10 r) 20 s) $10\sqrt{3}$

61. A small object of mass 0.5 kg is attached to an end of massless 2 meter long inextensible string with the other end of the string being fixed. Initially, the string is vertical and the object is at its lowest position ahving initial horizontal velocity of magnitude u. The tension in string is T when the object is at its lowest position. The object subsequently moves in vertical plane. The forces acting on object are tension exerted by string and gravitational pull by earth. Match the statements in column I with corresponding results in column II (take g = 10m/s²)

Column - I

(A) $u = 3.5 m/s$ (B) $u = 9.5 m/s$ (c) $T = 15N$ (d) $T = 35N$

Column - II

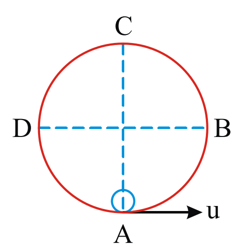
(p) There will be some point on the trajectory of object at which speed of the object is zero but tension in the string is not zero.

(q) There will be ome point on the trajectory of object for which tension in the string is zero but speed of the object is not zero

(r) There will be some point on the trajectory of object for which tension in the string is zero but spee of the object is not zero

(s) The acceleration of the object will be in direction

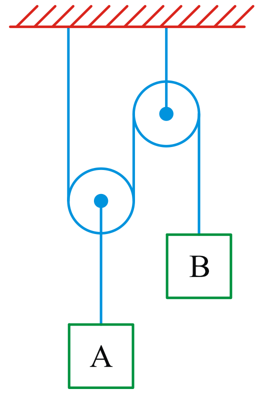
62. A particle is suspended from a string of length R. It is given a velocity $u = 3\sqrt{gR}$ at the bottom. Match the following.



Column - I	Column - II
A) Velocity at B	p) 7 mg
B) Velocity at C	q) $\sqrt{5gR}$
C) Tension in string at B	r) $\sqrt{7gR}$
D) Tension in string at C	s) 5 mg
	t) None

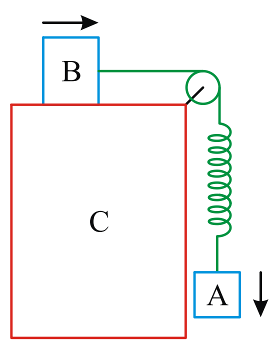
INTEGER ANSWER TYPE QUESTIONS

63. Block A has a weight of 300 N and block B has weight 50N. Calculate the distance A must descend from rest before it obtains a speed of 4 m/s (Neglect the mass of cord and pulleys). (Take g = 10 m/s²)

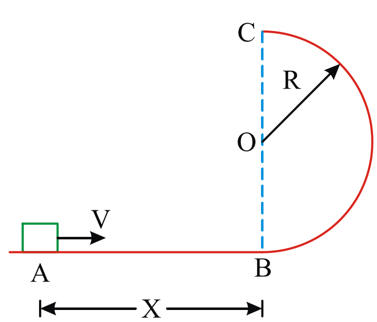


64. A particle of mass *m* moves along a circle of radius R with a normal acceleration varying with time as $a_n = bt^2$, where b is a constant. Find the time dependence of the power developed by all the forces acting on the particle, and the mean value of this power averaged over the first 2 seconds after the beginning of motion.(m = 1, v = 2, r = 1)

65. Two blocks A and B are connected to each other by a string and a spring; the string passes over a frictionless pulley as shown in the figure. Block B slides over the horizontal top surface of a stationary block C and the block A slides along the vertical side of C, both with the same uniform speed.The coefficient of friction between the surface and blocks is 0.5. K= 2000N/m. If mass of A is 2 kg calculate mass of B.



66. A small block is given a velocity v from point A. Given x=3R, R = 20 m and g = 9.8m/s^2.If the block strikes the point A after it leaves the smooth circular track in vertical plane , the value of v is 7x, find v ?



67. A particle is projected along the inner surface of a smooth vertical circle of

radius R, its velocity at the lowest point being (1/5) $\left(\sqrt{95gR}\right)$. If the particle leaves the circle at an angular distance $\cos^{-1}(x/5)$ from the highest point, the value of x is

EXERCISE -I - KEY

SINGLE ANSWER

1) D 3) D 3) C 4) C 5) D 6) A 7)C 8) C 9) B 10) B
11) B 12) D 13) A 14) C 15) D 16) A 17)B 18) B 19) D 20) C
21) D 22) C 23) D 24) C

MULTIPLE ANSWER

25) ABC 26) B,D 27) B 28) ABC 29) ABD 30) A,B,C,D
31) A,C 32) A,C 33) A,C,D 34) A,B,C
35) B,C,D 36) B,D 37) ACD

COMPREHENSION

38) A 39) A 40) B 41) C 42) A 43) B 44) C 45) A 46) A 47) B
48) C 49) B 50) D 51) B 52) B 53) A 54) C 55) A 56) A 57) B
58) B 59) B

MATRIX MATCHING

60) A-r;B-q;C-s;D-p
61) A-p,s,B-q,s,C-r,s,D-s 62) A-r,B-q,C-p,B-t

INTEGER ANSWER

63) 2 64) 2 65) 4 66) 5 67) 3

EXERCISE - II

SINGLE ANSWER QUESTIONS

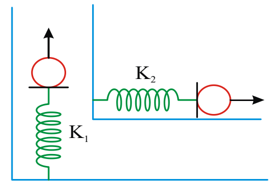
1. **An engine is pumping water continuously. The water passes through a nozzle with a velocity v. As water leaves the nozzle, the mass per unit length of the water jet is m_0. Find the rate at which kinetic energy is imparted to the water:**

A) $\frac{1}{2}m_0v^3$ B) $\frac{1}{2}m_0v^2$ C) $\frac{1}{2}m_0v^{3/2}$ D) $\frac{1}{2}m_0v^{1/2}$

2. **A hemispherical vessel of radius R moving with a constant velocity v_0 and containing a ball, is suddenly haulted. Find the height by which ball will rise in the vessel, provided the surface is smooth:**

A) $\frac{v_0^{\ 2}}{2g}$ B) $\frac{2v_0^{\ 2}}{g}$ C) $\frac{v_0^{\ 2}}{g}$ D) none of these

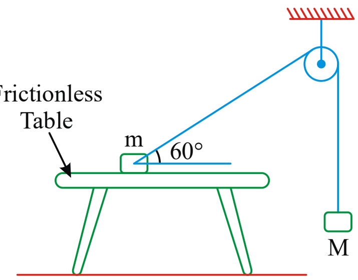
3. **Two balls of same mass are projected as shown, by compressing equally (say x) the springs of different force constants K_1 and K_2 by equal magnitude. The first ball is projected upwards along smooth wall and the other on the rough horizontal floor with coefficient of friction μ. If the first ball goes up by height h, then the distance covered by the second ball will be:**



A) $\frac{2hK_2}{\mu K_1}$ B) $\frac{hK_1}{2\mu K_2}$ C) $\frac{3hK_2}{2\mu K_1}$ D) $\frac{hK_2}{\mu K_1}$

4. What is the minimum value of the mass M so that the block is lifted off the table at the instant shown in the diagram ? Assume that the blocks are initially at rest.

A) $\frac{m}{\sin 60^0}$ B) $\frac{m}{\tan 60^0}$ C) $m\sin 60^0$ D) none of these



5. A bob of mass m is suspended from a fixed support with a light string and the system with bob and support is moving with a uniform horizontal acceleration. The breaking strength of the string is $mg\sqrt{2}$. Find the workdone by the tension in the string in the first one second:

A) $2mg^2$ B) $\frac{mg^2}{\sqrt{2}}$ C) $\frac{mg^2}{2}$ D) $mg^2\sqrt{2}$

6. A particle moves move on the rough horizontal ground with some initial velocity V_0. If $\frac{3}{4}$ of its kinetic energy lost due to friction in time t_0. The coefficient of friction between the particle and the ground is

A) $\frac{V_0}{2gt_0}$ B) $\frac{V_0}{4gt_0}$ C) $\frac{3V_0}{4gt_0}$ D) $\frac{V_0}{gt_0}$

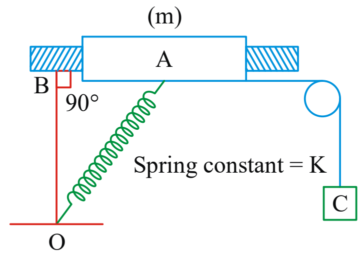
7. The total mechanical energy of a particle is E. The speed of the particle at $x=\left(\frac{2E}{K}\right)^{1/2}$ is $\left(\frac{2E}{m}\right)^{1/2}$. Find the potential energy of the particle at x:

A) zero B) $\frac{1}{2}Kx^2$ C) $\frac{1}{4}Kx^2$ D) $\frac{2}{5}Kx^2$

8. The coefficient of friction between a particle moving with some velcoity V_0 and the rough horizontal surface is $\left(\frac{V_0}{2gt_0}\right)$. Find how much kinetic energy is lost in time t_0 due to friction:

A) 1/4 B) 1/2 C) 3/4 D) 2/3

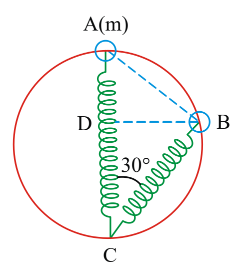
9. **A block A of mass m slides on a smooth slider in the system as shown. A block c of same mass hanging from a pulley pulls block A. When the block A was at position B, the spring was unstretched. Find the speed of the block A when** $AB = OB = L$



A) $\left[\frac{gL}{\sqrt{2}} - \frac{KL^2\sqrt{2}}{m}\right]^{\frac{1}{2}}$ B) $\left[gL - \frac{KL^2}{2m}\left(\sqrt{2}-1\right)^2\right]^{\frac{1}{2}}$

C) $\left[gL - \frac{2KL^2}{m}\left(\sqrt{2}-1\right)^2\right]^{\frac{1}{2}}$ D) $\left[\frac{gL}{2} - \frac{KL^2\sqrt{2}}{m}\right]^{\frac{1}{2}}$

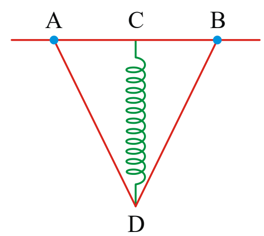
10. **A ring 'A' of mass 'm' is attached to a stretched spring of force constant K, which is fixed at C on a smooth vertical circular track of radius R. Points A and C are diametrically opposite. When the ring slips from rest on the track to point B, making an angle of $30°$ with AC. ($\angle ACB = 30°$) spring becomes unstretched. Find the velocity of the ring at B**



A) $\left[\frac{KR^2}{2m}\left(2-\sqrt{3}\right)^2 + gR\sqrt{3}\right]^{\frac{1}{2}}$ B) $\left[\frac{KR^2}{m}\left(2-\sqrt{3}\right)^2 + gR\right]^{\frac{1}{2}}$

C) $\left[\frac{2KR^2}{m}\left(2-\sqrt{3}\right)^2 + gR\sqrt{3}\right]^{\frac{1}{2}}$ D) $\left[\frac{KR^2}{2m}\left(\sqrt{2}-1\right)^2 + gR\right]^{\frac{1}{2}}$

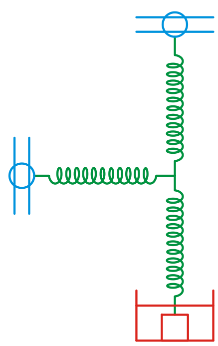
11. **A and B are smooth light hinges equidistant from C, which can slide on ABC. The spring of force constant K is fixed at its one end C and connected to light rods AD and BD at point D. A block of mass m is suspended at D. Find the velocity of the block, when $\angle CAD$ changes from $30°$ to $45°$.** $AD = BD = L$



A) $\left[gL-\frac{KL^2}{2m}\left(\sqrt{2}-1\right)^2\right]^{\frac{1}{2}}$ B) $\left[gL\sqrt{2}-\frac{KL^2}{2m}\left(\sqrt{2}-1\right)^2\right]^{\frac{1}{2}}$

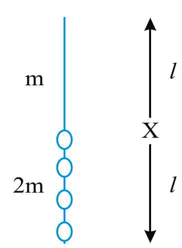
C) $\left[gL\left(\sqrt{2}-1\right)-\frac{KL^2}{4m}\left(\sqrt{2}-1\right)^2\right]^{\frac{1}{2}}$ D) $\left[gL-\frac{KL^2}{2m}\right]^{\frac{1}{2}}$

12. Three springs A,B and C each of force constant K, are connected at O. The other ends of B and C can slide on smooth sliders. A pan is hanging from other end of the spring A. When a block of mass m is placed int he pan, find the amount of workdone by the gravity on block system after it stops vibrating. The spring C does not sag:



A) $\frac{3m^2g^2}{2K}$ B) $\frac{m^2g^2}{K}$ C) $\frac{2m^2g^2}{K}$ D) $\frac{m^2g^2}{2K}$

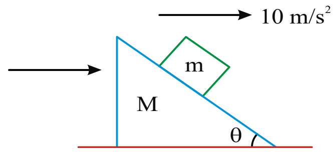
13. A rope of length l and mass 'm' is connected to a chain of length l and mass 2m and hung verticlly as shown. what is the change in gravitational potential energy if the system is inverted and hung from same point.



A) mg$l$ B) 4mg$l$ C) 3mg$l$ D) 2mg$l$

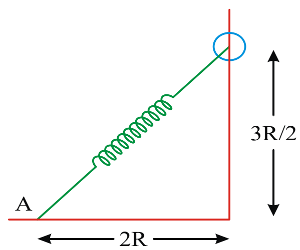
14. In the figure shown all the surfaces are frinctionless and mass of block m=1kg, block and wedge are held initially at rest, now wedge is given a horizontal

acceleration of $10 m/s^2$ by applying a force on the wedge so that the block does not slip on the wedge, the work done by normal force in ground frame on the block in $\sqrt{3}$ sec is



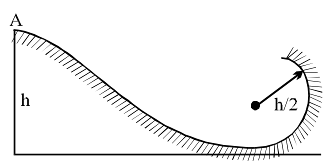
A) 30J B) 60J C) 150J D) $100\sqrt{3}$ J

15. **A ring of mass m can slide over a smooth vertical rod. The rod is connected to a spring of force constant $K = \frac{4mg}{R}$ where 2R is the natural length of the spring. the other end of the spring is fixed to the ground at a horizontal distance 2R from the base of the rod. The mass is released from the height of 1.5R from ground, then work done by spring, velocity of the ring as it reaches the ground is**



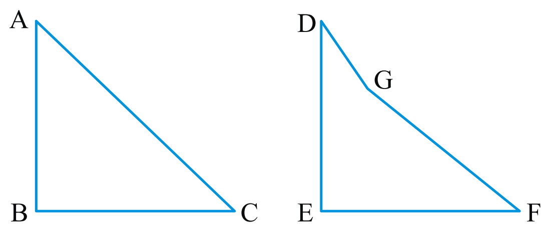
A) $\frac{mgR}{2}, 2\sqrt{gR}$ B) $mgR, 2\sqrt{gR}$ C) $\frac{mgR}{2}, \sqrt{2gR}$ D) $\frac{mgR}{2}, \sqrt{gR}$

16. **A small body A starts sliding from the height h down an inclined groove passing into a half - circle of radius h/2 (see figure). Assuming the friction to be negligible, find the velocity of the body at the highest point of its trajectory (after breaking off the groove).**



A) $\sqrt{\frac{9}{27}gh}$ B) $\sqrt{\frac{8}{27}gh}$ C) $\sqrt{\frac{27}{8}gh}$ D) $\sqrt{\frac{10}{27}gh}$

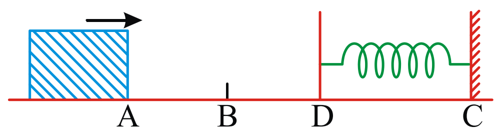
17. **In the figures (a) and (b) AC, DG and GF are fixed inclined planes, BC = EF = x and AB = DE = y. A small block of mass M is released from the point A. It slides down AC and reaches C with a speed V_C. The small block is released from rest from the point D. It slides down DGF and reaches the point F with speed V_F. The coefficients of kinetic frictions between the block and both the surfaces AC and DGF are m. Calculate V_C and V_F.**



(a) (b)

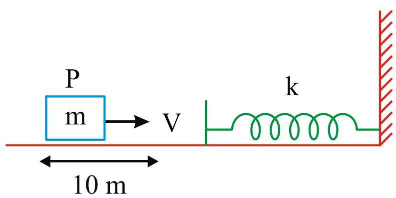
A) 1.7 m/s B) 2.7 m/s C) 3.7 m/s D) 0.7 m/s

18. **A 0.5 kg block slides from the point A (see figure) on a horizontal track with an initial speed of 3m/s towards a weightless horizontal spring of length 1 m and force constant 2 Newton/m.The part AB of the track is frictionlessand the part BC has the coefficients of static and kinetic friction as 0.22 and 0.2 respectively. If the distances AB and BD are 2m and 2.14 m respectively find the total distance through which the block moves before it comes to rest completely (Take g = 10 m/s^2).**



A) 4.20 m B) 4.14 m C) 4.24 m D) 4.26 m

19. **A block of mass 1 kg kept over a smooth surface is given velocity 2 m/s towards a spring of spring constant 1 N/m at a distance of 10m. Find after what time block will be passing through P again**



A) $(20+2\pi)$sec B) 10 sec C) $(10+2\pi)$sec D) $(10+\pi)$sec

20. **A body is displaced from $(0,0)$ to $(1m,1m)$ along the path $x=y$ by a force $\vec{F}=\left(x^2\hat{j}+y\hat{i}\right)N$. The work done by this force will be**

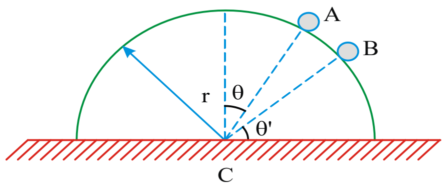
A) $\frac{4}{3}J$ B) $\frac{5}{6}J$ C) $\frac{3}{2}J$ D) $\frac{7}{5}J$

21. **Forces acting on a particle moving in a straight line varies with the velocity of the particle as $F=\frac{\alpha}{\upsilon}$ where α is constant. The work done by this force in time interval Δt is:**

A) $\alpha\Delta t$ B) $\frac{1}{2}\alpha\Delta t$ C) $2\alpha\Delta t$ D) $\alpha^2\Delta t$

22. **A particle of mass m initially at rest starts moving from point A on the surface of a fixed smooth hemisphere of radius r as shown. The particle looses its contact**

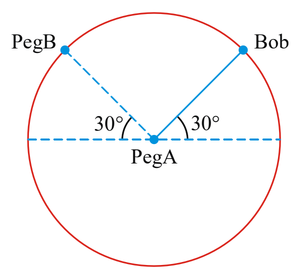
with hemisphere at point B. C is centre of the hemisphere. The equation relating θ and θ' is



(A) $3\sin\theta = 2\cos\theta'$ (B) $2\sin\theta = 3\cos\theta'$

(C) $3\sin\theta' = 2\cos\theta$ (D) $2\sin\theta = 3\cos\theta'$

23. **A bob attached to one end of a string, other end of which is fixed at peg A. The bob is taken to a position where string makes an angle of 30^0 with the horizontal. On the circular path of the bob in vertical plane there is a peg 'B' at a symmetrical position with respect to the position of release as shown in the figure. If V_c and V_a be the minimum speeds in clockwise and anticlock wise directions respectively, given to the bob in order to hit the peg 'B' then ratio $V_c : V_a$ is equal to**



(A) 1:1 (B) $1:\sqrt{2}$ (C) $1:2$ (D) 1:4

PREVIOUS IIT QUESTIONS

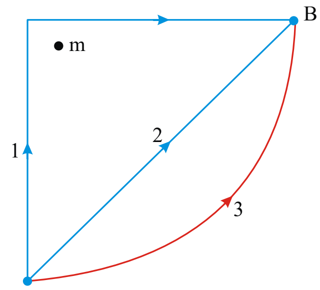
24. **A wind -powered genrator converts wind energy into electrical energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into electrical energy . For wind speed υ, the electrical powwer output will be proportional to [IIT-2008]**

A) υ B) υ^2 C) υ^3 D) υ^4

25. **An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstretched Then,the maxumum extension in the spring is [IIT-2002]**

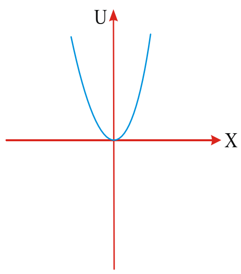
A) $\frac{4Mg}{k}$ B) $\frac{2Mg}{k}$ C) $\frac{Mg}{k}$ D) $\frac{Mg}{2k}$

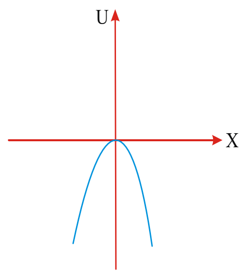
26. **If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1,2 and 3 respectively (as shown) in the gravitational field of a point mass m, find the correct relation between W_1, W_2 and W_3 [IIT-2003]**

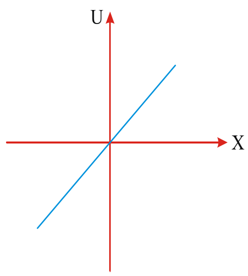


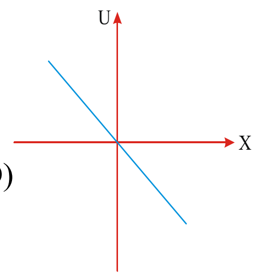
A) $W_1 > W_2 > W_3$ B) $W_1 = W_2 = W_3$ C) $W_1 < W_2 < W_3$ D) $W_2 > W_1 > W_3$

27. A particle is acted by a force F=kx, where k is a +ve constant. Its potential energy at x=0 is zero. which curve correctly represents the variation of potential energy of the block with respect to x ? [IIT-2004]

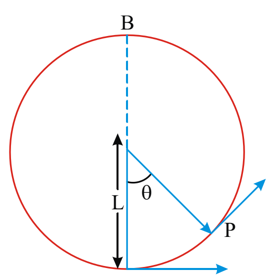
A) 

B) 

C) 

D) 

28. A bob of mass M is suspended by a massless string of length L. The horizontal velocity υ at just sufficient ot make it reach the point B.The angle θ at which the speed of the bob is half of that A, satisfies [IIT-2008]



A) $\theta = \frac{\pi}{4}$ B) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$ C) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ D) $\frac{3\pi}{4} < \theta < \pi$

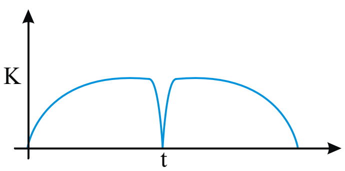
29. The work done on a particle of mass m by a force

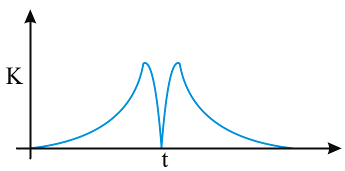
$k\left[\frac{x}{\left(x^2+y^2\right)^{3/2}}\hat{i} + \frac{y}{\left(x^2+y^2\right)^{3/2}}\hat{j}\right]$ **(k being a constant of appropriate dimensions)**

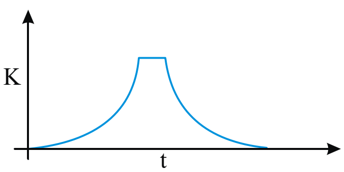
when the particle is taken from the point $(a, 0)$ along a circular path of radius a bout the origin in the x-y plane is **[IIT-2013]**

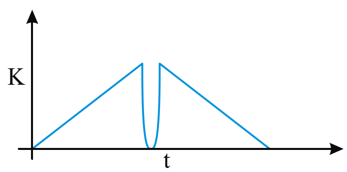
a) $\frac{2k\pi}{a}$ b) $\frac{k\pi}{a}$ c) $\frac{k\pi}{2a}$ d) zero

30. **A tennis ball is dropped on a horizontal smooth surface. It bounces back to its original position after hitting the surface. The force on the ball during the collision is proportional to the length of compression of the ball. Which one of the following sketches describes the variation of the kinetic energy K with time t most appropriately? The figures are only illustrative and not to the scale.** **(IIT-2014)**

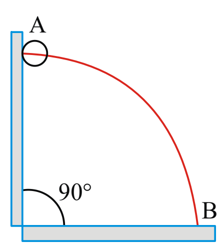
A) 

B) 

C) 

D) 

31) **A wire, which passes through the hole in a small bead, is bent in the form of quarter of a circle. The wire is fixed vertically on ground as shown in the figure. The bead is released from near the top of the wire and it slides along the wire without friction. As the bead moves from A to B, the force is applies on the wire is** **(IIT-2014)**



a) always radially outwards b) always radially inwards
c) radially outwards initially and radially inwards later.
d) radially inwards initially and radially outwards later.

MULTIPLE ANSWER QUESTIONS

32. **The potential energy of a particle moving along x-axis is given by $U = 20 + 5\sin(4\pi x)$, where U is in J and x is in metre under the action of conservative force:**

A) if total mechanical energy is 20 J, then at x = 7/8m, particle is at equilibrium
B) if total mechanical energy is 20 J, then at x = 7/8m particle is not at equilibrium
C) if total mechanical energy is 20 J, then at x = 3/8m, particle is at equilibrium
D) if total mechanical energy is 20 J, then at x = 3/8m, particle is not at equilibrium

33. **A block of mass 1 kg moves towards a spring of force constant 10 N/m. The**

spring is massless and unstretched. The coefficient of friction between block and surface is 0.30. After compressing the spring, block does not return back: (g = 10 m/s)

A) the maximum value of speed of block for which it is possible is 3.8 m/s

B) the maximum value of speed of block for which it is possible is 4.2 m/s

C) if E_i and E_f are initial and final mechanical energy, which is sum of kinetic energy and potential energy, then work done by friction on a system is (E_i - E_f)

D) statement in option (C) is wrong

34. **The spring constant of spring A is twice the spring constant of spring B. Each of the spring is cut into two pieces. First piece of spring A is (4/5) of the total length. Second piece of spring B is (5/6) of its total length. Both springs are of equal length initially:**

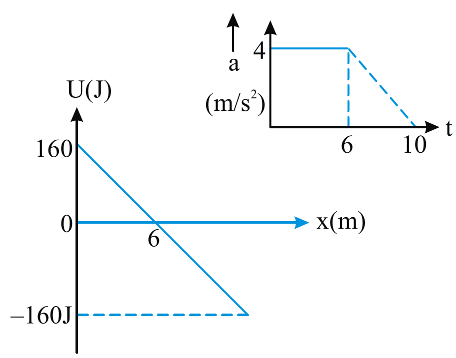
. A) the ratio of force constant of first piece of spring B to the first piece of spring A is (12/5)

B) the ratio of force constant of first piece of spring B to the first piece of spring A is 2

C) the ratio of force constant of second piece of spring A to the first piece of spring B is 5/3

D) the ratio of force constant of second piece of spring A to the first piece of spring B is 7/5

35. **A particle of mass 1 kg is moving along X-axis. Its velocity is 6 m/s at $x = 0$. Acceleration-displacement curve and potential energy-displacement curve of the particle are shown:**



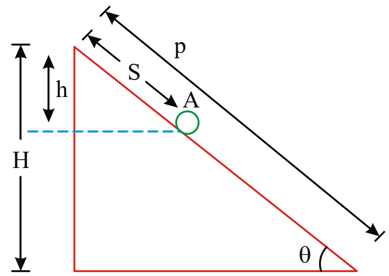
A) the work done by all the forces is 704 J

B) the work done by external forces is 350 J

C) the work done by external forces is 384 J

D) the work done by conservation forces is 300J

36. **A particle sides down from rest on an inclined plane of angle θ with horizontal. The distances are as shown. The particle slides down to the position A, where it velocity is v**



A) $\left(v^2-2gh\right)$ will remain zero B) $\left(v^2-2gs\sin\theta\right)$ will remain zero

C) $\left[\frac{v^2-2gs(H-h)}{(p-s)}\right]$ will remain zero D) $\left[v^2-\frac{2gsH}{p}\right]$ will remain zero

37. **A particle is taken from point A to point B under the influence of a force field. Now it is taken back from B to A and it is observed that the work done in taking the particle from A to B is not equal to the work done in taking it from B to A. If W_{nc} and W_c is the work done by non-conservative forces and conservative forces present in the system respectively, ΔU is the change in potential energy, Δk is the change kinetic energy, then**

A) $W_{nc} - \Delta U = \Delta D$ B) $W_c = -\Delta U$ C) $W_{nc} + W_c = \Delta k$ D) $W_{nc} - \Delta U = -\Delta k$

38. **An engine is pulling a train of mass m on a level track at a uniform speed u. The resistive force offered per unit mass is f.**

A) Power produced by the engine is mfu.

B) The extra power developed by the engine engine to maintain a speed u up inclined plane of h in s is $\frac{mgh\nu}{s}$

C) The frictional force exerting on the train is mf on the level track

D) None of above is correct

39. **The alternative that gives the conservative force of the following is**

A) $\vec{F_1} = 2xy\hat{i} + x^2\hat{j}$ B) $\vec{F_2} = y^3\hat{i} + xy^2\hat{j}$ C) $\vec{F_3} = y\hat{i} + x\hat{j}$ D) $\vec{F_4} = xy^2\hat{i} + x^2\hat{j}$

40. **A man is standing on a plank which is placed on smooth horizontal surface. There is sufficienet friction between feet of man and plank. Now man starts running over plank, correct statement is/are**

A) Work done by friction on man with respect to ground is nagative

B) Work done by friction on man with respect to ground is positive

C) Work done by friction on plank with respect to ground is positive

D) Work done by friction on man with respect to plank is zero

41. **A small sphere of mass m suspended by a thread is first taken a side so that the thread forms the right angle with the vertical and then released, then**

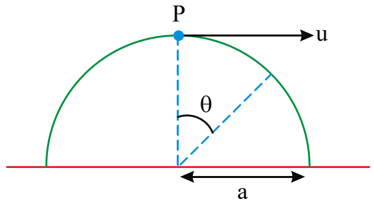
(A) Total acceleration of sphere as a function of θ measured from the vertical is $g\sqrt{1+3\cos^2\theta}$

(B) Thread tension as a function of θ measured from the vertical is $T = 3mg\cos\theta$

(C) The angle θ between the thread and the vertical at the moment when the total acceleration vector of the sphere is directed horizontally is $\cos^{-1} 1/\sqrt{3}$

(D) The thread tension at the moment when the vertical component of the sphere's velocity is maximum will be mg.

42. **A particle P is initially at rest on the top pf a smooth hemispherical surface which is fixed on a horizontal plane. The particle is given a velocity u horizontally. Radius of spherical surface is a.**



(A) If the particle leaves the sphere, when it has fallen vertically by a distance of $\frac{a}{4}, u = \frac{\sqrt{ga}}{2}$

(B) If the particle leaves the sphere at angle θ(fig) where $\cos\theta = \frac{\sqrt{3}}{2}$, then $u = \frac{\sqrt{ag}}{3}$

(C) If $u = 0$ and the particle just slides down the hemispherical surface, it will leave the surface when $\cos\theta = \frac{2}{3}$

(D) The minimum value of u, for the object to leave the sphere without sliding over the surface is $\sqrt{ag}$.

COMPREHENSION TYPE QUESTIONS

Comprehension-I

The potential energy U (in J) of a particle is given by $(ax + by)$, where a and b are constants. The mass of the particle is 1 kg and x and y are the coordinates of the particle in metre. The particle is at rest at $(4a, 2b)$ at time $t = 0$.

43. **Find the speed of the particle when it crosses x-axis**

A) $2\sqrt{a^2 + b^2}$ B) $\sqrt{a^2 + b^2}$ C) $\frac{1}{2}\sqrt{a^2 + b^2}$ D) $\sqrt{\frac{(a^2 + b^2)}{2}}$

44. **Find the speed of the particle when it crosses y-axis**

A) $4\sqrt{a^2 + b^2}$ B) $2\sqrt{2(a^2 + b^2)}$ C) $\sqrt{2(a^2 + b^2)}$ D) $\sqrt{(a^2 + b^2)}$

45. **Find the acceleration of the particle**

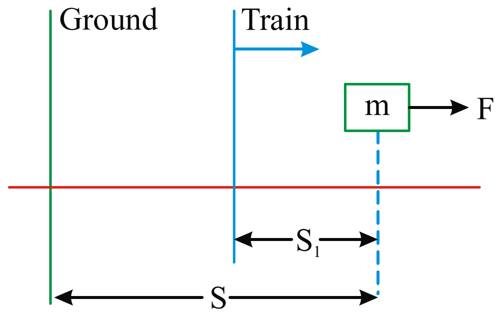
A) $4\sqrt{(a^2 + b^2)}$ B) $2\sqrt{2(a^2 + b^2)}$ C) $\sqrt{2(a^2 + b^2)}$ D) $\sqrt{(a^2 + b^2)}$

46. **Find the coordinates of the particle at t = 1 second**

A) $(3.5a, 1.5b)$ B) $(3a, 2b)$ C) $(3a, 3b)$ D) $(3a, 4b)$

Comprehension - II

A block of mass m sits at rest on a frictionless table in a rail car that is moving with speed v_c along a straight horizontal track (fig.) A person riding in the car pushes on the block with a net horizontal force F for a time t in the direction of the car's motion.



47. What is the final speed of the block according to a person in the car?

A) $\frac{Ft}{m}$ B) $\frac{2Ft}{m}$ C) $-\frac{Ft}{m}$ D) zero

48. According to a person standing on the ground outside the train?

A) $V_c + \frac{Ft}{m}$ B) $V_c - \frac{2Ft}{m}$ C) $\frac{Ft}{m} - V_c$ D) zero

49. How much did K.E of the block change according to the person in the car?

(A) $\frac{F^2t^2}{2m}$ (B) $\frac{F^2t^2}{m}$ (C) $\frac{2F^2t^2}{m}$ (D) none of these

50. According to the person on the ground. The change in KE of block is

(A) $\frac{m\left(V_c + \frac{Ft}{m}\right)^2}{2} - \frac{mv_c^2}{2}$ (B) $\frac{m\left(V_c + \frac{Ft}{m}\right)^2}{2} + \frac{mv_c^2}{2}$

(C) $\frac{mv_c^2}{2} - \frac{m\left(V_c + \frac{Ft}{m}\right)^2}{2}$ (D) None of these

51. In terms of F, m, & t, how far did the force displace the object according to the person in car?

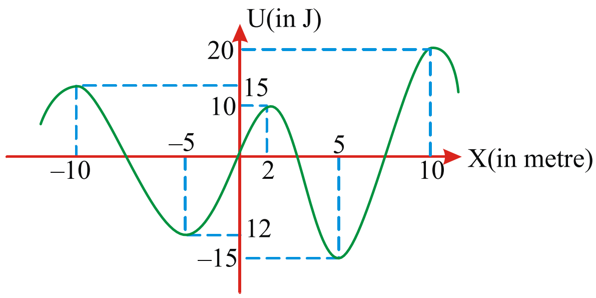
(A) $\frac{Ft^2}{m}$ (B) $\frac{Ft^2}{2m}$ (C) $\frac{2Ft^2}{m}$ (D) $\frac{4Ft^2}{m}$

52. According to the person on the ground. The displacement of block is

(A) $\frac{Ft^2}{2m} + 2v_ct$ (B) $\frac{Ft^2}{2m} + v_ct$ (C) $\frac{Ft^2}{m} + v_ct$ (D) $\frac{Ft^2}{2m} - v_ct$

Comprehension-III

In the figure the variation of potential energy of a particle of mass m = 2kg is represented w.r.t. its x-coordinate. The particle moves under the effect of this conservative force along the x-axis.



53. If the particle is released at the origin then

(A) it will move towards positive x-axis.
(B) it will move towards negative x-axis.
(C) it will remain stationary at the origin.
(D) its subsequent motion cannot be decided due to lack of information.

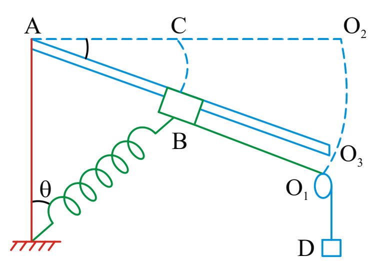
54. x = – 5 m and x = 10 m positions of the particle are respectively of

(A) neutral and stable equilibrium.
(B) neutral and unstable equilibrium.
(C) unstable and stable equilibrium.
(D) stable and unstable equilibrium.

Passage-IV

Rod AO_3 of length L can rotate about A. Initially rod was at potition AO_2, when spring OB of force constant K, attached to block B of mass m was at position OA with unstretched length L. The smooth block B can slide on rod when pulled by the block D of mass m through a massless spring and smooth pulley at O_1.

55. Find the velocity of the block B, when the rod and spring at B make an angle of $30°$ with their respective initial positions : (B is the middle point of the block)



A) $\left[\dfrac{10mgL-KL^2\left(2-\sqrt{3}\right)^2}{8m}\right]^{\frac{1}{2}}$

B) $\left[\dfrac{2mgL-KL^2\left(\sqrt{2}-1\right)}{4m}\right]^{\frac{1}{2}}$

C) $\left[\frac{5mgL - KL^2\left(\sqrt{2}-1\right)}{4m}\right]^{\frac{1}{2}}$ D) $\left[\frac{6mgL - KL^2\left(\sqrt{2}-1\right)}{4m}\right]^{\frac{1}{2}}$

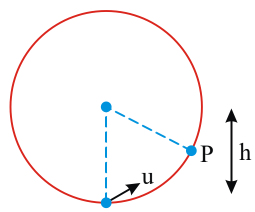
56. Find the work done by the frictional force (if slider is rough) at the instant when rod and the spring attached at block B make an anlge of 30° with their respective initial positions.

A) $\frac{1}{2}KL^2\left(2-\sqrt{3}\right)^2 - mgL$ B) $KL^2\left(2-\sqrt{3}\right)^2 - \frac{mgL}{4}$

C) $\frac{1}{8}KL^2\left(2-\sqrt{3}\right)^2 - \frac{5}{4}mgL$ D) $\frac{1}{2}KL^2\left(\sqrt{2}-1\right)^2$

PASSAGE-I:

A particle of mass M attached to an inextensible string is moving in a vertical circle of radius. R about fixed point O. It is imparted a velocity u in horizontal direction at lowest position as shown in figure.



Following information is being given

(i) Velocity at a height h can be calculated by using formula $v^2 = u^2 - 2gh$

(ii) Particle will complete the circle if $u \geq \sqrt{5gR}$

(iii) Particle will oscillates in lower half $\left(0^0 < \theta \leq 90^0\right)$ if $0 < u \leq \sqrt{2gR}$

(iv) The magnitude of tension at a height 'h' is calculated by using formula $T = \frac{M}{R}\left[u^2 + \left[gR - 3gh\right]\right]$

57. If $R = 2m, M = 2kg$ and $u = 12m/s$. Then value of tension at lowest position is

(A) 120 N (B) 164 N (C) 264 N (D) zero

58. Tension at highest point of its trajectory in above question will be

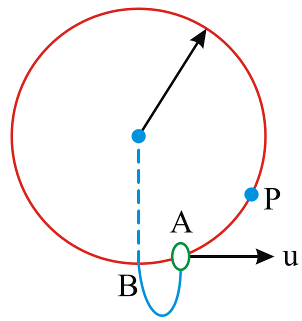
(A) 100 N (B) 44 N (C) 144 N (D) 264 N

59. If $M = 2kg, R = 2m$ and $u = 10m/s$. Then velocity of particle when $\theta = 60^0$ is

(A) $2\sqrt{5}\ m/s$ (B) $4\sqrt{5}\ m/s$ (C) $5\sqrt{2}\ m/s$ (D) $5\ m/s$

PASSAGE-II:

A bead of mass m is threaded on a smooth circular wire centre O, radius a, which is fixed in vertical plane. A light string of natural length 'a', elastic constant $= \frac{3mg}{a}$ and breaking strength 3mg connects the bead to the lowest point A of the wire. The other end of the string is fixed to ring at point B near point A. The string is slaked initially. The bead is projected from A with speed u.



60. **The smallest value u_0 of u for which the bead will make complete revolutions of the wire will be**

(A) $u_0 = \sqrt{5ga}$ (B) $u_0 = \sqrt{6ga}$ (C) $u_0 = \sqrt{7ga}$ (D) $u_0 = 2\sqrt{ga}$

61. **If $v = 2u_0$, the tension T in the elastic string when the bead is at the highest point B of the wire is**

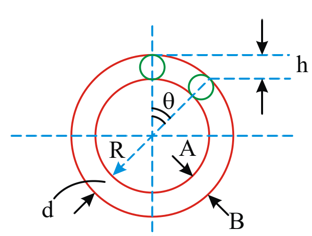
(A) $\frac{3mu_0^2}{a}$ (B) $4mg$ (C) $2mg$ (D) $\left(\frac{4u_0^2}{a} - g\right)m$

62. **The elastic energy stored in the string when the bead is at the highest point B will be**

(A) $\frac{3mga}{2}$ (B) $2mga$ (C) $4mga$ (D) $\frac{2mga}{2}$

MATRIX MATCHING TYPE QUESTIONS

63. **A spherical ball of mass m is kept at the highest point in the space between two fixed, concentric spheres A and B as shown. The sphere A has radius R and sphere B has a radius $(R+d)$. All surfaces are smooth. The diameter of ball is slightly less than d. The ball is given a gentle push so that angle made by radius vector of the ball with vertical is θ. N_A and N_B are the magnitudes of normal reaciton forces on the ball exerted by spheres A and B respectively:**



Match the columns:

Column-I

A) $\theta \le \cos^{-1}\left(\frac{2}{3}\right)$ B) $\theta \le \cos^{-1}\left(\frac{3}{4}\right)$

C) $\theta \ge \cos^{-1}\left(\frac{3}{4}\right)$ D) $\theta \ge \cos^{-1}\left(\frac{2}{3}\right)$

Column-II

p) N_B =0 and $N_A = mg(3\cos\theta - 2)$

q) N_B =0 and $N_A = mg(4\cos\theta - 2)$

r) N_A =0 and $N_B = mg(2 - 3\cos\theta)$

s) none of these

64. The velocity of a particle is $\vec{v} = at\hat{i} + bt^2\hat{j}$, where t is the time in second. Match the columns for $t = 1$ second:

Column-I

A) Acceleration of particle is

B) Tangential acceleration is

C) Radial acceleration is

D) Radius of curvature of path is

Column-II

p) less than $(a^2 + b^2)^{3/2}$ q) less than ab

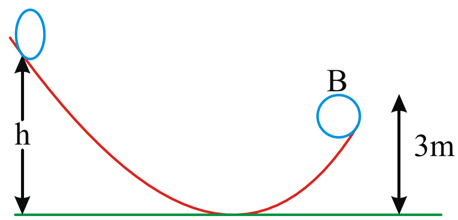
r) less than $(a^2 + b^2)$ s) greater than 2b

65. A particle of 500 gm mass moves along a horizontal circle of radius 16m such that normal acceleration of particle varies with time as $a_n = 9t^2$

Column - I	**Column - II**
(a) Tangential force on particle at t = 1 on particle at t = 1 second (in newton)	p) 72
(b) Total force on particle at t = 1 second (in newton)	q) 36
(c) Power delivered by total force at t = 1 sec (in watt)	r) 75
(d) Averge power developed by total force over first one second (in watt)	s) 6

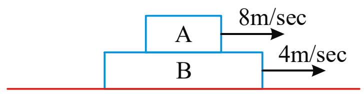
INTEGER ANSWER TYPE QUESTIONS

66. A ball leaves the track at B which is at 3m height from bottom most point of the track. The ball further rises upto 4m height from the bottom most point before falling down. Find h (in m), if the track at B makes an angle 30^0 with horizontal.

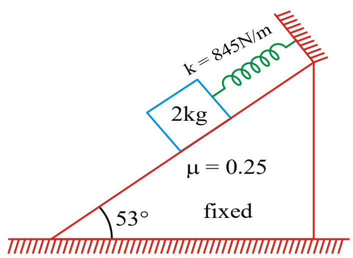


67. The displacment x (in m), of a particle of mass m (in kg) is related to the time t (in second) by $t=\sqrt{x}+3$. Find the work done in first six second. (in mJ)

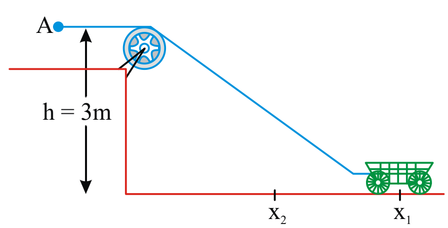
68. Block A of mass 1kg is placed on the rough surface of block B of mass 3 kg. Block B is placed on smooth horizontal surfac. Blocks are given the velocities as shown. Find net work done by the frictional force. [in (-) ve J]



69. A block of mass 2kg is placed on an inclined plane of angle 53°, attached with a spring as shown. Friction coefficient between block and the incline is 0.25. The block is released from the rest and when spring is in natural length. Find maximum speed of the block it acquires after the release in cm/s is found to be nearly 5n. Find 'n'(take g = 10 m/s^2)

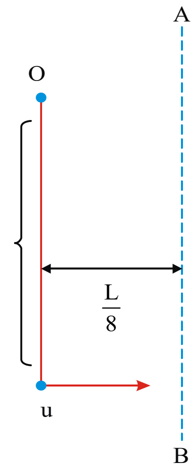


70. Figure shows a light, inextensible string attached to a cart that can slide along a frictionless horizontal rail aligned along an x axis. The left end of the string is pulled over a pulley, of negligible mass and friction and fixed at height h = 3m from the ground level. The cart slides from $x_1 = 3\sqrt{3}$ m to $x_2 = 4$ m and during the move, tension in the string is kept constant 50 N. Find change in kinetic energy of the cart in joules. (Use $\sqrt{3} = 1.7$) in form of 10 x n, where n =

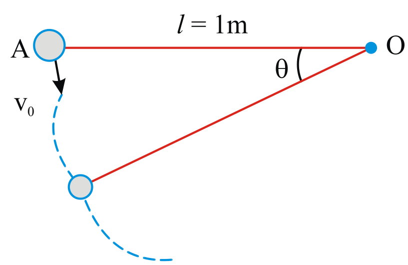


71. A particle is suspended vertically from a point O by an inextensible massless string of length L. A vertical line AB is is at a distance of L/8 from O as shown. The object is given a horizontal velocity u. At some point, its motion ceases to be circular and eventually the object passed through the line AB. At the instant of crossing AB, its velocity is horizontal. Find u.

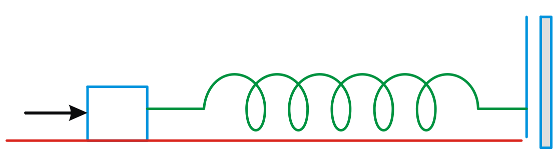
[1999]



72. **The sphere at P is given a down ward velocity v_0 and swings in a vertical plane at the end of a rope of $l = 1m$ attached to a support at O. The rope breaks at angle 30^0 from horizontal, knowing that it can withstand a maximum tension equal to four times the weight of the sphere. Then the value of v_0 will be** $\left(g = 10m/s^2\right)$



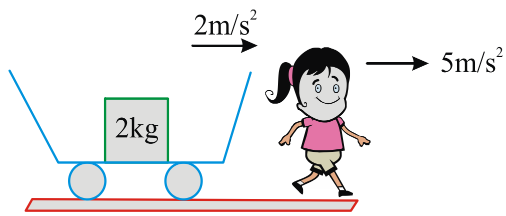
73. A block of mass 0.18kg is attached to a spring of force-constant 2 N/m. The coefficient of friction between the block and the floor is 0.1 Initially the block is at rest and the spring is un-stretched. An impulse is given to the block as shown in the figure.The block slides a distance of 0.06m and comes to rest for the first time . The initial velocity of the block in m/s is $V = N/10$. Then N is: [IIT-2011]



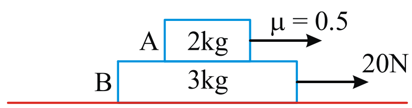
74. A particle of mass 0.2 kg is moving in one dimension under a force that delivers constant power 0.5W to the particle . If the initial speed (in ms^{-1}) after 5s is [IIT-2013]

SUBJECTIVE TYPE QUESTIONS

75. An observer and a vehicle, both start moving together from rest with accelerations 5 m/s^2 and 2 m/s^2, respectively. There is a 2 kg block on the floor of the vehicle, and $\mu = 0.3$ between their surfaces. Find the work done by frictional force on the 2 kg block as observed by the running observer, during first 2 seconds of the motion.

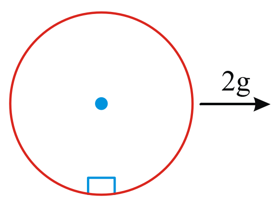


76. Two blocks A and B are placed one over other. Block B is acted upon by a force of 20 N which displaces it through 5 m. Find work done by frictional force on block A



Frictionless

77. A block of mass m is placed inside a smooth hollow cylinder of radius R kept horizontally . Initially system was at rest . Now cylinder is given constant acceleration 2 g in the horizontal direction by external agent . Find the maximum angular displacement of the block with the vertical.



EXERCISE - II - KEY

SINGLE ANSWER TYPE

1) A 2) A 3) D 4) D 5) C 6) A 7) A 8) C 9) B 10) B
11) C 12) C 13) A 14) C 15) A 16) B 17) A 18) C 19) D 20) B
21) A 22) C 23) C 24)C 25)B 26)B 27)A 28)D 29)D 30)B
31)D

MULTIPLE ANSWER TYPE

32) A,C 33) A,C 34) A,C 35) A,C 36) ABCD
37) ABC 38) ABC 39) A,C 40) B,C,D 41) ABC
42)ACD

COMPREHENSION TYPE

43) A 44) B 45) D 46) A 47) A 48) A 49) A 50) B 51) B 52) B
53) D 54) D 55) A 56) C 57)B 58)B 59) B 60)C 61) D 62) A

MATRIX MATCHING TYPE

63)A-P, B-S, C-S, D-R 64) A-s; B-r; C-q; D-p 65) A-s,B-r,C-p,D-q

INTEGER ANSWER TYPE

66) 7 67) 0 68) 6 69)10 70) 5

71) $u=\sqrt{gL\left(2+\frac{3\sqrt{3}}{2}\right)}$ 72) 5 73) 4 74) 5

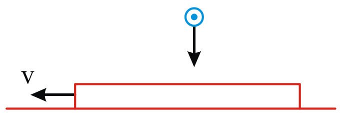
SUBJECTIVE TYPE QUESTIONS

75) 24 J 76) 40 J 77) $2\tan^{-1}(2)$

EXERCISE - III

SINGLE ANSWER TYPE

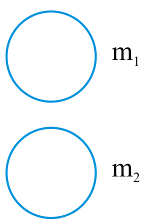
1)



A board is moving with velocity v on a smoother horizontal plane. The upper surface of the board is rough on which a ball falls with velocity v and rebounds with velocity $\frac{v}{2}$. The mass of the board is same as that of ball. After the collision , the board comes to state of rest. The co-efficient of friction between the board and the ball is

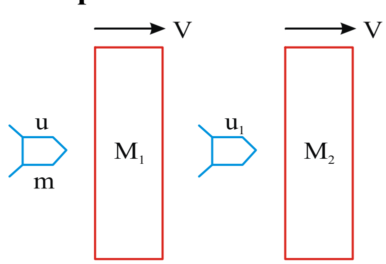
A) $\frac{1}{2}$ **B)** $\frac{2}{3}$ **C)** $\frac{1}{4}$ **D)** $\frac{3}{5}$

2) **Two balls of masses m_1 and m_2 are placed on top of one over the other (with a small gap between them) and then dropped on to the ground. What is the ratio m_1/m_2 for which the upper ball ultimately receives the largest possible fraction of the total energy? Take all collisions as elastic. Neglect air resistance**



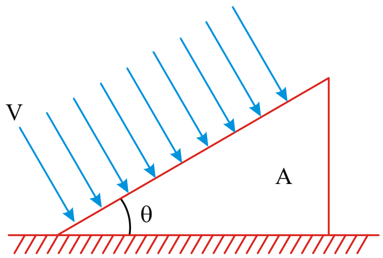
a) 1:1 b) 1:2 c) 1:3 d) 1:4

3) **A 20g bullet pierces through a plate of mass M_1 = 1kg and then comes to rest inside a second plate of mass M_2 = 2.98kg as shown in Fig. It is found that the two plates, initially at rest, now move with equal velocities. Find the percentage loss in the initial velocity of the bullet when it is between M_1 and M_2. Neglect any loss of material of the plates due to the action of bullet.**



(A) 50% (B) 25% (C) 100% (D) 75%

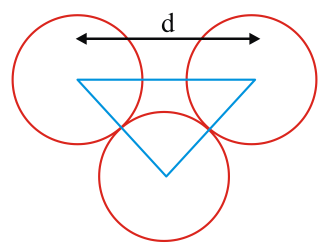
4) **The air of density ρ and moving with a velocity v strikes perpendicularly the inclined surface of area A and of a wedge kept on a horizontal surface. The mass of the wedge is m. Assuming the collisions to be perfectly inelastic, the minimum value of the coefficient of friction between the wedge and the ground so that the wedge does not move is (Assume mass of particles of air is negligible)**



(A) $\frac{\rho A v^2 \sin\theta}{mg + \rho A v^2 \cos\theta}$ (B) $\tan\theta$

(C) $\frac{\rho A v^2}{mg}\tan\theta$ (D) $\frac{\rho A v^2}{mg + \rho A v^2 \cos\theta}$.

5) **Two identical ball of radii r are kept on a horizontal plane with their centers d distance apart. A third ball, identical to previous one, collide elastically with both the balls symmetrically as shown in the figure. If the third ball comes to rest after the collision, d should be**

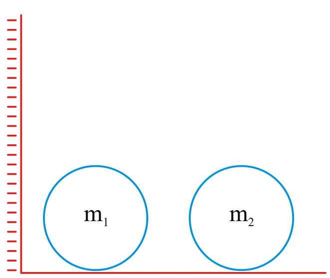


(A) 3r (B) $2\sqrt{2}r$ (C) $\left(\sqrt{2}+1\right)r$ (D) $\left(\sqrt{2}+2\right)r$

6. **A particle of mass *m* moving with velocity 1m/s collides perfectly elastically with another particle of mass 2m. if the incident particle is deflected by 90°. The heavy mass will make an angle θ with the initial direction of *m* equal to:**

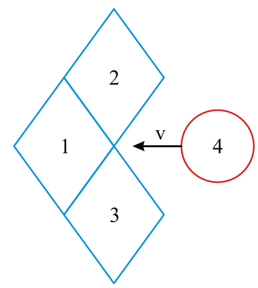
(A) 60° (B) 45° (C) 15° (D) 30°

7. **Mass m_1 strikes m_2 which is at rest. The ratio of masses for which they will collide again. (Collisions between ball and wall are elastic. Coefficient of restitution between m_1 and m_2 is e and all the surfaces are smooth)**



A) $\frac{e}{2+e}$ B) $\frac{2e}{2+e}$ C) $\frac{e}{2(2+e)}$ D) 1

8. A smooth washer impinges at a velocity 'v' on a group of three smooth identical blocks resting on a smooth horizontal surface as shown in fig. Mass of each block is equal to mass of the washer. The diameter of the of the washer and its height are equal to edge of the block. The velocity of blocks (2) and (3) after collision is

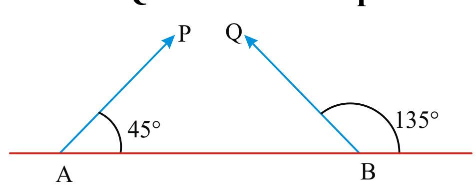


(A) v (B) $\frac{v}{\sqrt{2}}$ (C) $\frac{v}{2}$ (D) 2v

9. A particle of mass 'm' moving with a velocity $\left(3\hat{i}+2\hat{j}\right)m/s$ collides with stationary mass 'M' and finally 'm' moves with a velocity $\left(-2\hat{i}+\hat{j}\right)m/s$ if $\frac{m}{M}=\frac{1}{13}$ the velocity of the M after collision is?

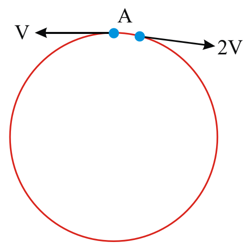
(A) $\left(5\hat{i}+\hat{j}\right)m/s$ (B) $\left(5\hat{i}-\hat{j}\right)m/s$ (C) $\left(\frac{5\hat{i}}{13}-\frac{\hat{j}}{13}\right)m/s$ (D) $\left(\frac{5\hat{i}}{13}+\frac{\hat{j}}{13}\right)m/s$

10. Particles P and Q of masses 20g and 40g, respectively, are projected from positions A and B on the ground. The initial velocities of P and Q make angles of 45^0 and 135^0, respectively with the horizontal as shown in the Fig. Each particle has an initial speed of 49m/s. The separation AB is 245m. Both particles travel in the same vertical plane and undergo a collision. After the collision P retraces its path. The separation of Q from its initial position when it hits the ground is



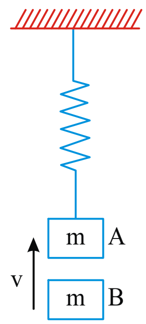
(A) 245 m (B) $\frac{245}{3}m$ (C) $\frac{245}{2}m$ (D) $\frac{245}{\sqrt{2}}m$

11. Two small particles of equal masses start moving in opposite directions from a respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particles will again reach the point A? [IIT-JEE2009]



(A) 4 (B) 3 (C) 2 (D) 1

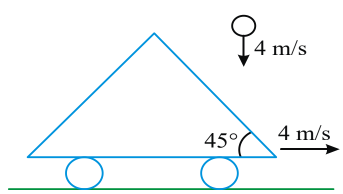
12. **Block A is hanging from a vertical spring of spring constant k and is at rest. Block B strikes block A with velocity v and sticks to it. Then the value of v for which the spring just attains natural length is**



A) $\sqrt{\frac{60mg^2}{k}}$ B) $\sqrt{\frac{6mg^2}{k}}$

C) $\sqrt{\frac{10mg^2}{k}}$ D) $\sqrt{\frac{mg^2}{k}}$

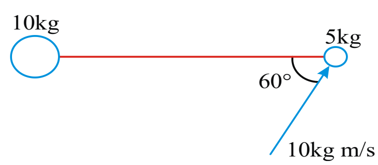
13. **A small ball falling vertically downward with constant velocity 4m/s strikes elastically a massive inclined cart moving with velocity 4m/s horizontally as shown. The velocity of the rebound of the ball is**



A) 402 m/s B) 403 m/s C) 4m/s D) 405m/s

MULTIPLE ANSWER QUESTIONS

14. **Two point masses are connected by a light inextensible string are lying on a frictionless surface as shown in figure. An impulse of magnitude 10 kg-m/s is given to 5 kg block.**



A) Velocity of 10 kg block immediately after impulse is given $\frac{1}{3}$ m/s

B) Velocity of 10 kg block immediately after impulse is given 2 m/s

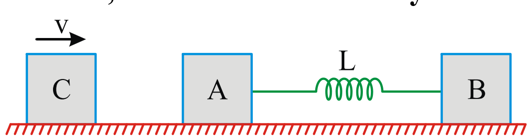
C) Speed of 5 kg block immediately after impulse is given $\sqrt{\frac{28}{9}}$ m/s

D) Speed of 5 kg block immediately after impulse is given $\frac{\sqrt{28}}{9}$ m/s

15. **A body moving towards another body of finite mass at rest collides with it. As result of collision.**
A) Both the bodies come to rest
B) The stationary body remains at rest while the moving body changes the direction of its velocity
C) Both bodies may move after the collision
D) The moving body may come to rest while the body at rest may move.

16. **A ball of mass m_1, collides elastically and head on with ball of mass m_2 at rest. Then**
A) The transfer of kinetic energy to the second ball is maximum when $m_1 = m_2$
B) The change of momentum of first ball is maximum, when $m_1 << m_2$.
C) The velocity of the second ball is maximum, when $m_1 >> m_2$.
D) None of these

17. **Two blocks *A* and *B* each of mass *m*, are connected by a massless spring of natural length *L* and spring constant *k*. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length, as shown in fig. A third identical block *C*, also of mass *m*, moves on the floor with a speed *v* along the line joining *A* and *B*, and collides elastically with *A*. Then : (1993; 2M)**



A) the kinetic energy of the *A–B* system, at maximum compression of the spring, is zero
B) the kinetic energy of the *A–B* system, at maximum compression of the spring, is $\frac{mv^2}{4}$
C) the maximum compression of the spring is $v\sqrt{\left(\frac{m}{K}\right)}$
D) the maximum compression of the spring is $v\sqrt{\frac{m}{2K}}$

18. **Two balls, having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$, undergo a collision in free space. There is no external force acting on the balls. Let $\vec{p}_1'$ and $\vec{p}_2'$ be their final momenta. The following option (s) is (are) not allowed for any non–zero value of p, a_1, a_2, b_1, b_2, c_1 and c_2. [2008]**

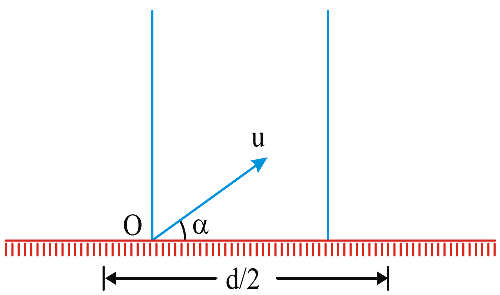
A) $\vec{p}_1' = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$, $\vec{p}_2' = a_2\hat{i} + b_2\hat{j}$
B) $\vec{p}_1' = c_1\hat{k}$, $\vec{p}_2' = c_2\hat{k}$
C) $\vec{p}_1' = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$, $\vec{p}_2' = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$
D) $\vec{p}_1' = a_1\hat{i} + b_1\hat{j}$, $\vec{p}_2' = a_2\hat{i} + b_1\hat{j}$.

19. **If the resultant of all the external forces acting on a system of particles is zero, then from an inertial frame, one can surely say that [2009]**
A) linear momentum of the system does not change in time
B) kinetic energy of the system does not change in time
C) angular momentum of the system does not change in time
D) potential energy of the system does not change in time.

COMPREHENSION TYPE QUESTIONS

Comprehension -I

Suppose a ball is projected with speed *u* at an angle α with horizontal. It collides at some distance with a wall parallel to y-axis. Let v_x and v_y be the components of its velocity along *x* and y-directions at the time of impact with wall. Coefficient of restitution between the ball and the wall is *e*. Component of its velocity along y-direction (common tangent) v_y will remain unchanged while component of its velocity along x -direction (common normal) v_x will become ev_x is opposite direction.



The situation shown in the figure a small ball is projected at an angle α between two vertical walls such that in the absence of the wall its range would have been 5d. Given that all the collisions are perfectly elastic (for first and second problems), the walls are supposed to be very tall.

20. The maximum height attained by the ball is

a) $\frac{2u^2 \sin^2 \alpha}{g}$ b) $\frac{2u^2 \cos^2 \alpha}{g}$ c) $\frac{u^2 \sin^2 \alpha}{2g}$ d) $\frac{u^2}{2g}$

21. Total number of collisions with the walls before the ball comes back to the ground is

a) 5 b) 7 c) 9 d) 11

22. The total time taken by the ball to come back to the ground (if collision is inelastic) is

a) $> \frac{2u \sin \alpha}{g}$ b) $< \frac{2u \sin \alpha}{g}$ c) $= \frac{2u \sin \alpha}{g}$ d) $= \frac{2u \cos \alpha}{g}$

Comprehension : II

Two pendulum bobs of mass *m* and 2*m* collide elastically at the lowest point in their motion. If both the balls are released from height H above the lowest point,

23. Velocity of the bob of mass *m* just after collision is

(A) $\sqrt{\frac{2gH}{3}}$ (B) $\frac{5}{3}\sqrt{2gH}$ (C) $\sqrt{2gH}$ (D) None of these

24. The bob of mass *m* rise after the collision is

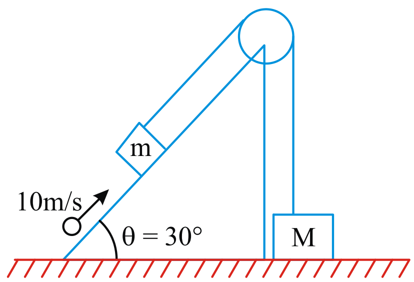
(A) $\frac{25H}{9}$ (B) $\frac{H}{9}$ (C) $\frac{16H}{9}$ (D) $\frac{H}{4}$

25. The height of the bob of mass rise after the collision

(A) $\frac{25}{9}H$ (B) $\frac{H}{9}$ (C) $\frac{16H}{9}$ (D) None of these

Comprehension : III

A light in extensible thread passes over a small frictionless pully. Two blocks of masses m = 1kg and M = 3kg respectively are attached with the thread as shown in the fig. The heavier block rests on a horizontal surface. A shell of mass 1kg moving upward with a velocity 10m/s collides and sticks with the block of mass 'm' as shown in the fig at t = 0. If the long inclined plane is smooth.



26. Find velocity of (m + shell) just after collision.

(A) 5m/s (B) 10m/s (C) 2.5m/s (D) 7.5 m/s

27. Find the maximum height ascended by 'M'

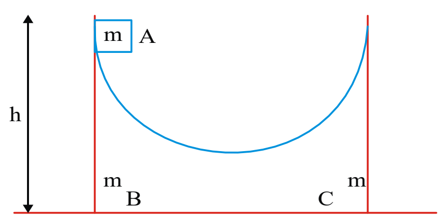
(A) $\frac{1}{4}m$ (B) $\frac{1}{2}m$ (C) 1m (D) $\frac{1}{6}m$

28. Find total time T at that instant of maximum height ascended by M

(A) $\frac{7}{2}s$ (B) $\frac{5}{2}s$ (C) $\frac{3}{2}s$ (D) $\frac{1}{2}s$

Comprehension-IV

Wedges B and C are smooth and they are placed in contact as shown. Block A is placed on wedge B at a height *h* above ground. Block and the two wedges are all of same mass *m* . Neglect friction every where.



29. The maximum height upto which block A rises on wedge C is

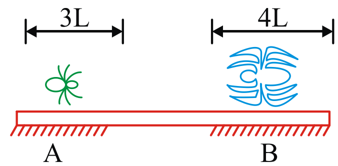
a) *h* b) *h/2* c) *h/4* d) *h/3*

30. The velocity of A when it has slide down to ground from wedge C is

a) 0 b) $\sqrt{\frac{gh}{2}}$ c) $\sqrt{\frac{gh}{4}}$ d) $\frac{\sqrt{gh}}{3}$

Comprehension-V

A uniform bar of length 12 L and mass 48 m is supported horizontally on two smooth tables as shown in the figure. A small moth (an insect) of mass 8 m is sitting on end A of the rod and a spider (an insect) of mass 16 m is sitting on the other end B. Both the insects start moving towards each other along the rod with moth moving at speed 2v and the spider at half of this speed. They meet at a point P on the rod and the spider eats the moth. After this the spider moves with a velocity v/2 relative to the rod towards the end A. The spider takes negligible time in eating the insect. Also, let v = L/T, where T is a constant having value 4 sec.



31. Displacement of the rod by the time when the insects meet is

A) L/2 B) L C) 3L/4 D) zero

32. The point P is at

A) the centre of the rod
B) the edge of the table supporting the end B
C) close to the edge of the table supporting the end A
D) none of the above

33. The speed of the bar after the spider eats up the moth and moves towards A is

A) v/2 B) v C) v/6 D) 2v

Comprehensive-VI

A projectile of mass 50kg is shot vertically upwards with an initial velocity of 100m/s. After 5s, it explodes into two fragments, one of (1st fragment) which having a mass of 20kg travels vertically up with a velocity of 150m/s ($g = 10m/s^2$). Bases on the above paragraph answer the following questions.

34. What is the magnitude and direction of velocity of the 2nd fragments just after explosion is

(A) $\frac{50}{3} m/s(up)$ (B) 50m/s (down) (C) 50 m/s(up) (D) $\frac{50}{3} m/s(down)$

35. What is the linear momentum of 2nd fragment 3s after the explosion is

(A) 140/3 kg-m/s (B) 40/3 kg – m/s (C) 80/3 kg – m/s (D) 100/3 kg – m/s

36. The sum of linear momenta of fragments 3s after the explosion is

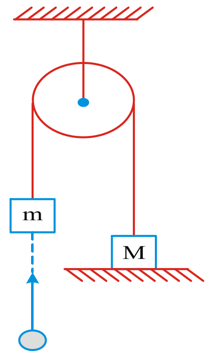
(A) 2400 kg – m/s (B) 1400 kg – m/s (C) 1000 kg – m/s (D) 3800 kg – m/s

MATRIX–MATCH TYPE QUESTIONS

Statements (A, B, C, D) in **Column I** have to be matched with statements (p, q, r, s) in **Column II**. The answers to these questions have to be appropriately bubbles as illustrated in the following example.

If the correct matches are A–p, A–s, B–q, B–r, C–p, C–q and D–s, then the correctly bubbled 4 × 4 matrix should be as follows :

37. A light flexible thread passes over a small, frictionless pully. Two blocks of mass m = 1kg, and M = 3kg are attached with the thread as shown. Heavier block rests on a slab. A shell of mass 1kg., moving upwards with velocity 10m/s, collides with the hanging block at time t = o (collision between shell and m is elastic).



Column - I

(A) Velocity of a block of mass 'm' just before the string taught is (m/s)

(B) Time taken by 'm' just before the string taught is

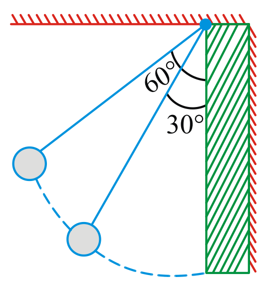
(C) Maximum height ascended by M is

(D) The total time (T) at that instant of maximum height ascended by M is

Column - II

p) 2.5 q) 0.625 r) 10 s) 2

38. **A small sphere of mass 10g is attached to a point of a smooth vertical wall by a light string of length 1m. The sphere is pulled out in a vertical plane perpendicular to the wall so that the string makes an angle of 60^0 with the wall and is then released. It is found that after the first rebound the string makes a maximum angle of 30^0 with the wall ($g = 10m/s^2$).**



Column –I

(A) The velocity of the sphere just before the collision with the wall is

(B) The velocity of the sphere just after collision with the wall is

(C) The Co-efficient of restitution between sphere and wall is

(D) Lose of kinetic energy during collision is

Column – II

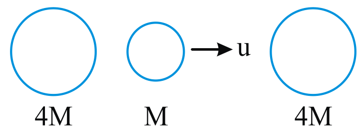
p) $\sqrt{10\left(2-\sqrt{3}\right)}$ q) $\sqrt{2-\sqrt{3}}$

r) $\dfrac{\left(\sqrt{3}-1\right)}{20}$ s) $\sqrt{10}$

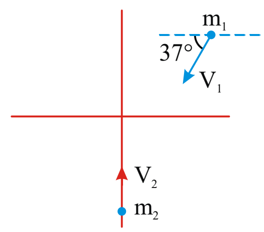
INTEGER TYPE QUESTIONS

39. **Two Particle of equal masses 4 M are initially at rest. A particle of mass M moving at speed u collide elastically with one of the larger balls. How many**

collisions occur?

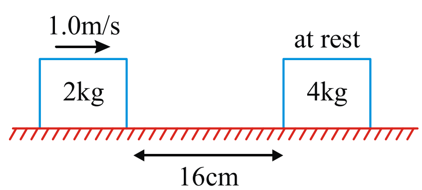


40. **Two balls with masses $m_1 = 3kg$ and $m_2 = 5kg$ have identical velocity V = 5 m/s in the direction shown in figure. They collide at origin. Find the distance of position of C.M. from the origin 2sec after the collision.**



41. **A simple pendulum is suspended from a peg on a vertical wall. The pendulum is pulled away from the wall to a horizontal position and released. The ball hits the wall, the coefficient of restitution, being $\left(2/\sqrt{5}\right)$. What is the minimum number of collisions after which the amplitude of oscillation becomes less than 60°?**

42. **The friction coefficient between the horizontal surface and each of the block shown in the figure is 0.2. The collision between the blocks is perfectly elastic. Find the separation between them (in cm) when they come to rest. (Take g = 10 m/s^2)**



EXERCISE - III - KEY

SINGLE ANSWER TYPE

1.B 2.C 3.B 4.A 5.B 6.D 7.C 8.B 9.D 10.C
11.C 12.B 13.C

MORE THAN ONE ANSWER

14.A,C 15.C,D 16. A,B,C 17. B,D 18. A,D 19. A,C

COMPREHENSION TYPE

20.C 21.C 22.C 23.B 24.A 25.B 26.A 27.B 28.B 29.C
30.A 31.C 32.B 33.C 34.D 35.A 36.C

MATRIX MATCHING

37. A$\rightarrow$r B$\rightarrow$s C$\rightarrow$q D$\rightarrow$p 38. A$\rightarrow$s B$\rightarrow$p C$\rightarrow$q D$\rightarrow$r

INTEGER TYPE:

39. 2 40.5 41.4 42.5

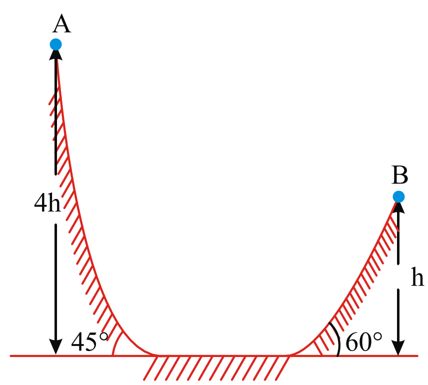
EXERCISE - IV

SINGLE ANSWER TYPE QUESTIONS

1. **A spaceship travelling along + y axis with speed v_0 suddenly shoots out one fourth of its part with speed $2v_0$ along + x-axis. xy axes are fixed with respect to ground. The velocity of the remaining part is**

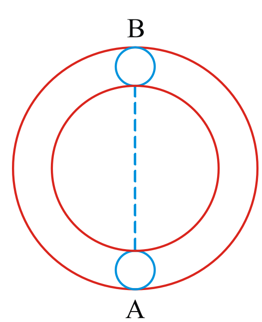
A) $\frac{2}{3}v_0$ B) $\frac{\sqrt{20}}{3}v_0$ C) $\frac{\sqrt{5}}{3}v_0$ D) $\frac{\sqrt{13}}{3}v_0$

2. **Two identical balls A and B are released from the position shown in Fig. They collide elastically with each other on the horizontal portion. The ratio of heights attained by A and B after collision is(neglect friction)**



(A) 1 : 4 (B) 2 : 1 (C) 4 : 13 (D) 2 : 5

3. **Two equal spheres A and B lie on a smooth horizontal circular groove at opposite ends of a diameter. At time t =0, A is projected along the groove and it first impinges on B at time**
t =T_1 and again at timet = T_2. If e is the coefficient of restitution the ratio T_2/T_1 is



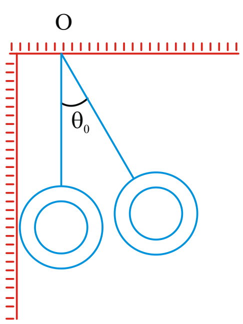
(A) $\frac{2}{e}$ (B) $\frac{(2+e)}{2}$ (C) $\frac{2(e+1)}{e}$ (D) $\frac{(2+e)}{e}$

4. **A ball of mass 10kg strikes another ball of mass 25kg at rest. If they separate in mutually perpendicular directions then the coefficient of restituion is:**

(A) $\frac{10}{25}$ (B) $\frac{25}{10}$ (C) 1 (D) 0.8

5. **The coefficient of restitution for a body is $e = \frac{1}{3}$. At what angle the body must be incident on a perfectly hard plane so that the angle between the direction before and after the impact be at right angles:**
(A) 37° (B) 60° (C) 45° (D) 30°

6. **An iron ball of mass m, suspended by a light inextensible string of length l from a fixed point O, is shifted by an angle q_0 as shown so as to strike the vertical wall perpendicularly. The maximum angle made by the string with vertical after the first collision (e is the coefficient of restitution), is__________**



a) $sin^{-1}\{1 - e^2(1 - cos\theta_0)\}$

b) $cos^{-1}\{1 - e^2(1 - cos\theta_0)\}$

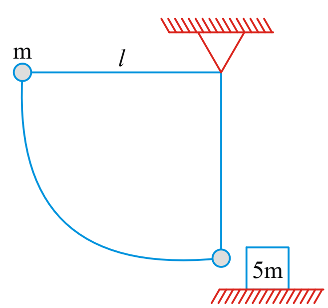
c) $Tan^{-1}\{1 - e^2(1 - cos\theta_0)\}$

d) Zero

7. **Three small bodies with the mass ratio 3 : 4 : 5 (the mass of the highest body is m) are kept at three different points on the inner surface of a smooth hemispherical cup of radius r. The cup is fixed at its lowest point on a horizontal surface. At a certain instant the bodies are released. Determine the maximum amount of heat 'Q' that can be liberated in such a system. At what initial arrangement of the bodies will the amount – liberated heat be maximum. Assume that collisions are perfectly inelastic**
(A) 2mgr (B) 3mgr (C) 6mgr (D) 4mgr

MULTIPLE ANSWER QUESTIONS

8. **A pendulum bob of mass m connected to the end of an ideal string of length *l* is released from rest from horizontal position as shown in Fig. At the lowest point, the bob makes an elastic collision with a stationary block of mass 5m, which is kept on a frictionless surface. Mark out the correct statement(s) for the instant just after the impact**

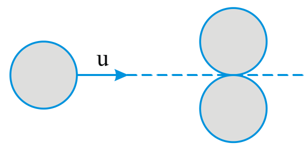


(A) Tension in the string at lowest point just after collision is (17/9) mg
(B) Tension in the string at lowest point just before collision is 3mg

(C) The velocity of the block is $\sqrt{2gl}/3$

(D) The maximum height attained by the pendulum bob after impact is (measured from the lowest position) $\frac{4l}{9}$

9. Two equal spheres of mass *m* are in contact on a smooth horizontal table. A third identical sphere impinges symmetrically on them and reduces to rest. then:



(A) Coefficient of restitution is $e = \frac{2}{3}$

(B) Loss of kinetic energy $\frac{1}{6}mu^2$ where u is velocity before impact

(C) After the collision, velocity of equal mass sphere is $\frac{u}{\sqrt{3}}$

(D) Loss of kinetic energy $\frac{1}{3}mu^2$

10. A particle (A) of mass m_1 elastically collides with another stationary particle (B) of mass m_2. then:

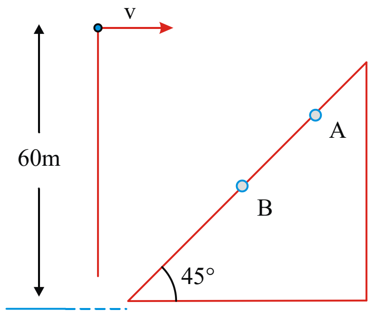
(A) $\frac{m_1}{m_2} = \frac{1}{2}$ and the particles fly a part in the opposite direction with equal velocities.

(B) $\frac{m_1}{m_2} = \frac{1}{3}$ and the particles fly apart in the opposite direction with equal velocities.

(C) $\frac{m_1}{m_2} = \frac{2}{1}$ and the collision angle between the particles is 60° symmetrically.

(D) $\frac{m_1}{m_2} = \frac{2}{1}$ and the particles fly apart symmetrically at an angle 90°

11. A particle is to be projected horizontally with velocity v from a point P, which is 60m above the foot of a plane inclined at angle 45^0 with horizontal as shown in figure. The particle hits the plane perpendicularly at A. After rebound from inclined plane it again hits at B. If coefficient of restitution between particle and plane is $\frac{1}{\sqrt{2}}$ then,



a) $v = 20\ m/s$

b) $v = 10\ m/s$

c) $AB = 80\sqrt{2}m$

d) $AB = 80m$

12. A body of mass *m* moving with a velocity v in the x direction collides with another body of mass M moving in *y* direction with a velocity V. They coalesce into one body during collision.

(A) The magnitude of momentum of the composite body $\left[(mv)^2 + (MV)^2\right]^{1/2}$

(B) The fraction of initial K.E. transformed into heat is = $\left(\frac{mM}{m+M}\right)\left(\frac{v^2+V^2}{mv^2+MV^2}\right)$

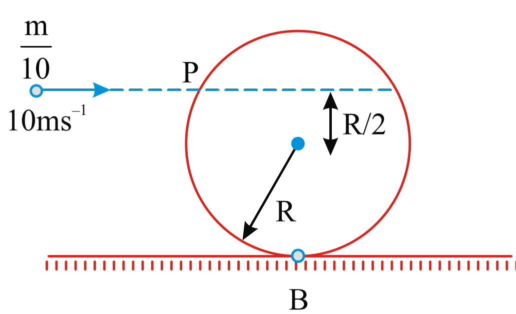
(C) Decrease in kinetic energy is $\frac{mM}{2(m+M)}\left(v^2+V^2\right)$

(D) None of these

COMPREHENSION TYPE QUESTIONS

Comprehension : I

A small particle of mass m/10 is moving horizontally at a height of 3R/2 from ground with velocity 10 m/s. A perfectly inelastic collision occurs at point P of sphere of mass m placed on smooth horizontal surface. The radius of sphere is R. (m =10 Kg and R =0.1 m) (Assume all surfaces to be smooth). Answer the following questions.



13 speed of particle just after collision is approximately......

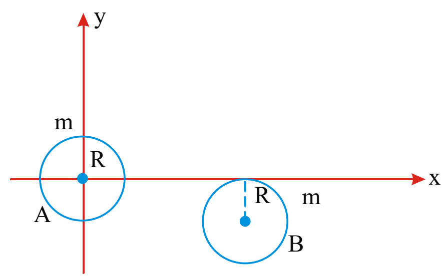
1) 5.0 m/s 2) 10 m/s 3) 15.0 m/s 4) 20.0 m/s

14. Speed of sphere just after collision is

1) 27/43 m/s 2) $\frac{30}{43} m/s$ 3) $\frac{35}{43} m/s$ 4) $\frac{40}{43} m/s$

Comprehension: II

Two smooth balls A and B, each of mass m and radius R, have their centres as shown in fig. Ball A, moving along positive x – axis, collides with ball B. Just before the collision, speed of ball 'A' is 4m/s and ball 'B' is stationary. The collision between the balls is elastic.



15. Velocity of the ball 'A' just after the collision is

(A) $\left(\hat{i}+\sqrt{3}\hat{j}\right)m/s$ (B) $\left(\hat{i}-\sqrt{3}\hat{j}\right)m/s$ (C) $\left(2\hat{i}+\sqrt{3}\hat{j}\right)m/s$ (D) $\left(2\hat{i}+2\hat{j}\right)m/s$

16. What is velocity of ball 'B' after collision is

(A) $\left(3\hat{i}-\sqrt{3}\hat{j}\right)m/s$.

(B) $\left(2\sqrt{3}\hat{i}-2\sqrt{3}\hat{j}\right)m/s$

(C) $\left(2\hat{i}-2\sqrt{3}\hat{j}\right)m/s$

(D) $\left(\sqrt{3}\hat{i}-\sqrt{3}\hat{j}\right)m/s$

17. Impulse of the force exerted by 'A' on 'B' during the collision is equal to

(A) $\left(\sqrt{3}m\hat{i}+3m\hat{j}\right)kg-\frac{m}{s}$

(B) $\left(\frac{\sqrt{3}}{2}m\hat{i}-3m\hat{j}\right)kg-\frac{m}{s}$

(C) $\left(3m\hat{i}-\sqrt{3}m\hat{j}\right)kg-\frac{m}{s}$

(D) $\left(2\sqrt{3}m\hat{i}-3m\hat{j}\right)kg-\frac{m}{s}$

18. Coefficient of restitution during the collision is changed to $\frac{1}{2}$, keeping all other parameters unchanged. What is the velocity of the ball 'B' after the collision.

(A) $\frac{1}{2}\left(3\sqrt{3}\hat{i}+9\hat{j}\right)m/s$

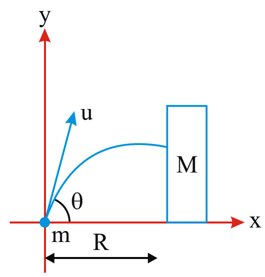
(B) $\frac{1}{4}\left(9\hat{i}-3\sqrt{3}\hat{j}\right)m/s$

(C) $\left(6\hat{i}+3\sqrt{3}\hat{j}\right)m/s$

(D) $\left(6\hat{i}-3\sqrt{3}\hat{j}\right)m/s$

Comprehension : III

A ball of mass m is projected with a velocity 'u' at angle θ with the horizontal. It collides with a smooth box of mass 'M' at its highest position. If the co-efficient of restitution is 'e'.



19. Find velocity of the ball after collision

(A) $\left(\frac{m-eM}{M+m}\right)u\cos\theta$ (B) $\left(\frac{M-em}{M+m}\right)u\cos\theta$

(C) $\left(\frac{m+eM}{M+m}\right)u\sin\theta$ (D) $\left(\frac{m-eM}{M+m}\right)u\sin\theta$

20. Find the horizontal distance travelled by the ball before collision.

(A) $\frac{u^2 2\sin\theta\cos\theta}{g}$ (B) $\frac{u^2\sin\theta\cos\theta}{g}$

(C) $\frac{u^2\sin\theta\cos\theta}{2g}$ (D) $\frac{u^2\sin\theta\cos\theta}{4g}$

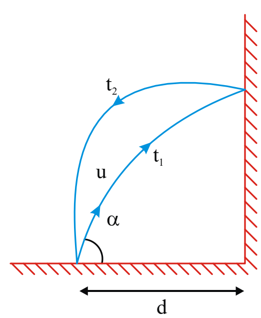
21. Find the position at which the ball meets the x–axis from the origin

(A) $\left(\frac{M(1-e)+2m}{M+m}\right)R$ (B) $\left(\frac{m(1-e)+2M}{M+m}\right)R$

(C) $\left(\frac{M+m(1-e)}{M+m}\right)R$ (D) $\left(\frac{M(1-e)+2m}{2(M+m)}\right)R$

Comprehension: IV

An inelastic ball is projected with a velocity 'u' at an angle 'α' to the horizontal, towards a wall distant 'd' from the point of projection. After collision the ball returns to the point of projection (Co-efficient of restitution between sphere and wall is 'e')



22. The total time of journey of the ball is

(A) $\frac{u\sin\alpha}{g}$ (B) $\frac{2u\sin\alpha}{g}$ (C) $\frac{2u\cos\alpha}{g}$ (D) $\frac{u\tan\alpha}{2g}$

23. **The horizontal distance 'd' from the wall is**

(A) $\frac{u^2 \sin 2\alpha}{g}\left(\frac{e}{1+e}\right)$ (B) $\frac{u^2 \sin \alpha}{g}\left(\frac{e}{1+e}\right)$

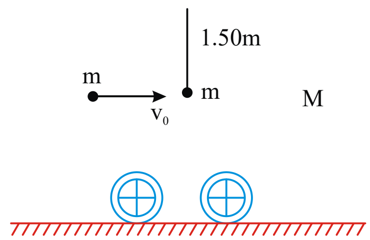
(C) $\frac{u^2 \cos 2\alpha}{g}\left(\frac{e}{1+e}\right)$ (D) $\frac{u^2 \sin 2\alpha}{2g}\left(\frac{e}{1+e}\right)$

24. **If the line joining the point of projection and the point of impact makes an angle 'θ' with the horizontal, then tan θ is**

(A) $e\tan\alpha$ (B) $(1+e)\tan\alpha$ (C) $\frac{(1+e)}{\tan\alpha}$ (D) $\frac{\tan\alpha}{(1+e)}$

Comprehension : VI

A ball of mass m = 1kg is hung vertically by a thread of length l=1.50m. Upper end of the thread is attached to the ceiling of a trolley of mass M =4kg. Initially, the trolley is stationary and it is free to move along horizontal rails with out friction. A shell of mass m=1 kg, moving horizontally with velocity v_0 = 6m/s, collides with the ball and gets stuck with it. As a result, the thread starts to deflect towards right



25. **The velocity of the combined body just after collision is**

A) 2m/s B) 3 m/s C) 1m/s D) 4m/s

26. **At the time of maximum deflection of the thread with vertical, the trolley will move with velocity**

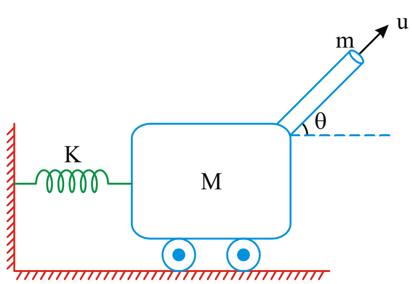
A) 2 m/s B) 3 m/s C) 1 m/s D)4 m/s

27. **The maximum deflection of the thread with the vertical is**

A) $\cos^{-1}\left(\frac{4}{5}\right)$ B) $\cos^{-1}\left(\frac{3}{5}\right)$ C) $\cos^{-1}\left(\frac{2}{3}\right)$ D) $\cos^{-1}\left(\frac{3}{4}\right)$

Comprehension : VII

A bullet of mass 'm' is fired from a gun of mass M with a (muzzle) velocity u. If the cart on which gun is fixed can move on the smooth horizontal floor as shown



28. **Find recoil velocity of the cart**

(A) $\frac{Mu\cos\theta}{M+m}$ (B) $\frac{mu\cos\theta}{M}$ (C) $\frac{Mu\cos\theta}{m}$ (D) $\frac{mu\cos\theta}{M+m}$

29. **Find maximum compression of spring of spring constant (K) is**

(A) $\sqrt{\frac{M}{K}}\left(\frac{mu\cos\theta}{m}\right)$ (B) $\sqrt{\frac{K}{M}}\left(\frac{Mu\cos\theta}{M+m}\right)$

(C) $\sqrt{\frac{M}{K}}\left(\frac{mu\cos\theta}{M+m}\right)$ (D) $\sqrt{\frac{M}{K}}\left(\frac{mu\cos\theta}{M}\right)$

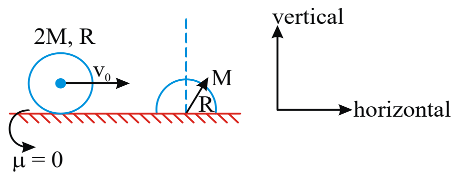
30. **Energy of explosion (or) change in kinetic energy of the system is**

(A) $\frac{m\left(M+m\sin^2\theta\right)u^2}{2(M+m)}$ (B) $\frac{M\left(M+m\cos^2\theta\right)u^2}{(M+m)}$

(C) $\frac{m(M+m)u^2}{M}$ (D) None of these

MATRIX MATCHING TYPE QUESTIONS

31. **A hemisphere of mass 'M' and radius 'R' is at rest. One solid sphere of mass '2M' and radius 'R', moving with a velocity v_0, collides with the hemisphere. If '1' is the co - efficient of restitution.**



Column – I

(A) Velocity of hemisphere along common normal direction after collision is
(B) Velocity of solid sphere along common normal direction after collision is
(C) Velocity of hemisphere along horizontal direction after collision is
(D) Velocity of solid sphere along horizontal direction after collision is

Column – II

p) $\frac{v_o}{3}(2-e)$ q) $\frac{2v_o}{3}(1+e)$

r) $\frac{v_o}{\sqrt{3}}(1+e)$ s) $\frac{v_o}{2\sqrt{3}}(2-e)$

32. **A ball falls freely from a height onto an smooth inclined plane forming an angle 'θ' with horizontal. (Assume the impacts to be elastic). Match the following (v_o is the velocity of ball just before striking the inclined plane).**

Column – I

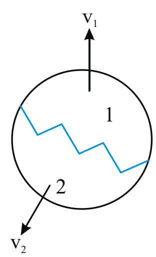
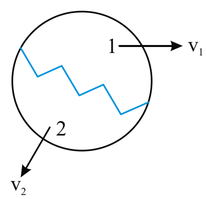
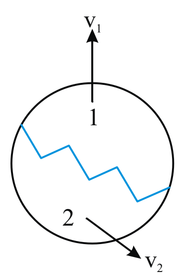
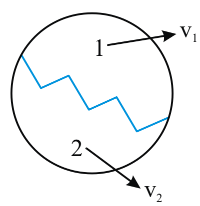
(A) The distance travelled by the ball along inclined plane in first and second collision is
(B) The distance travelled by the ball along inclined plane between 2[nd] and 3[rd] collision is
(C) The velocity of ball along inclined plane just after the second collision is
(D) The ratio of the distances between the points at which the jumping ball strikes the inclined
plane.

Column – II

p) $\frac{8v_0^2 \sin\theta}{g}$ q) $\frac{4v_0^2 \sin\theta}{g}$

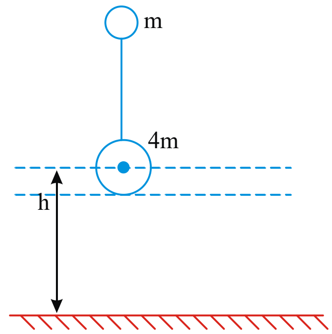
r) $3v_0 \sin\theta$ s) 2 : 3 : 1 t) 1 : 2 : 3

33. **A body initially moving towards the right explodes into two pieces 1 and 2. the magnitudes of v_1 *and* v_2 (the final velocities) are completely arbitary. Directions of motion of the pieces are shown in column I and possible mass ratios are shown in column II**

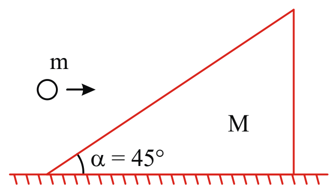
Column- I		column-II
A)		(p) $m_1 > m_2$
B)		(q) $m_1 = m_2$
C)		r) $m_1 < m_2$
D)		s) Impossible for any masses

INTEGER TYPE QUESTIONS

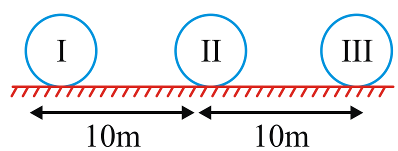
34. **A small ball of mass 'm' is connected by an inextensible mass less string of length ('l'=10m) with an another ball of mass M= 4m. They are released with zero tension in the string from a height h (h = 5m) as shown. Find the time when the string becomes taut for the first time after the mass 'M' collides with the ground is ——S. (Take all collisions to be elastic) ($g = 10m/s^2$)**



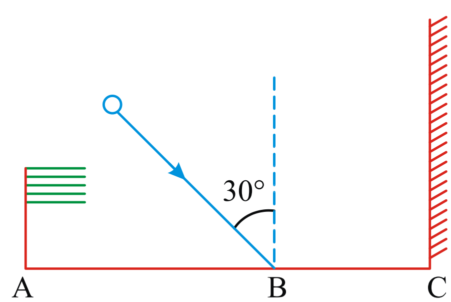
35. A small particle of mass m = 2 kg moving with constant horizontal velocity u = 10 m/s strikes a wedge shaped block of mass M = 4 kg placed on smooth horizontal surface on its inclined surface as shown in figure. After collision particle starts moving up the inclined plane. Calculate the velocity of wedge immediately after collision.



36. Three identical balls, ball I, ball II and ball III are placed on a smooth floor on a straight line at the separation of 10 m between balls as shown in figure. Initially balls are stationary. Ball I is given velocity of 10 m/s towards ball II. Collision between ball I and II is inelastic with coefficient of restitution 0.5 but collision between ball II and III is perfectly elastic. What is the time interval between two consecutive collisions between ball I and II?

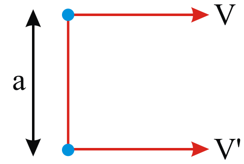


37. A ball collides at B with velocity 10 m/s at 30º with vertical. There is a flag at A and a will at C. Collision of ball with groundis perfectly inelastic (e = 0) and that with wall is elastic (e=1). Given AB = BC = 10 m. Find the time after which ball will collide with the flag.

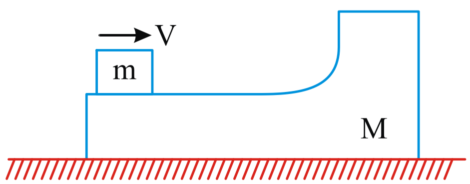


SUBJECTIVE TYPE QUESTIONS

38. Two particles of masses m and m' moving on parallel straight lines are at the distance 'a' apart with velocities v and $v'(v > v')$. The particles are connected by a string of lenth l (>a) which was loose in the beginning. Calculate the impulse of tension of the string when it becomes taut.



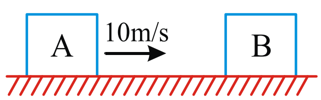
39. A body of mass M with a small block m placed on it rests on a smooth horizontal surface. The block is set in motion in the horizontal direction with a velocity v. To what height relative to the initial level will the block rise after breaking off from the body M. Friction can be assumed to be absent.



40. From a point on a smooth floor of a room a ball is shot to hit a wall. The ball then returns back to the point of projection. If the time taken by the ball in returning is twice the time taken to reach the wall, find the coefficient of restitution between wall and ball.

41. Stationary particles of mass m_2 is hit by another particles of mass m_1. The stationary particle deviates through θ and the other by 90°. Find the value of θ if the collision is perfectly elastic.

42. The blocks shown in figure have equal masses. The surface of A is smooth but that of B has a friction coefficient of 0.10 force with the floor. Block A is moving at a speed of 10 m/s towards B which is kept at rest. Find the distance travelled by B if (a) the collision is perfectly elastic and (b) the collision is perfectly inelastic. Take g = 10 m/s^2.



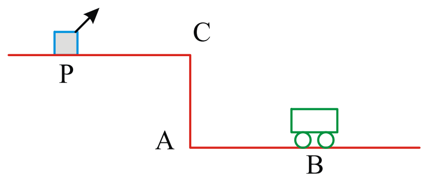
43. Two identical smooth balls are projected towards each other from points A and B on the horizontal ground with same speed of projection. The angle of projection in each case is 30°. The distance between A and B is 100m. The balls collide in air and return to their respective points of projection. If coefficient of restitution is e = 0.7, find

(a)the speeds of projection of either ball.

(b)coordinates of point with respect to a point of projection of A, where the balls collide.

(Take $g = 10\ m/s^2$)

44. A car P is moving with a uniform speed of $5\sqrt{3}$ m/s towards a carriage of mass 9 kg at rest kept on the rails at a point B as shown in fig. The height AC is 120 m. Cannon balls of 1 kg are fired from the car with an initial velocity 100 m/s at an angle 30^0 with the horizontal. The first cannon ball hits the stationary carriage after a time t_0 and sticks to it. Determine t_0. AT t_0, the second connon ball is fired. Assume that the resistive force between the rails and the carriage is constant and ignore the vertical motion of the carriage throughout. If the second ball also hits and sticks to the carriage, what will be the horizontal velocity of the carriage just after the second impact?

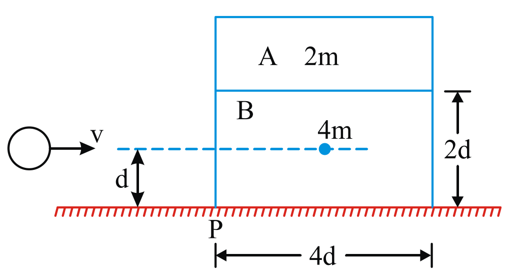


45. An object of mass 5 kg is projected with a velocity of 20 m/s at an angle of 60° to the horizontal. At the highest point of its path the projectile explodes and breaks up into two fragments of masses 1 kg and 4 kg. The fragments separate horizontally after the explosion. The explosion releases internal energy such that the kinetic energy of the system at the highest point is doubled. Calculate the separation between the two fragments when they reach the ground.

46. A block A of mass 2m is placed on another block B of mass 4m which in turn is Placed of a fixed table. The two blocks have a same length 4d and they are placed as shown in fig. The coefficient of friction (both static and kinetic) between the block B and table is m. There is no friction between the two blocks. A small object of mass m moving horizontally along a line passing through the centre of mass (CM) of the block B and perpendicular to its face with a speed v collides elastically with the block B at a height d above the table.

(a)What is the minimum value of v (call it v_0) required to make the block A topple?

(b)If $v = v_0$, find the distance (from the point P in the figure) at which the mass m falls on the table after collision. (Ignore the role of friction during the collision.)



EXERCISE - IV - KEY

SINGLE ANSWER TYPE

1.B 2.C 3.D 4.A 5. D 6.B 7.D

MULTIPLE ANSWER TYPE

8.A,B, C, D 9.A,B,C 10.B,C 11.A,C 12. A,B,C

COMPREHANSION TYPE

13.A 14.B 15.A 16.B 17.C 18.B 19.A 20.B 21.A 22.B

23.A 24.D 25.B 26.C 27.A 28.D 29.C 30.A

MATRIX MATCHING TYPE

31. A$\rightarrow$ r, B$\rightarrow$ s, C$\rightarrow$ q, D$\rightarrow$ p

32. A$\rightarrow$ q, B$\rightarrow$ p, C$\rightarrow$ r, D$\rightarrow$ t

33. A$\rightarrow$ s B$\rightarrow$ s C$\rightarrow$ p,q,r D$\rightarrow$ p,q,r

INTEGER ANSWER TYPE

34.1 35.2 36.4 37.6

SUBJECTIVE ANSWER TYPE

38. $\frac{mm'(v-v')\sqrt{l^2-a^2}}{(m+m')l}$ 39. $\frac{Mv^2}{2(M+m)g}$ 40. $\frac{1}{2}$

41. $\cos\theta = \sqrt{\frac{m_1+m_2}{2m_2}}$ 42. i) 50m ii) 12.5m

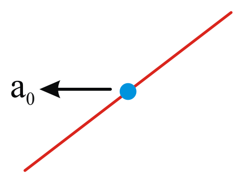
43. a) $\mu = 37.5\,m/s$ b) (50m, 17m) 44. 125, 15.75 m/s

45. 44.25m 46. a) $\frac{5}{2}\sqrt{6\mu gd}$ b) $6d\sqrt{3\mu}$

EXERCISE - I

SINGLE ANSWER QUESTIONS

1. **A bead of mass m moves on a rod without friction. Initially the bead is at the middle of the rod and the rod moves translationally in a vertical plane with an acceleration a_0 in a direction forming angle α with the rod. The acceleration of bead with respect to rod is**



(A) g sin α

(B) $(g + a_0)\sin\alpha$

(C) $g\sin\alpha + a_0\cos\alpha$

(D) $g\sin\alpha - a_0\cos\alpha$

2. **A particle is projected with a velocity '8 m/sec' at an angle '45^0' with the horizontal. What is the radius of curvature of the trajectory of the particle at the instant of '$\frac{1}{4}th$' of the time of ascent.**

(A) 6.25 m (B) 12.5 m (C) 8 m (D) 10 m

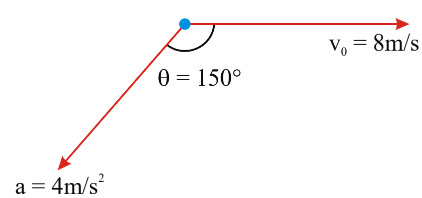
3. **A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time as $a_c = k^2rt^2$, where k is a constant. The power delivered to the particle by the forces acting on it is –**

(A) $2\pi mk^2r^2t$ (B) mk^2r^2t (C) $\frac{1}{3}mk^4r^2t^5$ (D) 0

4. **A particle is projected with a velocity '9m/sec' at an angle '45^0' with the horizontal. What is the radius of curvature of the trajectory of the particle at the position 'x=R/3' (R - Range of the projectile).**

(A) $3\sqrt{20}m$ (B) $3\sqrt{10}$ (C) $\frac{3\sqrt{10}}{2}m$ (D) $\frac{3}{4}\sqrt{10}m$

5. **The figure shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The minimum radius of curvature of trajectory of the body is**

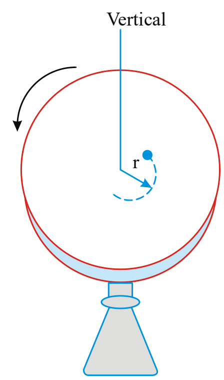


(A) 2 meter (B) 4 meter (C) 8 meter (D) 16 meter

6. **A stone is thrown horizontally with a velocity of 10m/sec. Find the radius of curvature of it's trajectory at the end of 3 s after motion began.** $\left(g = 10m/s^2\right)$

(A) $10\sqrt{10}\,m$ (B) $100\sqrt{10}\,m$ (C) $\sqrt{10}\,m$ (D) $100\,m$

7. **A small coin of mass 80g is placed on the horizontal surface of a rotating disc. The disc starts from rest and is given a constant angular acceleration $\alpha = 2rad/s^2$. The coefficient of static friction between the coin and the disc is $\mu_s = 3/4$ and coefficient of kinetic friction is $\mu_k = 0.5$. The coin is placed at a distance $r = 1m$ from the centre of the disc. The magnitude of the resultant force on the coin exerted by the disc just before it starts slipping on the disc is**

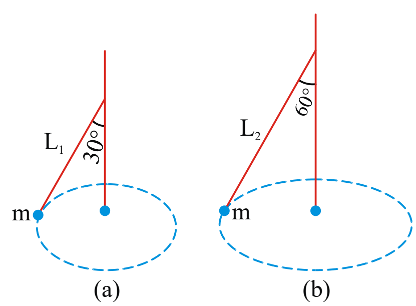


(A) 0.2 N (B) 0.3 N (C) 0.4 N (D) 1N

8. **Water of density 'ρ flows with a linear speed 'v' through a horizontal rubber tube having the form of a ring of radius 'R'. If the diameter of the tube is 'd' (d<<<<R). Then the tension developed in the rubber tube is**

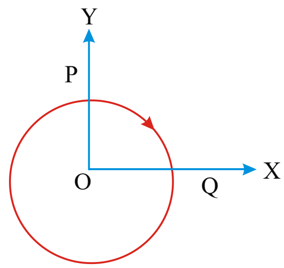
(A) $\frac{\pi d^2 \rho v^2}{4}$ (B) $\frac{\pi d^2 \rho v^2}{8}$ (C) $\frac{\pi d^2 \rho v^2}{6}$ (D) None

9. **Two particles tied to different strings are whirled in a horizontal circle as shown in figure. The ratio of lengths of the strings so that they complete their circular path with equal time periods is**



(A) $\sqrt{\frac{3}{2}}$ (B) $\sqrt{\frac{1}{3}}$ (C) 1 (D) $\sqrt{3}$

10. **A particle moves in a circle of radius 4cm clockwise at constant speed 2cm/sec. If $\hat{x}$ and $\hat{y}$ are unit acceleration vectors along x and y-axes respectively (in cm/sec²), the acceleration of the particle at the instant halfway between P and Q is given by**



(A) $-4(\hat{x}+\hat{y})$ (B) $4(\hat{x}+\hat{y})$ (C) $-(\hat{x}+\hat{y})\frac{1}{\sqrt{2}}$ (D) $(\hat{x}-\hat{y})4$

MULTIPLE ANSWER QUESTIONS

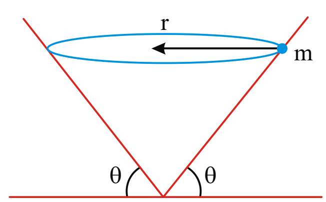
11. Regarding a frame attached to the Earth which of the following statement is wrong

(A) Is an inertial frame by definition
(B) Cannot be an inertial frame because the Earth is revolving around the sun
(C) is an inertial frame because Newton's laws of motion are applicable in this frame
(D) Cannot be inertial frame because the Earth is rotating about its own axis.

12. A particle is moving along a circular path of radius R such that radial acceleration of particle is proportional to t^2 then

(A) Speed of particle is constant
(B) Magnitude of tangential acceleration of particle is constant
(C) Speed of particle is proportional to time
(D) Magnitude of tangential acceleration is variable

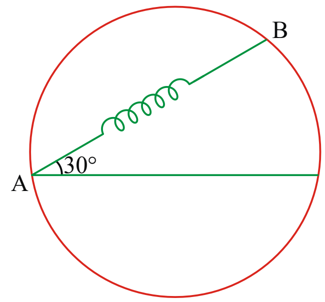
13. A ball of mass m is rotating in a circle of radius r with speed v inside a smooth cone as shown in figure. Let N be the normal reaction on the ball by the cone, then choose the correct option:



(A) $N\cos\theta = mg$ (B) $g\sin\theta = \frac{v^2}{r}\cos\theta$

(C) $N\sin\theta - \frac{mv^2}{r} = 0$ (D) None of these

14. A Bead of mass 'm' is attached to one end of a spring of natural length 'R' and spring cosntant '$k = \frac{(\sqrt{3}+1)mg}{R}$'. The other end of the spring is fixed at point 'A' on a smooth vertical ring of radius 'R' as shown.



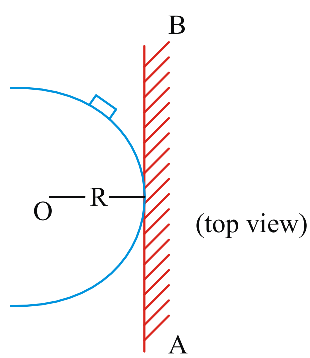
(A) The normal reaction at 'B' just after the bead is released to move is : $\frac{3\sqrt{3}mg}{2}$

(B) The tangential acceleration of the bead just after it is released to move is : g/2

(C) The normal reaction at 'B' just after the bead is released to move is : $\frac{3mg}{2}$

(D) Just after the bead is released to move the normal acceleration and Tangential acceleration are numerically equal.

15. As shown in figure 'AB' represents an infinite wall tangential to a horizontal semi circular track. 'O' is a point source of light on the ground at the centre of the circle. A block moves along the circular track with speed '*v*' starting from the point where the wall touches the circle. If the velocity and acceleration of shadow along the length of the wall is respectively 'V' and 'a' then;



(A) $V = v\cos\frac{vt}{R}$ (B) $V = v\sec^2\left(\frac{vt}{R}\right)$

(C) $a = \frac{v^2}{R}\sec^2\left(\frac{vt}{R}\right)\tan\left(\frac{vt}{R}\right)$ (D) $a = \frac{2v^2}{R}\sec^2\left(\frac{vt}{R}\right)\tan\left(\frac{vt}{R}\right)$

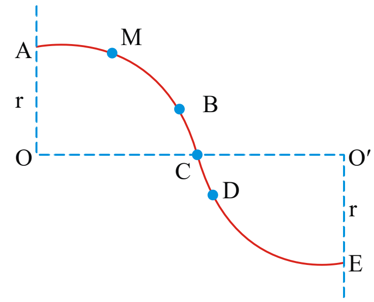
16. If a_r and a_t represent radial and tangential accelerations, the motion of a particle will be circular if:

(A) $a_r = 0$ and $a_t = 0$ (B) $a_r = 0$ and $a_t \neq 0$

(C) $a_r \neq 0$ and $a_t = 0$ (D) $a_r \neq 0$ and $a_t \neq 0$

17. ABCDE is a smooth iron track in the vertical plane. The sections ABC and CDE are quarter circles. Points B and D are very close to C. M is a small magnet of mass m. The force of attraction between M and the track is F, which is constant

and always normal to the track. M starts from rest at A, then:



(A) If M is not to leave the track at C, then F>2 mg
(B) AT B, the normal reaction ofthe track is F - 2 mg
(C) AT D, the normal reaction of hte track is F+2 mg
(D) The normal reaction of the track is equal to F at some point between A and M

COMPREHENSION TYPE QUESTIONS

PASSAGE-I:

When a cyclist turns on a circular path, the necessary centripetal force is provided by friction between the tyres and the road. If centripetal force is not provided by friction, then for the vehicle to move on circular path, the track is banked.

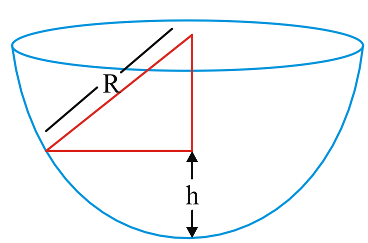
18. A cyclist going straight suddenly turns on wet road, then
(A) the cyclist is likely to skid
(B) the cyclist will skid only if his weight is less than the weight of cycle.
(C) the cyclist will skid if his weight is more than weight of cycle.
(D) cyclist will not skid at all.

19. The correct angle of banking for a curved smooth road of radius 120 m for a speed of 108 km/h ($g = 10\ ms^{-2}$) is
(A) 30^0 (B) 37^0 (C) 45^0 (D) 60^0

20. If the speed of a vehicle is doubled, then for safety of vehicle
(A) the angle of banking must be doubled
(B) the angle to banking must be four times
(C) the tangent of angle of banking must be doubled
(D) the tangent of angle of banking must be increased to four times.

PASSAGE-II:

A hemi spherical bowl of radius ‘R = 0.1 m’ is rotating about its own axis (which is vertical) with an angular velocity ‘ω’. A particle of mass ‘10^{-2} kg’ on the friction less inner surface of the bowl is also rotating with same ‘ω’. The particle is at a height ‘h’ from the bottom of the bowl.



21. The relation between ‘h’ and ‘ω’ is

(A) $h = \frac{\omega^2}{g}$ (B) $h = \frac{R}{2}$ (C) $h = R - \frac{g}{\omega^2}$ (D) None

22. The minimum value of 'ω' which is needed in order to have a non-zero value of 'h'

(A) $\sqrt{\frac{g}{R}}$ (B) $\sqrt{\frac{g}{2R}}$ (C) $\sqrt{\frac{g}{3R}}$ (D) None

23. It is desired to measure 'g' using this set up, by measuring 'h' accurately. Assuming 'r' and 'ω' are known precisely and that the least count in the measurement of 'h' is '$10^{-4}m$'. The minimum possible error in the measured value of 'g' is (g = 9.8 m/sec^2).

(A) $9.8\times10^{-3} m/\sec^2$ (B) $-9.8\times10^{-3} m/\sec^2$

(C) $4.9\times10^{-3} m/\sec^2$ (D) $5.9\times10^{-3} m/\sec^2$

PASSAGE-III:

Two blocks of mass $m_1 = 10kg$ and $m_2 = 5kg$, connected to each other by a massless inextensible string of length 0.3m are placed along a diameter of a turn table. The coefficient of friction between the table and m_1 is 0.5 while there is no friction between m_2 and the table. The table is rotating with an angular velocity of 10rad/s about a vertical axis passing through its centre O. The masses are placed along the diameter of the table on either side of the centre O such that the mass m_1 is at a distance 0.124m from O. The masses are observed to be at rest with respect to an observer on the turn table.

24. Calculate the fricitonal force on m_1

(A) 28 N (B) 32 N (C) 36 N (D) 40 N

25. What should be the minimum angular speed of the turn table so that the masses will slip from this position?

(A) 12.82 rad/s (B) 10.28 rad/s (C) 13.56 rad/s (D) 11.67 rad/s

26. How should the masses be placed with the string remaining taut, so that there is no frictional force acting on the mass m_1?

(A) 0.2 m (B) 0.3 m (C) 0.4 m (D) 0.5 m

MATRIX MATCHING TYPE QUESTIONS

This section contains 1 question. Each question contains statements given in two column which have to be matched. Statements (A, B, C, D) in **Column-I** have to be matched with statements (p, q, r, s) in **Column-II**. The answers to these questions have to be appropriately bubbles as illustrated in the following example. If the correct matches are A–p, A–s, B–q, B–r, C–p, C–q and D–s, then the correctly bubbled 4 × 4 matrix should be as follows :

27. In column-1 condition on velocity, force and acceleration of a particle is given. Resultant motion is described in column-II. $\vec{u}$ is initial velocity, $\vec{F}$ is resultant force and $\vec{v}$ is instantaneous velocity.

Column-I	**Column-II**
(A) $\vec{u}\times\vec{F}=0$ and $\vec{F}$ = constant	(p) path will be circular
(B) $\vec{u}.\vec{F}=0$ and $\vec{F}$ = constant	(q) speed will increase
(C) $\vec{v}.\vec{F}=0$ all the time and $\left\|\vec{F}\right\|$=constant and the particle always remains in one plane	(r) path will be straight line
(D) $\vec{u}=2\hat{i}-3\hat{j}$ and acceleration at all time $\vec{a}=6\hat{i}-9\hat{j}$	(s) path will be parabolic
	(t) speed will be constant

28. **A particle is moving with speed $v=4t$ on the circumference of circle of radius R, Match the quantities given in column-I with corresponding results in column-II**

Column-I	**Column-II**
(A) Magnitude of tangetial acceleraiton particle	(p) decreases with of time
(B) Magnitude of centripetal acceleration of particle	(q) increases with time
(C) Magnitude of angular speed of particle with respect to centre of circle	(r) remains constant
(D) Angle between the total acceleration vector and centripetal acceleration vector of particle	(s) decreases as value of 'R' increases
	t) increases as value of radius R increases

INTEGER ANSWER TYPE QUESTIONS

29. **What is the radius of curvature of the parabola traced out by the projectile. Projected with a speed $u=\sqrt{30}$ at angle $\theta=60^\circ$ with the horizontal at a point where the particle velocity makes an angle $\theta/2$ with the horizontal ?**

30. **An automobile moving with a speed of 10m/s enters an unbanked curve of radius r = 50m. If g=10m/s^2, the maximum value of μ so as to safely negotiate the curve is 1/x. Then x=**

EXERCISE - I - KEY

SINGLE ANSWER QUESTIONS

1. D 2. A 3. B 4. C 5. B 6. B 7. D 8. A 9. B 10. C

MULTIPLE ANSWER QUESTIONS

11. A&C 12. B&C 13. ABC 14. AB 15. B&D

16. C&D 17. BCD

COMPREHENSION TYPE QUESTIONS

18. A 19. B 20. D 21. C 22. A 23. B 24. C 25. D 26. A

MATRIX MATCHING QUESTIONS

27. A-r,B-q,sC-p,t,D-q,r 28. A-r,B-q,s,C-q,s,D-p,t

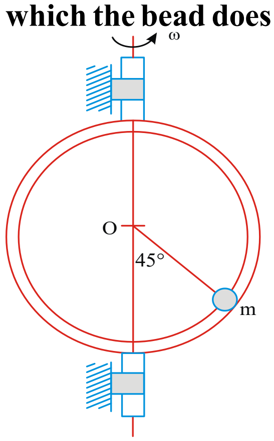
INTEGER ANSWER TYPE QUESTIONS

29. 1 30. 5

EXERCISE - II

SINGLE ANSWER QUESTIONS

1. **A small bead of mass m is carried by a circular hoop having centre at O and radius = $\sqrt{2}$ m which rotates about a fixed vertical axis. The coefficient of friction between beed and hoop is $\mu = 0.5$. The maximum angular speed of the hoop for which the bead does not have relative motion with respect to hoop.** $\left(g = 10m/s^2\right)$



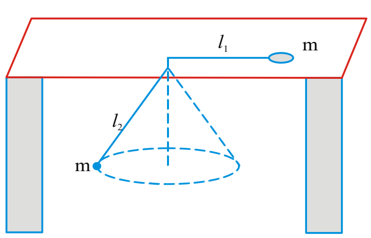
(A) $\sqrt{5}$

(B) $\sqrt{10}$

(C) $\sqrt{15}$

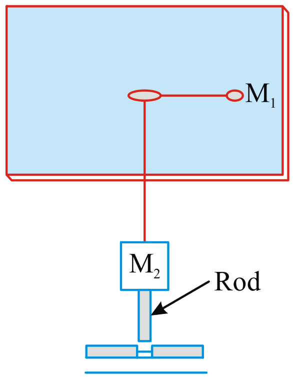
(D) $\sqrt{30}$

2. **Two identical particles are attached at the ends of a light string which passes through a hole at the centre of a table another particle on the table is made to revolve with angular velocity ω_1. One of the particles is made to move in a horizontal circle as a conical pendulum with angular velocity ω_2. If l_1 and l_2 are the length of the string over and under the table, then in order that particle under the table neither moves down nor moves up the ratio $\frac{l_1}{l_2}$ is :**



1) $\frac{\omega_1}{\omega_2}$ 2) $\frac{\omega_2}{\omega_1}$ 3) $\frac{\omega_1^2}{\omega_2^2}$ 4) $\frac{\omega_2^2}{\omega_1^2}$

3. **For the arrangement in the Figure, the particle M_1 attached to one end of a string which moves on a horizontal table in a circle of radius = $\frac{l}{2}$ (where l is the length of the string) with constant angular speed ω. The other end of the string attached to mass M_2 which rest on a vertical rod. When the rod collapse, the acceleration of mass M_2 at that instant**



1) g

2) $\frac{\omega^2 l}{2}$

3) $\frac{2M_2 g - M_1 l\omega^2}{2(M_1+M_2)}$

4) $\frac{M_2 g + M_1 l\omega^2}{M_1+M_2}$

4. **Two particles A and B separated by a distance 2R are moving counter clockwise along the same circular path of radius R each with uniform speed v. At time $t=0$, A is given a tangential acceleration of magnitude $a=\frac{32v^2}{25\pi R}$ in the same direction of initial velocity**

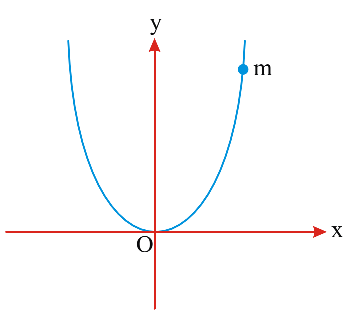
(A) The time lapse for the two bodies to collide is $\frac{6\pi R}{5V}$

(B) The angle covered by A is $\frac{9\pi}{4}$

(C) Angular velocity of A is $\frac{11V}{5R}$

(D) Radial acceleration of A is $\frac{289v^2}{5R}$

5. **A bead of mass m is located on a parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equation is $x^2=4ay$. The wire frame is fixed and the bead can slide on it without friction. The bead is released from the point $y=4a$ on the wire frame from rest. The tangential acceleration of the bead when it reaches the position given by $y=a$ is**



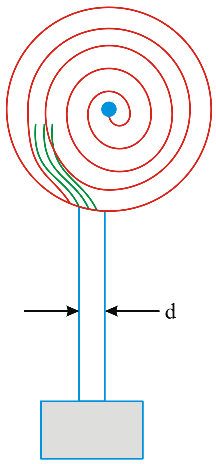
(A) $\frac{g}{2}$

(B) $\frac{\sqrt{3}g}{2}$

(C) $\frac{g}{\sqrt{2}}$

(D) g

6. **A mass 1kg attached to the end of a flexible rope of diameter $d = 0.25\,m$ is raised vertically by winding the rope on a reel as shown. If the reel is turned uniformly at the rate of 2 r.p.s. What is the tension in rope. The inertia of rope may be neglected.**



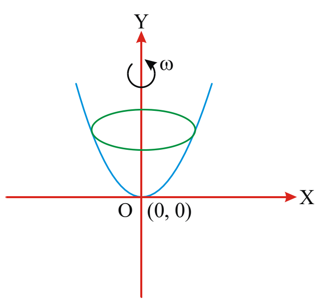
(A) 16.28 N

(B) 10N

(C) 20 N

(D) 1 N

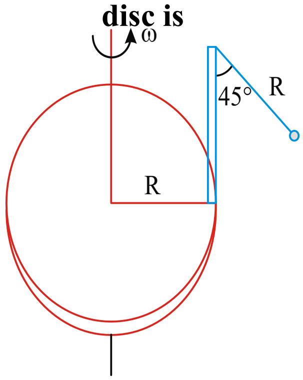
7. **In the given figure, a smooth parabolic wire track lies in the xy-plane (vertical). The shape of track is defined by the equation $y = x^2$. A ring of mass m which can slide freely on the wire track, is placed at the position A (1,1). The track is rotated with constant angular speed ω such that there is no relative slipping between the ring and the track. The value of ω is**



1) $\sqrt{g/2}$ 2) $\sqrt{g}$

3) $\sqrt{2g}$ 4) $2\sqrt{g}$

8. **A disc of radius R has a light pole fixed perpendicular to the disc at the circumference which in turn has a pendulum of length R attached to its other end as shown in figure. The disc is rotated with a constant angualr velocity ω. The string is making an angle 45^0 with the rod. Then the angular velocity ω of disc is**



(A) $\left(\dfrac{\sqrt{3}g}{R}\right)^{1/2}$ (B) $\left(\dfrac{\sqrt{3}g}{2R}\right)^{1/2}$

(C) $\left(\dfrac{g}{\sqrt{3}R}\right)^{1/2}$ (D) $\left(\dfrac{\sqrt{2}g}{\left(\sqrt{2}+1\right)R}\right)^{1/2}$

9. **A particle travels along the arc of a circle of radius r. Its speed depends on the distance travelled *l* as $v = a\sqrt{l}$, where 'a' is a constant. The angle α between the vectors of total acceleration and the velocity of the particle is**

(A) $\alpha = \tan^{-1}(2l/r)$ (B) $\alpha = \cos^{-1}(2l/r)$

(C) $\alpha = \sin^{-1}(2l/r)$ (D) $\alpha = \cot^{-1}(2l/r)$

10. A Particle is moving in a circle of radius R in such a way that at any instant the normal and tangential component of the acceleration are equal. If its speed at $t = 0$ is u_0, the time taken to complete the first revolution is

(a) R/u_0 (b) $u_0 R$ (c) $\frac{R}{u_0}\left(1-e^{-2\pi}\right)$ (d) $\frac{R}{u_0}e^{-2\pi}$

MULTIPLE ANSWER TYPE QUESTIONS

11. Particle A moves with 4m/s along positive y-axis and particle B in a circle $x^2 + y^2 = 4$ (anticlockwise) with constant angular velocity $\omega = 2rad/s$. At time *t = 0* particle is at (2m,0). Then

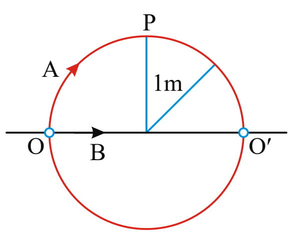
A) magnitude of relative velocity between them at time t is $8\sin t$

B) magnitude of relative velocity between them is maximum at $t = \frac{\pi}{4}s$

C) magnitude of relative velocity between them is maximum at $t = \frac{\pi}{2}s$

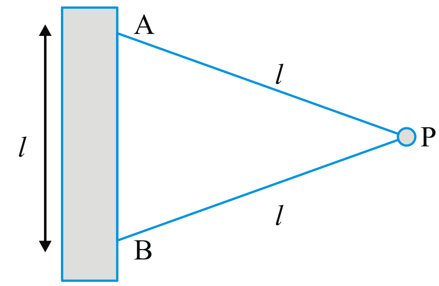
D) magnitude of relative velocity between them at time t is $8\sin 2t$

12. **A particle 'A' moves along a circle with a velocity $v = at$, where $a = 0.50m/s^2$. Another particle B moves along a diameter OO' of the circle with the velocity $v = at$. Both the particles start simultaneously at $t = 0$ from the point O on the circle . For these particles, (the radius of circle = 1m).**



(A) The velocity of B relative to A at the instant when A is at the point O' is zero.
(B) The velocity of B relative to A when A is at P for the first time is zero.
(C) The velocity vector of A with respect to B has zero component along the vector direction OO' at all times.
(D) The distances moved by A and B in their respective paths are the same at all times.

13. A particle P of mass m is attached to a vertical axis by two strings AP and BP of length *l* each. The separation *AB=l, P* rotates around the axis with an angular velocity ω. The tensions in the two strings are T_1 and T_2 . Then



(A) $T_1 = T_2$ (B) $T_1 + T_2 = m\omega^2 l$

(C) $T_1 - T_2 = 2mg$

(D) BP will remain taut only if $\omega \geq \sqrt{2g/l}$

14. A body moves on a horizontal circular road of radius r, with a tangential acceleration a_T. Coefficient of friction between the body and road surface is u. It begin to slip when it's speed is v, then:

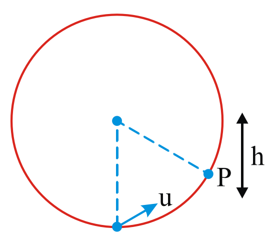
(a) $v^2 = \mu rg$ (b) $\mu g = \frac{v^2}{r} + a_T$ (c) $\mu^2 g^2 = \frac{v^4}{r^2} + a_T^2$

(d) The force of friction makes an angle $\tan^{-1}\left(\frac{v^2}{a_T \times r}\right)$ with direction of motion at point of slipping.

COMPREHENSION TYPE QUESTIONS

PASSAGE-I:

A particle of mass M attached to an inextensible string is moving in a vertical circle of radius. R about fixed point O. It is imparted a velocity u in horizontal direction at lowest position as shown in figure.



Following information is being given

(i) Velocity at a height h can be calculated by using formula $v^2 = u^2 - 2gh$

(ii) Particle will complete the circle if $u \geq \sqrt{5gR}$

(iii) Particle will oscillates in lower half $\left(0^0 < \theta \leq 90^0\right)$ if $0 < u \leq \sqrt{2gR}$

(iv) The magnitude of tension at a height 'h' is calculated by using formula $T = \frac{M}{R}\left[u^2 + \left[gR - 3gh\right]\right]$

15. **If** $R = 2m, M = 2kg$ **and** $u = 12m/s$**. Then value of tension at lowest position is**

(A) 120 N (B) 164 N (C) 264 N (D) zero

16. **Tension at highest point of its trajectory in above question will be**

(A) 100 N (B) 44 N (C) 144 N (D) 264 N

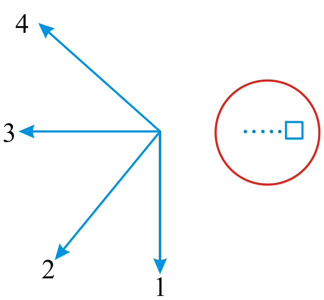
17. **If** $M = 2kg, R = 2m$ **and** $u = 10m/s$**. Then velocity of particle when** $\theta = 60^0$ **is**

(A) $2\sqrt{5}\ m/s$ (B) $4\sqrt{5}\ m/s$ (C) $5\sqrt{2}\ m/s$ (D) $5\ m/s$

MATRIX MATCHING TYPE QUESTIONS

This section contains 1 question. Each question contains statements given in two column which have to be matched. Statements (A, B, C, D) in **Column I** have to be matched with statements (p, q, r, s) in **Column II**. The answers to these questions have to be appropriately bubbles as illustrated in the following example. If the correct matches are A–p, A–s, B–q, B–r, C–p, C–q and D–s, then the correctly bubbled 4 × 4 matrix should be as follows

18. **A block is placed on a horizontal table which can rotate about its axis. A block is placed at a certain distance from centre as shown in figure. Table rotates such that particle does not slide. Select possible direction of net acceleration of block at the instant shown in figure.Then match the column.**



Column I	Column-II
(a) When rotation is clockwise with constant ω	p) 1
(b) When rotation is clockwise with decreasing ω	q) 2
(c) When rotation is clockwise with increasing ω	r) 3
(d) Just after clockwise rotation begins from rest	s) 4

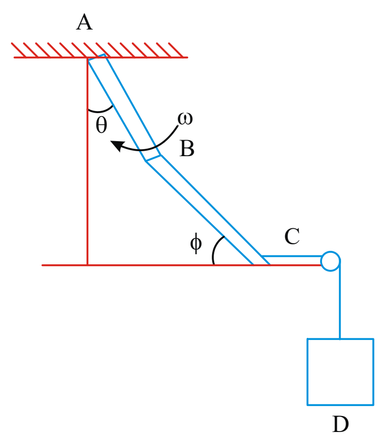
19. **A particle of 500 gm mass moves along a horizontal circle of radius 16m such that normal acceleration of particle varies with time as** $a_n = 9t^2$

Column - I	Column-II
(a) Tangential force on particle at t = 1 second (in newton)	p) 72
(b) Total force on particle at t = 1 second (in newton)	q) 36

(c) Power delivered by total force at t = 1 sec (in watt) r) 75

(d) Averge power developed by total force over first one second (in watt) s) 6

20. **Two light rods oflength '1m' each are hinged together as shown in figure. Rod 'AB' makes an angle θ with the vertical while rod 'BC' makes an anlge ϕ with horizontal. End 'C' of the rod 'BC' remains in contact with horizontal. Rod 'AB' is rotated with constat angular velocity $\omega = 1$ $\omega = 1 rad/\sec$ in clock wise direction. At the instant $\theta = 30^0$ and $\phi = 30^0$ match the variable in column 'I' with column'II'**



Column - I

a) Angular velocity of rod 'BC' in rad/sec

b) magnitude of angular acceleration of rod

c) magnitude of angular acceleration of rod 'BC' in rad/sec^2

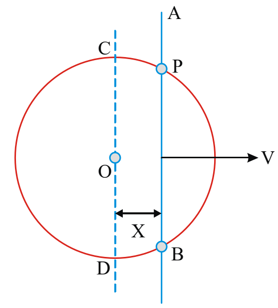
d) acceleration of point 'B' in m/sec^2

Column - II

p) $\dfrac{\left(3\sqrt{3}+1\right)}{3\sqrt{3}}$ q) $\dfrac{\sqrt{3}-1}{\sqrt{6}}$ r) $\dfrac{1}{\sqrt{3}}$ s) 1 t) 0

INTEGER ANSWER TYPE QUESTIONS

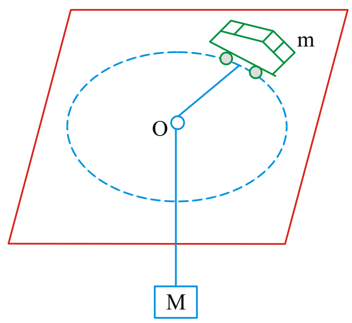
21. **A rod AB is moving on a fixed circle of radius R=5m with constant velocity $v = 4m/s$ as shown in figure. P is the point of intersection of the rod and the circle. At an instant the rod is at a distance $x = \dfrac{3R}{5}$ from centre of the circle. The velocity of the rod is perpendicular to its length and the rod is always parallel to the diameter (CD)**



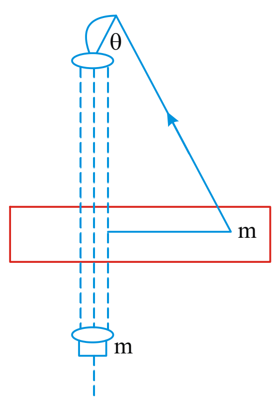
Speed of point of intersection P is

22. **In the above probelm angular speed of pointof intersection P with respect to centre is**

23. **A toy car of mass m can travel at a fixed speed. It moves in a circle on a fixed horizontal table. A string is connected to the car and attached to a block of mass M that hangs as shown in figure (the portion of string below the table is always vertical). The coefficient of friction between the surface of table and tyres of the toy car is μ. Find the ratio of the maximum radius to the minimum radius for which the toy car can move in a circular path with centre O on table. (Given $M = 3kg; m = 2kg; \mu = 1/2$)**

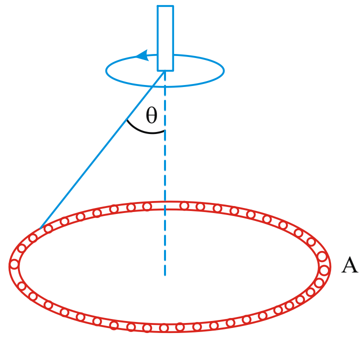


24. **A large mass *M* and a small mass m hang at the two ends of string that passes through a smooth tube as shown in fig. The mass m moves around in a circular path which lies in a horizontal plane. The length of the string from the mass m to the top of the tube is of length *l* and θ is the angle, this length makes with the vertical, what should be the frequency of rotation of the mass m so that *M* remains stationary if M=16kg, m=4kg, *l*=1m and $g = \pi^2 m/s^2$**

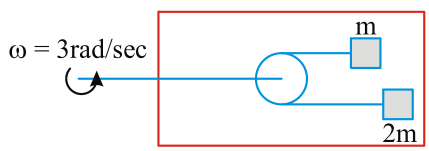


25) **A closed chain A of mass m = 0.36kg is attached to a vertical rotating shaft by**

means of thread showin in fig. and rotates with a constant angular velocity $\omega = 35 rad/s$. The thread forms an angle $\theta = 45^0$ with the vertical. Then the tension of the thread is



26) **A table with smooth horizontal surface is placed in a cabin which moves in a circle of a large radius R = 100 m, with $\omega = 3rad/s$ (see figure). A smooth pulley of small radius is fastened to the table. Two masses m and 2m placed on the table are connected through a string going over the pulley. Initially the masses are held by a person with the strings along the outward radius and then the system is released from rest (with respect to the cabin). Then the magnitude of the initial acceleration of the mass m as seen from the cabin is $n \times 100$. Find n.**



27. **A solid body starts rotating about a stationary axis with an angular acceleration $\beta = at$ where a = 2 x 10^{-2} rad/ sec^2. How soon the begining of rotation will the total acceleration vector of a arbitory point of the body from an angle α = 60^0 with its velocity vector?**

EXERCISE - II - KEY

SINGLE ANSWER QUESTIONS

1. D 2. D 3. C 4. B 5. C 6. A 7. C 8. D 9. A 10. C

MULTIPLE ANSWER QUESTIONS

11. AC 12. BD 13. BCD 14. BC

COMPREHENSION TYPE

15. B 16. B 17. B

MATRIX MATCHING QUESTIONS

18. A-r,B-s,C-q,D-p 19. A-s,B-r,C-p,D-q 20. A-r, B-r, C-p, D-s

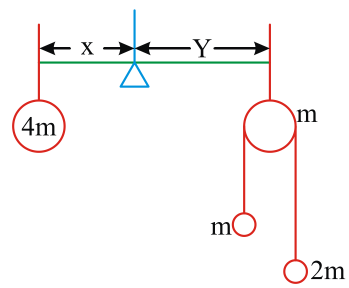
INTEGER ANSWER QUESTIONS

21. 5 22. 1 23. 2 24. 1 25. 5 26. 3 27. 7

EXERCISE - III

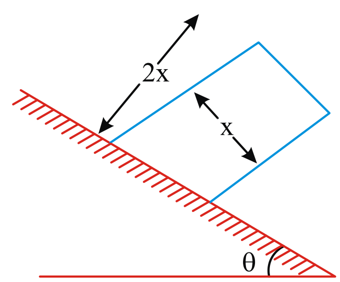
SINGLE ANSWER QUESTIONS

1. **A rigid massless beam is balanced by a particle of mass $4m$ in left hand side and a pulley particle system in right hand side. The value of $\frac{x}{y}$ is:**



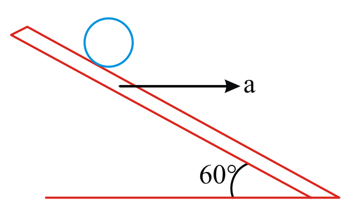
(a) $\frac{7}{6}$ (b) $\frac{5}{6}$ (c) $1:1$ (d) 11/12

2. **A uniform box is kept on a rough inclined plane. It begins to topple when θ is equal to :**



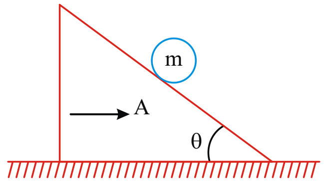
(a) 30^0 (b) 60^0 (c) $\tan^{-1}\frac{1}{2}$ (d) 45°

3. **A rod touches a disc kept on a smooth horizontal plane. If the rod moves with an accleration a, the disc rolls on the rod without sliding.Then, the acceleration of the disc is**



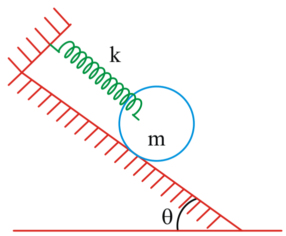
(a) $\frac{a}{3}$ (b) $\frac{\sqrt{3}a}{2}$ (c) zero (d) a/2

4. **A uniform cylinder of mass m is kept on an accelerating wedge. If the wedge moves with an acceleration $a = 3g\tan\theta$, the minimum coefficient of friction between the cylinder and wedge to avoid relative sliding between them is**



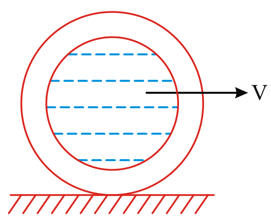
(a) $\frac{2}{3}\tan\theta$ (b) $\frac{2}{9}\tan\theta$ (c) $\frac{1}{6}\tan\theta$ (d) none of these

5. A disc of mass m is connected with an ideal spring of stiffness k. If it is released from rest., it rolls without sliding on an inclined plane. The maximum elongation of the spring is :



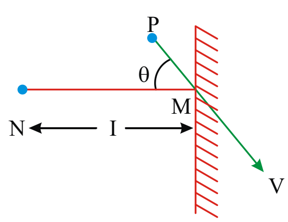
(a) $\frac{mg\sin\theta}{k}$ (b) $\frac{2mg\sin\theta}{3k}$ (c) $\frac{3mg\sin\theta}{k}$ (d) $\frac{2mg\sin\theta}{k}$

6. A massless thin hollow sphere is completely filled with water of mass m. If the hollow sphere rolls with a velocity v. the kinetic energy of the sphere of water is :(Asune water is non viscous)



(a) $\frac{1}{2}mv^2$ (b) $\frac{1}{3}mv^2$ (c) $\frac{7}{10}mv^2$ (d) $\frac{5}{6}mv^2$

7. A particle P collides elastically at M with a speed v. The change in angular momentum of the particle about the point N during collision is :



(a) $2mvl\cos\theta\downarrow$ (b) $2mvl\cos\theta\uparrow$ (c) zero (d) $mvl\cos\theta\uparrow$

8. Aball is attached to a string that is attached to a thick pole. When the ball is hit, the string warps around the pole and the ball spirals inwards sliding on the frictionless surface. Neglecting air resistance, what happens as the ball swings around the pole?

(a) The mechnical energy and angular momentum are conserved

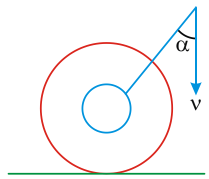
(b) The angular momentum of the ball is conserved at the mechanical energy of the ball increases

(c) The angular momentum of the ball is conserved and the mechanical energy of the ball decreases

(d) The mechanical energy of the ball is conserved and angular momentum of the ball decreases

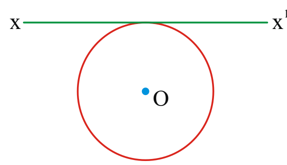
9. The free end of a thread wound on a bobbin is passed round a nail A hammered into the wall. The thread is pulled at a constant velocity'v' Assuming pure rolling of bobbin, find the

velocity v_0 of the centre of the bobbin at the instant when the thread forms an angle α with the vertical:(R and r are outer and inner radii off the babbin)



(a) $\frac{vR}{R\sin\alpha - r}$ (b) $\frac{vR}{R\sin\alpha + r}$ (c) $\frac{2vR}{R\sin\alpha + r}$ (d) $\frac{v}{R\sin\alpha + r}$

10. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is :



(a) $\frac{\rho L^3}{8\pi^2}$ (b) $\frac{\rho L^3}{16\pi^2}$ (c) $\frac{5\rho L^3}{16\pi^2}$ (d) $\frac{3\rho L^3}{8\pi^2}$

11. A particle moves in a circular path with decreasing speed. Choose the correct statement

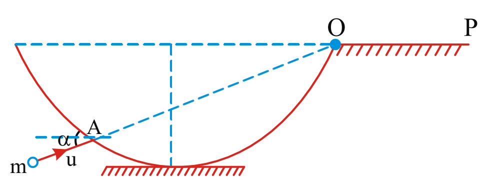
(a) Angular momentum remains constant

(b) Acceleration $(\vec{a})$ is towards the centre

(c) Particle moves in a spiral path wth decreasing radius

(d) The direction of angular momentum remains constant

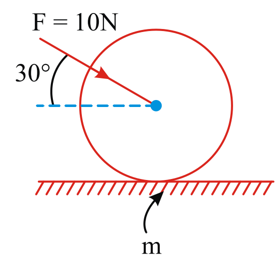
12. A hemispherical shell of mass M and radius R is hinged at point O and palced on a horizontal surface. A ball of mass M moving with a velocity *u* inclined at an angle $\theta = \tan^{-1}\left(\frac{1}{2}\right)$ strikes the shell at point A (as shown in the figure) and stops. What is the minimum speed *u* if the given shell is to reach the horizontal surface OP?



(a) Zero (b) $\sqrt{\frac{2gR}{3}}$ (c) $\frac{gR}{\sqrt{5}}$

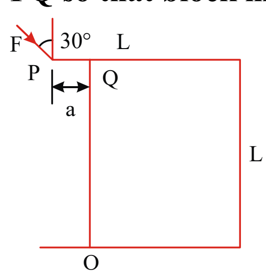
d) it cannot come on the surface for any value of u

13. A hollow sphere of mass 2kg is kept on a rough horizontal surface. A force of 10 N is applied at the centre of the sphere as shown in the figure. Find the minimum value of μ so that the sphere starts pure rolling. (Take g=10m/s^2)



(a) $\sqrt{3}\times 0.16$ (b) $\sqrt{3}\times 0.08$ (c) $\sqrt{3}\times 0.1$ (d) Data insufficient

14. A cubical block of side L and mass m is placed on a horizontal floor. In the arrangement as shown, a force F is applied at the end of the plane sheet PQ which is firmly attached with the block. What should be the minimum value of PQ so that block may be tipped about an edge?



(a) $L/\sqrt{3}$

(b) $L/\sqrt{2}$

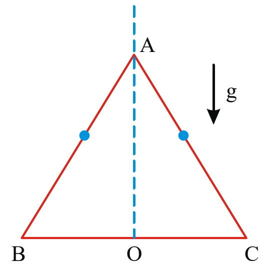
(c) $L\sqrt{2}/3$

(d) $L\sqrt{3}/\sqrt{2}$

15. A rigid body of moment of inertial I is projected with velocity V making an angle of 45^0 with horizontal. The magnitude of angular momentum of the projectile about the point of projection when the body is at its maximum height is given by $\frac{IV^3}{2\sqrt{2}gR^2}$ where R is the radius of the rigid body. The ridid body is:

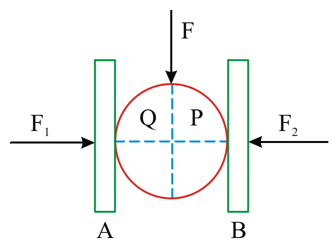
(a) sphere (b)spherical shell (c) disc (d) none of these

16. An equilateral triangle ABC formed a uniform wire has two small identical beads initially located at A. The triangle is set rotating about the vertical axis AO.Then the beads are relased from rest simultanously and allowed to slide down,one along Ab and other AC as shown.Meglecting frictional effects,the quantities that are conserved as beads slides down are:



(a) angular velocity and total energy(kinetic and potential)
(b) total angular momentum and moment of interia about the axis of rotation
(c) angular velocity and moment of interia about the aixs of rotation
(d) total angular momentum and total energy

17. On a smooth horizontal table, a sphere is pressed by blocks A and B by forces F_1 and F_2 respectively $(F_1 > F_2)$ exactly normal to the tangent at the point of contact of blocks and sphere. A force F is applied on the sphere along a diameter perpendicular to another diameter OP, which is the line of action of forces F_1 and F_2. The sphere moves out of block A and B. FInd minimum value of F. the coefficient of friction is μ at all contacts:



(a) $\frac{\mu}{2}(7F_1 - 3F_2)$ (b) $\frac{\mu}{2}(5F_1 - 3F_2)$ (c) $\mu(3F_1 - F_2)$ (d) $\frac{\mu}{2}(3F_1 - F_2)$

18. Consider the following statements:

s_1 : Zero net torque on a body means always absence of rotational motion of the body.

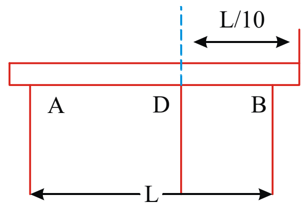
s_2 : A particle may have angular momentum even though the particle is not moving in a circle.

s_3 : A ring of rolling without sliding on a fixed surface. the centripetal acceleration of each particle with respect to the centre of the ring is same.

State in order, whether s_1, s_2, s_3 are ture or false.

(a) FTT (b) FFT (c) TTF (d) FTF

19. A uniform rod of length L (in between the supports) and mass m is placed on two suports A and B. The rod breaks suddenly at length L/10 from the support B. Find the reaction at support A immediately after the rod breaks.

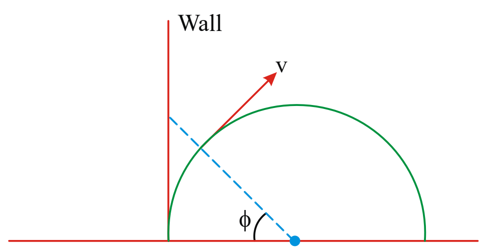


A) $\frac{9}{40}mg$ B) $\frac{19}{40}mg$ C) $\frac{mg}{2}$ D) $\frac{9}{20}mg$

20. **A uniform disc of mass m and radius R is rolling up a rough inclined plane which makes an angle of 30^0 with the horizontal. If the coefficients of static and kinetic friction are each equal to μ and the only forces acting are gravitatinal and frictional, then value of μ for maximum magnitude of the frictional force acting on the disc is**

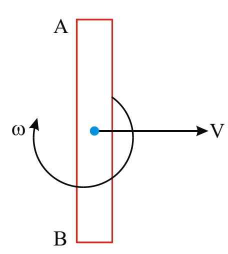
A) $\frac{1}{\sqrt{3}}$ B) $\frac{1}{2\sqrt{3}}$ C) $\frac{1}{3\sqrt{3}}$ D) $\frac{1}{3}$

21. **On a particle moving on a circular path with a constant speed v, light is thrown from a projectors placed at the centre of the circular path. The shadow of the particle is formed on the wall. The velocity of shadow up the wall is**



(A) $v\sec^2\varphi$ (B) $v\cos^2\varphi$ (C) $v\cos\varphi$ (D) None of these

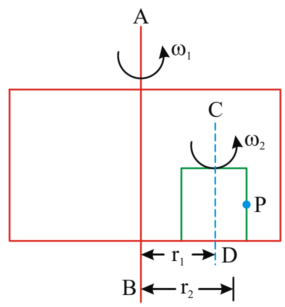
22. **A rod of length l is travelling with velocity v and rotating with angular velocity ω such that $\frac{\omega l}{2} = v$. The distance travelled by end B of the rod when rod rotates by an angle, $\frac{\pi}{2}$ is**



(a) $\sqrt{2}l$ (b) $\frac{5}{2}l$ (c) $3l$ (d) $4l$

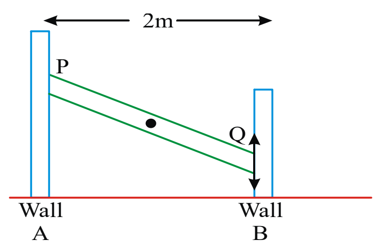
23. **A large rectangular box has been rotated with a constant angular velocity ω_1 about its axis as shown in the figure. Another small box kept inside the**

bigger box is rotated in the same sense with angular velocity ω_2 about its axis (which is fixed to floor of bigger box). A particle *P* has been identified, its angular velocity about
***AB* would be**



(A) $\frac{\omega_2(r_2 - r_1) + \omega_1 r_2}{r_2}$ (B) $\frac{\omega_2(r_2 - r_1) + \omega_1 r_1}{r_2}$ (C) ω_1 (D) ω_2

24 . **Two vertical walls are separated by a distance of 2 metres. Wall 'A' is smooth while wall B is rough with a coefficient of friction $\mu = 0.5$ A uniform rod is probed between them. The length of the longest rod that can be probed between the walls is equal to**

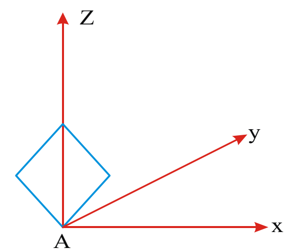


(a) 2 metres (b) $2\sqrt{2}$ metres (c) $\sqrt{2}$ metres (d) $\frac{\sqrt{17}}{2}$ *metres*

25. **A disc is rotating at an angular velocity ω_0. A constant retardation torque is applied on it to stop the disc. After a certain time at which some number of rotation of the disc have been performed so that total angle rotated is θ_1 and that only $\frac{2}{3}$ th of these rotatios will further stop the disc. Find the retarding force.**

a) $\frac{11\omega_0^2}{14\theta_1}$ 2) $\frac{9\omega_0^2}{14\theta_1}$ 3) $\frac{5\omega_0^2}{14\theta_1}$ 4) $\frac{3\omega_0^2}{14\theta_1}$

26. **A square plate hinged at A, of side a and mas M is placed in $(x-z)$ plane. The plate is allowed to fall upto $(x-y)$ plane. Find its angular velocity.**



a) $\left[\frac{3g}{a\sqrt{2}}\right]^{1/2}$ b) $\left[\frac{24g}{7a}\right]^{1/2}$ c) $\left[\frac{12g}{7a}\right]^{1/2}$ d) $\left[\frac{12g}{7\sqrt{2}a}\right]^{1/2}$

27. A disc of mass m and radius r is placed on a rough horizotal surface. A cue of mass m hits the disc at a height h from the axis passing through centre and parallel to the surface. The disc will start pure rolling for.

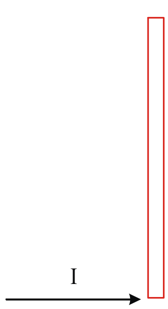
a) $h < \frac{r}{3}$ b) $h = \frac{r}{2}$ c) $h > \frac{r}{2}$ d) $h \geq \frac{r}{2}$

MULTIPLE ANSWER QUESTIONS

28. A solid cylinder is rolling down the inclined plane without slipping. Which of the following is/are correct

(a) The friction force is dissipative
(b) The friction force is necessarily changing
(c) The friction force will aid rotation but opposes translation
(d) The friction force is reduced if θ is reduced

29. An impulse I is applied at the end of a uniform rod if mass m. then :



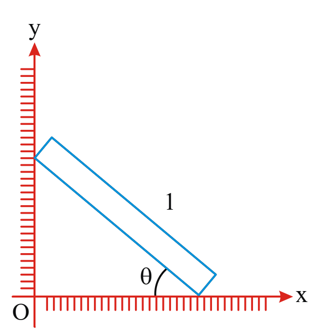
(a) KE of translaton of the rod is $\frac{I^2}{2m}$

(b) KE of rotation of the rod is $\frac{I^2}{6m}$

(c) KE of rotation of the rod is $\frac{3I^2}{2m}$

(d) KE of the rod is $\frac{2I^2}{m}$

30. A uniform rod of mass m and length l is in equilibrium under the constraints of horizontal and vertical rough surfaces. Then :



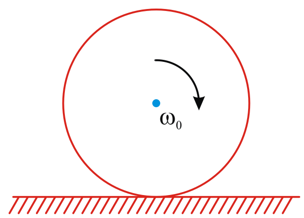
(a) the net torque of normal reaction about O is equal to $\frac{mgl}{2}\cos\theta$

(b) the net rorque due to friction about O is zero

(c) the net torque due to normal reactions is numerically equl to the net torque due to the frictional force abou the CM of the rod

(d) all of the above

31. A disc is given an initial angular velocity ω_0 and placed on rough horizontal surface as shown. The quantities which will not depend on the coefficient of friction is/are



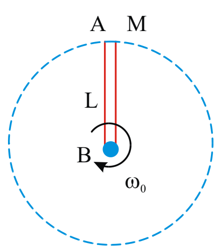
(a) The time until rolling begins

(b) The displacement of the disc until rolling begins

(c) The velocity when rolling begins

(d) The work done by the force of friction

32. A thin rod AB of mass M and length L is rotating with angular speed ω_0 about vertical axis passing through its end B on a horizontal smooth table as shown. If at some instant the hinge at end B of rod is opened then which of the following statement is/are correct about motion of rod ?



(a) The angular speed of rod after opening the hinge will remain ω_0

(b) The angular speed of rod after opening the hinge will be less than ω_0

(c) In the process of opening the hinge the kinetic energy of rod will remain conserved.

(d) Angular momentum of rod will remain conserved about centre of mass of rod in the process of opening the hinge

33. A cylinder rolls without slipping on a rough floor, moving with a speed *v*. It makes an elastic collision with smooth vertical wall. After impact

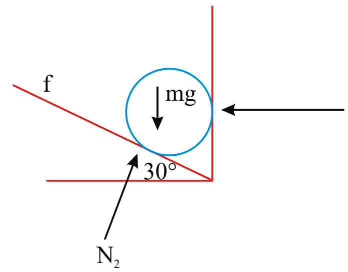
(a) it will move with a speed *v* initially

(b) its motion will be rolling without slipping

(c) its motion will be rolling with slipping initially and its rotational motion will stop momentarily at some instant

(d) its motion will be rolling without slipping only after some time

34. A sphere of radius 0.10m and mass 10kg rests in the corner formed by a 30° inclined plane and a smooth vertical wall. Choose the correct options

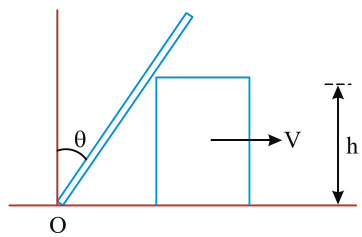


(a) $N_1 = 56.5N$ (b) $N_2 = 113N$ (c) $f = 0$ (d) $f \neq 0$

35. **If the resultant of all the external forces acting on a system of particles is zero, then from an inertial frame, one can surely say that**

(a) linear momentum of the system does not change in time
(b) kinetic energy of the system changes in time
(c) angular momentum of the system does not change in time
(d) potential energy of the system does not change in time

36. **A rod of length '*l*' is pivoted smoothly at *O* is resting on a block of height *h*. If the block moves with a constant velocity *V*, pick the current alternatives.**



(a) angular velocity of rod is $\dfrac{V\cos\theta}{h}$

(b) angular acceleration of rod is $\dfrac{2V^2\cos^3\theta\sin\theta}{h^2}$

(c) angular velocity of rod is $\dfrac{V\cos^2\theta}{h}$

(d) tangential velocity of free end of rod is $\dfrac{lV\cos^2\theta}{h}$

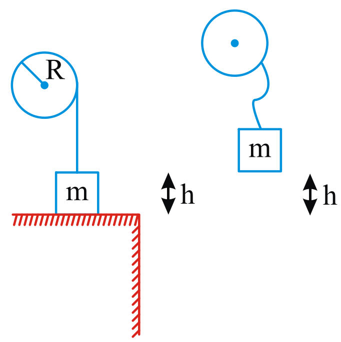
37. **A wheel is under pure rotational motion about an axis passing through its centre. It moves with constant angular velocity.**

a) if angular velocity is increasing then acceleration of particles on a spoke if moved from centre to periphery remains constant
b) acceleration of particles on a spoke if moved from centre to periphery continuously increases
c) acceleration of particles on a spoke if moved from centre to periphery continuously increases and on peripherial points,it remains same
d) accelerations of particles in both the cases remain same

COMPREHENSION TYPE QUESTIONS

Passage - I :

A string is wrapped several times on a cylinder of mass M and radius R. the cylinder is pivoted about its axis of symmetry. A block of mass m tied to the string rests on a support so that the string is slack. the block is lifted upto a height h and the support is removed. (shown in figure)



38. What is the angular velocity of cylinder just before the string becomes taut

(a) zero (b) $\frac{\sqrt{2gh}}{R}$ (c) $\frac{\sqrt{gh}}{R}$ (d) $\frac{2\sqrt{gh}}{R}$

39. When the string experience a jerk, a large impulsive force is generated for a short duration, so that contribution of weight mg can be neglected during this duration. Then what will be speed of block m, just after string has become taut

(a) $\frac{\sqrt{2gh}}{\left[1+\frac{M}{m}\right]}$ (b) $\frac{\sqrt{2gh}}{\left[1+\frac{M}{2m}\right]}$ (c) $\frac{\sqrt{gh}}{\left[1+\frac{M}{m}\right]}$ (d) $\frac{\sqrt{gh}}{\left[1+\frac{M}{2m}\right]}$

40. If M = m, what fraction of KE is lost due to the jerk developed in the string

(a) 1/2 (b) 2/3 (c) 1/3 (d) 1/4

Passage-II :

A man of mass 100 kg stands at the rim of a turn table of radius 2m, moment of inertia 4000 kg. The table is mounted on a vertical smooth axis, through its center. The whole system is initially at rest. The man now walks on table with a velocity 1m/s relative to earth

41. With what angular velocity will the turn table rotate

(a) 0.5 rad/sec (b) 0.1 rad/sec (c) 0.05 rad/sec (d) 0.2 rad/sec

42. Through what angle will the turn table have rotated when the man reaches his initial position on it

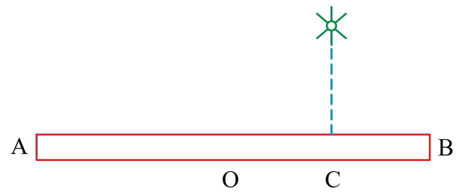
(a) $\frac{\pi}{11}$ rad/sec (b) $\frac{3\pi}{11}$ rad/sec (c) $\frac{2\pi}{11}$ rad/sec (c) $\frac{4\pi}{11}$ rad/sec

43. Through what angle will it have rotated when the man reaches his initial position relative to earth

(a) $\frac{\pi}{5}$ rad/sec (b) $\frac{2\pi}{5}$ rad/sec (c) $\frac{2\pi}{11}$ rad/sec (d) $\frac{\pi}{11}$ rad/sec

Passage-III :

A homogeneous rod AB of length L and mass M is hinged at the centre O in such a way that it can rotate freely in the vertical plane. The rod is initially in horizontal position. An insect S of the same mass M falls vertically with speed V on point C, midway between the points O and B. Immediately after falling, the insect starts to move towards B such that the rod rotates with a constant angular velocity ω.



44.Calculate angular velocity in terms of V and L

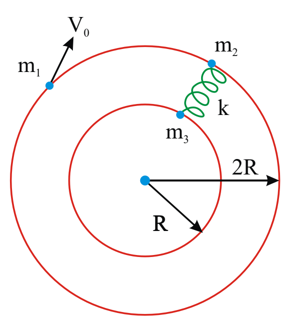
(a) $\frac{12V}{7L}$ (b) $\frac{V}{L}$ (c) $\frac{7V}{12L}$ (d) $\frac{3V}{2L}$

45. If insect reaches the end B when the rod has turned through an angle of 90^0 calculate V interms of L

(a) $\frac{3}{7}\sqrt{2gL}$ (b) $\frac{7}{12}\sqrt{2gL}$ (c) $\frac{1}{12}\sqrt{gL}$ (d) $\frac{2}{7}\sqrt{2gL}$

Passage - IV :

. Three particles each of mass m can slide on fixed frictinless circular tracks in the same horizontal plane as shown . Particle m_1 (= m)moves with veocity v_0 and hits patricle m_2 (= m), the cofficient of restitution being e = 0.5. Assume that m_2 and m_3 (=m)are at rest initially and lie along a radial line before impact, and the spring is initially unstretched.



46. Velocity of m_2 immediately after impact is

(a) $\frac{v_0}{4}$ (b) $\frac{3v_0}{4}$ (c) $\frac{v_0}{2}$ (d) $\frac{3v_0}{2}$

47. The maximum veloctiy of m_3 is

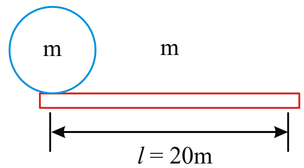
(a) $\frac{3}{5}v_0$ (b) $\frac{3}{10}v_0$ (c) $\frac{3}{4}v_0$ (d) $\frac{3}{2}v_0$

48. The maximum stretch of the spring is

(a) $\frac{3}{4}v_0\sqrt{\frac{m}{5R}}$ (b) $\frac{3}{2}v_0\sqrt{\frac{m}{5R}}$ (c) $\frac{3}{5}v_0\sqrt{\frac{m}{5R}}$ (d) $\frac{3}{10}v_0\sqrt{\frac{m}{5R}}$

Passage - V :

A plank of length 20 m and mass 1 kg is kept on a horizontal smooth surface. A cylinder of mass 1kg is kept near one end of the plank. The coefficient of friction between the two surfaces is 0.5. The plank is suddenly given a velocity 20m/s towards left.



49. Which of the following statement is correct?

(a) Intitial acceleration of cylinder is $5m/s^2$ towards left

(b) Initial acceleration of cylinder is $5m/s^2$ towards right

(c) Initial acceleration of cylinder is $10m/s^2$ towards right

(d) Initial acceleration of cylinder is $10m/s^2$ towards left

50. Which of the following statement is correct?

(a) Pure rolling of cylinder takes place immediately

(b) Intitally cylinder slips and then pure rolling begins

(c) Pure rolling never begins

(d) There is no lose in kinetic energy during its entire motion.

51. Velocity of plank when pure rolling begins is

(a) 10m/s (b) 1.5sec (c) 20m/s (d) 25m/s

52. Time in which plank and cylinder separate

(a) 1 sec (b) 1.5 sec (c) 2.5 sec (d) 2 sec

Passage - VI :

A ring of radius R is rolling purely on the outer surface of a pipe of radius 4R. At some instant, the centre of the ring has a constnat speed of v.

53. The acceleration of the point on the ring which is in contact with the surface of the pipe is

(a) $4v^2/5R$ (b) $3v^2/5R$ (c) $v^2/4R$ (d) zero

54. The acceleration of the point on the ring which is farthest from the centre of the pipe at the given moment is :

(a) $4v^2/5R$ (b) $3v^2/5R$ (c) $3v^2/4R$ (d) $6v^2/5R$

Passage - VII :

A uniform rod of mass 'm' and length L is released from rest, with its lower end touching a frictionless horizontal floor. At the initial moment, the rod is inclined at an angle of 30^0 with the vertical.

55. Then,the value of normal reaction from the floor just after release,will be:

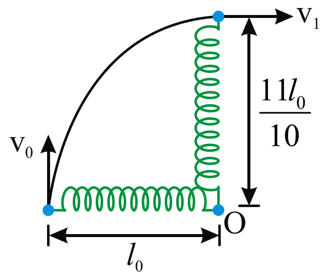
a) 4mg/7 b) 5mg/9 c) 2mg/5 d) mg/5

56. In the above problem, the initial acceleration of the lower end of the rod will be:

a) $g\sqrt{3}/4$ b) $g\sqrt{3}/5$ c) $3g\sqrt{3}/7$ d) $g\sqrt{3}/7$

Passage-VIII:

One end of an ideal spring of unstretched length $l_O = 1m$, is fixed on a frictionless horizontal table. The other end has a small disc of mas 0.1 kg attahed to it. The disc is projected with a velocity $v_0 = 11\ m/s$ perpendicular to the spring:



57. Choose the correct statement

(a) Linear momentum of disc is conserved as the spring force is always perpendicular to elocity of disc.

(b) Angular momentum of disc about fixed end of spring is conserved.

(c) Kinetic energy of disc is conserved

(d) Angular velocity of disc remains constant

58. In the subsequent motion of disc, maximum elongation of spring is $l_0/10$. The velocity of disc at this instant is:

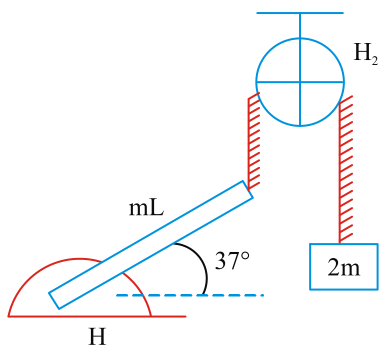
(a) 11 m/s (b) 10 m/s (c) 5 m/s (d) 7 m/s

59. What is the force constant of spring?

(a) 210 N/m (b) 100 N/m (c) 110 N/m (d) 200 m/s

Passage - IX:

A thin uniform rod of mass *m* and length *L* is hinged at one end and from other end a light string is attached. The string is wound over a frictionless pulley (having mass 2*m*) and a block of mass 2*m* is connected to string on other side of pulley as shown. The system is released from rest when the rod is making an angle of 37^0 with horizontal.Based on above information answer the following questions:



60. Just after release of the system from rest, acceleration of block is

(a) $\frac{72g}{121}$, downwards (b) $\frac{48g}{119}$, downwards

(c) $\frac{90g}{121}$, downwards (d) $\frac{90g}{121}$, upwards

61. Just after release of the system, the resultant force exerted by hinge on rod is

(a) $0.7mg$ (b) $0.92mg$ (c) $0.53mg$ (d) mg

62. Just after release of the system from rest, the resultant force exerted by hinge H_2 on pulley is

(a) $\frac{46}{121}mg$ in upward direction
(b) $\frac{46}{121}mg$ in downward direction
(c) $\frac{438}{121}mg$ in upward direction
(d) $\frac{438}{121}mg$ in downward direction

MATRIX MATCHING QUESTIONS

63. For the *following* statements, except gravity and contact force between the contact surfaces, no other force is acting on the body.

Column I	Column II
(a) When a sphere is in pure–rolling on a fixed horizontal surface.	(p) Upward direction
(b) When a cylinder is in pure rolling on a fixed inclined plane in upward direction then friction force acts in	(q) $v_{cm} > R\omega$
(c) When a cylinder is in pure rolling down a fixed incline plane, friction force acts in	(r) $v_{cm} < R\omega$
(d) When a sphere of radius R is rolling acts with slipping on a fixed horizontal surface, the relation between v_{cm} and ω is	(s) No frictional force
	(t) Work done by the frictional force is zero

64. A uniform disc is acted upon by some forces and it rolls on a horizontal plank without slipping from north to south. The plank, in turn lies on a smooth horizontal surface. Match the following regarding this situation :

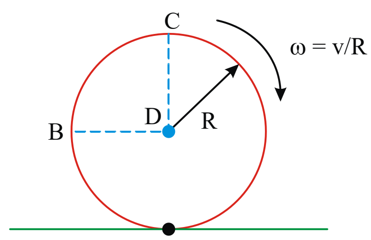
Column I	Column II
(a) Frictional force on the disc by the surface	(p) May be directed towards north
(b) Velocity of the lowermost point of the disc	(q) May be directed towards south
(c) Acceleration of centre of mass of the disc	(r) May be zero
(d) Vertical component of the acceleration of centre of mass	(s) Must be zero

65. A rigid body of mass M and Radius R rolls without slipping on an inclined plane of inclination θ under gravity Match the type of body with magnitude of the force of friction.

Column I | **Column II**

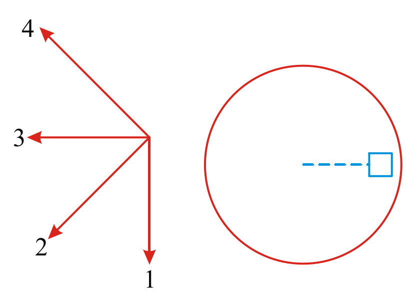
a) For ring	p) $\frac{Mg\sin\theta}{2.5}$
b) For solid sphere	q) $\frac{Mg\sin\theta}{3}$
c) For solid cylinder	r) $\frac{Mg\sin\theta}{3.5}$
d) For hollow spherical shell	s) $\frac{Mg\sin\theta}{2}$

66. A rigid body is rolling without slipping on horizontal surface.At given instant BD is perfectly horizontal and CD is perfectly vertical.



Column I	Column II
a) Velocity at pointA, v_A	p) $v\sqrt{2}$
b) Velocity at point B, v_B	q) Zero
c) Velocity at point C, v_C	r) v
d) Velocity at point D, v_D	s) 2v

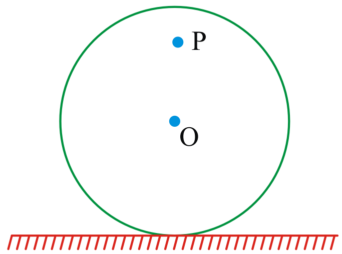
67. A horizontal table can rotate about its axis. A block is placed at a certain distance from center as shown in figure. The table rotates such that block does not slide. Select possible direction of net acceleration of block at the instant shown in figure. Then match the columns.



Column I	Column II
a) When rotation is clockwise with constant ω	p) 1
b) When rotation is clockwise with decreasing ω	q) 2
c) When rotation is clockwise with increasing ω	r) 3

d) Just after clockwise rotation begins form rest — s) 4

68. An uniform disc rolls without slipping on a rough horizontal surface with uniform angular velocity. Point O is the centre of disc and P is a point on disc as shown. In each situation of column I a statement is given and the corresponding result are given in column –II. Match the statements in coloumn-I with the results in column-II

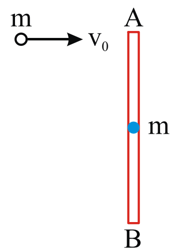


Column I	**Column II**
a) The velocity of `	p) Change at point P in disc magnitude with time
b) The acceleration from that point not	q) Is always directed of point P on disc towards centre of disc.
c) The tangential acceleration of point P on disc	r) is always zero
d) The acceleration of point on disc which is in contact with rough horizontal surface	s) is non-zero and remains constant in magnitude

69. A light string is wrapped on a pulley and two blocks of masses m_1 and m_2 are attached to free end of string as shown in figure. T_1 and T_2 are the tension in string on two sides of pulley. In column I, some information is mentioned about friction between of inertia of pulley, while in colunm II the effect of the information mention in column I on the motion of system is given. Match the entries of column I with the entries of column II.

Column I	Column II
1. No friction between pulley and string, and moment of inertia of pulley is not negligible.	p. Angular acceleration of pulley is 0
2. Friction is there between pulley and string, and pulley is light.	q. $T_1 = T_2$
3. Friction is not there and pulley is light.	r. $T_1 \neq T_2$
D. Friction is there and pulley is having some moment of inertia.	s. Angular acceleration of pulley $\neq 0$

70. A smooth ball of mass m moving with a uniform velocity v_0 strikes a smooth uniform rod AB of equal mass m, lying on a frictionless horizontal table. The ball strikes the rod at one end A, perpendicular to the rod, as shown in the figure. The collision is perfectly elastic. Some physicaL quantities pertaining to this situation are given in COLUMN-1 while their values are given in COLUMN-2 in a different order . Match the values in COLUMN-II and the quantities in COLUMN-I

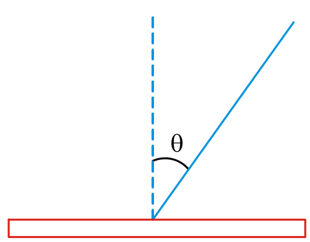


Column-I	Column-II
A) Final kinetic energy of ball / Initial kinetic energy of ball	p) $\frac{2}{5}$
B) Impulse delivered to the rod / Initial momentum of ball	q) $\frac{3}{5}$
C) Angular momentum of rod about its centre of mass / Initial angular momentum of the ball about the centre of mass of the rod	r) $\frac{9}{25}$
Final kinetic energy of rotation of the rod / Final kinetic energy of translation of the rod	s) 3
D) Final kinetic energy of rotation of the rod / Final kinetic energy of translation of the rod	

INTEGER TYPE QUESTIONS

71. A rod of mass *m* and length ℓ is released from rest from vertical position as shown in the figure. The normal force as a function of θ, which is exerted on the rod by the ground as it falls downward, assuming that it does not slip is

$mg\left(\frac{3\cos\theta - 1}{n}\right)^2$ **then n =**

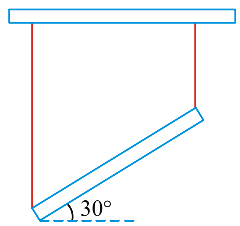


72. One end of a uniform rod of mass M and length L is supported by a frictionless

hinge which can with stand a tension of 1.75 Mg. The rod is free to rotate in a vertical plane. The maximum angle should the rod be rotated from the vertical position so that when left, the hinge does not break is $\frac{\pi}{n}$

73. A thin uniform bar of mass m and length 2L is held at an angle 30^0 with the horizontal by means of two vertical inextensible strings, at each end as shown in figure. If the string at the right end breaks, leaving the bar to swing the tension in the string at the left end of the bar immediately after string breaks is

$$T = \frac{n}{13}mg$$



74. A uniform sphere of radius $\frac{R}{16}$ starts rolling down without slipping from the top of another sphere of radius R = 1 m. The angular velocity of the sphere in rad s^{-1}, after it leaves the surface of the larger sphere is 8 x n. Where n = --.

EXERCISE - III - KEY

SINGLE ANSWER QUESTIONS

1.D 2.C 3. A 4.D 5. D 6. A 7. C 8. D 9. A 10.D
11. D 12. D 13. B 14. A 15. C 16. D 17. A 18. D 19. A 20. C
21. A 22. A 23. B 24. D 25. C 26. A 27. B

MULTIPLE ANSWER QUESTION

28. C,D 29. A,C,D 30. A,B,C,D 31. C,D 32. A,C,D
33. A,C,D 34. A,B,C 35. A,B 36. B,C 37.B,C

COMPREHENSION QUESTIONS

38. A 39. B 40. C 41. C 42.A 43. A 44. A 45. B 46. B 47.B
48. A 49. B 50. B 51. B 52.B 53. A 54. D 55. A 56. C 57. B
58. B 59. A 60. A 61. C 62. C

MATRIX MATCHING TYPE

63. $A \to s,t; B \to p; C \to p; D \to q,r$ 64. $A \to p,q,r; B \to p,q,r; C \to p,q,r; D \to s$
65. $A \to s; B \to r; C \to q; D \to p$ 66. $A \to q; B \to p; C \to s; D \to r$
67. $A \to r; B \to s; C \to q; D \to p$ 68. $A \to p; B \to q,s; C \to p; D \to q$
69. $A \to p,q; B \to q,s; C \to p,q; D \to p,q,r,s$ 70. $A \to r; B \to P; C \to P; D \to S$

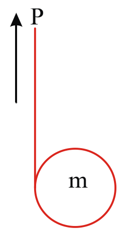
INTEGER TYPE QUESTIONS

71. 2 72. 3 73. 4 74. 5

EXERCISE - IV

SINGLE ANSWER QUESTIONS

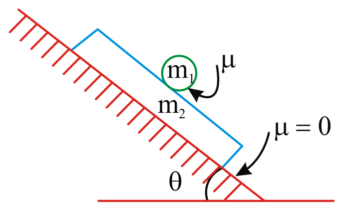
1. **The point P of a string is pulled up with an acceleration g. then the acceleration of the hanging disc (w.r.t ground) over which the string is warpped, is**



(a) $\frac{2g}{3}\downarrow$ (b) $\frac{g}{3}\uparrow$

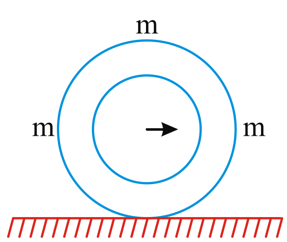
(c) $\frac{4g}{3}\downarrow$ (d) $\frac{g}{3}\downarrow$

2. **A sphere of mass m_1 is placed on a plank of mass m_2. The coeffcient of friction between the plank and sphere is μ. If the inclined plane is smooth, the frictional force between the plank and sphere :**



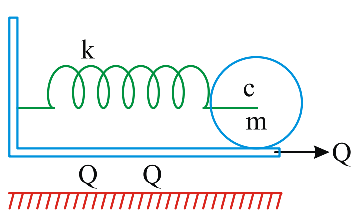
(a) depends on m_1 (b) depends on m_2 (c) 0 (d) $= \mu m_1 g\cos\theta$

3. **Four beads each of mass m are glued at the top, bottom and the ends of the horizontal diameter of a ring of mass m. If the ring rolls without sliding with the velocity v of its , the kinetic energy of the system (beads +ring) is:**



(a) $5mv^2$ (b) $4mv^2$ (c) $2mv^2$ (d) mv^2

4. **A rolling body is connected with a trolley car by a spring of stiffness k. It does not slide and remains in equilibrium relative to the accelerating trolley car. If the trolly car is stopped after a time $t = t_0$:(the rolling body touches the trolly)**

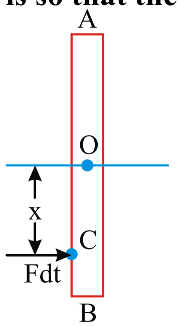


(a) $\tau_C \neq 0\ for\ ct < t_0$ (b) $f = 0\ for\ t < t_0$

(c) $x = \frac{ma}{k}$, where x = deformation of the spring

(d) $(KE)_{max} = \frac{1}{2}ma^2t_0^2$, where $(KE)_{max}$ is the maximum KE of the rolling body

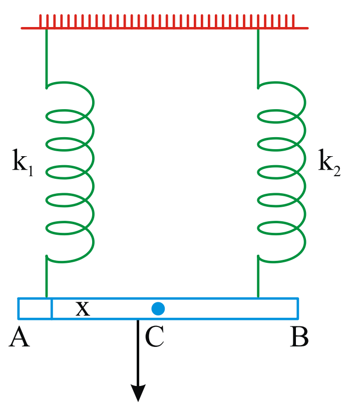
5. **A linear impulse $\int Fdt$ acts at a point C of the smoothe rod AB. The value of x is so that the end A remains stationary just after the impact is :**



(a) $\frac{l}{4}$ (b) $\frac{l}{3}$

(c) $\frac{l}{6}$ (d) $\frac{l}{5}$

6. **Two light vertical springs with equal natural lengths and spring constants k_1 and k_2 are sparated by a distance l. Their upper ends are fixed to the ceiling and their lower ends to the ends A and B of a light horizontal rod AB. A vertical downwards force F is applied at point C on the rod. AB will remain horizontal in equilibrium if the distance AC is :**



(a) $\frac{l}{2}$ (b) $\frac{lk_1}{k_1+k_2}$ (c) $\frac{lk_2}{k_1}$ (d) $\frac{lk_2}{k_1+k_2}$

7. **Let I be the moment of inertia of a uniform square plate about an axis AB that passes through its centre and is parallel to two of its sides. CD is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with AB. Then the moment of inertia of the plate about the axis CD is equal to :**

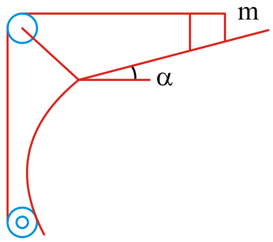
(a) I (b) $I\sin^2\theta$ (c) $I\cos^2\theta$ (d) $I\cos^2(\theta/2)$

8. **Two point masses A of mass M and B of mass 4M are fixed at the ends of a rod of length l and of negligible mass. The rod is set rotation about an axis perpendicular to its length with a uniform anguular speed. The work required**

for rotating the rod will be minimum when the distance of axis of rotation from the mass A is at

(a) $\frac{2}{5}l$ (b) $\frac{8}{5}l$ (c) $\frac{4}{5}l$ (d) $\frac{l}{5}$

9. A spool of mass M and internal and external radii R and 2R hanging from a rope touches a curved surface, as shown. A block of mass m plaed on a rough surface inclined at an angle α with horizontal is attached with other end of the rope. The pulley is massless and system is in equilibrium. Find the coefficient of friction



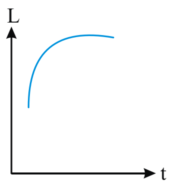
(a) $\frac{3mg+2Mg}{3mg-2Mg}$

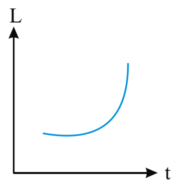
(b) $\frac{3mg\sin\alpha+2Mg\cos\alpha}{3mg\cos\alpha-2Mg\sin\alpha}$

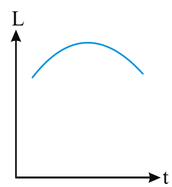
(c) $\frac{3mg\cos\alpha+2Mg\sin\alpha}{3mg\sin\alpha-2Mg\cos\alpha}$

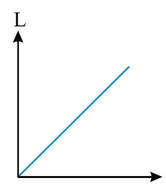
(d) $\frac{3mg+2Mg\tan\alpha}{3mg-2Mg\tan\alpha}$

10. A ring of mass m and radius R is rolling down on a rough inclined plane of angle θ with horizontal. Plot the angular momentum of the ring about the point of contact of ring and the plane as a function of time.

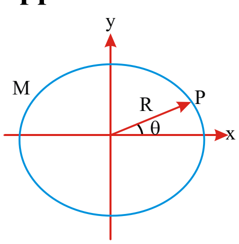
a) 

b) 

c) 

d) 

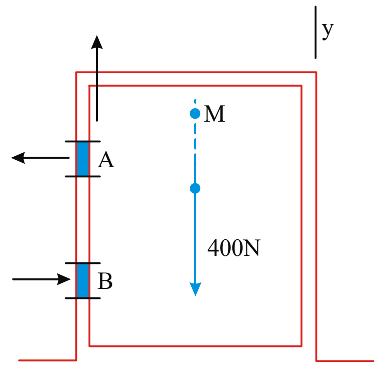
11. A ring of mass M and radius R lies in x-y plane with its centre at origin as shown. The mass distribution of rings is non-uniform such that at any point P on the ring, the mass per unit length is given by $\lambda=\lambda_0\ \cos^2\theta$ (where λ_0 is a appositive constant). Then the moment of inertia of the ring about z- axis is



(a) MR^2 (b) $\frac{1}{2}MR^2$

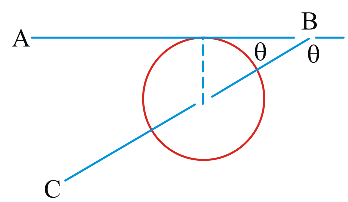
(c) $\frac{MR}{2\lambda}$ (d) $\frac{MR}{5\lambda}$

12. As shown in figure, the hinges A and B hold a uniform 400 N door in place. the upper hinge supports the entire weight of the door. find the resultant force exerted on the door at the hinges . the width of the door is $\frac{h}{2}$, where h is the distance between the hinges.



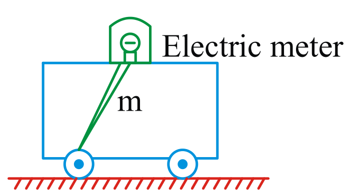
(a) 312 N (b) 280 N (c) 412 N (d) 480 N

13. **A thin wire of lenght L is is bent into a circular wire of uniform linear density ρ. When circular wire is in a vertical plane find the moment of inertia of loop about an axis BC,pasing through centre of the loop and which makes an angle θ with the tangent at the topmost point of the loop**



a) $\frac{\rho L^3}{8\pi^2}$ **b)** $\frac{\rho L^3}{2\sqrt{2}\pi^2}$ **c)** $\frac{\rho L^3}{4\pi^2}$ **d)** $\frac{\rho L^3}{3\pi^2}$

14. **A box of mass 1 kg is mounted with two cylinders each of mass 1kg, moment of inertia0.5kg m^2 and radius 1m as shown in figure, Cylinders are mounted on their control axis of rotation and this system is placed on a rough horizontal surface, the rear cylinder is connected to battery operated motor which provides a torque of 100n-m to this vcylinder via a belt as shown. if sufficient friction is present between cylinder and horizontal surface for pure rolling, find acceleration of the vehicle in $\frac{m}{s^2}$. (Neglect mass of motor, belt and other accessories of vehicle).**



(a) 20 $\frac{m}{s^2}$ (b) 10 $\frac{m}{s^2}$ (c) 25 $\frac{m}{s^2}$ (d) 30 $\frac{m}{s^2}$

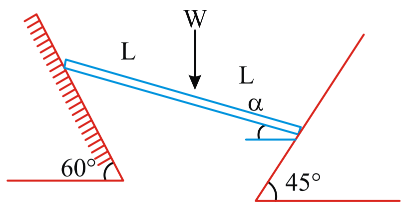
15. **Two identical rings Aand Bare acted upon by torques τ_A and τ_B respectively.A is rotating about an axis passing through the centre of mass and perpendicular**

to the plane of the ring. B is rotating about a chord at a distance $\frac{1}{\sqrt{2}}$ times the radius from the centre of the ring. if the angular acceleration of the rings is the same, then

(a) $\tau_A = \tau_B$ (b) $\tau_A > \tau_B$ (c) $\tau_A < \tau_B$

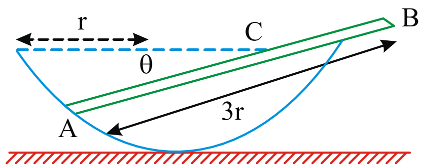
(d) Nothing can be said about τ_A and τ_B as data are insufficient

16. **A uniform plank of weight W and total length 2L is placed as shown in figure with its ends in contact with the inclined planes. the angle.of friction is 15^0. determine the maximum value of the angle a at which slipping impends.**



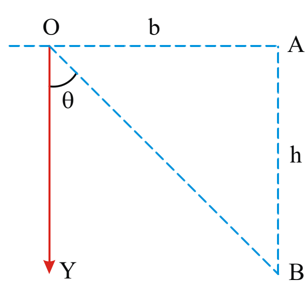
(a) 18.1^0 (b) 48.4^0 (c) 36.2^0 (d) 88.8^0

17. **A uniform rod AB of length three times the radius of a hemisphered bowl remains in equilibrium in the bowl as shown. Neglecting friction find the inclination of the rod with the horizontal.**



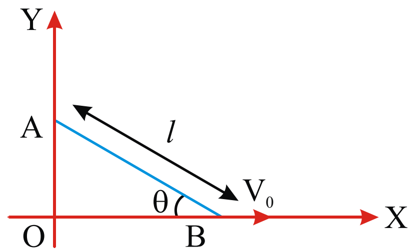
(a) $\sin^{-1}(0.92)$ (b) $\cos^{-1}(0.92)$ (c) $\cos^{-1}(0.49)$ (d) $\tan^{-1}(0.92)$

18. **A particle of mass m is released from rest at point A in the figure falling freely under gravity parallel to the vertical Y-axis. the magnitude of angular momentum of particle about point O when it reaches B is (whereOA=b and AB=h)**



(a) $\frac{mh}{bg}$ (b) $mb\sqrt{2gh}$ (c) $mb\sqrt{3gh}$ (d) $2mb\sqrt{gh}$

19. **The end B of the rod AB which makes an angle θ with the floor is being pulled with a constant velocity V_0 as shown in the figure. The length of the rod is l. At the instant when $\theta = 37^0$**



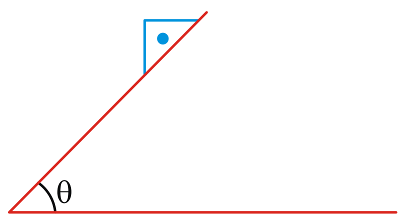
(a) Velocity of end A is $\frac{2}{3}V_0$ downwards

(b) *angular velocity of rod is* $\frac{5}{3}\frac{V_0}{l}$

(c) angular velocity of rod is constant

(d) velocity of end A is constant

20. **A block having equilateral triangular cross-section of side a and mass *m* is placed on a rough inclined surface, so that it remains in equilibrium as shown in figure. The torque of normal force acting on the block about its centre of mass is**



(a) $\frac{\sqrt{3}}{2}mga\sin\theta$ (b) $\frac{1}{2\sqrt{3}}mga\sin\theta$ (c) $\frac{1}{2\sqrt{3}}mga\cos\theta$ (d) Zero

21. **A thin horizontal uniform rod *AB* of mass *m* and and length l can rotate freely about a vertical axis passing thorough its end A. At a certian moment the end B starts experiencing a constant force *F* which is always perpendicular to the original position of the stationary rod and directed in a horizontal plane. The angular velocity counted relative to the intial position is**

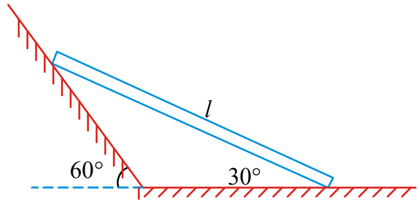
(a) $\sqrt{\frac{6F}{ml}\sin\phi}$ (b) $\sqrt{\frac{6F}{ml}\cos\phi}$ (c) $\sqrt{\frac{8F}{ml}\sin\phi}$ (d) $\sqrt{\frac{8F}{ml}\cos\phi}$

22. **Ablock of mass *m* moves on a horizontal circle against the wall of a cylindrical room of radius *R*. The floor of the room, on which the block moves, is smooth but the friction coefficient between the wall and the block is μ. The block is given an initial speed V_0. The power developed by the resultant force acting on the block as a function of distance travelled *s is***

(a) $\frac{\mu m_0^3}{R}e^{\frac{-3s}{\mu}}$ (b) $-\frac{\mu m V_0^3}{R}e^{\frac{-3\mu s}{R}}$ (c) $\frac{\mu m V_0^3}{R}$ (d) $\frac{\mu m V_0^3}{R}e^{\frac{-3\mu s}{R}}$

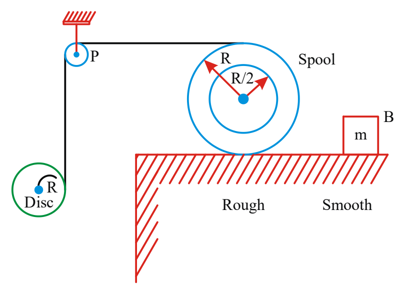
23. **A uniform rod of length *l* is released from the position shown in the figure. The acceleration due to gravity is g. There is no friction at any surfae. Find the**

intial angular acceleration of the rod.



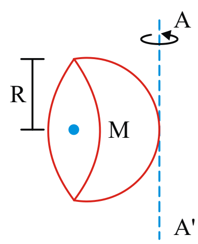
(a) $\frac{3\sqrt{3}g}{10l}$ (b) $\frac{5\sqrt{3}g}{7l}$ (c) $\frac{3\sqrt{3}g}{11l}$ (d) $\frac{5\sqrt{3}g}{19l}$

24. **Consider an arrangement shown in the figure. The pulley P is frictionless and the threads are massless. The mass of the spools is *m* and moment of inertia of the spool is $\frac{1}{2}mR^2$. The mass of the disc of radius R is also m. The surface below the spool is rough to ensure pure rolling of spool. The mass of the block is *m* and the surface below the block is smooth. Find the initial acceleration of the block when the system is released from rest.**



(a) $\frac{4}{37}g$ (b) $\frac{2}{37}g$ (c) $\frac{8}{37}g$ (d) $\frac{10}{37}g$

25. **Find the moment of inertia of a hemisphere of mass M and radius R shown in the figure, about an axis AA' tangential to the hemisphere.**

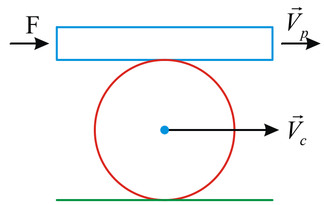


(a) $I = \left(\frac{9}{20}\right)mR^2$ (b) $I = \left(\frac{13}{20}\right)mR^2$

(c) $I = \left(\frac{7}{20}\right)mR^2$ (d) $I = \left(\frac{3}{20}\right)mR^2$

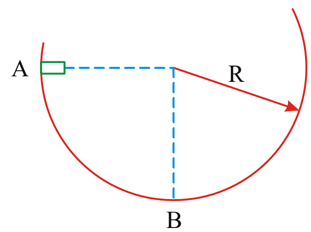
MULTIPLE ANSWER QUESTIONS

26. **A wheel rolls purely between a rough horizontal surface below it and a horizontal plank above it under the action of a horizontal force *F* applied on the plank. If at any time $\vec{v_p}$ and $\vec{v_c}$ represent velocity of plank and velocity of centre of mass of wheel and $\vec{a_p}$ and $\vec{a_c}$ represent acceleration of plank and acceleration of centre of mass of wheel repectively then which of the following is/are correct.**



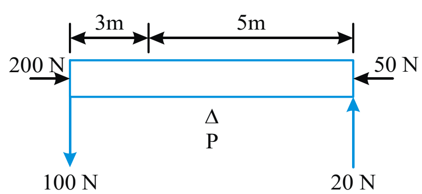
(a) $|\vec{v}_p| = 2|\vec{v}_c|$ (b) $|\vec{a}_p| = 2|\vec{a}_c|$ (c) $|\vec{v}_p| = |\vec{v}_b|$ (d) $|\vec{a}_p| = |\vec{a}_c|$

27. **A small block of mass *m* is released from rest from position A inside a smooth hemispherical bowl of radius R as shown in figure. Choose the wrong option(s)**



(a) Acceleration to block is constant throughout
(b) Acceleration of block is g at A
(c) Acceleration of block is $3g$ at B
(d) Acceleration of block is $2g$ at A

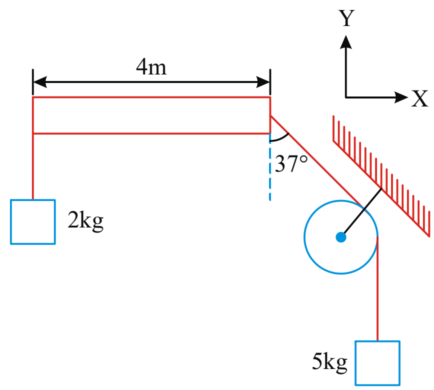
28. **Consider a uniform rod of mass 40 kg and length 8m, pivoted about a point *P* 3m from one end as shown in the figure. Few external forces are acting on the rod as shown in figure.**



mark out the correct statement (s). $\left[Take\ g = m/s^2\right]$

(a) The rod is in translational and rotational equilibrium.
(b) The rod is in rotational equilibrium only.
(c) The magnitude of the froce exerted by the rod on the pivot is 503N
(d) The rod is in rotational equilibrium about *P* only

29. **A light rod of length 4 m can be maintained in equilibrium position as shown in the figure if we apply single force on it.**



The required force

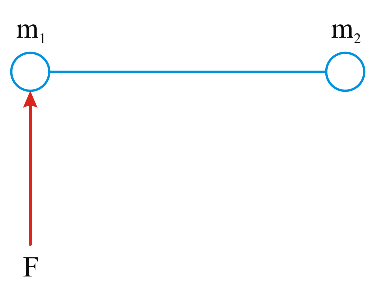
(a) would have magnitude of 77

(b) Would have a line of action making an angle of $\tan^{-1}(17/9)$ with negative x-axis

(c) would be appiled at a distance of $\frac{48}{17}m$ from the right end

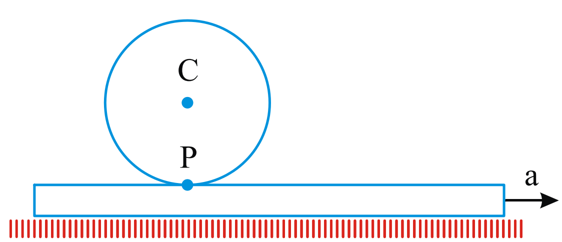
(d) the rod cannot be maintained in equilibrium under the action of a single force.

30. **Two particles of masses m_1 and m_2 are connected with a rigid rod of length l. If a force F acts perpendicular to the rod then (a_1 & a_2 are instantaneous acceleration of m_1 & m_2)**



(a) $a_2 = 0$ (b) $a_1 = \frac{F}{m_1}$ (c) $a_{CM} = \frac{F}{m_1 + m_2}$ (d) $\alpha = \frac{F(m_1 + m_2)}{m_1 m_2 l}$

31. **A uniform solid sphere of mass m is placed on a sheet of paper on a horizontal surface. The coefficient of friction between paper and sphere is μ. If the paper is pulled horizontally with an acceleration**



(a) the tension in the string is equal to $mg \sin\theta$

(b) force acting on the cylinder is $\frac{mg\sin\theta}{2}$

(c) tension in the string is equal to $\frac{mg\sin\theta}{2}$

(d) frictional force acting on the cylinder is zero

32. A rigit body is in pure rotation, that is, undergoing fixed axis rotation. Then which of the following statement(s) are true

(a) You can find two points in the body in a plane perpendicular to the axis of rotation
having same velocity

(b) You can find two points in the body in a plane perpendicular to the axis of rotation having same acceleration

(c) Speed of all the particles lying on the curved surface of a cylinder whose axis coincides with the axis of rotation is same

(d) Angular speed of the body is same as seen from any point in the body

33. A rough disc of mas m rotates freely with an angular velocity ω. If another rough disc of mass $\frac{m}{2}$ and same radius but spinning in opposite sense with angular speed ω is kept on the first disc. Then:

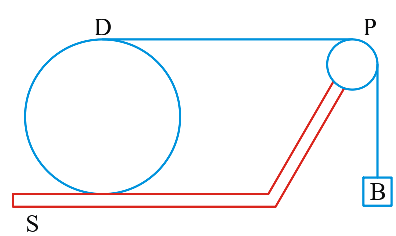
(a) the final angular speed of the dise is $\frac{\omega}{3}$

(b) the net work done by friction is zero

(c) the friction does a positive work on the lighter disc

(d) the net work done by friction is $\frac{-mR^2\omega^2}{3}$

34. In the figure, the disc D does not slip on the surface S, the pulley P has mass and the string does not slip on it. The string is wound around the disc.



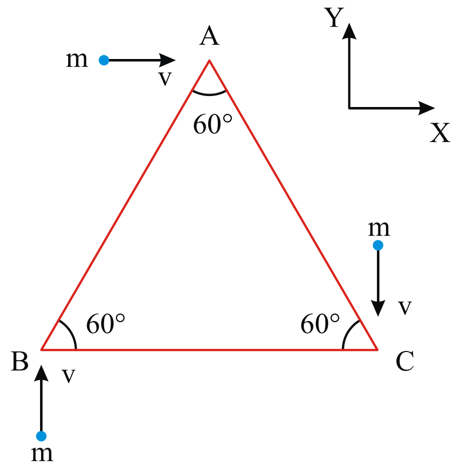
(a) The acceleration of the block B is double the acceleration of the centre of D

(b) The force of friction exerted by D on S acts to the left

(c) The horizontal and the vertical sections of the string hae the same tension

(d) The sum of the kinetic energies of D and B is less than the loss in the potential energy of B as it moves down

35. A triangular block ABC of mass m and side 2a lies on a smooth horizontal plane is shown. There point masses of mass m each strikes the block at A, B and C with speed as shown. After the collision the particle come to rest. Then:



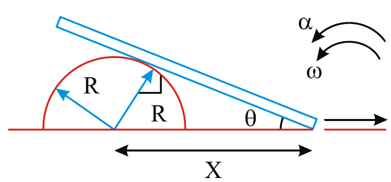
(a) the centre of mass of ΔABC remains stationary after collision

(b) the centre of mass of ΔABC moves with a velocity v along x- axis after collision

(c) the triangular block rotates with an angular velocity $\omega = \frac{2\sqrt{3}mva}{I}$ about its centriod axis perpendicular to its plane

(d) a point lying at a distance of $\left(\frac{1}{2\sqrt{3}ma}\right)$ from centroid G on perpendicular bisector of BC is at rest just after collision

36. A rod leans against a stationary cylindrical body as shwon in figure, and its right end slides to the right on the floor with a constant speed *v*. Choose the correct option(s)



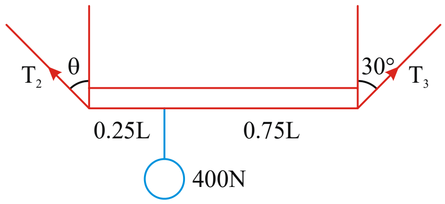
(a) the angular speed ω is $\frac{-Rv^2\left(2x^2-R^2\right)}{x^2\left(x^2-R^2\right)^{3/2}}$

(b) the angular acceleration α is $\frac{Rv}{x\sqrt{x^2-R^2}}$

(c) the angular speed ω is $\frac{Rv}{x\sqrt{x^2-R^2}}$

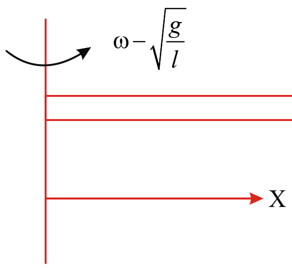
(d) the angular acceleration α is $\frac{-Rv^2\left(2x^2-R^2\right)}{x^2\left(x^2-R^2\right)^{3/2}}$

37. The uniform 120 N board shown in figure is supported by two ropes. A 400 N weight is suspended one-fourth of the way from the left end. Choose the correct options



(a) $T_1 = 185N$ (b) $T_2 = 371N$ (c) $T_2 = 185N$ (d) $\tan\theta = 0.257$

38. **The KE and moment of inertia about the given end point of a rod of mass m and length l and cross sectional area A which is rotating with $\omega = \sqrt{\frac{g}{l}}$ as shown in the Fig. will be [density of the rod varies as $\rho = \rho_0\left(1 + \frac{x}{l}\right)$]**



(a) $KE = \frac{7}{36} mgl$

(b) $I = \frac{7\rho_0 A l^3}{36}$

(c) $KE = \frac{7}{39} mgl$

(d) $I = \frac{11\rho_0 A l^3}{36}$

39. **The torque τ on a body about a given point is found to be equal to A x L where A is a constant vector, and L is the angular momentum of the body about that point. From this it follows that**

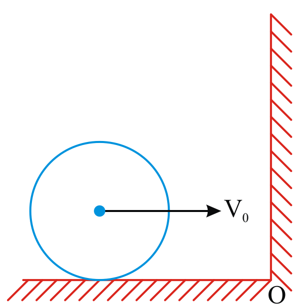
(a) $\frac{dL}{dt}$ is perpendicular to L at all instants of time

(b) the component of L in the direction of A does not change with time

(c) the magnitude of L does not change with time

(d) L does not change with time

40. **Consider a sphere of mass 'm' radius 'R' doing pure rolling motion on a rough surface having velocity $\vec{v}_0$ as shown in the Figure. It makes an elastic impact with the smooth wall and moves back and starts pure rolling after some time again.**



(a) Change in angular momentum about 'O' in the entire motion equals $2mv_0R$ in magnitude.

(b) Moment of impulse provided by the wall during impact about O equals $2mv_0R$ in magnitude.

(c) Final velocity of ball will be $\frac{3}{7}\vec{v}_0$

(d) Final velocity of ball will be $-\frac{3}{7}\vec{v}_0$

41. If a cylinder is rolling down a rough inclined with initial sliding.

(a) after some time it may start pure rolling
(b) after sometime it must start pure rolling
(c) it may be possible that it will never start pure rolling
(d) cannot conclude anything

42. Which of the following statements are correct.

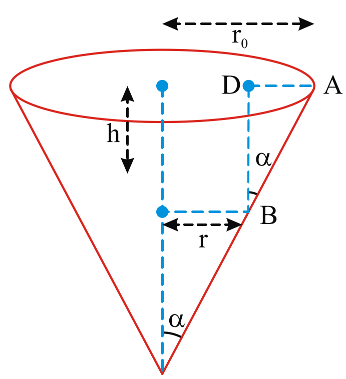
(a) friction acting on a cylinder without sliding on an inclined surface is always upward along the incline irrespective of any external force acting on it.
(b) friction acting on a cylinder without sliding on an inclined surface is may be upward may be downwards depending on the external force acting on it.
(c) friction acting on a cylinder rolling without sliding may be zero depending on the external force acting on it.
(d) nothing can be said exactly about it as it depends on the friction coefficient on inclined plane.

COMPREHENSION TYPE QUESTIONS

Passage - I : (43-45)

A small particle of mass m is given an initial velocity v_0 tangent to the horizontal rim of a smooth cone at a radius r_0 from the vertical centerline as shown at point A. As the particle slides to point B, a vertical distance h below A and a distance r from the vertical centerline, its velocity v makes an angle θ with the horizontal tangent to the cone through B.

43. The value of θ is



(a) $\cos^{-1}\frac{v_0r_0}{(r_0-h\tan\alpha)\sqrt{v_0^2+2gh}}$ (b) $\cos^{-1}\frac{v_0r_0}{(r_0+h\tan\alpha)\sqrt{v_0^2+2gh}}$

(c) $\cos^{-1}\dfrac{v_0 r_0}{(r_0 - h\tan\alpha)\sqrt{v_0^2 - 2gh}}$ (d) $\cos^{-1}\dfrac{v_0 r_0}{r_0\sqrt{v_0^2 + 2gh}}$

44. The speed of particle at point B

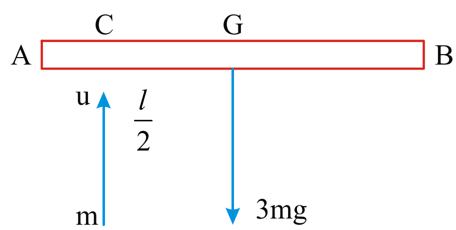
(a) $\sqrt{v_0^2 + 2gh}$ (b) $\sqrt{v_0^2 - 2gh}$ (c) $\sqrt{v_0^2 + gh}$ (d) $\sqrt{2v_0^2 + 2gh}$

45. The minimum value of v_0 for which particle will be moving in a horizontal circle of radius r_0.

(a) $\sqrt{\dfrac{2gr_0}{\tan\alpha}}$ (b) $\sqrt{\dfrac{gr_0}{2\tan\alpha}}$ (c) $\sqrt{\dfrac{gr_0}{\tan\alpha}}$ (d) $\sqrt{\dfrac{4gr_0}{\tan\alpha}}$.

Passage - II : (46-48)

A rod AB of mass 3m and length 4a is falling freely in a horizontal position and c is a point distant a from A. When the speed of the rod is u, the point c collides with a particle of mass m which is moving vertically upwards with speed u. If the impact between the particle and the rod is perfectly elastic find



46. The velocity of the particle immediately after the impact

(a) $\dfrac{29}{19}u$ *down* (b) $\dfrac{19}{29}u$ *down* (c) $\dfrac{29}{19}u$, *up* (d) $\dfrac{27}{19}u$ *down*

47. The angular velocity of the rod immediately after the impact

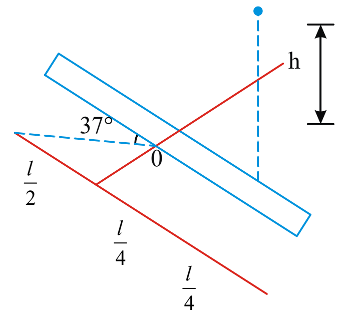
(a) $\dfrac{19u}{12a}$ (b) $\dfrac{12u}{19a}$ (c) $\dfrac{29u}{19a}$ (d) $\dfrac{19u}{29a}$

48. The speed of B immediately after the impact is

(a) $\dfrac{19}{27}u$ *down* (b) $\dfrac{19}{27}u$ *up* (c) $\dfrac{27}{19}u$ *down* (d) $\dfrac{27}{19}u$ *up*

Passage - III : (49-50)

An uniform rod of mass m=30kg and length l=0.80m is free to rotate about a horizontal axis O passing through its centre. A particle P of mass M=11.2kg falls vertically through a height $h = \dfrac{36}{245}m$ and collides elastically with the rod at a distance $\dfrac{l}{4}$ from O. At the instant of collision the rod was stationary and was at an angle $\alpha = 37^0$ with horizontal as shown in figure



49. Calculate angular velocity of the rod just after collision is

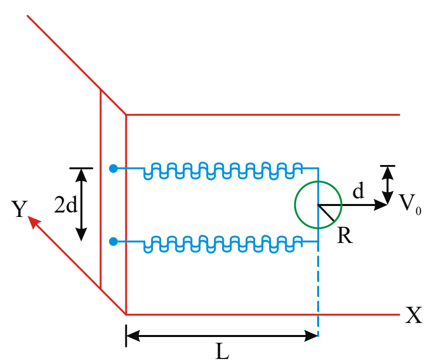
(a) 1 rad/s (b) 3 rad/s (c) 2 rad/s (d) 4 rad/s

50. Velocity of particle P after collision is $(g = 10ms^{-2})$

(a) $\frac{7}{9}ms^{-1}$ (b) $7ms^{-1}$ (c) $\frac{9}{7}ms^{-1}$ (d) $1ms^{-1}$

Passage - IV : (51-53)

A uniform thin cylinder M and radius R is attached to two identical massless springs of spring constant K, which are fixed to the wall, as shown. The spring are attached to the axle of the disc symmetrically on either side at distance d from its centre. The axle is massless and both the springs and the axle are in horizontal plane. The unstretched length of each spring is L. The disc is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disc rolls without slipping with velocity $\vec{V}_0 = V_0\hat{i}$. The coefficient of friction is μ



51. The net external force acting on the disc when its CM is at displacement x with respect to its equilibrium position is

(a) $-Kx$ (b) $-2Kx$ (c) $-\frac{2Kx}{3}$ (d) $-\frac{4Kx}{3}$

52. The centre of mass of the disc undergoes SHM with angular velocity ω, equal to

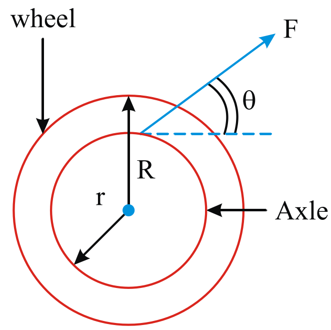
(a) $\sqrt{\frac{K}{M}}$ (b) $\sqrt{\frac{2K}{M}}$ (c) $\sqrt{\frac{2K}{3M}}$ (d) $\sqrt{\frac{4K}{3M}}$

53. The maximum value of V_0 for which the disc will roll without slipping.

(a) $\mu g\sqrt{\frac{M}{K}}$ (b) $\mu g\sqrt{\frac{M}{2K}}$ (c) $\mu g\sqrt{\frac{3M}{K}}$ (d) $\mu g\sqrt{\frac{5M}{2K}}$

Passage - V : (54-56)

A wheel of radius R, mass m with an axle of radius r is placed on a horizontal surface. Its moment of inertia is $I = mR^2$ .Unwinding a rope from its axel a force F is applied to pull it along a horizontal surface. The friction is sufficient enough for its pure rolling $\left(\angle\theta = 0^0\right)$



54. Find the linear acceleration of the wheel

(a) $\frac{F\left[(I/m)-Rr\right]}{\left[(I/m)+r^2\right]}$ (b) $\frac{2F\left[(I/m)-Rr\right]}{\left[(I/m)+r^2\right]}$

(c) $\frac{F\left[(2I/m)-\sqrt{2}Rr\right]}{\left[(I/m)+r^2\right]}$ (d) $\frac{F\left[\left(I\sqrt{2}/m\right)-Rr\right]}{\left[(I/m)+r^2\right]}$

55. Find the condition for which frictional force acts in backward direction

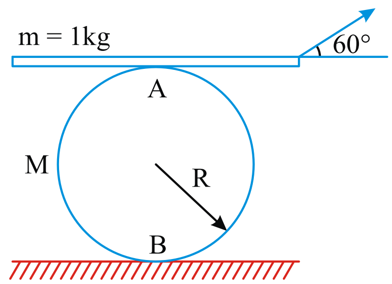
(a) $(I/m) > Rr$ (b) $(2I/m) > Rr$ (c) $\left(\frac{I\sqrt{2}}{m}\right) > Rr$ (d) $\left(\frac{I}{m\sqrt{2}}\right) > Rr$

56. Find the condition for which frictional force acts in forward direction

(a) $(I/m) < Rr$ (b) $(2I/m) < Rr$ (c) $\left(\frac{I\sqrt{2}}{m}\right) < Rr$ (d) $\left(\frac{I}{m\sqrt{2}}\right) < Rr$

Passage - VI : (57-59)

Consider a cylinder of mass M = 1kg and radius R=1 m lying on a rough horizontal plane. It has a plank lying on its stop as shown in the figure.



A force F = 55 N is applied on the plank such that the plank moves and causes the cylinder to roll. The plank always remains horizontal. There is no slipping at any point of contact.

57. The acceleration of cylinder is

(a) 20 m/s^2 (b) 10 m/s^2 (c) 5 m/s^2 (d) 12 m/s^2

58. The value of frictional force at A is

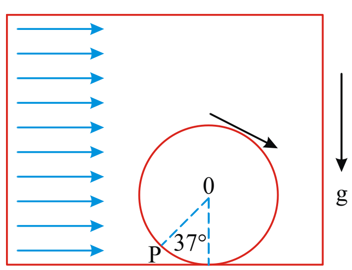
(a) 7.5 N (b) 5.0 N (c) 2.5 N (d) 1.5 N

59. The value of frictional force at B is

(a) 7.5 N (b) 5.0 N (c) 2.5 N (d) 1.5 N

Passage - VII :(60-62)

A cabin is falling freely and inside the cabin a disc of mass M and radius R is made to undergo uniform pure rolling motion with the help of some external agent. Inside the cabin wind is blowing in horizontal direction which imparts an acceleration a to all the objects present in cabin in horizontal direction. [Disc still performs uniform pure rolling motion]. A very small particle gets separated from disc from point P and after some time it passes through the centre of disc O. Based on above information, answer the following questions:



60. The time taken by particle to reah from *P* to *O* is

(a) $\frac{4}{3}\sqrt{\frac{15R}{8a}}$ (b) $4\sqrt{\frac{6R}{4a}}$ (c) $3\sqrt{\frac{6R}{7a}}$ (d) $\frac{3}{4}\sqrt{\frac{15R}{8a}}$

61. The angular velocity of disc is

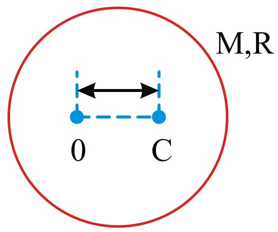
(a) $\frac{1}{3}\times\sqrt{\frac{7a}{6R}}$ (b) $\sqrt{\frac{8a}{15R}}$ (c) $\frac{4}{9}\times\sqrt{\frac{7a}{6R}}$ (d) $\frac{16}{9}\times\sqrt{\frac{8a}{15R}}$

62. The revolution made by disc in time interval computed in Q.No. (i) is

(a) 8 (b) $\frac{6}{5\pi}$ (c) $\frac{5\pi}{6}$ (d) $\frac{2}{3\pi}$

Passage - VIII :(63-65)

A disc of a mass M and radius R can rotate freely in vertical plane about a horizontal axis at O. distant r from the centre of disc as shown in the figure. The disc is relased from rest in the shown position.



63. **The angular acceleration of disc when OC rotates by an angle of 37^0, is**

(a) $\frac{8rg}{5\left[R^2+2r^2\right]}$ (b) $\frac{5rg}{4\left[R^2+2r^2\right]}$ (c) $\frac{10rg}{3\left[R^2+2r^2\right]}$ (d) $\frac{8rg}{5R^2}$

64. **The angular velocity of disc in above described case is**

(a) $\sqrt{\frac{8gr}{5\left[R^2+2r^2\right]}}$ (b) $\sqrt{\frac{6gr}{5\left[R^2+2r^2\right]}}$ (c) $\sqrt{\frac{12gr}{5\left[R^2+2r^2\right]}}$ (d) $\sqrt{\frac{12gr}{5R^2}}$

65. **Reaction force exerted by hinge on disc at this instant is**

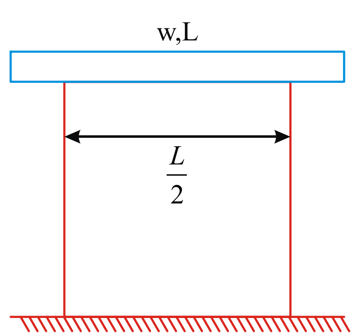
(a) $\frac{Mg}{5\left(R^2+2r^2\right)} \times\sqrt{g\left(R^2+6r^2\right)^2+\left(4R^2\right)^2}$ (b) $\frac{Mg}{5\left(R^2+2r^2\right)}\times 3\left(R^2+6r^2\right)$

(c) $\frac{4Mg}{5\left(R^2+2r^2\right)}\times R^2$ (d) $\frac{Mg}{5\left(R^2+2r^2\right)}\times 4R^2$

MATRIX MATCHING TYPE QUESTIONS

66. **A *rod* of length L and weight w is kept in equilibrium on the two support separated by $\frac{L}{2}$ as shown in the figure. The right support is taken out at time t = 0.**

Match the following questions based on the above information



Column I	**Column II**
(a) The moment	(p) 3g/7

of inertia of the rod
about the support point at t = 0 is

(b) The angular (q) $\frac{12g}{7L}$

acceleration of rod about
the support point at t = 0 is

(c) The linear (r) $\frac{4\omega}{7}$

acceleration of centre
of mass of rod at t = 0 is

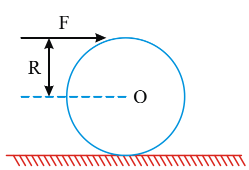
(d) The normal (s) $\frac{7\omega L^2}{48g}$

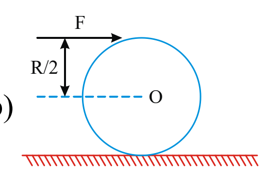
reaction on the rod

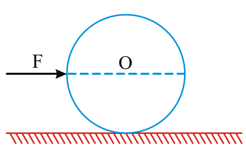
by the support at t = 0 is (t) $\frac{\omega L^2}{3g}$

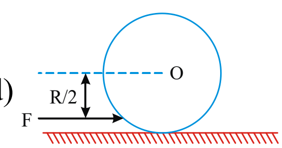
67. A uniform solid cylinder of mass m and radius R is placed on a rough horizontal surface where friction is sufficient to provide pure rolling. A horizontal force of magnitude F is applied on cylinder at different positions with respect to its centre *O* in each of four situations of column-1, due to which magnitude of acceleration of centre of mass of cylinder is 'a' Match the appropriate results in column-II for conditions of columnI

Column-I

(a)


(b)


(c)


(d)


Column-II

(p) Friction force on cylinder will not zero

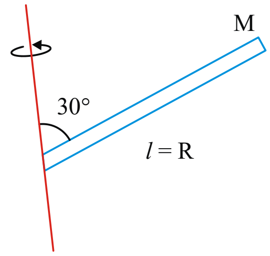
q) $a = \frac{F}{m}$

r) $a \neq \frac{F}{m}$

s) friction force acting on cylinder is zero

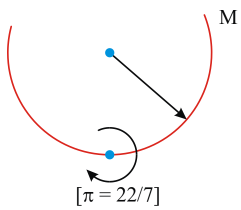
68. **Column I** **Column II**
(Object) **(Moment of inertia)**

(a) Uniform rod p) $\frac{8MR^2}{11}$



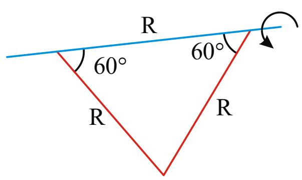
(b) Uniform semicircular ring. q) $\frac{MR^2}{12}$

Axis is perpendicular
to plane of ring



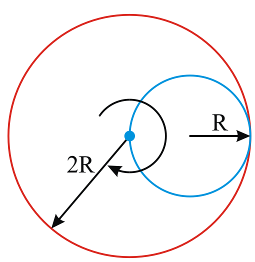
(c) Uniform triangular r) $\frac{13MR^2}{8}$

plate of mass M



(d) Uniform disk of initial mass s) $\frac{MR^2}{8}$

M from which circular Portion of radius R is then removed M.I of remaining mass about axis which is perpendicular to plane of plate and passing through its centre

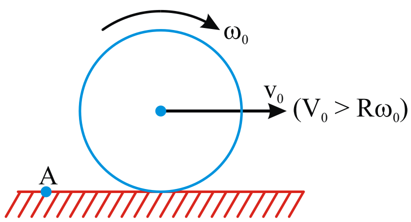


69. **In each situation of column-I, a uniform disc of mass m and radius R rolls on a rough fixed horizontal surface as shown. At t=0(initially) the angular velocity of disc is ω_o and velocity of centre of mass of disc is V_0 (in horizontal direction).**

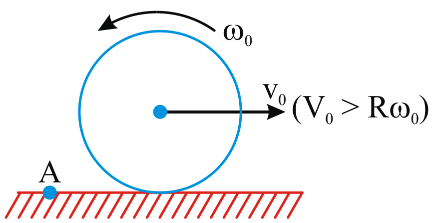
The relation between V_0 and ω_0 for each situation and also initial sense of rotation is given for each situation in column-I. Then match the statements in column-I with the corresponding results in column-II

Column-I

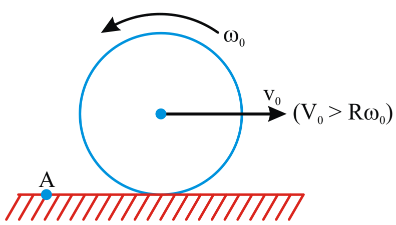
(A)



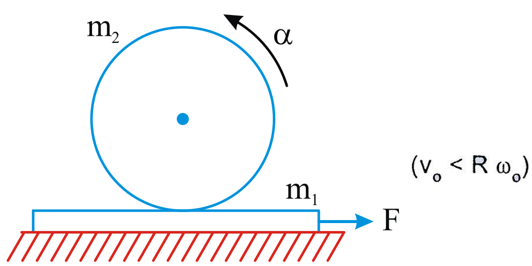
(B)



(C)



(D)



Column-II

p) The angular momentum of disc about point A (as shown in figure) remains conserved.

q) The kinetic energy of disc after it starts rolling without slipping is less than its initial kinetic energy.

r) In the duration disc rolls with slipping, the friction acts on disc towardsleft

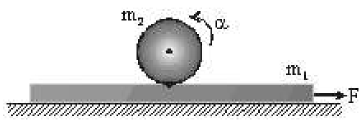
s) Before rolling starts acceleration of the disc remain constant in magnitude and direction.

t) Final angular velocity is independent of friction coefficient between disc and the surface.

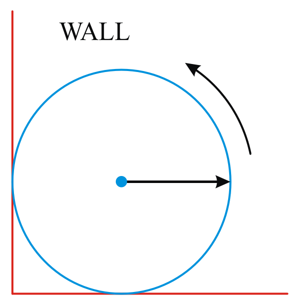
INTEGER ANSWER TYPE QUESTIONS

70. A plank of mass m_1 with a uniform solid sphere of mass m_2 placed on it rests and a force F is applied to the plank. The acceleration of the plank provided

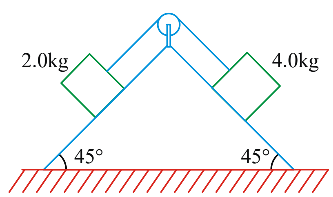
there is no sliding between the plank and the sphere is $\frac{F}{m_1 + \frac{n}{7}m_2}$ then the value of n is



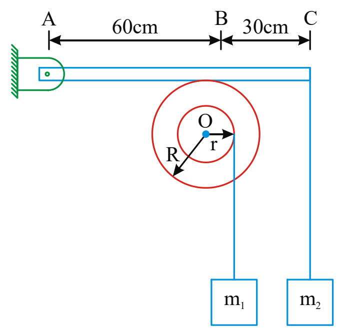
71. **A uniform cylinder of radius *r* is rotating about its axis at the angular velocity ω_0. It is now placed into a corner as shown in figure. The coefficient of friction between the wall and the cylinder as well as the ground and the cylinder is μ. The number of turns, the cylinder completes before it stops, are given by $\left(\frac{\omega_0^2 r}{n\pi g}\right)\left(\frac{1+\mu^2}{\mu(1+\mu)}\right)$ the value of n is**



72. **The pulley shown in figure, has a radius 10 cm and moment of inertia 0.5 kg-m^2 about its axis. Assuming the inclined planes to be frictionless, the acceleration of the 4.0 kg block is $\frac{1}{n}$ that value of n is**



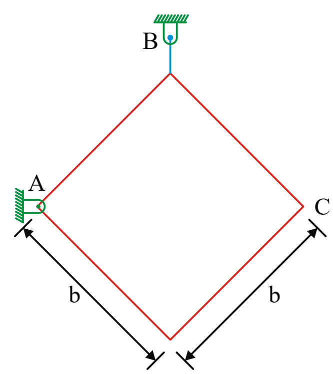
73. **In the arrangement shown in figure, ABC is a straight, light and rigid rod of length 90cm. End A is pivoted so that the rod can rotate freely about it, in vertical plane. A pulley, having internal and external radii R=7.5cm and r=5cm is fixed to a shaft of radius 5cm. The pulley - shaft system can rotate about a fixed horizontal axis O. B is point of contact of the pulley and the rod. From free end C of the rod a mass $m_2 = 2kg$ is suspended by a thread. Another thread is wound over the shaft and a block of mass $m_1 = 4kg$ is suspended from it.**
If coefficient of friction between the rod and the pulley surface is $\mu = 0.4$ and moment of inertia of pulley-shaft system about axis O is $I = 0.045\,kg - m^2$, the acceleration of block m_1, when the system is released $(g = 10\,ms^{-2})$ is



74. **A ball of radius R=20cm has mass m=0.75kg and moment of inertia (about its diameter) $I = 0.0125\,kgm^2$. The ball rolls without sliding over a rough horizontal floor with velocity $V_0 = 10\,ms^{-1}$ towards a smooth vertical wall. If coefficient of restitution between the wall and the ball is e=0.7, velocity V of the ball long after the collision is $(g = 10\,ms^{-2})$**

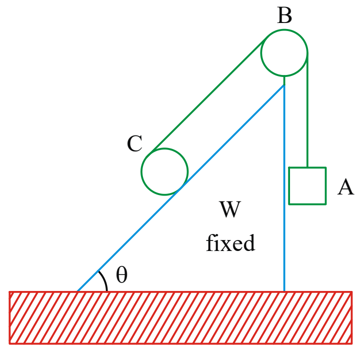
75. **A uniform square plate of mass 'm' is supported as shown. If the cable suddenly breaks, assuming centre of mass is on horizontal ine passing through A determine ;**

The reaction at A is $\frac{mg}{n}$ that n is

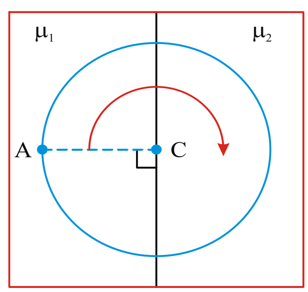


76. **In the figure shown there is a fixed wedge 'W' of inclination θ. A is a block, B is a disc and 'C' is a solid cylinder. A, B and C each has mass 'm'. Assuming there is no sliding anywhere and string to be of negligible mass find :**

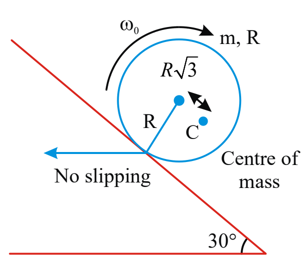
The friction force acting on the cylinder due to the wedge is $\frac{mg}{15}(1 + n\sin\theta)$ that n is



77. In the figure shown a uniform ringh ofmass m is placed on arough horizontal fixed surface. The coefficient of friction between left half of ring and table is μ_1 whereas between right half and table is μ_2 at the moment shown. The ring has angular velcoity in clockwise sense in the figure shown. At this moment find the magnitude of acceleration $(in\ m/s^2)$ of centre C of ring. [Given $g = 10 m/s^2$]



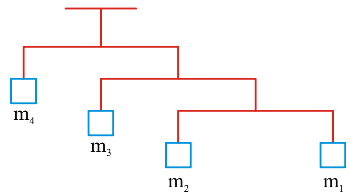
78. In the given diagram a sphere of mass m and radius R is rolling without slipping on a rough inclined surface of inclination $(\pi/6)$. Centre of mass of sphere is at C which is $\frac{R}{\sqrt{3}}$ distiance from centre in a direction parallel to inclined plane. Moment of a intertia of the sphere about point of contact is I_0 (given). At the given instant sphere is rotating with constant velcity ω_0. Calculate the angular accel eration of sphere at this instant to near est integer?



[Given that $m = 2kg$, $R = 0.5m$

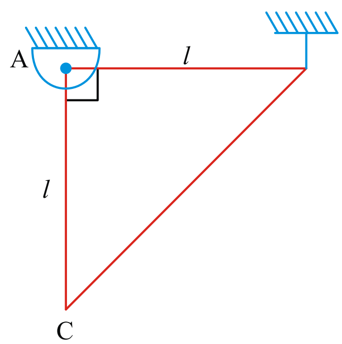
$g = 10 m/s^2$, $\omega_0^2 = \sqrt{3}$ in SI unit and $I_0 = 10 kg - m^2$]

79. **Figure shows an arrangement of masses hanging from a ceilling. In equilibrium each rod is horizontal, has negligible mass and extends three times as far to the right of the wire supporting is as to the left. If mass m_4 is $48 kg$, then $\frac{m_3}{m_2}$ is**



80. **An isosceles right triangular plate *ABC* of mass *m* is free to rotate in vertical plane about a fixed horizontal axis through *A*. It is supported by a string such that the side *AB* is horizontal. The reaction at the support *A is* $\frac{p(mg)}{q}$ *t h u s***

$p + q = -$.



EXERCISE - IV - KEY

SINGLE ANSWER QUESTIONS

1. D 2. C 3. A 4.B 5. C 6. D 7.A 8.C 9.B 10.D
11.A 12.C 13.A 14.A 15.A 16.C 17.B 18.B 19.B 20.B
21.A 22.B 23.A 24.A 25.B

MULTIPLE ANSWER QUESTIONS

26. A,B 27. A,C 28. A,C 29. A,B,C 30. A,B,C
31. B,D 32. C,D 33. A,D 34. A,B,D 35. B,C
36. C,D 37. A,B,D 38. A,B 39. A,B,C 40. A,B,D
41. A,C 42. B,C

COMPREHENSION QUESTIONS

43. A 44. A 45. C 46. A 47. B 48. C 49. D 50. C 51. D 52. D
53. C 54. A 55. A 56. A 57. B 58. A 59. C 60. A 61. B 62. D
63. A 64. C 65. A

MATRIX MATCHING TYPE

66. $A \to s; B \to q; C \to p; D \to r$ 67. $A \to p; B \to q, s; C \to p, r; D \to p, r$
68. $A \to q; B \to p; C \to s; D \to r$ 69. $A \to p, q, r; B \to p, q, r; C \to p, q; D \to p, q, r$

INTEGER TYPE QUESTIONS

70. 2 71. 8 72. 4 73. 1 74. 2 75. 4 76. 7 77. 4 78. 1 79. 4
80. 5

SINGLE ANSWER TYPE QUESTIONS

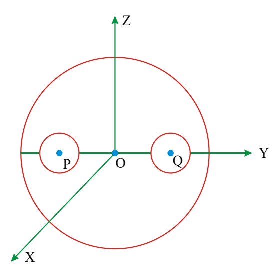
1. A spherical hollow is made in a lead sphere of radius R such that its surface touches the outside surface of the lead sphere and passes through the centre. The mass of the lead sphere before hollowing was M. The force of attraction that this sphere would exert on a particle of mass m which lies at a distance d from the centre of the lead sphere on the straight line joining the centre of the sphere and the hollow is

A) $\frac{GMm}{d^2}$ B) $\frac{GMm}{d^2}\left[1-\frac{1}{8\left(1-\frac{R}{2d}\right)^2}\right]$ C) $\frac{GMm}{d^2}\left[1+\frac{1}{8\left(1+\frac{R}{2d}\right)^2}\right]$ D) $\frac{GMm}{8d^2}$

2. A thin rod of length L is bent to form a circle. Its mass is M. What force will act on the mass m placed at the centre of the circle?

A) $\frac{4\pi^2 GMm}{L^2}$ B) $\frac{GMm}{4\pi^2 L^2}$ C) $\frac{2\pi GMm}{L^2}$ D) zero

3. A solid sphere of uniform density and mass M has radius $4\,m$. Its centre is at the origin of the coordinate system. Two spheres of radii 1 m are taken out so that their centres at $P(0,-2,0)$ and $Q(0,2,0)$ respectively. This leaves two spherical cavities. What is the gravitational field at the origin of the coordinate axes?



A) $\frac{31GM}{1024}$ B) $\frac{Gm}{1024}$ C) $31GM$ D) zero

4. The gravitational potential due to earth at infinite distance from it is zero. Let the gravitational potential at a point P be $-5\,J\,kg^{-1}$. Suppose, we arbitrarily assume the gravitational potential at infinity to be $+10\,J\,kg^{-1}$, then the gravitational potential at P will be

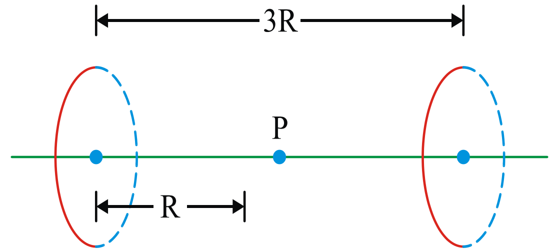
A) $-5\,J\,kg^{-1}$ B) $+5\,J\,kg^{-1}$ C) $-15\,J\,kg^{-1}$ D) $+15\,J\,kg^{-1}$

5. A body starts from rest from a point at a distance r_0 from the centre of the earth. It reaches the surface of the earth whose radius is R. The velocity acquired by the body is

A) $2GM\sqrt{\frac{1}{R}-\frac{1}{r_0}}$ B) $\sqrt{2GM\left(\frac{1}{R}-\frac{1}{r_0}\right)}$ C) $GM\sqrt{\frac{1}{R}-\frac{1}{r_0}}$ D) $\sqrt{GM\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

6. Two rings having masses M and $2M$, respectively, having same radius are

placed coaxially as shown in figure.



If the mass distribution on both the rings is non-uniform, then gravitational potential at point P is

A) $-\frac{GM}{R}\left[\frac{1}{\sqrt{2}}+\frac{2}{\sqrt{5}}\right]$ B) $-\frac{GM}{R}\left[1+\frac{2}{2}\right]$ C) zero

D) cannot be determined from given information

7. **A point P lies on the axis of a fixed ring of mass M and radius R, at a distance $2R$ from its centre O. A small particle starts from P and reaches O under gravitational attraction only. Its speed at O will be:**

A) $\sqrt{\frac{2GM}{R}\left(1-\frac{1}{\sqrt{5}}\right)}$ B) $\sqrt{\frac{2GM}{R}}$

C) $\sqrt{\frac{2GM}{R}\left(\sqrt{5}-1\right)}$ D) zero

8. **The gravitational field due to a mass distribution is given by $E = K/x^3$ in $x-$direction. Taking the gravitational potential to be zero at infinity, its value at distance x is:**

A) $\frac{2K}{x^2}$ B) $\frac{K}{2x^2}$ C) $\frac{K}{x^2}$ D) $\frac{3K}{2x^2}$

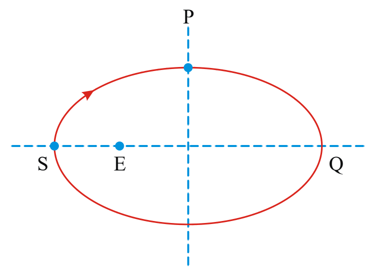
9. **An artificial satellite of earth is launched in circular orbit in equatorial plane of the earth and satellite is moving from west to east. With respect to a person on the equator, the satellite is completing one round trip in $24\,h$. Mass of earth is, $M = 6\times10^{24}\,kg$. For this situation, orbital radius of the satellite is:**

A) $2.66\times10^{4}\,km$ B) $6400\,km$ C) $36,000\,km$ D) $29,600\,km$

10. **A satellite is orbiting around earth in a circular orbit of radius r. A particle of mass m is projected from satellite in forward direction with velocity $v=\sqrt{\frac{2}{3}}$ times orbital velocity (this velocity is given with respect to earth). During subsequent motion of the particle, its minimum distance from the centre of earth is**

A) $\frac{r}{2}$ B) r C) $\frac{2r}{3}$ D) $\frac{4r}{5}$

11. The satellite is moving in an elliptical orbit about the earth as shown in figure:



The minimum and maximum distance of satellite from earth are 3 units and 5 units, respectively. The distance of satellite from the earth when it is at P is equal to

A) 4 units B) 3 units C) 3.75 units D) none of these

12. An exploratory rocket of mass m is in orbit about the sun at a radius of $R_{ES}/10$ (one tenth of the radius of the earth's orbit about the sun). To exit this orbit, it fires its engine over a short period of time. This quickly doubles the velocity of the rocket while halving its mass (due to fuel consumption). Immediately after the burn, what is the kinetic energy of the rocket? Take mass of sun as M_S

A) $\dfrac{GM_S m}{2R_{ES}}$ B) $\dfrac{10GM_S m}{R_{ES}}$ C) $\dfrac{20GM_S m}{R_{ES}}$ D) $\dfrac{5GM_S m}{R_{ES}}$

13. A shell is fired vertically from the earth with speed v_{esc}/N, where N is some number greater than one and v_{esc} is escape speed on the earth. Neglecting the rotation of the earth and air resistance, the maximum altitude attained by the shell will be (R_E is radius of the earth):

A) $\dfrac{R_E}{N^2-1}$ B) $\dfrac{R_E}{N^2}$ C) $\dfrac{NR_E}{N^2-1}$ D) $\dfrac{N^2R_E}{N^2-1}$

14. A planet of small mass m moves around the sun of mass M along an elliptical orbit such that its minimum and maximum distance from sun are r and R respectivley. Its period of revolution will be:

A) $2\pi\sqrt{\dfrac{(r+R)^3}{6GM}}$ B) $2\pi\sqrt{\dfrac{(r+R)^3}{3GM}}$ C) $\pi\sqrt{\dfrac{(r+R)^3}{2GM}}$ D) $2\pi\sqrt{\dfrac{(r+R)^3}{GM}}$

15. A satellite revolving around the planet in a circular orbit is to be raised to a bigger circular orbit. The required energy can be supplied to the satellite for achieving the bigger orbit:

A) in one stage B) in minimum two stages

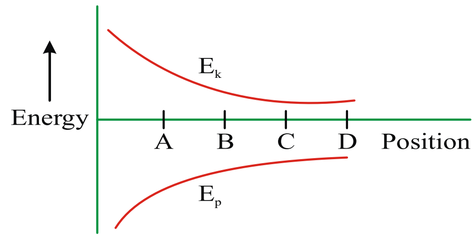
C) in minimum four stages D) in minimum three stages

16. A spherical uniform planet is rotating about its axis. The velocity of a point on its equator is v. Due to rotation of planet about its axis the acceleration due to gravity g at equator is $\dfrac{1}{2}$ of g at poles. The escape velocity of a particle on the pole of planet in terms of v_e:

A) $v_e = 2v$ B) $v_e = \sqrt{3}v$ C) $v_e = v$ D) $v_e = v/2$

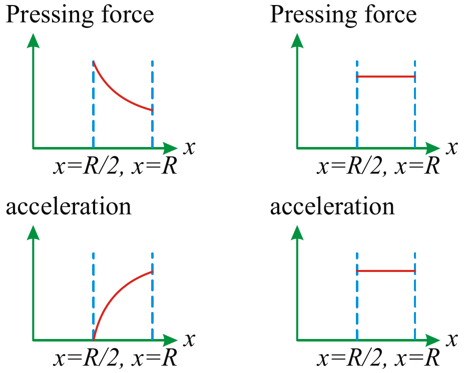
MULTI ANSWER TYPE QUESTIONS

17. Figure shows the kinetic energy (E_k) and potential energy (E_P) curves for a two-particle system. Name the point at which the system is bound.

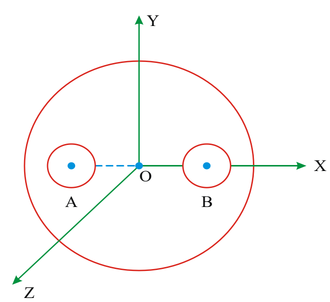


A) A B) B C) C D) D

18. A tunnel is dug along a chord of the earth at a perpendicular distance $R/2$ from the earth's centre. The wall of the tunnel may be assumed to be frictionless. A particle is released from one end of the tunnel. The pressing force by the particle on the wall, and the acceleration of the particle vary with x (distance of the particle from the centre of earth) according to



19. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two spheres of equal radii 1 unit, with their centres at $A(-2,0,0)$ and $B(2,0,0)$ respectively, are taken out of the solid leaving behind spherical carvities as shown in the figure. Then



A) the gravitational force due to this object at the origin is zero

B) the gravitational force at the point $B(2,0,0)$ is zero

C) the gravitational potential is the same at all points of the circle $z^2 + y^2 = 36$

D) the gravitational potential is same at all points of the circle $y^2 + z^2 = 4$

20. A double star consists of two stars having masses M and $2M$. The distance between their centres is equal to r. They revolve under their mutual gravitational interaction. Then, which of the following statements are not correct?

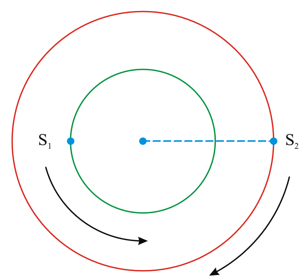
A) Heavier star revolves in orbit of radius $2r/3$

B) Both the stars revolve with same speed, period of which is equal to $(2\pi/r^3)(2GM^2/3)$

C) Kinetic energy of the heavier star is twice that of the other star

D) Havier star revolves in orbit of radius r/3

21. Two satellites S_1 and S_2 are revolving around the earth in coplanar concentric orbits in the opposite sense. At $t = 0$, the positions of satellites are shown in the diagram. The period of S_1 and S_2 are 4 h and 24 h, respectively. The radius of orbit of S_1 is 1.28×10^4 km. For this situation mark the correct statement(s).



A) The angular velocity of S_2 are observed by S_1 at $t = 12h$ is $0.486\pi \, rad \, s^{-1}$.

B) The two satellites are closest to each other for the first time at $t = 12h$ and then after every 24 h they are closest to each other.

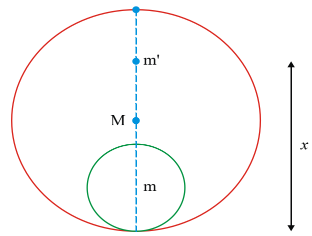
C) The orbital velocity of S_1 is $0.64\pi \times 10^4 km$ ·

D) The velocity of S_1 relative to S_2 is continuously changing in magnetic and direction both

COMPERHENSION TYPE QUESTIONS

Comprehension-24-26:

A solid sphere of mass m radius r is placed inside a hollow thin spherical shell of mass M and radius R as shown in figure. A particle of mass m' is placed on the line joining the two centres at a distance x from the point of contact of the sphere and the shell. Find the magnitude of the resultant gavitational force on this particle due to the sphere and the shell if



22. **r < x < 2r**

A) $\frac{Gmm'(2r-x)}{2r^3}$ B) $\frac{Gmm'(x-r)}{2r^3}$ C) $\frac{Gmm'(x-r)}{r^3}$ D) $\frac{Gmm'(2x-r)}{r^3}$

23. **2r < x < 2R**

A) $\frac{Gmm'}{4(x-x)^2}$ B) $\frac{Gmm'}{(x-r)^2}$ C) $\frac{Gmm'}{(x-r)^3}$ D) $\frac{2Gmm'}{(x-r)^2}$

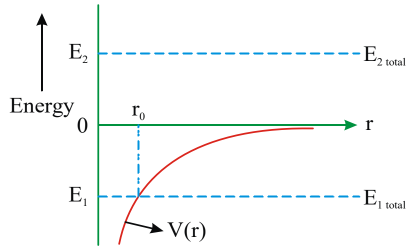
24. **x > 2R**

A) $\frac{2GMm'}{(x-r)^2}+\frac{Gmm'}{(x+r)^2}$ B) $\frac{GMm'}{2(x-R)^2}+\frac{2Gmm'}{(x-r)^2}$

C) $\frac{GMm'}{(x+R)^2}+\frac{Gmm'}{(x+r)^2}$ D) $\frac{GMm'}{(x-R)^2}+\frac{Gmm'}{(x-r)^2}$

Comprehension-25-27:

In the graph shown, the PE of earth-satellite system is shown by solid line as a function of distance r (the separation between earth's centre and satellite). The total energy of the two objects which may or may not be bounded to earth are shown in figure by dotted lines.



Based on the above information answer the following questions:

25. **Mark the correct statement(s):**

A) The object having total energy E_1 is bounded one

B) The object having total energy E_2 is bounded one

C) Both the objects are bounded

D) Both the objects are unbounded

26. **If object having total energy E_1 having same PE curve as shown in figure, then**

A) r_0 is the maximum distance of object from earth's centre

B) this object and earth system is bounded one

C) the KE of the object is zero when $r = r_0$

D) all the above

27. If both the objects have same PE curve as shown in figure, then

A) for objects having total energy E_2 all values of r are possible

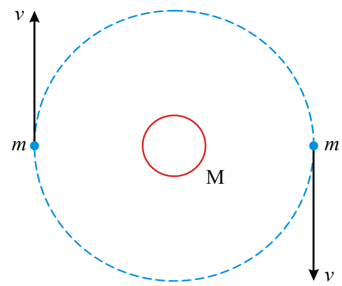
B) for object having total energy E_2 values of $r < r_0$ are only possible

C) for object having total energy E_1 all values of r are possible

D) none of the above

Comprehension-28-30:

A triple star system consists of two stars, each of mass m, in the same circular orbit about central star with mass $M = 2\times10^{30}\,kg$. The two outer stars always lie at opposite ends of a diameter of their common circular orbit. The radius of the circular orbit is $r = 10^{11}m$ and the orbital period of each star is $1.6\times10^{7}s$.



[Take $\pi^2 = 10$ and $G = \frac{20}{3}\times10^{-11}Nm^2kg^{-2}$]

28. The mass m of the outer star is

A) $\frac{16}{15}\times10^{30}kg$ B) $\frac{11}{8}\times10^{30}kg$ C) $\frac{15}{16}\times10^{30}kg$ D) $\frac{8}{11}\times10^{30}kg$

29. The orbital velocity of each star is

A) $\frac{5}{4}\sqrt{10}\times10^{3}m/s$ B) $\frac{5}{4}\sqrt{10}\times10^{5}m/s$

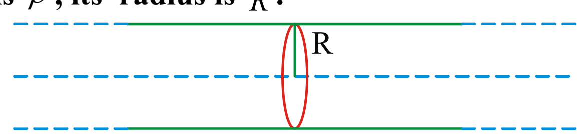
C) $\frac{5}{4}\sqrt{10}\times10^{2}m/s$ D) $\frac{5}{4}\sqrt{10}\times10^{4}m/s$

30. The total mechanical energy of the system is

A) $-\frac{1375}{64}\times10^{35}J$ B) $-\frac{1375}{64}\times10^{38}J$ C) $-\frac{1375}{64}\times10^{34}J$ D) $-\frac{1375}{64}\times10^{37}J$

Comprehension-31-33:

Consider a hypothetical planet which is very long and cylindrical. The density of the planet is ρ, its radius is R.



31. What is the possible orbital speed of the satellite in moving around the planet in circular orbit in a plane which is perpendicular to the axis of planet?

A) $R\sqrt{\pi G\rho}$ B) $2R\sqrt{\pi G\rho}$ C) $R\sqrt{2\pi G\rho}$ D) $R\sqrt{\frac{G\rho}{2\pi}}$

32. If an object is projected radially outwards from the surface such that it reaches

upto a maximum distance of $3R$ from the axis then what should be the speed of projection?

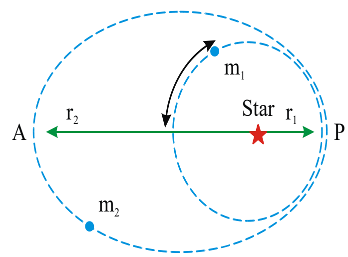
A) $R\sqrt{\frac{2}{3}\pi\rho G}$ B) $2R\sqrt{\pi\rho G\ln 3}$ C) $R\sqrt{\frac{4}{3}\pi\rho G}$ D) $R\sqrt{\frac{2}{3}\pi\rho G\ln 3}$

33. **Assume that the planet is rotating about its axis with time period T. How far from the axis of the planet do the synchronous telecommunications satellites orbit?**

A) $RT\sqrt{\pi G\rho}$ B) $2RT\sqrt{\pi G\rho}$ C) $RT\sqrt{2\pi G\rho}$ D) $RT\sqrt{\frac{G\rho}{2\pi}}$

Comprehension-34-36:

Two planets of equal mass orbit a much more massive star. Planet m_1 moves in a circular orbit of radius 1×10^8 km with a period of 2 years Planet m_2 moves in an elliptical orbit with closest distance $r_1 = 1\times10^8$ km and farthest distance $r_2 = 1.8\times10^8 km$, as shown:



34. **Using the fact that the mean radius of an elliptical orbit is the length of the semimajor axis, find the period of m_2's orbit.**

A) $3.31\,years$ B) $2.21\,years$ C) $4.25\,years$ D) $1.52\,years$

35. **What is the mass of the star?**

A) $5.29\times10^{20}\,Kg$ B) $1.49\times10^{25}\,Kg$ C) $1.49\times10^{29}\,Kg$ D) $1.49\times10^{30}\,Kg$

36. **Compare the speed of planet m_2 at P with that at A.**

A) $V_P = 2.4V_A$ B) $V_P = 3.6V_A$ C) $V_P = 4.2V_A$ D) $V_P = 1.8V_A$

INTEGER TYPE QUESTIONS

37. **A planet revolves about the sun in elliptical orbit of semi-major axis $2\times10^{12}\,m$. The areal velocity of the planet when it is nearest to the sun is $4.4\times10^{16}\,m/s$. The least distance between planet and the sun is $1.8\times10^{12}\,m$.**
The minimum speed of the planet in km/s is k/10. Determine the value of k.

38. **The gravitational potential energy of a satellite revolving around the earth in circular orbit is - 4 MJ. Find the additional energy (in MJ) that should be given to the satellite so that it escapes from the gravitational field of the earth.**

39. **A particle is projected from the earth's surface with an initial speed of 4 km/s. What will be themaximum height attained by the particle ?**

40. **Earth is a sphere of uniform mass density. If the weight of the body is 10n N half way down the centre of earth find the value of n. The body weighed 100 N on the surface.**

41. **An infinite collection of equal masses of 2 kg are kept on a horizontal line $(x-axis)$ at positions $x = 1, 2, 4, 8, ...$. Find the gravitational potential at $x = 0$ in GJ units.**

42. **Three uniform spheres, each having a mass $M = 5kg$ and radius $a = 2.5m$ are kept in such a way that each touches the other two. Find the magnitude of the gravitational force in GN on any of the spheres due to the other two.**

43. **A chord of length 64m is used to connect a 100kg astronaut to a spaceship whose mass is much lager than that of the astronaut. Estimate the value of the tension in 10^{-2} N in the chord. Assume that the spaceship and the astronanut fall on a straight line from the earth's centre. The radius of the earth is 6400 km.**

44. **Two satellites of mass ratio $1:2$ are revolving around the earth in circular orbits such that the distance of the second satellite is four times as compared to the distance of the first satellite. Find the ratio of their centripetal forces.**

EXERCISE -I -KEY

SINGLE ANSWER QUESTIONS

1) B 2) D 3) D 4) B 5) B 6) A 7) A 8) B 9) A 10) A
11) A 12) B 13) A 14) C 15) B 16) A

MULTI - ANSWER QUESTIONS

17) A, B, C, D 18) B, C 19) A, C, D 20) A, C 21) A, B, C, D

COMPERHENSION QUESTIONS

22) C 23) B 24) D 25) A 26) D 27) A 28) B 29) D 30) B 31) C
32) B 33) D 34) A 35) C 36) D

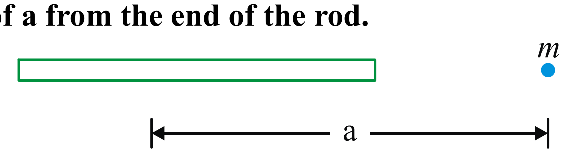
INTEGER TYPE QUESTIONS

37) 4 38) 2 39) 1 40) 5 41) 4 42) 4 43) 3 44) 8

EXERCISE - II

SINGLE ANSWER QUESTIONS

1. **Find the potential energy of the gravitational interaction of a point mass m and a rod of mass m and lengt l if they are along a straight line. Point mass is at a distance of a from the end of the rod.**

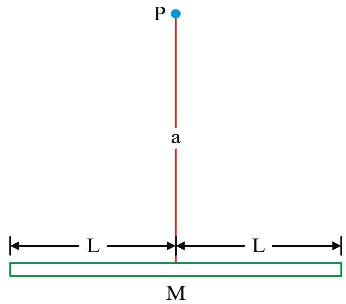


A) $U = \frac{-Gm^2}{l} \ln\left(\frac{2a+l}{2a-l}\right)$ B) $U = \frac{-Gm}{l^2} \ln\left(\frac{2a+l}{2a-l}\right)$

C) $U = \frac{-Gm^2}{l^2} \ln\left(\frac{2a-l}{2a+l}\right)$ D) $U = \frac{-Gm^2}{l^2} \ln\left(\frac{2a+l}{2a-l}\right)^2$

2. **Mass M is distributed uniformly along a line of length 2L. A particle of mas m is at a point that is a distance a above the centre of the line on its perpendiculr bisector (Point P in figure). The gravitational force that the line exerts on the**

particle is



A) $\frac{GMm}{\sqrt{L^2+a^2}}$ B) $\frac{GMm}{a\left(L^2+a^2\right)}$

C) $\frac{GMm}{a\sqrt{L^2+a^2}}$ D) $\frac{GMm}{a\left(L^2+a^2\right)^2}$

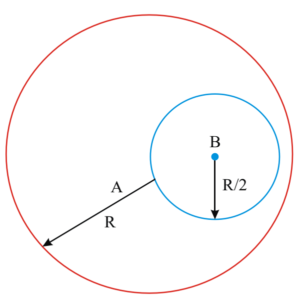
3. **A planet of mass m moves along an ellipse around the sun so that its maximum and minimum distances from the sun are equal to r_1 and r_2 respectively. Find the aqnglular momentum of this planet relative to the centre of the sun. Mass of the sun is M.**

A) $m\sqrt{\frac{2GMr_1r_2}{\left(r_1+r_2\right)^2}}$ B) $m\sqrt{\frac{2GMr_1r_2}{\left(r_1+r_2\right)}}$ C) $m\sqrt{\frac{2GMr_1^2r_2^2}{\left(r+r_2\right)}}$ D) $m^2\sqrt{\frac{2GMr_1r_2}{\left(r+r_2\right)}}$

4. **Inside a uniform shere of density ρ there is a spherical cavity whose centre is at a distance l from the centre of the sphere. Find the strengh of the gravitational field inside the cavity.**

A) $E=\frac{-2}{3}\pi G\rho l$ B) $E=\frac{-4}{3}\pi G\rho l$ C) $E=\frac{-4}{3}\pi^2 G\rho l$ D) $E=\frac{-4}{3}\pi G\rho^2 l^2$

5. **Inside a fixed sphere of radius R and uniform density ρ, there is spherical cavity of radius $\frac{R}{2}$ such that surface of the cavity passes through the centre of the sphere as shown in figure. A particle of mass m is released from rest at centre B of the cavity. Calculate velocity with which particle strikes the centre A of the sphere. Neglect earth's gravity. Initially sphere and particle are at rest.**



A) $\sqrt{\frac{2}{3}\pi G\,\mathrm{PR}^2}$ B) $\sqrt{\frac{2}{3}\pi GP^2R^2}$ C) $\sqrt{\frac{2}{5}\pi GPR^2}$ D) $\sqrt{\frac{2}{3}\pi^2G^2P^2R^2}$

6. **A ring of radius $R = 4m$ is made of a highly dense meterial. Mass of the ring is $m_1 = 5.4\times10^9\,kg$ distributed uniformly over uts circumference. a highly dense partice of mass $m_2 = 6\times10^8\,kg$ is placed on the axis of he ring at a distance $x_0 = 3$ m from the centre. Neglecting all other forces, except mutual gravitational interaction of the two, calculate**
(i) displacement of the ring when particle is at the centre of ring and
(ii) speed of the paricle at that instant.

A) (i) $0.4m$ (ii) $16cms^{-1}$ B) (i) $0.3m$ (ii) $18cm/\mathrm{s}$

C) (i) $0.2m$ (ii) $12cm/\mathrm{s}$ D) (i) $0.6m$ (ii) $24cm/\mathrm{s}$

7. **A cosmic body A moves to the sun with velocity v_0 (when far from the sun) and aiming parameter l the arm of the vector v_0 relative to the centre of the sun . Find the minimum distance by which this body will get to the sun. Mass of the sum is M.**

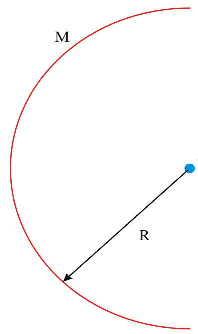
A) $\frac{GM}{v_0^2}\left[\sqrt{1+\left(\frac{lv_0^2}{GM}\right)^2}-1\right]$ B) $\frac{GM}{v_0^2}-1$ C) $\frac{GM}{v_0^2}\left[\sqrt{1+\left(\frac{lv_0^2}{GM}\right)^2}-1\right]$ D) $GMlv_0^2-1$

8. **Two satellites S_1 and S_2 revolve around a planet in coplanar circular orbits in the opposit sense. The periods of revolutions are T and ηT rspectively. Find the angular speed of S_2 as observed by an astronaut in S_1, when they are closest to each other.**

A) $W = \frac{2\pi\left(n^{-\frac{1}{3}}+1\right)}{T\left(n^{\frac{1}{3}}-1\right)}$ B) $W = \frac{2\pi\left(n^{-\frac{1}{3}}+1\right)}{T^2\left(n^{\frac{2}{3}}-1\right)}$

C) $W = \frac{2\pi\left(n^{-\frac{1}{3}}+1\right)}{T\left(n^{\frac{2}{3}}-1\right)}$ D) $W = \frac{2\pi\left(n^{-\frac{2}{3}}+1\right)}{T\left(n^{\frac{1}{3}}-1\right)}$

9. **A particle of mass m is placed on centre of curvature of fixed, uniform semi - circular ring of radius R and mass M as shown in figure. Calculate :**
(a) interaction force between the ring and the particle and
(b) work required to displace the particle from centre of curvature to infinity.



A) (a) $F=\dfrac{2GM}{\pi R^2}$ (b) $\dfrac{GM}{R}$ B) (a) $F=\dfrac{2GMm}{\pi R}$ (b) $\dfrac{GMm}{R^2}$

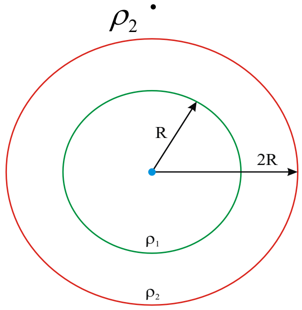
C) (a) $F=\dfrac{2GMm^2}{\pi R^2}$ (b) $\dfrac{GMm}{R^2}$ D) (a) $F=\dfrac{2GMm}{\pi R^2}$ (b) $\dfrac{GMm}{R}$

10. Given a thin homogeneous disc of radius a and mass m_1. A particle of mass m_2 is placed at a distance l from the disk on its axis of symmetry. Initially both are motionless in free space but they ultimately collide because of graviational attraction. Find the relative velocity at the time of collision. Assume a<<1.

A) $\left[2G(m_1+m_2)\left(\dfrac{2}{a}-\dfrac{1}{l}\right)\right]^{\frac{1}{2}}$ B) $\left[2G(m_1+m_2)\left(\dfrac{2}{a}-\dfrac{1}{l}\right)\right]$

C) $\left[2G(m_1+m_2)\left(\dfrac{2}{a}-\dfrac{1}{l}\right)^2\right]$ D) $\left[2G(m_1+m_2)^2\left(\dfrac{1}{a}-\dfrac{1}{l}\right)\right]$

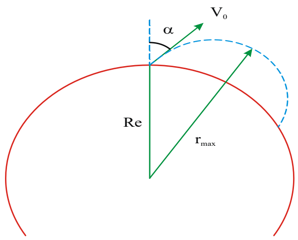
11. The density of the core of a planet is ρ_1 and that of the outer shell is ρ_2. The radii of the core and that the planet are R and 2R respectively. Gravitational acceleration at the surface of the planet is same as at a depth R. Find the ratio $\dfrac{\rho_1}{\rho_2}$.



A) $\dfrac{P_1}{P_2}=\dfrac{3}{7}$ B) $\dfrac{P_1}{P_2}=\dfrac{4}{9}$

C) $\dfrac{P_1}{P_2}=\dfrac{7}{3}$ D) $\dfrac{P_1}{P_2}=\dfrac{3}{8}$

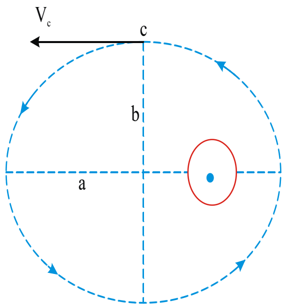
12. A projectile of mass m is fired from the surface of the earth at an angle $\alpha=60^0$ from the vertical. The initial speed v_0 is equal to $\sqrt{\dfrac{GM_e}{R_e}}$. How high does the projectile rise? Neglect air resistance and the earth's rotation.



A) $\frac{Re}{2}$ B) $\frac{Re}{5}$

C) $\frac{Re}{4}$ D) $\frac{Re}{8}$

13. Find the velocity of a satellite travelling in an elliptical orbit, when it reaches point C on the end of the semiminor axis.



A) $V_c = R\sqrt{\frac{a}{g}}$ B) $V_c = R^2\sqrt{\frac{g}{a}}$

C) $V_c = R\sqrt{\frac{g}{a}}$ D) $V_c = R\sqrt{\frac{g}{a^2}}$

MULTIPLE ANSWER QUESTIONS

14. A cannon shell is fired to hit a target at a horizontal distance R. However it breaks into two equal parts at its highest point. One partd A returns to the cannon. The other part

A) Will fall at a distance R beyond the target

B) Will fall at a distance 3R beyond the target

C) Will hit the target

D) Have nine times the kinetic energy of A

15. A particle mooving with kinetic energy 3 J makes an elastic collison (head - on) with a stationary particle which has twice its mass, During impact :

A) The minimum kinetic energy potential of system is 1 J

B) The minimum elastic potential energy of the system is 2 J

C) Momentum and total energy are conserved at energy instant

D) The ratio of kinetic energy to potential energy of the system first decreases and then increases.

16. Consider a thin spherical shell of uniformly density of mass M and radius R :

A) The gravitational field inside the shell will be zero

B) The gravitational self energy of shell is $\frac{GM^2}{2R}$

C) Attractive force experience by unit area of the shell pull the other half is $\frac{GM^2}{2R^2}$

D) Net gravitational force with which one hemisphere of the shell arrracts other, is $\frac{GM^2}{8R^2}$

17. A satellite moves in an elliptical orbit about the earth. The minimum and maximum distance of the satellite from the centre of earth are 7000 km and 8750 km respectively. For this situation mark the correct statement(s).

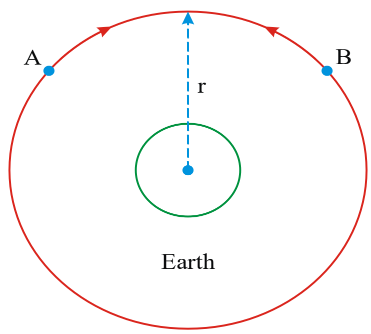
[Take $M_e = 6\times10^{24} kg$]

A) The maximum speed of the satellite during its motion is 5.64 km/s
B) The minimum speed of the satellite during its motion is 4.51 km/s
C) The length of major axis of orbit is 15750 km
D) None of the above

18. The gravitational potential changes uniformly from -20J/kg to -40J/kg as one moves along x-axis from $x=-1m$ to $x=+1m$. Mark the correct statement about gravitational field intensity of origin.

A) The gravitational field intensity at $x=0$ must be equal to 10N/kg.
B) The gravitational field intensity at $x=0$ may be equal to 10N/kg.
C) The gravitational field intensity at $x=0$ may be greater than 10N/kg.
D) The gravitational field intensity at $x=0$ must not be less than 10N/kg.

19. Consider two satellites A and B of equal mass m, moving in same circular orbit about earth, but in opposite sense as shown in figure. The orbital radius is r. The satellites undrgoes a collision which is perfectly inelastic. Which is perfectly inelastic. For this situation, mark out the correct statement(s). [Take mass of earth as M].



A) The total energy of the two satellites plus earth system just before collision is $-\frac{GMm}{r}$

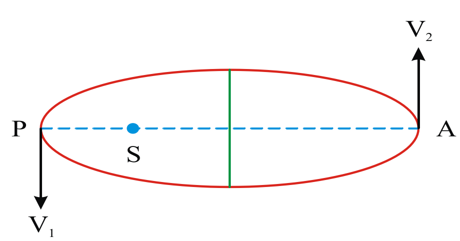
B) The total energy of the two satellites plus earth system just before collision is $-\frac{2GMm}{r}$

C) The total energy of two satellites plus earth system just after collision is $-\frac{GMm}{2r}$

D) The combined mass (two satellites) will fall towards the earth just after collision.

COMPREHENSION QUESTIONS

Comprehension - 23 -25



A planet of mass m is moving in an elliptical orbit around the sun of mass M. The semi major axis of its orbit is a, eccentricity is e.

20. Find speed of planet V_1 at perihelion P

A) $\sqrt{\frac{GM}{a}\frac{(1+e)}{(1-e)}}$ B) $\frac{1+e}{1-e}\sqrt{\frac{GM}{a}}$ C) $\sqrt{\frac{GM}{a^3}\frac{(1+e)}{(1-e)}}$ D) $\sqrt{\frac{GM}{a}\frac{(1+e^2)}{(1-e^2)}}$

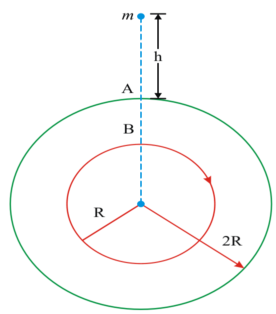
21. Find speed of planet V_2 at aphelion A.

A) $\sqrt{\frac{GM}{a}\frac{(1+e)}{(1-e)}}$ B) $\sqrt{\frac{GM}{a}\frac{(1-e)}{(1+e)}}$ C) $\sqrt{\frac{GM}{a}\frac{(1+e^2)}{(1-e^2)}}$ D) $\sqrt{\frac{GM}{a}\frac{(1-e^2)}{(1+e^2)}}$

22. Find total energy of planet interms of given parameters.

A) $-\frac{GMm}{4a}$ B) $-\frac{GMm^2}{2a}$ C) $-\frac{GMm}{8a}$ D) $-\frac{GMm}{2a}$

Comprehension - 26 - 28



Sphere of mass M and radius R is surrounded by a spherical shell mass M and radius 2R as shown. A small particle of mass m is released from rest from a height $h(<< R)$ abovethe shell. There is a hole in the shell.

23. **In what time will it enter the hole at A ?**

A) $2\sqrt{\frac{hR^2}{GM}}$ B) $\sqrt{\frac{2hR^2}{GM}}$ C) $\sqrt{\frac{hR^2}{GM}}$ D) None of these

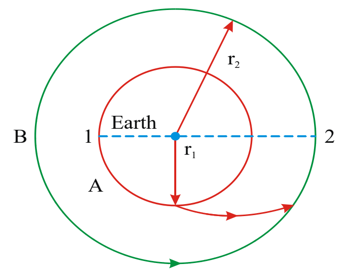
24. What time will it take to move from A to B?

A) $=\frac{R^2}{\sqrt{GMh}}$ B) $>\frac{R^2}{\sqrt{GMh}}$ C) $<\frac{R^2}{\sqrt{GMh}}$ D) None of these

25. With what approximate speed will it collide at B ?

A) $\sqrt{\frac{2GM}{R}}$ B) $\sqrt{\frac{GM}{2R}}$ C) $\sqrt{\frac{3GM}{2R}}$ D) $\sqrt{\frac{GM}{R}}$

Comprehension - 29 - 31



Two satellites A and B are revolving around the earth in circular orbits of radius r_1 and r_2 respectively with $r_1 < r_2$. Plane of motion of the two are same. At position 1, A is given an impulse in the direction of velocity by firing a rocket so that it follows an elliptical path to meet B at position 2 as shown. Focal lengths of the elliptical path are r_1 and r_2 respectively. At position 2, A is given another implulse so that velocities of A and B at 2 become equal and the two move together.
For any elliptical path of the satellite time period of revolution is given by Kepler's planetary law as $T^2 \alpha r^3$ where a is semi-major axis of the ellipse which is $\frac{r_1 + r_2}{2}$ in this case. Also angular momentum of any satellite revolving around the earth will remain a constant about earth's centre as force of gravity on the satellite which keeps it in elliptical path is along its position vector relative to the earth centre.

26. When A is given its first impulse at that moment

A) A, B and earth centre are in same straight line
B) B is a head of A angularly
C) B is behinds of A angularly D) None of the above

27. If the two have same mass

A) A would have more potential energy than B while on their initial circular paths
B) A would have more kinetic energy than B while on their initial circular paths
C) Relative to earth's centre, angular momentum of A when it is in elliptical path would be less than angular momentum of B
D) During the whole process angular momentum of B would be more than angular momentum of A

28. If $r_2 = 3r_1$ and time period of revolution ford B be T than time taken by A in moving from position 1 to position 2 is

A) $T\frac{\sqrt{3}}{\sqrt{2}}$ B) $T\frac{\sqrt{3}}{2}$ C) $\frac{T\sqrt{2}}{3\sqrt{3}}$ D) $\frac{T\sqrt{2}}{3}$

INTEGER TYPE QUESTIONS

29. A mass of $6 \times 10^{24} kg$ is to be compressed in a sphere in such a way that the escape velocity from its surface is $3 \times 10^8 m/\text{sec}$. Find the radius of the sphere (in mm).

30. Two equal masses are held at a distance of 3.0 cm in a line and released simultaneously. What will be the separation between them after 2 sec ?

31. **Two satellites S_1 and S_2 are to be set in the orbits of R / 4 and R / 6above the earth's sufrace. They revolve around the earth in a coplanar circular orbit in the opposite sense. What will be the ratio of speed of projection from the earth's surface ?**

32. **Distance between the centre of two stars is 10a. The masses of these stars are M and 16M and their radii are a and 2a, respectively. A body of mass m is fired straight from the surface of the larger star towards the smaller star. What should be its minimum speed to reach the surface of the smaller star (round off to the nearest integer in the unit of $\sqrt{\frac{GM}{a}}$) ?**

33. **Two particles A and B of masses 1kg and 2kg, respectively, are kept at a very large separation. When they are released, they move under their gravitational attraction. Find the speed (in $10^{-5} m/\sec$) of A when that of B is 3.6 cm/hr.**

34. **An artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of the escape velocity from the earth. If the satellite is stopped suddenly in its orbit and allowed to fall freely on the earth, Find the speed (in km/s) with it hits the surface of earth**
($g = m/\sec^2$ and $R = 6400\,km$).

EXERCISE -II-KEY

SINGLE ANSWER QUESTIONS

1) A 2) C 3) B 4) B 5) A 6) B
7) A 8) C 9) D 10) A 11) C 12) A 13) C

MULTI - ANSWER QUESTIONS

14) A, D 15) A, B, C, D 16) A, B, D
17) A, B, C 18) B, C, D 19) A, B, D

COMPREHENSION QUESTIONS

20) A 21) B 22) D 23) A 24) C
25) D 26) B 27) B,C 28) C

INTEGER TYPE QUESTIONS

29) 9 30) 3 31) 1 32) 3 33) 2 34) 8

GRAVITATION

CONCEPTUAL QUESTIONS

1. If F_g and F_e are gravitational and electrostatic forces between two electrons at a distance 0.1 m then F_g / F_e is in the order of
   1) 10^{43} 2) 10^{-43} 3) 10^{35} 4) 10^{-35}
2. Out of the following interactions the weakest is
   1) gravitational 2) electromagnetic 3) nuclear 4) electrostatic
3. Neutron changing into Proton by emiting electron and anti neutrino this due to
   1) Gravitiaonal Forces 2) Electro magnetic Forces
   3) Weak Nuclear Forces 4) Strong Nuclear Forces
4. Attractive Force is exists between two protons inside the Nucleous this is due to
   1) Gravitiaonal Forces 2) Electro magnetic Forces
   3) Weak Nuclear Forces 4) Strong Nuclear Forces
5. Repulsive force exist between two protons out side the nucleous this due to
   1) Gravitiaonal Forces 2) Electro magnetic Forces
   3) Weak Nuclear Forces 4) Strong Nuclear Forces
6. Radio activity decay exist due to
   1) Gravitiaonal Forces 2) Electro magnetic Forces
   3) Weak Nuclear Forces 4) Strong Nuclear Forces
7. Two equal masses separated by a distance (d) attract each other with a force (F). If one unit of mass is transferred from one of them to the other, the force
   1) does not change 2) decreases by (G/d^2)
   3) becomes d^2 times 4) increases by $(2G/d^2)$
8. Which of the following is the evidence to show that there must be a force acting on earth and directed towards Sun?
   1) Apparent motion of sun around the earth
   2) Phenomenon of day and night
   3) Revolution of earth round the Sun
   4) Deviation of the falling body towards earth
9. If R=radius of the earth and g =acceleration due to gravity on the surface of the earth, the acceleration due to gravity at a distance (r<R) from the centre of the earth is proportional to
   1) r 2) r^2 3) r^{-2} 4) r^{-1}
10. If R=radiusof the earth and g=acceleration due to gravity on the surface of the earth, the acceleration due to gravity at a distance (r>R) from the centre of the earth is proportional to
    1) r 2) r^2 3) r^{-2} 4) r^{-1}
11. The orbit of geo-stationary satellite is circular, the time period of satellite depends on **(2008 E)**
    1) mass of the Earth 2) radius of the orbit
    3) height of the satellite from the surface of Earth
    4) all the above
12. Assertion (A) : A particle of mass 'm' dropped into a hole made along the diameter of the earth from one end to the other end possesses simple harmonic motion.
    Reason (R) : Gravitational force between any two particles is inversely proportional

to the square of the distance between them. **(2006 E)**

1) Both A and R are true and R is the correct explanation of A
2) Both A and R are true and R is not the correct explanation of A
3) A is true but R is false
4) A is false but R is true

13. Moon is revolving in a circular orbit with a uniform velocity V_0. If the gravitational force suddenly disappears, the moon will
1) continue to move in the same orbit
2) move with a velocity V_0 tangentially to the orbit
3) fall down freely
4) ultimately comes to rest

14. Stars having masses more than 5 times the solar the mass end their lives as
1) White dwarfs 2) Red giants 3) Black dwarfs 4) Black holes

15. Of the following, which one has the core of highest density?
1) Neutron star 2) White dwarf 3) Yellow star 4) Red giant

16. The radius of a black hole (R_B) and its Schwartzchild radius (R_S) are related as
1) $R_B > R_S$ 2) $R_B \geq R_S$ 3) $R_B \leq R_S$ 4) $R_B = R_S =$ Infinity

17. A black hole has
1) zero volume and zero density 2) zero density and infinite volume
3) zero volume and infinite density 4) infinite volume and infinite density

18. The boundary of a black hole is called
1) event horizon 2) Schwartzchild radius
3) Chandra sekhar limit 4) Einstein's space time

19. If M is mass of the sun, then the mass of a white dwarf star may be
1) M 2) 2M 3) 3M 4) 4M

20. Chandra Sekhar limit is about
1) 2.4 times the solar mass 2) 1.4 times the solar mass
3) 14 times the solar mass 4) 24 times the solar mass

21. During the transformation of a massive star ultimately into a black hole, which of the following sequence is correct?
1) Red giant stage, supernova stage, white dwarf stage
2) White dwarf stage, red giant stage, supernova stage
3) White dwarf stage, supernova stage, red giant stage
4) Red giant stage, white dwarf stage, supernova stage

22. How many times more, the mass of the original star is to be larger than that of the sun for the formation of 'Black Hole' ? **(2006 M)**
1) 2 2) 6 3) 8 4) 10

23. According to the size, identify the correct decreasing order in **(2005 M)**
a) Original star b) Red giant
c) White Dwarf
1) a,b,c 2) b,c,a 3) c,a,b 4) b,a,c

24. Pseudo force also called fictitious force such as centrifugal force arises only in
1) Inertial frames 2)Non-intertial frames 3) Both inertial and non-inertial frames

4) Rigid frames

25. Earth is flattend at poles and bulging at equators this is due to
1) revolution of earth around the sun is an elliptical orbit
2) angular of velocity of spining about its axis is more at equator
3) centrifugal force is more at equator than poles
4) more centrifugal force at poles than equator

26. The tidal waves in the sea are primarily due to
1) the gravitational effect of the moon on the earth
2) the gravitational effect of the sun on the earth
3) the gravitational effect of the venus on the earth
4) the atmospheric effect of the earth itself

27. Consider earth to be a homogeneous sphere. Scientist A goes deep down in a mine and scientist B goes high up in a baloon. The gravitational field measured by
1) A goes on decreasing and that of B goes on increasing
2) B goes on decreasing and that of A goes on increasing
3) Each decreases at the same rate
4) Each decreases at different rates.

28. The speed at which the gravitational field propagates is
1) Equal to the speed of light in vacuum
2) Less than the speed of light in vacuum
3) More than the speed of light in vacuum
4) Either less or more than the speed of light in vacuum

29. If a satellite is moved from one stable circular orbit to a farther stable circular orbit, then the following quantity increases
1) Gravitational force 2) Gravitational P.E.
3) linear orbital speed
4) Centripetal acceleration

30. For a planet revolving round the sun, when it is nearest to the sun is
1) K.E. is min and P.E. is max. 2) Both K.E. and P.E. are min
3) K.E. is max. and P.E. is min 4) K.E. and P.E. are equal

31. The gravitational field is a conservative field. The work done in this field by moving an object from one point to another
1) depends on the end-points only
2) depends on the path along which the object is moved
3) depends on the end-points as well as the path between the points.
4) is not zero when the object is brought back to its initial position.

32. A body has weight (w) on the ground. The work which must be done to lift it to a height equal to the radius of the earth is
1) equal to WR 2) greater than WR 3) less than WR 4) we can't say

33. The earth retains its atmosphere. This is due to
1) The special shape of the earth
2) The escape velocity being greater than the mean speed of the molecules of the atmospheric gases.

3) The escape velocity being smaller than the mean speed of the molecules of the atmospheric gases.

4) The sun's gravitational effect.

34. Ratio of the radius of a planet A to that of planet B is 'r'. The ratio of accelerations due to gravity for the two planets is x. The ratio of the escape velocities from the two planets is

1) $\sqrt{rx}$ 2) $\sqrt{r/x}$ 3) $\sqrt{r}$ 4) $\sqrt{x/r}$

35. The ratio of the escape velocity and the orbital velocity is **(1998 M)**

1) $\sqrt{2}$ 2) $\frac{1}{\sqrt{2}}$ 3) 2 4) 1/2

36. The escape velocity from the earth for a rocket is 11.2 km/sec. Ignoring the air resistance, the escape velocity of 10 mg grain of sand from the earth will be **(1989 E)**

1) 0.112 km/sec 2) 11.2 km/sec
3) 1.12 km/sec 4) None

37. The escape velocity for a body projected vertically upwards from the surface of earth is 11 km/s. If the body is projected at an angle of 45^0 with the vertical, the escape velocity will be **[AIEEE 2003]**

1) $11\sqrt{2}\,\text{km/s}$ 2) $22\,\text{km/s}$
3) $11\,\text{km/s}$ 4) $11\sqrt{2}\,\text{km/s}$

38. For a satellite escape velocity is 11 km/s. If the satellite is launched at an angle of 60° with the vertical, then escape velocity is

1) 33 km/s 2) $11/\sqrt{3}$ km/s 3) $11\sqrt{3}\,kms^{-1}$ 4) $11\,kms^{-1}$

39. A missile is launched with a velocity less than the escape velocity. The sum of its kinetic and potential energies is

1) Positive 2) Negative 3) Zero
4) May be positive or negative depending upon its initial velocity

40. The escape velocity of a body depends upon its mass as **[AIEEE 2002]**

1) m^0 2) m^1 3) m^3 4) m^2

41. If the universal gravitational constant decreases uniformly with time, then a satellite in orbit will still maintain its

1)weight 2) tangential speed
3)period of revolution 4)angular momentum

42. Two satellites of masses m_1 and m_2 ($m_1 > m_2$) are revolving around earth in circular orbits of radii r_1 and r_2 ($r_1 > r_2$) respectively. Which of the following statements is true regarding their velocities V_1 and V_2.

1) $V_1 = V_2$ 2) $V_1 < V_2$ 3) $V_1 > V_2$ 4) $\frac{V_1}{r_1} = \frac{V_2}{r_2}$

43. If the mean radius of earth is R, its angular velocity is ω and the acceleration due to gravity at the surface of the earth is 'g' then the cube of the radius of the orbit of a satellite will be

1) $\frac{Rg}{\omega^2}$ 2) $\frac{R^2 g}{\omega}$ 3) $\frac{R^2 g}{\omega^2}$ 4) $\frac{R^2 \omega}{g}$

44. For a satellite projected from the earth's surface with a velocity greater than orbital velocity the nature of the path it takes when its energy is negative, zero and positive respectively is
1) Elliptical, parabolic and hyperbolic 2) Hyperbolic, parabolic and elliptical
3) Elliptical, circular and parabolic 4) Parabolic, circular and Elliptical

45. The period of a satellite moving in circular orbit near the surface of a planet is independent of
1) mass of the planet 2) radius of the planet
3) mass of the satellite 4) density of planet

46. Out of the following statements, the one which correctly describes a satellite orbiting about the earth is
1) There is no force acting on the satellite
2) The acceleration and velocity of the satellite are roughly in the same direction
3) The satellite is always accelerating about the earth
4) The satellite must fall, back to earth when its fuel is exhausted.

47. When an astronaut goes out of his space-ship into the space he will
1) Fall freely on the earth
2) Go upwards
3) Continue to move along with the satellite in the same orbit.
4) Go spiral to the earth

48. When the height of a satellite increases from the surface of the earth.
1) PE decreases, KE increases 2) PE decreases, KE decreases
3) PE increases, KE decreases 4) PE increases, KE increases

49. When a satellite going round the earth in a circular orbit of radius r and speed v loses some of its energy, then r and v change as
1) r decreases, v increases 2) both decrease
3) both increase 4) r increases, v decreases

50. The energy required to remove an earth satellite of mass 'm' from its orbit of radius 'r' to infinity is

1) $\frac{GMm}{r}$ 2) $\frac{-GMm}{2r}$ 3) $\frac{GMm}{2r}$ 4) $\frac{Mm}{2r}$

51. Assume that a satellite is revolving around earth in a circular orbit almost close to the surface of earth. The time period of revolution of satellite is (Radius of earth is 6400 km, g = 9.8 ms^{-2})
1) 5076 s 2) 5068 min 3) 24 hour 4) 1 year

52. The time period of revolution of geostationary satellite with respect to earth is
1) 24 hrs 2) 1 year 3) Infinity 4) Zero

53. A relay satellite transmits the television programme from one part of the world to another part continuously because its period
1) is greater than the period of the earth about its axis
2) is less than period of rotation of the earth about its axis.
3) has no relation with the period of rotation of the earth about its axis.
4) is equal to the period of rotation of the earth about its axis.

54. A synchronous satellite should be at a proper height moving
1) From West to East in equatorial plane
2) From South to North in polar plane
3) From East to West in equatorial plane
4) From North to South in polar plane

55. The orbital angular velocity vector of a geostationary satellite and the spin angular velocity vector of the earth are
1) always in the same direction 2) always in opposite direction
3) always mutually perpendicular 4) inclined at 23 1/2° to each other

56. A body of mass 5 kg is taken into space. Its mass becomes.
1) 5 kg 2) 10 kg 3) 2 kg 4) 30 kg

57. The radius vector drawn from the sun to a planet sweeps out ___ areas in equal time **(1996 E)**
1) equal 2) unequal 3) greater 4) less

58. A geostationary satellite has an orbital period of
1) 2 hours 2) 6 hours 3) 24 hours 4) 12 hours

59. The orbital period of revolution of an artificial satellite revolving in a geostationary orbit is ... **(1988 E)**
1)24 Hrs 2)48Hrs 3)12Hrs 4) 6 Hrs

60. If suddenly the gravitational force of attraction between earth and satellite revolving around it becomes zero, then the satellite will **(AIEEE 2002)**
1) Continue to move in its orbit with same velocity
2) Move tangential to the original orbit with the same velocity
3) Becomes sationary in its orbit
4) Move towards the earth

61. A satellite is moving in a circular orbit round the earth. If gravitational pull suddenly disappears, then it
1) Continuous to move with the same speed along the same path
2) Moves with the same velocity tangential to original orbit.
3) Falls down with increasing velocity.
4) Comes to rest after moving certain distance along original path.

62. A space-ship entering the earth's atmosphere is likely to catch fire. This is due to
1) The surface tension of air
2) The viscosity of air
3) The high temperature of upper atmosphere
4) The greater portion of oxygen in the atmosphere at greater height.

63. An astronaut orbiting the earth in a circular orbit 120 km above the surface of earth, gently drops a ball from the space-ship. The ball will
1) Move randomly in space
2) Move along with the space-ship
3) Fall vertically down to earth
4) Move away from the earth

64. Following physical quantity of a planet that revolves around Sun in an elliptical orbit is constant.
1) Kinetic energy 2) Potential energy
3) Angular momentum 4) Linear velocity

65. If the area swept by the line joining the sun and the earth from Feb 1 to Feb 7 is 'A', then the area swept by the radius vector from Feb 8 to Feb 28 is

1) A 2) 2A 3) 3A 4) 4A

66. A body is dropped from a height equal to radius of the earth. The velocity acquired by it before touching the ground is

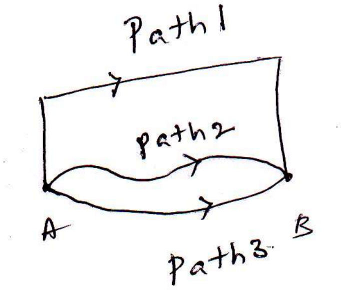
1) $V=\sqrt{2gR}$ 2) V=gR 3) $V=\sqrt{gR}$ 4) V=2gR

67. A hole is drilled through the earth along a diameter and a stone is dropped into it. When the stone is at the centre of the earth, it has finite

a) weight b) acceleration c) P.E. d) mass

1) a & b 2) b & c 3) a, b & c 4) c & d

68. A gravitation field is present in a region. A point mass is shifted from A to B, along different paths shown in the figure. If W_1, W_2 and W_3 represent the work done by gravitational force for respective paths, then



1. $W_1 = W_2 = W_3$ 2. $W_1 > W_2 > W_3$ 3. $W_1 > W_3 > W_2$ 4. none of these

69. Two identical spherical masses are kept at some distance as shown. Potential energy when a mass 'm' is taken from the surface of one sphere to the other

1. increases continuously 2. decreases continuously
3. first increases, then decreases 4. first decreases, then increases

70. A thin spherical shell of mass 'M' and radius 'R' has a small hole. A particle of mass 'm' is released at the mouth of them. Then

1. the particle will execute S.H.M inside the shell
2. the particle will oscillate inside the shell, but the oscillations are not simple harmonic
3. the particle will not oscillate, but the speed of the particle will go on increasing
4. none of these

71. If earth were to rotate faster than its present speed, the weight of an object

1. increase at the equator but remain unchanged at poles
2. decrease at the equator but remain unchanged at the poles
3. remain unchanged at the equator but decrease at the poles
4. remain unchanged at the equator but increase at the poles

72 The time period of a simple pendulum at the centre of the earth is

1. zero 2. infinite 3. less than zero 4.none of these

73. If suddenly the gravitation force of attraction between earth and a satellite revolving around it becomes zero, then the satellite will

1. continue to move in its orbit with same velocity

2. move tangentially to the original orbit with the same velocity
3. become stationary in its orbit
4. move towards the earth

74. When a satellite going round the earth in a circular orbit of radius 'r' and speed 'v' looses some of its energy, then r and v changes as:
1. both 'r' and 'v' will increase
2. both 'r' and 'v' will decrease
3. 'r' will decrease and 'v' will increase
4. 'r' will increase and 'v' will decrease

75. The time period of an earth's satellite in circular orbit is independent of
1. the mass of the satellite
2. radius of its orbit
3. both the mass and radius of the orbit
4. neither the mass of the satellite nor the radius of its orbit

76. A man covers 60m distance in one minute on the surface of earth. The distance he will cover on the surface of moon in one minute is $\left(g_m = \frac{g_e}{6}\right)$
1. 60 m
2. 60 X 6 m
3. $\frac{60}{6}m$
4. $\sqrt{60}m$

77. Six particles each of mass 'm' are placed at the corners of a regular hexagon of edge length 'a'. If a point mass 'm_0' is placed at the centre of the hexagon, then the net gravitational force on the point mass 'm_0' is
1. $\frac{6Gm^2}{a^2}$
2. $\frac{6Gmm_0}{a^2}$
3. zero
4. none of these

78. An artificial satellite of the earth releases a packet. If air resistance is neglected, the point where the packet will hit, will be
1. a head
2. exactly below
3. behind
4. it will never reach the earth

79. The ratio of acceleration due to gravity at a depth 'h' below the surface of earth and at a height 'h' above the surface for $h<<R$
1. constant
2. increases linearly with h
3. increases parabolically with h
4. decreases

80 Consider the two identical particles shown in the given figure. They are released from rest and may move towards each other under the influence of mutual gravitational force. The velocity of the centre of mass of the two particle system is
1. is zero
2. is constant($\neq 0$)
3. increases as the separation decreases
4. none of the above

81. A pendulum clock which keeps correct time at the surface of the earth is taken into a mine, then
1. it keeps correct time
2. it gains time
3. it loses time
4. none of these

82. Two identical trains A and B move with equal speeds on parallel tracks along the equator. A moves from east to west and B moves from west to east. Which train will exert greater force on the track?

1. A   2. B   3. they will exert equal force

4. The mass and the speed of each train must be known to reach a conclusion.

83 The escape velocity of a body thrown vertically upwards from the surface of earth is 11.2 Km/s. If it is thrown in a direction making an angle of 30^0 from the vertical, the new escape velocity will be

1. 5.6 Km/s   2. 11.2 Km/s   3. $11.2X\sqrt{2}$ Km/s   4. $11.2X\frac{\sqrt{3}}{2}$ Km/s

84. A person will get more quantity of matter in Kg-Wt at

1. poles   2. at lattitude of 60^0 3. equator   4. satellite

85. A satellite is revolving round the earth in an eliptical orbit. It speed will be

1. same at all points of the orbit   2. different at different point of the orbit

3. maximum at the forthest point   4. minimum at the nearest point

86. Average density of the earth

1. does not depend on 'g'   2. is a complex function of 'g'

3. is directly proportional to 'g'   4. is inversely proportional to 'g'

87 For a satellite moving in an orbit around the earth, the ratio of K.E to P.E is

1. $\frac{1}{2}$ 2. $\frac{1}{\sqrt{2}}$ 3. 2   4. $\sqrt{2}$

88. Which of the following quantities remain constant in a planetory motion, when seen from the usrface of the sun.

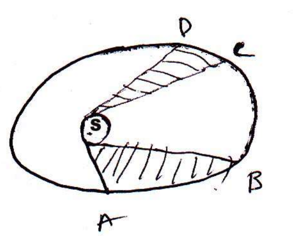
1. K.E   2. angular speed   3. speed

4. Angular momentum

89 Let V_G and E_G denote gravitational potential and field respectively, then choose the wrong statement.

1. $V_G = 0, E_G = 0$ 2. $V_G \neq 0, E_G = 0$ 3. $V_G = 0, E_G \neq 0$ 4. $V_G \neq 0, E_G \neq 0$

90 The motion of a planet around sun in an elliptical orbit is shown in the following figure. Sun is situated on one focus. The shaded areas are equal. If the planet takes time 't_1' and 't_2' in moving from A to B and from C to D respectively, then



1. $t_1 > t_2$ 2. $t_1 < t_2$ 3. $t_1 = t_2$ 4. incomplete information

LEVEL-I
(Numerical Problems)
NEWTON'S UNIVERSAL LAW OF GRAVITATION:
MODEL QUESTIONS

91. The gravitational force between two bodies is 6.67×10^{-7}N when the distance between their centres is 10 m. If the mass of first body is 800 kg, then the mass of second body is
1) 1000 kg 2) 1250 kg 3) 1500 kg 4) 2000kg

92. A 3 kg mass and a 4 kg mass are placed on x and y axes at a distance of 1 metre from the origin and a 1 kg mass is placed at the origin. Then the resultant gravitational force on 1 kg mass is
1) 7G 2) G 3) 5G 4) 3G

93. Two particles of equal mass go around in a circle of radius 'r'under the action of their mutual gravitational attraction. If the mass of each particle is m, the speed of each particle is
1) $\sqrt{\frac{Gm}{r}}$ 2) $\sqrt{\frac{Gm}{2r}}$ 3) $\sqrt{\frac{Gm}{4r}}$ 4) $\sqrt{\frac{2Gm}{r}}$

94. Three particles of identical masses 'm' are kept at the vertices of an equilateral triangle of each side length 'a'. The gravitational force of attraction on any one of the particles is
1) $\sqrt{2}\frac{Gm^2}{a^2}$ 2) $\sqrt{3}\frac{Gm^2}{a^2}$ 3) $\frac{3Gm^2}{a^2}$ 4) $\frac{2Gm^2}{a^2}$

95. Three spherical balls of masses 1kg, 2kg and 3kg are placed at the corners of an equilateral triangle of side 1m. The magnitude of the gravitational force exerted by 2kg and 3kg masses on 1kg mass is
1) $\sqrt{17}G$ 2) $\sqrt{19}G$ 3) $\sqrt{15}G$ 4) $\sqrt{13}G$

PRACTICE QUESTIONS

96. Two metal spheres of same material and radius 'r' are in contact with each other. The gravitational force of attraction between the spheres is given by
1) $F = Kr^4$ 2) $F=K / r^3$ 3) $F=K / 4r^2$ 4) Kr^2

97. The ratio of electromagnetic and gravitational forces between two electrons, (charge of the electron e= $1.6\times10^{-19}C$, mass of the electron $m = 9.1\times10^{-31}kg$, permitivity of free space $\frac{1}{4\pi\varepsilon_0} = 9\times10^9 Nm^2C^{-2}$, universal gravitational constant $G = 6.67\times10^{-11}Nm^2kg^{-2}$) is nearly
1) 4×10^{42} 2) 2×10^{31} 3) 3×10^{21} 4) 6×10^{72}

98. The gravitational force between two identical objects at a separation of 1m is 0.0667mg wt. The masses of the objects ($G = 6.67\times10^{-11}Nm^2/kg^2$ and $g = 10m/s^2$)
1) 200kg, 200kg 2) 100kg, 100 kg 3) 300kg, 300kg 4) 400kg, 400kg

99. Four particles of masses m, 2m, 3m and 4m are placed at the corners of a square of side length a. The gravitational force on a particle of mass m placed at the centre of the square is

1) $4\sqrt{2}\frac{Gm^2}{a^2}$ 2) $\frac{3\sqrt{2}Gm^2}{a^2}$ 3) $\frac{2\sqrt{2}Gm^2}{a^2}$ 4) $\frac{\sqrt{2}Gm^2}{a^2}$

100. The point at which the gravitational force acting on any mass is zero due to the earth and the moon system is. (The mass of the earth is approximately 81 times the mass of the moon and the distance between the earth and the moon is 3,85,000km.)

1) 36,000km from the moon 2) 38,500km from the moon
3) 34500km from the moon 4) 30,000 from the moon

101. Two spherical balls each of mass 1kg are placed 1 cm apart. The gravitational force of attraction between them is

1) $6.67\times10^{-7}N$ 2) $6.67\times10^{-4}N$ 3) $6.67\times10^{-2}N$ 4) $6.67\times10^{-9}N$

102. The mass of a ball is four times the mass of another ball. When these balls are separated by a distance of 10cm, the gravitational force between them is $6.67\times10^{-7}N$. The masses of the two balls are

1) 10 kg, 20 kg 2) 5 kg, 20 kg 3) 20 kg, 30 kg 4) 20 kg, 40 kg

ACCELERATION DUE TO GRAVITY
MODEL QUESTIONS

103. If g on the surface of the earth is 9.8 m/s^2, its value at a height of 6400 km is (Radius of the earth = 6400km).

1) $4.9ms^{-2}$ 2) $9.8ms^{-2}$ 3) $2.45ms^{-2}$ 4) $19.6ms^{-2}$

104. If g on the surface of the earth is $9.8ms^{-2}$, its value at a depth of 3200km (Radius of the earth = 6400km) is

1) $9.8ms^{-2}$ 2) zero 3) $4.9ms^{-2}$ 4) $2.45ms^{-2}$

105. How much faster than its normal rate should the earth rotate about its axis so that the weight of the body at the equator becomes zero ? (radius of the earth $=6.4\times10^6 m$ $g=9.8m/s^2$.)

1) nearly 17 times 2) nearly 12 times 3) nearly 10 times 4) nearly 14 times

106. The value of acceleration due to gravity on the earth at a place having a latitude of 30^0.
(g = 9.8 m/s^2.) is

1) $9.77ms^{-2}$ 2) $8.77ms^{-2}$ 3) $7.76ms^{-2}$ 4) $5.77ms^{-2}$

107 If the gravitational force of earth suddenly disappears, then which of the following is correct?

1) weight of the body is zero 2) mass of the body is zero
3) both mass and weight become zero 4) neither the weight nor the mass is zero

108. If the change in the value of 'g' at a height 'h' above the surface of the earth is same as at a depth 'x' below it when both 'x' and 'h' are much smaller than the radius of the

earth, then

1) $x = h$ 2) $x = 2h$ 3) $x = \frac{h}{2}$ 4) $x = \frac{h}{3}$

109. Assume that the acceleration due to gravity on the surface of the moon is 0.2 times the acceleration due to gravity on the surface of the earth. If R_e is the maximum,range of a projectile on the earth's surface, what is the maximum range on the surface of the moon for the same velocity of projection

1) $0.2R_e$ 2) $2R_e$ 3) $0.5\mathrm{R}_e$ 4) $5R_e$

PRACTICE QUESTIONS

110. The value of g at a height of 100km from the surface of the earth. (Radius of the earth = 6400km, g on the surface of the earth $= 9.8m/s^2$) is nearly

1) $9.5ms^{-2}$ 2) $8.5ms^{-2}$ 3) $10.5ms^{-2}$ 4) $9.8ms^{-2}$

111. The height at which the value of acceleration due to gravity becomes 50% of that at the surface of the earth. (Radius of the earth = 6400km.) is

1) 2650km 2) 2430km 3) 2250km 4) 2350km

112. The depth at which the value of g becomes 25% of that at the surface of the earth. (Radius of the earth = 6400km.)

1) 4800km 2) 2400km 3) 3600km 4) 1200km

113. The time period of rotation of the earth around its axis so that the objects at the equator become weightless is nearly (g = $9.8m/s^2$, Radius of earth = 6400km.)

1) 64min 2) 74min 3) 84min 4) 94min

114. The angular velocity of the earth with which it has to rotate so that the acceleration due to gravity on 60^0 latitude becomes zero is

1) 2.5×10^{-3} $rad\ s^{-1}$ 2) 1.5×10^{-3} $rad\ s^{-1}$ 3) 4.5×10^{-3} $rad\ s^{-1}$ 4) 0.5×10^{-3} $rad\ s^{-1}$

115. If the radius of earth were to shrink by one percent, its mass remaining the same, the acceleration due to gravity on the earth's surface would

1) decrease 2) remain unchanged
3) increase 4) nothing will happen

116. At what height, the value of 'g' is half that on the surface of the earth of radius R?

1) R 2) 2R 3) 0.414R 4) 0.75R

117 Where is the intensity of the gravitational field of the earth maximum?

1) centre of earth 2) equator 3) poles 4) same everywhere

118. If the radius of earth decreases by 10%, the mass remaining unchanged, then the acceleration due to gravity

1) decreases by 19% 2) increases by 19%
3) decreases by more than 19% 4) increases by more than 19%

119. If the speed of rotation of earth about its axis increases, then the weight of the body at the equator will

1) increase 2) decrease 3) remainunchanged
4) sometimesdecrease and sometimes increase

ESCAPE & ORBITAL VELOCITIES : MODEL QUESTIONS

120. The escape velocity from the earth for a rocket is 11.2 km/s ignoring air resistance. The escape velocity of 10 mg grain of sand from the earth will be
1) 0.112 km/s 2) 11.2 km/s 3) 1.12 km/s 4) 0.0112 kms^{-1}

121. A body is projected vertically up from surface of the earth with a velocity half of escape velocity. The ratio of its maximum height of ascent and radius of earth is
1) 1 : 1 2) 1 : 2 3) 1 : 3 4) 1 : 4

122. The escape velocity of an object on a planet whose radius is 4 times that of the earth and 'g' value 9 times that on the earth, in $km.s^{-1}$, is
1) 33.6 2) 67.2 3) 16.8 4) 25.2

123. The ratio of the radii of planets A and B is K_1 and ratio of accelerations due to gravity on them is K_2 The ratio of escape velocities from them will be
1) $K_1 K_2$ 2) $\sqrt{K_1 K_2}$ 3) $\sqrt{\frac{K_1}{K_2}}$ 4) $\sqrt{\frac{K_2}{K_1}}$

124. The kinetic energy needed to project a body of mass m from earth's surface (radius R) to infinity is **[AIEEE -2002]**
1) $\frac{mgR}{2}$ 2) $2mgR$ 3) mgR 4) $\frac{mgR}{4}$

125. A satellite of mass 'm' revolves round the earth of mass 'M' in a circular orbit of radius 'r' with an angular velocity 'ω'. If the angular velocity is $\omega/8$ the radius of the orbit will be
1) 4r 2) 2r 3) 8r 4) r

126. If the mass of earth were 4 times the present mass, the mass of the moon were half the present mass and the moon were revolving round the earth at the same present distance, the time period of revolution of the moon would be
1) 56 days 2) 28 days 3) 14 days 4) 7 days

127. The orbital speed for an earth satelite near the surface of the earth is 7 km/sec. If the radius of the orbit is 4 times the radius of the earth, the orbital speed would be **(1995 E)**
1) 3.5 km/sec 2) 7 km/sec 3) $7\sqrt{2}$ km/sec 4) 14 km/sec

128. A planet moves around the sun. At a given point P, it is closest from the sun at a distance d_1, and has a speed v_1. At another point Q, when it is farthest from the sun at a distance d_2, its speed will be
1) $\frac{d_1^2 v_1}{d_2}$ 2) $\frac{d_2 v_1}{d_1}$ 3) $\frac{d_1 v_1}{d_2}$ 4) $\frac{d_2^2 v_1}{d_1^2}$

PRACTICE QUESTIONS

129. The escape velocity on a planet is 'v'. If the radius of the planet contracts to 1/4th of present value without any change in its mass, the escape velocity will be
1) halved 2) doubled 3) quadrupoled
4) becomes one fourth

130. The escape velocity from the surface of the earth of radius R and density ρ

1) $2R\sqrt{\frac{2\pi\rho G}{3}}$ 2) $2\sqrt{\frac{2\pi\rho G}{3}}$ 3) $2\pi\sqrt{\frac{R}{g}}$ 4) $\sqrt{\frac{2\pi G\rho}{R^2}}$

131. Two satellites are revolving round the earth at different heights. The ratio of their orbital speeds is 2 : 1. If one of them is at a height of 100km, the height of the other satellite is

1) 19600km 2) 24600km 3) 29600km 4) 14600km

132. The radius in kilometers, to which the present radius of the earth (R = 6400 km) is to be compressed so that the escape velocity is increased ten times is : **(2003 M)**

1) 6.4 2) 64 3) 640 4) 4800

133 The escape velocities on two planets of masses m_1 and m_2 and having same radius are v_1 and v_2 respectively then **(1998 E)**

1) $\frac{v_1}{v_2}=\frac{m_1}{m_2}$ 2) $\frac{v_2}{v_1}=\frac{m_1}{m_2}$ 3) $\frac{v_1}{v_2}=\left(\frac{m_1}{m_2}\right)^2$ 4) $\frac{v_1}{v_2}=\sqrt{\frac{m_1}{m_2}}$

134. The escape velocity of a sphere of mass 'm' is given by **(1998 M)**

1) $\sqrt{\frac{2GMm}{R_e}}$ 2) $\sqrt{\frac{2GM}{R_e^2}}$ 3) $\sqrt{\frac{2GMm}{R_e^2}}$ 4) $\sqrt{\frac{2GM}{R_e}}$

135. The escape velocity of a body from the earth is u. What is the escape velocity from a planet whose mass and radius are twice those of the earth?
(1995 E)

1) 2u 2) u 3) 4u 4) 16 u

136. If the escape velocity on earth is 11.2 km/sec, its value for a planet having double the radius and 8 times the mass of earth is ..... m./sec. **(1990 E)**

1) 11.2 km/sec 2) 22.4 km/sec 3) 5.6 km/sec0
4) 8 km/sec

137. A space craft is launched in a circular orbit very close to earth. What additional velocity should be given to the space craft so that it might escape the earth's gravitational pull

1) 20.2 Kms^{-1} 2) $3.25kms^{-1}$ 3) $8kms^{-1}$ 4) $11.2kms^{-1}$

138. A particle falls towards earth from infinity. The velocity with which it reaches earth's surface is.

1) v = 2gR 2) $v=\sqrt{2gR}$ 3) $v=\sqrt{gR}$ 4) v = R/g

139. Two satellites are revolving round the earth in circular orbits of radii in the ratio 1 :2. Their orbital velocities are in the ratio of

1) 1 : 2 2) $\sqrt{2}:1$ 3) $2\sqrt{2}:1$ 4) 8 : 1

140. An artificial satellite is revolving in a circular orbit at height of 1200 km above the surface of the earth. If the radius of the earth is 6400km and mass is 6×10^{24} kg the orbital velocity $\left(G=6.67\times10^{-11}Nm^2/kg^2\right)$ is

1) $7.26kms^{-1}$ 2) $4.26kms^{-1}$ 3) $9.26kms^{-1}$ 4) $2.26kms^{-1}$

141 The ratio of escape velocities of two planets if g values on the two planets are $9.9m/s^2$

and $3.3 m/s^2$ and their radii are 6400km and 3400km respectively is

1) 2.36 : 1 2) 1.36 : 1 3) 3.36 : 1 4) 4.36 : 1

142. The ratio of the orbital speeds of two satellites of the earth if the satellites are at heights 6400km and 19200km. (Radius of the earth = 6400km.)

1) $\sqrt{2}:1$ 2) $\sqrt{3}:1$ 3) 2 : 1 4) 3 : 1

143. The acceleration due to gravity at a depth of 1600km inside the earth is

1) $6.65 ms^{-2}$ 2) $7.35 ms^{-2}$ 3) $8.65 ms^{-2}$ 4) $4.35 ms^{-2}$

144. A satellite is revolving near the earth's surface. Its orbital velocity is **(1999 M)**

1) 5.8 km/s 2) 18.4 km/s 3) 11.2 km/s 4) 8.0 km/s

145. A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is **[AIEEE-2004]**

1) gx 2) $\left(\frac{gR^2}{R+x}\right)^{1/2}$ 3) $\frac{gR^2}{R+x}$ 4) $\frac{gR}{R-x}$

146 orbit of radius R is T. Its period of revolution in an orbit of radius 4R will be

1) 2T 2) $2\sqrt{2}\,T$ 3) 4T 4) 8T

SATELLITES MOTION
MODEL QUESTIONS

147. The K.E. of a satellite is 10^4 J, its P.E. is

1) -10^4 J 2) 2×10^4 J 3) -2×10^4 J 4) -4×10^4 J

148. If R is radius of the earth and W is work done in lifting a body from the ground to an altitude R, the work which should be done in lifting it further to twice that altitude is

1) W/2 2) W 3) W/3 4) 3W

149. The PE of three objects of masses 1kg, 2kg and 3kg placed at the three vertices of an equilateral triangle of side 20cm is

1) 25G 2) 35G 3) 45G 4) 55G

150. Two satellites of masses 50 kgs and 100 kgs revolve around the earth in circular orbit of radii 9R and 16 R respectively, where 'R' is the radius of the earth. The speeds of the two satellites will be in the ratio. **(1999M)**

1) 3/4 2) 4/3 3) 9/16 4) 16/9

151. The time of revolution of planet A around the sun is 8 times that of another planet B. The distannce of planet A from the sun is how many times greater than that of the planet B from the sun **[AIEEE -2002]**

1) 2 2) 3 3)4 4) 5

152. The period of revolution of an earth's satellite close to the surface of earth is 90 minutes. The period of another earth's satellite in an orbit at a distance of three times earth's radius from its surface will be

1) 90 minutes` 2) $90 \times \sqrt{8}$ minutes 3) 270 minutes 4) 720 minutes

PRACTICE QUESTIONS

153. Two satellites of masses 400 kg, 500 kg are revolving around earth in different circular orbits of radii r_1, r_2 such that their kinetic energies are equal. The ratio of r_1, r_2 is

1) 4 : 5 2) 16 : 25 3) 5 : 4 4) 25 : 16

154. A satellite moves around the earth in a circular orbit with speed 'V'. If 'm' is mass of the satellite then its total energy is

1) $\frac{1}{2}mv^2$ 2) mv^2 3) $-\frac{1}{2}mv^2$ 4) $\frac{3}{2}mv^2$

155. The difference in PE of an object of mass 10kg when it is taken from aheight of 6400km to 12800km from the surface of the earth is

1) $1.045\times10^8 J$ 2) $1.565\times10^8 J$ 3) $2.65\times10^8 J$ 4) $4.5\times10^8 J$

156. A satellite is orbiting round the earth. If both gravitational force and centripetal force on the satellite is 'F' then net force acting on the satellite to revolve round the earth is

1) F/2 2) F 3) 2F 4) Zero

157. The minimum number of geostationary satellites required to televise a programme all over the earth is

1) 2 2) 6 3) 4 4) 3

158. When a satellite going around the earth in a circular orbit of radius r and speed v loses some of its energy , then **(1999 M)**

1) r and v both increase
2) r and v both decrease
3) r will increase and v will decrease
4) r will decrease and v will increase

159. The satellite is orbiting a planet at a certain height in a circular orbit. If the mass of the planet is reduced to half, the satellite would **(1993 M)**

1) fall on the planet
2) go to orbit of smaller radius
3) go to orbit of higher radius
4) escape from the planet

160. If the earth is at one-fourth of its present distance from the sun, the duration of the year would be **(1984 E)**

1) Half the present year
2) One-eigth the present year
3) One-fourth the present year
4) One -sixteenth the present year

161. The distance of Neptune and saturn from the Sun are respectively. 10^{13} and 10^{12} meters and their periodic times are respectively T_n and T_s. If their orbits are assumed to be circular, the value of T_n / T_s is

1) 100 2) $10\sqrt{10}$ 3) $\frac{1}{10\sqrt{10}}$ 4) 10

BLACK HOLES THEORY
MODEL QUESTIONS

162. Two lead spheres of same radius are in contact with each other. The gravitational force of attraction between them is F. If two lead spheres of double the previous radius are in contact with each other, the gravitational force of attraction between them will be

1) 2F 2) 32F 3) 8F 4) 16F

163. Two particles of masses 'm' and '2m' are at a distance '3r' apart at the ends of a straight line AB. C is the centre of mass of the system. The magnitude of the gravitational intensity due to the masses at C is
1) Zero 2) $\frac{7Gm}{4r^2}$ 3) $\frac{9Gm}{4r^2}$ 4) $\frac{3Gm}{2r^2}$

164. Two stars have masses $5\times10^{30}kg$ and $7.5\times10^{30}kg$ respectively.If they ultimately convert into black holes, the ratio of Schwartzschild radius of the black holes is
1) 2:3 2) 4:9 3) 3:2 4) 9:4

PRACTICE QUESTIONS

165. If two stars of masses in the ratio 2 : 3 become black holes, their radii will be in the ratio of
1) 4 : 9 2) 3 :2 3) 2:3 4) 9 :4

166. When a star of mass $9\times10^{30}kg$ ends as a black hole, the Schwartzschild radius of the star is $\left(G=6.7\times10^{-11}Nm^2kg^{-2}\right)$
1) 13.4 m 2) 6.7 m 3) 13.4 km 4) 26.8 km

167. Two masses 'M' and '4M' are at a distance 'r' apart on the line joining them, 'P' is point where the resultant gravitational intesity is zero (such a point called null point). The distance of 'P' from the mass 'M' is
1) $\frac{r}{5}$ 2) $\frac{r}{3}$ 3) $\frac{2r}{3}$ 4) $\frac{4r}{5}$

168. After super nova explosion, the mass of remaining star is greater than .... times then only it returns into black hole
1) M_s 2) $2M_s$ 3) $3M_s$ 4) $4M_s$

169. Degenerate electron pressure will not be sufficient to prevent core collapse of white dwarf if its mass becomes 'n' times of our solar mass.Value of 'n' is **(2005 E)**
1) 0.5 2) 0.8 3) 1 4) 1.4

LEVEL-II
NEWTON'S UNIVERSAL LAW OF GRAVITATION: MODEL QUSTIONS

170. Mass of the earth is 81 times that of the moon. If the distance between the centre of the earth and the center of moon is d then the distance from the centre of the earth at which gravitational field strength due to earth - moon system is zero is
1) d/81 2) 9d/10 3) d/10 4) 8d/9

171. Two lead balls of masses m and 5m having radii R and 2R are separated by 12R. If they attract each other by gravitational force, the distance covered by small sphere before they touch each other is
1) 10 R 2) 7.5 R 3) 9 R 4) 2.5 R

172. Mass M is divided into two parts Xm and (1–X)m. For a given seperation the value of X for which the gravitational attraction between the two pieces becomes maximum is **(2001 M)**
1) 1/2 2) 3/5 3) 1 4) 2

173. If the mass of one particle is increased by 50 % and the mass of another particle is decreased by 50 %, the force between them

1) decreases by 25% 2) decreases by 75 %
3) increases by 25% 4) does not change

PRACTICE QUESTIONS

174. Masses 2 kg and 8 kg are 18 cm apart. The point where the gravitational field due to them is zero is

1) 6 cm from 8 kg mass 2) 6 cm from 2 kg mass
3) 1.8 cm from 8 kg mass 4) 9 cm from each mass

175. The gravitational force between two bodies is decreased by 36 % when the distance between them is increased by 3m. The initial distance between them is

1) 6 m 2) 9 m 3) 12 m 4) 15 m

176. If the distance between two bodies is increased by 25%, then the % change in the gravitational force is

1) Decreases by 36% 2) Increases by 36 %
3) Increases by 64% 4) Decreases by 64 %

ACCELERATION DUE TO GRAVITY
MODEL QUESTIONS

177. A particle hanging from a spring stretches it by 1 cm at earth's surface. Radius of earth is 6400 km. At a place 800 km above the earth's surface, the same particle will stretch the spring by

1) 0.79 cm 2) 1.2 cm 3) 4 cm 4) 17 cm

178. A tunnel is dug along a diameter of the earth. The force on a particle of mass 'm' placed in the tunnel at a distance x from the centre is

1) $\frac{GM_e m}{R^3}x$ 2) $\frac{GM_e m}{R^2}x$ 3) $\frac{GM_e m}{R^3 x}$ 4) $\frac{GM_e m R^3}{x}$

PRACTICE QUESTIONS

179. If the Earth shrinks such that its density becomes 8 times to the present value then the new duration of the day in hours will be **(2008 M)**

1) 24 2) 12 3) 6 4) 3

180. Assume the earth's orbit around the sun as circular and the distance between their centres as 'D. Mass of the earth is 'M' and its radius is 'R'. If earth has an angular velocity 'ω_0' with respect to its centre and 'ω' with respect to the centre of the sun, the total kinetic energy of the earth is : **(2006 E)**

1) $\frac{MR^2\omega_0^2}{5}\left[1+\left(\frac{\omega}{\omega_0}\right)^2+\frac{5}{2}\left(\frac{D\omega}{R\omega_0}\right)^2\right]$ 2) $\frac{MR^2\omega_0}{5}\left[1+\frac{5}{2}\left(\frac{D\omega}{R\omega_0}\right)^2\right]$

3) $\frac{2}{5}MR^2\omega_0^2\left[1+\frac{5}{2}\left(\frac{D\omega}{R\omega_0}\right)^2\right]$ 4) $\frac{2}{5}MR^2\omega_0^2\left[1+\left(\frac{\omega}{\omega_0}\right)^2\frac{5}{2}\left(\frac{D\omega}{R\omega_0}\right)^2\right]$

ESCAPE & ORBITAL VELOCITIES : MODEL QUESTIONS

181. A satellite is revolving around earth in a circular orbit of radius equal to diameter of earth. The minimum % increase in the speed of that satellite so that it escapes from earth's gravity is

1) 100 % 2) 82.8 % 3) 50 % 4) 41.4 %

182. Two satellites M and N go around the earth in circular orbits at heights of R_M and R_N respectively from the surface of the earth. Assuming the earth to be a uniform sphere of radius R_E, the ratio of the velocities of the satellites $\frac{V_M}{V_N}$ is

1) $\left(\frac{R_M}{R_N}\right)^2$ 2) $\sqrt{\frac{R_N + R_E}{R_M + R_E}}$ 3) $\frac{R_N + R_E}{R_M + R_E}$ 4) $\sqrt{\frac{R_N}{R_M}}$

183. A particle is kept at rest at a distance R (Earth's radius) above the earth's surface. The minimum speed with which it should be projected so that it does not return is

1) $\sqrt{\frac{GM}{R}}$ 2) $\sqrt{\frac{GM}{2R}}$ 3) $\sqrt{\frac{GM}{3R}}$ 4) $\sqrt{\frac{GM}{4R}}$

184. A spaceship is launched into a circular orbit of radius 'R' close to the surface of earth. The additional velocity to be imparted to the spaceship in the orbit to overcome the earth's gravitational pull is : (g = acceleration due to gravity) **(2004 M)**

1) 1.414Rg 2) $1.414\sqrt{Rg}$ 3) 0.414Rg 4) $0.414\sqrt{gR}$

185. The acceleration due to gravity on the surface of moon is 1/6 that on the earth and the diameter of the earth is 4 times the diameter of the moon. The ratio of the escape velocity of the moon to that of the earth is **(1992 E)**

1) 1 : 4 2) 4 : 1 3) 5 : 1 4) 1 : 5

PRACTICE QUESTIONS

186 The speed of a satellite that revolves around earth at a height 3R from earth's surface is (g = 10 m/s^2 at the surface of earth, radius of earth R = 6400 km.)

1) $2\sqrt{2}$ kms^{-1} 2) 4 kms^{-1} 3) $4\sqrt{2}$ kms^{-1} 4) 8 kms^{-1}

187. Two satellites P, Q are revolving around earth in different circular orbits. The velocity of P is twice the velocity of Q. If the height of P from earth's surface is 1600 km. The radius of orbit of Q is (radius of earth R =6400 km).

1) 1600 km 2) 20000 km 3) 32000 km 4) 40000 km

188. The escape velocity from an altitude equal to radius of earth above earth's surface is (escape velocity from surface of earth is 11.2kms^{-1})

1) 5.6 kms^{-1} 2) 7.92 kms^{-1} 3) 2.8 kms^{-1} 4) 11.2 kms^{-1}

189. If the radius of the earth is reduced by 1 % keeping the mass constant. The escape velocity will

1) increase by 0.5% 2) decrease by 0.5%
3) decrease by 11% 4) remain same

190. The moon escapes for ever, if the minimum increase in its velocity is

1) 200 % 2) 41.4 % 3) 50 % 4)100 %

191. The mass of a planet is half that of the earth and the radius of the planet is one fourth that of earth. If we plan to send an artificial satellite from the planet, the escape velocity

will be, $(V_e = 11kms^{-1})$ **(2007 E)**

1) $11kms^{-1}$ 2) $5.5\ kms^{-1}$ 3) $15.55\ kms^{-1}$ 4) $7.78\ kms^{-1}$

192. The eacape velocity of a body on the earth's surface is V_E. A body is thrown up with a speed $\sqrt{5}V_E$. Assuming that the sun and planets do not influence the motion of the body, velocity of the body at infinite distance is **(2004 E)**

1) 0 2) V_E 3) $\sqrt{2}V_E$ 4) $2V_E$

193. A body is projected up with a velocity equal to 3/4 th of the escape velocity from the surface of the earth. The height it reaches is (Radius of the earth is R) **(2002 E)**

1) 10R/9 2) 7R/9 3) 9R/8 4) 10R/3

194. The mass of the earth is 9 times that of Mars. The radius of the earth is twice that of Mars. The escape velocity of the earth is 12 km/sec. The escape velocity on Mars is ... km/sec.

1) $4\sqrt{2}km/\sec$ 2) $2\sqrt{2}km/\sec$ 3) $6\sqrt{2}km/\sec$ 4) $8\sqrt{2}km/\sec$

195. The angular velocity of rotation of a star (of mass M and radius R) at which the matter will start escaping from its equator is

1) $\sqrt{\frac{2GR}{M}}$ 2) $\sqrt{\frac{2GM}{R^3}}$ 3) $\sqrt{\frac{2GM}{R}}$ 4) $\sqrt{\frac{2GM^2}{R}}$

SATELLITES MOTION
MODEL QUESTIONS

196. Two identical particles each of mass 'm' start moving towards each other from rest from infinite separation under gravitational attraction. Their relative velocity of approach at separation 'r' is

1) $\sqrt{\frac{Gm}{r}}$ 2) $\sqrt{\frac{2Gm}{r}}$ 3) $2\sqrt{\frac{Gm}{r}}$ 4) $\sqrt{\frac{Gm}{2r}}$

197. Three identical particles each of mass "m" are arranged at the corners of an equilateral triangle of side "L". If they are to be in equilibrium, the speed with which they must revolve under the influence of one another's gravity in a circular orbit circumscribing the triangle is

1) $\sqrt{\frac{3Gm}{L}}$ 2) $\sqrt{\frac{Gm}{L}}$ 3) $\sqrt{\frac{Gm}{3L}}$ 4) $\sqrt{\frac{3Gm}{L^2}}$

198. A small body is initially at a distance 'r' from the centre of earth. 'r' is greater than the radius of the earth. If it takes W joule of work to move the body from this position to another position at a distance 2r measured from the centre of earth, how many joules would be required to move it from this position to a new position at a distance of 3r from the centre of the earth.

1) W/5 2) W/3 3) W/2 4) W/6

199 Two satellites S_1 and S_2 are revolving round a planet in coplanar and concentric circular orbits of radii R_1 and R_2 in the same direction respectively. Their respective periods of revolution are 1 hr. and 8 hr. The radius of the orbit of satellite S_1 is

equal to 10^4 km. Their relative speed when they are closest, in kmph is : **(2 0 0 2 M)**

1) $\frac{\pi}{2}\times 10^4$ 2) $\pi\times 10^4$ 3) $2\pi\times 10^4$ 4) $4\pi\times 10^4$

200. The time period of satellite of earth is 5 hr. If the separation between earth and the satellite is increased to 4 times the previous value, the new time period will become. **[AIEEE -2003]**

1) 10 hrs 2) 80 hrs 3) 40 hrs 4) 20 hrs

PRACTICE QUESTIONS

201. The gravitational P.E. of a rocket of mass 100 kg at a distance of 10^7 m from the earths centre is -4 x 10^9J. The weight of the rocket at a distance of 10^9 m from the centre of the earth is

1) 4 x 10^{-2} N 2) 4 x 10^{-9} N 3) 4 x 10^{-6} N 4) 4 x 10^{-3} N

202. A man weighs 75 kg on the surface of the earth. His weight in a geostationary satellite is

1) infinity 2) 150 kg 3) zero 4) 75/2 kg

203. The mass of the sun is approximately $2x10^{30}kg$. The Schwarzschild radius for the mass of a star that is ten times the mass of sun is nearly

1) 3km 2) 30 km 3) 300 km 4) 0.3 km

204. A satellite is launched into a circular orbit of radius "R' around the earth while a second satellite is launched into an orbit of radius 1.02 R. The percentage difference in the time periods of the two satellites is : **(2003 E)**

1) 0.7 2) 1.0 3) 1.5 4) 3

205. Two satellites A and B go round the earth in ciruclar orbits at a height of R_A and R_B respectively from the surface of the earth. Assume the earth to be a uniform sphere of radius R_E. The ratio of the magnitudes of the velocities of the satellites V_A / V_B is **(1991 E)**

1) $\sqrt{\frac{R_B}{R_A}}$ 2) $\frac{R_B+R_E}{(R_A+R_E)}$ 3) $\sqrt{\frac{(R_B+R_E)}{(R_A+R_E)}}$ 4) $\left(\frac{R_A}{R_B}\right)^2$

206. Suppose the gravitational force varies inversely as the n^{th} power of distance, then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to **[AIEEE -2004]**

1) $R^{\left(\frac{n+1}{2}\right)}$ 2) $R^{\left(\frac{n-2}{2}\right)}$ 3) R^n 4) $R^{\left(\frac{n-1}{2}\right)}$

207. A geo-stationary satellite orbits around the earth in a circular orbit of radius 36000 km. Then, the period of spy satellite orbiting a few hundred kilometers above theearth's surface $(R_{earth} = 6400\,km)$ will become.

1) $(1/2)$hr 2) 1.5 hr 3) 2 hr 4) 4 hr

GRAVITATIONAL POTENTIALENERGY OF A MASS M AT A HEIGHT H ABOVE THE SURFACE OF EARTH, WORK DONE.

MODEL QUESTIONS

208. A body of mass 'm' is raised from the surface of the earth to a height 'nR' (R -radius of earth). Magnitude of the change in the gravitational potential energy of the body is (g - acceleration due to gravity on the surface of earth) **(2007 M)**

1) $\left(\frac{n}{n+1}\right)mgR$ 2) $\left(\frac{n-1}{n}\right)mgR$ 3) $\frac{mgR}{n}$ 4) $\frac{mgR}{(n-1)}$

209. If 'g' is acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass 'm' raised from the surface of the earth to a height equal to the radius 'R' of the earth is **[AIEEE - 2004]**

1)2 mgR 2)mgR 3) mgR/4 4) mgR/2

PRACTICE QUESTIONS

210. Energy required to move a body of mass 'm' from an orbit of radius 2R to 3R is**[AIEEE-2002]**

1) $\frac{GMm}{2R^2}$ 2) $\frac{GMm}{3R^2}$ 3) $\frac{GMm}{8R}$ 4) $\frac{GMm}{6R}$

LEVEL III

MODEL QUESTIONS

211. Three particles, each of mass 'm' are situated at the vertices of an equilateral triangle of side 'a'. The only forces acting on the particles are their mutual gravitational forces. It is desired that each particle should move in a circle while maintaining the original mutual separation 'a'. Then their time period of revolution is

1) $2\pi\sqrt{\frac{a^2}{3Gm}}$ 2) $2\pi\sqrt{\frac{a^3}{3Gm}}$ 3) $2\pi\sqrt{\frac{3a^4}{Gm}}$ 4) $2\pi\sqrt{\frac{a^4}{Gm}}$

212. Particles each of mass M are placed along x-axis at x=1m, x=2m, x=4m, x=8m,..... etc to infinity. Gravitational field strength at the origin due to this system of particles is

1) 2GM 2) 2GM/3 3) 4GM/3 4) 5GM/4

213. If d is the distance between the centres of the earth of mass M_1 and moon of mass M_2, then the velocity with which a body should be projected from the mid point of the line joining the earth and the moon, so that it just escapes is

1) $\sqrt{\frac{G(M_1+M_2)}{d}}$ 2) $\sqrt{\frac{G(M_1+M_2)}{2d}}$ 3) $\sqrt{\frac{2G(M_1+M_2)}{d}}$ 4) $\sqrt{\frac{4G(M_1+M_2)}{d}}$

214. The altitude of geostationary satellite is nearly 6 times the radius of the earth. The period of revolution of an identical satellite revolving at an altitude 0.75 times the radius of the earth will be

1) 4 hrs 2) 3 hrs 3) 12 hrs 4) 2 hrs

215. Gravitational field is uniform, the gravitational P.D between surface of a planet and point 100 m above is 50 J / Kg. The work done in moving a man 5 kg from surface to a point 10 m above is

1) 5 J 2) 25 J 3) 2.5 J 4) 50 J

PRACTICE QUESTIONS

216. Explorer- 38, a radio-activity research satellite of mass 200 kg circles the earth in an orbit of radius 3R/2, where R is the radius of the earth. Assuming the gravitational pull on a mass of 1 kg at the earth's surface to be 10 N, the pull on the satellite is

1) 889 N 2) 4500 N 3) 9000 N 4) None

217. Particles of masses m_1 and m_2 are at a fixed distance apart. If the gravitational field strength at m_1 and m_2 are l_1 and l_2 respectively. Then,

1) $m_1l_1 + m_2l_2 = 0$ 2) $m_1l_2 + m_2l_1 = 0$ 3) $m_1l_1 - m_2l_2 = 0$ 4) $m_1l_2 - m_2l_1 = 0$

218. The work done to increase the radius of orbit of a satellite of mass 'm' revolving

around a planet of mass M from orbit of radius R into another orbit of radius 3R is

1) $\frac{2GMm}{3R}$ 2) $\frac{GMm}{R}$ 3) $\frac{GMm}{6R}$ 4) $\frac{GMm}{24R}$

219. The change in the P.E. when a body of mass 'm' is displaced from earth's surface to a vertical height equal to radius of earth (g = acceleration due to gravity on earth surface) is

1) $\frac{mgR}{2}$ 2) $\frac{2mgR}{3}$ 3) $\frac{3mgR}{4}$ 4) $\frac{mgR}{3}$

220. The escape velocity from the earth is 11 km/sec. The escape velocity from a planet having twice the radius and same density as earth is

1) 22 km/sec 2) 15.5 km/sec 3) 11 km/sec 4) 5.5 km/sec

221 The escape velocity of a body from earth is 11.2 km/s. If a body is projected with a velocity twice its escape velocity, then the velocity of the body at infinity is

1) 19.4 km/s 2) 194 km/s 3) 1.94 km/s 4) 0.194 km/s

222. If an artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of the escape velocity from the earth, the height of the satellite above the surface of the earth is

1) 2R 2) R/2 3) R 4) R/4

223. The K.E. of a satellite in an orbit close to the surface of the earth is E. Its max K.E. so as to escape from the gravitational field of the earth is.

1) 2E 2) 4E 3) $2\sqrt{2}$ E 4) $\sqrt{2}$ E

224. K.E. of an orbiting satellite is K. The
min additional K.E. required so that it goes to infinity is

1) K 2) 2K 3) 3K 4) K/2

225. A stone is dropped from a height equal to nR, where R is the radius of the earth, from the
surface of the earth. The velocity of the stone on reaching the surface of the earth is

1) $\sqrt{\frac{2g(n+1)R}{n}}$ 2) $\sqrt{\frac{2gR}{n+1}}$ 3) $\sqrt{\frac{2gnR}{n+1}}$ 4) $\sqrt{2gnR}$

226 A satellite is geostationary in a particular orbit. It is allowed to go to another orbit having orbital radius 2 times that of the earlier orbit from the centre of the earth. The time period in the second orbit is

1) 48hrs 2) 24hrs 3) $48\sqrt{2}$ hrs 4) $24\sqrt{2}$ hrs

227. A geo-stationary satellite is orbitting the earth at a height 6R above the surface of the earth, where R is the radius of earth. The time period of another satellite revolving around earth at a height 2.5 R from earth's surface is

1) $12\sqrt{2}$ Hr 2) 12 hr 3) $6\sqrt{2}$ hr 4) 6 hr

228. A person bring a mass of 1 kg from infinite to point A. Initially the mass was at rest but is moves a speed of 2 m /s as it reaches to A. The workdone by the person on mass is -3 J the gravitational potential at A is

1) -3 J / kg 2) -2 J / kg 3) -5 J / kg 4) -7 J / kg

LEVEL-IV

AIEEE MODEL PROBLEMS

229. A satellite of mass 'm' revolves around the earth of radius 'R' at a height 'x' from its surface. If 'g' is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is

1. gx 2. $\frac{gR}{R-x}$ 3. $\frac{gR^2}{R+x}$ 4. $\sqrt{\frac{gR^2}{R+x}}$

230. If 'g' is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass 'm' raised from the surface of the earth to a height equal to the radius 'R' of the earth is

1. 2mgR 2. $\frac{1}{2}$ mgR 3. $\frac{1}{4}$ mgR 4. mgR

231. A particle of mass 10 gm is kept on the surface of a uniform sphere of mass 100 Kg and radius 10 cm. Find the work done against the gravitational force between them, to take the particle for away from the sphere $(G = 6.67 X 10^{-11} Nm^2 / Kg^2)$

1. $13.34 X 10^{-10} J$ 2. $3.33 X 10^{-10} J$ 3. $6.67 X 10^{-9} J$ 4. $6.67 X 10^{-10} J$

232. Suppose the gravitational force varies inversely as the n^th power of the distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to

1. R^n 2. $R^{\frac{n+1}{2}}$ 3. $R^{\frac{n-1}{2}}$ 4. R^{-n}

233. If a rocket is fired with a velocity, $V = 2\sqrt{gR}$ near the earth's surface and goes upwards, its speed in the inter-stellar space is

1. $4\sqrt{gR}$ 2. $\sqrt{2gR}$ 3. $\sqrt{gR}$ 4. $\sqrt{4gR}$

234. A projectile is fired vertically upwards from the surface of the earth with a velocity KV_e, where V_e is the escape velocity and K<1. If R is the radius of the earth, the maximum height to which it will rise measured from the centre of the earth will be (neglect air resistance)

1. $\frac{1-K^2}{R}$ 2. $\frac{R}{1-K^2}$ 3. $R(1-K^2)$ 4. $\frac{R}{1+K^2}$

235. A satellite moving on a circular path of radius 'r' around earth has a time period T. If its radius slightly increases by Δr, the change in its time period is

1. $\frac{3}{2}\left(\frac{T}{r}\right)\Delta r$ 2. $\left(\frac{T}{r}\right)\Delta r$ 3. $\frac{3}{2}\left(\frac{T^2}{r^2}\right)\Delta r$ 4. none of these

236. Two bodies of masses m and M are placed a distance d apart. The gravitational potential at the position were the gravitational field due to them is zero is

1. $V = \frac{-G}{d}(m+M)$ 2. $V = \frac{-Gm}{d}$

3. $V = \frac{-GM}{d}$ 4. $V = \frac{-G}{d}\left(\sqrt{m}+\sqrt{M}\right)^2$

237. A particle of mass 'm' is projected from the surface of earth with a speed V_0 (V_0< escape velocity). The speed of the particle at a height h=R (radius of the earth) is

1. $\sqrt{gR}$ 2. $\sqrt{V_0^2 - 2gR}$ 3. $\sqrt{V_0^2 - gR}$ 4. none of these

238. The magnitudes of the gravitational field at distance r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are E_1 and E_2 respectively. Then:

1. $\frac{E_1}{E_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$ 2. $\frac{E_1}{E_2} = \frac{r_2^2}{r_1^2}$ if $r_1 > R$ and $r_2 > R$

3. $\frac{E_1}{E_2} = \frac{r_1^3}{r_2^3}$ if $r_1 < R$ and $r_2 < R$ 4. $\frac{E_1}{E_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ and $r_2 < R$

239 A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius 1.01 R. The time period of the second satellite is larger than that of the first one by approximately

1. 0.5% 2. 1.5% 3. 1% 4. 3%

240. The value of 'g' at a height 'h' above the surface of the earth is the same as at a depth 'd' below the surface of the earth. When both 'd' and 'h' are much smaller than the radius of earth, then which one of the following is correct

1 $d = \frac{h}{2}$ 2. $d = \frac{3h}{2}$ 3.d=2h 4.d=h

241. The time period of a satellite of earth is 5 hr. If the separation between the earth and the satellite is increased by 3 times the previous value, the new time period will become

1. 10 hr 2. 80 hr 3. 40 hr 4. 20 hr

242. Two spherical bodies having the masses 'M' and '5M' and radii R and 2R respectively are released in free space with initial separation between their centres equal to 12R. If they attract each other due to gravitational force only, then the distance covered by the smaller body just before collision is

1.2.5 R 2 4.5 R 3.7.5 R 41.5 R

243.. The gravitational intensity a region is $10\left(\hat{i} - \hat{j}\right) N/Kg$. The work done by the gravitational force to shift slowly a particle of mass 1 Kg from point (1m, 1m) to a point (2m, -2m) is

1.10J 2.-10J 3 -40J 4.+40J

244. Two particles each of mass 'm' are placed at A and C are such AC=BC=L. The gravitational force on the third particle placed at D at a distance L on the perpendicular bisector of the line AC is

1. $\frac{Gm^2}{\sqrt{2}L^2}$ along BD 2. $\frac{Gm^2}{\sqrt{2}L^2}$ along DB 3. $\frac{Gm^2}{L^2}$ along AC 4. none of these

245. Three point masses each of mass 'm' rotate in a circle of radius r with constant angular velocity ω due to their mutual gravitational attraction. If at any instant, the masses are on the vertex of an equilateral triangle of side 'a', then the value of ω is

1. $\sqrt{\frac{Gm}{a^3}}$ 2. $\sqrt{\frac{3Gm}{a^3}}$ 3. $\sqrt{\frac{Gm}{3a^3}}$ 4. zero

246. A particle hanging from a massless spring stretches it by 2 cm at earth's surface. How much will the same particle stretch the spring at a height of 2624 KM from the surface of the earth? (Radius of earth = 6400 KM).
1. 1 cm 2. 2 cm 3. 3 cm 4) 4 cm

247. The work done in shifting a particle of mass 'm' from the centre of earth to the surface of the earth is
1. -mgR 2. $\frac{1}{2}mgR$ 3. zero 4) mgR

248 A planet of mass m_1 revloves round the sun of mass m_2. The distance between the sun and the planet is r. Considering the motion of the sun find the total energy of the system assuming the orbits to be circular.
1. $-\frac{Gm_1m_2}{r}$ 2. $-\frac{Gm_1m_2}{3r}$ 3. 4. $-\frac{Gm_1m_2}{2r}$

249 Two satellites S and S^1 revolve around the earth at distances, 3R and 6R from the centre of earth. Their periods of revolution will be in the ratio
1. 1:2 2. 2:1 3. $1:2\sqrt{2}$ 4. 1: 0.67

250 A satellite of mass 'm' moves along an elliptical path around the earth. The areal velocity of the satellite is proportional to
1. m 2. m^{-1} 3. m^0 4. $m^{1/2}$

251. The angular momentum (L) of earth revolving round the sun is proportional to r^n, where r is the orbital radius of the earth. The value of 'n' is:(assume the orbit to be circular)
1. $\frac{1}{2}$ 2. 1 3. $-\frac{1}{2}$ 4. 2

252 For a given density of the planet, the orbital period of a satellite near the surface of planet of radius 'R' is proportional to
1. $R^{1/2}$ 2. $R^{3/2}$ 3. $R^{-1/2}$ 4. R^0

253. The ratio of the energy required to raise a satellite upto a height R (radius of earth) from the surface of earth to that required to put it into orbit there is
1. 1:1 2. 8:1 3. 4:1 4. 2:3

254 A thin rod of length 'L' is bent to form a semi circle. The mass of the rod is 'M'. What will be the gravitational potential at the centre of the circle?
1. $\frac{-GM}{L}$ 2. $\frac{-GM}{2\pi L}$ 3. $\frac{-\pi GM}{2L}$ 4. $\frac{-\pi GM}{L}$

255. Three particles, each of mass 10^{-2} Kg are brought from infinity to the vertices of an equilateral triangle of side 0.1 m, the work done is
1. $2X10^{-8}J$ 2. $2X10^{-11}J$ 3. $2X10^{-12}J$ 4. $2X10^{-13}J$

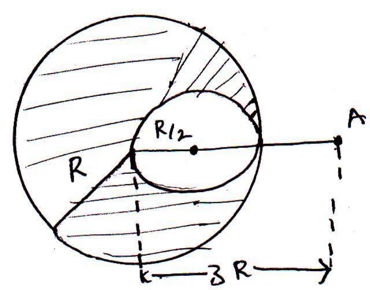
256. The kinetic energy needed to project a body of mass ‘m’ from the earth surface to infinity is

1. $\frac{1}{2}mgR$ 2. 2 mgR 3. mgR 4. $\frac{1}{4}mgR$

257. The work done by an external agent to shift a point mass from infinity to the centre of the earth is ‘W’. Then choose the correct relation.

1. W=0 2. W>0 3. W<0 4. $W \leq 0$

258. A solid sphere of uniform density and radius ‘R’ applies a gravitational force of attraction equal to F_1 on a particle placed at a distance 3R from the centre of the sphere. A spherical cavity of radius ‘$\frac{R}{2}$’ is now made in the sphere as shown in the figure. The sphere with cavity now applies a gravitational force F_2 on the same particle. The ratio $\frac{F_2}{F_1}$ is



1. $\frac{9}{50}$ 2. $\frac{41}{50}$ 3. $\frac{3}{25}$ 4. $\frac{22}{25}$

259. Two identical thin rings each of radius ‘R’ are co-axially placed at a distance ‘R’. If the rings have a uniform mass distribution and each has mass m_1 and m_2 respectively, then the work done in moving a mass ‘m’ from the centre of one ring to that of the other is:

1. zero 2. $\frac{Gm(m_1 - m_2)(\sqrt{2}-1)}{\sqrt{2}R}$

3. $\frac{Gm\sqrt{2}(m_1 + m_2)}{R}$ 4. $\frac{Gm_1 m(\sqrt{2}+1)}{m_2 R}$

260. The masses and radii of the earth and moon are M_1, R_1 and M_2, R_2 respectively. Their centres are at distance ‘d’ apart. The minimum velocity with which a particle of mass ‘m’ should be projected from a point midway between their centres so that it escapes to infinity is

1.0 2 $2\sqrt{\frac{Gm}{d}(M_1+M_2)}$

3. $2\sqrt{\frac{G}{d}(M_1+M_2)}$ 4. $2\sqrt{\frac{G}{md}(M_1+M_2)}$

261. Consider the two identical particles, they are released from rest and may move towards each other under the influence of mutual gravitational force. The speed of each particle, when the separation reduces to half of the initial separation is

1. $\sqrt{\frac{Gm}{d}}$ 2. $\sqrt{\frac{2Gm}{d}}$ 3. $\sqrt{\frac{Gm}{2d}}$ 4. none of these

262. A point $P(\sqrt{3}R, 0, 0)$ lies on the axis of a ring of a mass 'M' and radius 'R'. The ring is located in y-z plane with its centre at origin 'O'. A small particle of mass 'm' starts from 'P' and reaches 'O' under gravitational attraction only. Its speed at 'O' will be

1. $\sqrt{\frac{GM}{R}}$ 2. $\sqrt{\frac{Gm}{R}}$ 3. $\sqrt{\frac{GM}{\sqrt{2}R}}$ 4. $\sqrt{\frac{Gm}{\sqrt{2}R}}$

263. The gravitational field in a region is given by $\vec{E_g} = 5\hat{i} + 12\hat{j} N/Kg$, then the magnitude of the gravitational force acting on a particle of mass 2 Kg. placed at the origin, will be

1. zero 2. 13 N 3. 26 N 4. 75 N

264. A satellite is revolving round the earth. Its kinetic energy is E_k. How much energy is required by the satellite such that it escapes out of the gravitation field of earth

1. 2 E_k 2. 3 E_k 3. $\frac{E_k}{2}$ 4. infinity

265. If the radius of the earth is made three times, keeping the mass constant, then the weight of a body on the earth's surface will be as compared to its previous value

1. one third 2. one ninth 3. three times 4. nine times

266. At what weight from the surface of earth, the gravitational force will be reduced by 10%, if the radius of earth is 6370 Km.

1. 750 Km 2. 650 Km 3. 450 Km 4. 344 Km

267. An artificial satellite is revolving round the earth in a circular orbit. Its velocity is half of the escape velocity. Its height from the earth's surface is

1. 6400 KM 2. 12800 KM 3. 3200 KM 4. 1600 KM

268. What should be the angular velocity of rotation of earth about its own axis, so that the weight of a person on equator reduces to $\frac{3}{5}$ of its present value (R=6400 KM)

1. $7.8X10^{-4} rad/s$ 2. 7.8 rad/s 3. $0.8X10^{-4} rad/s$ 4. 1 rad/s

269. The radius and density of two artificial satellites are R_1, R_2 and respectively. The ratio of acceleration due to gravities on them will be

1) $\frac{R_2\rho_2}{R_1\rho_1}$ 2) $\frac{R_1\rho_2}{R_2\rho_1}$ 3) $\frac{R_1\rho_1}{R_2\rho_2}$ 4) $\frac{R_2\rho_1}{R_1\rho_2}$

270. Three particles of equal mass 'm' are situated at the vertices of an equilateral triangle of side 'L'. The work done in increasing the side of the triangle to 2L will be

1. $\frac{2G^2m}{2L}$ 2. $\frac{Gm^2}{2L}$ 3. $\frac{3Gm^2}{2L}$ 4. $\frac{3Gm^2}{L}$

271. If the force inside the earth surface varies as r^x, then the value of x will be ($r \rightarrow$ distance of the body from the centre of earth)

1. x=-1 2. x=-2 3. x=1 4. x=2

272. The potential energy of a body of mass 'm' is given by U=px+qy+rz. The magnitude of the acceleration of the body will be

1. $\frac{p+q+r}{m}$ 2. $\frac{\sqrt{p^2+q^2+r^2}}{m}$ 3. $\frac{\sqrt{p^3+q^3+r^3}}{m}$ 4. $\frac{\sqrt{p^4+q^4+r^4}}{m}$

273. Infinite bodies, each of mass 3 Kg are situated at distances, 1m, 2m, 4m, 8m,......... respectively on X-axis. The resultant intensity of gravitational field at the origin will be

1. G 2. 2G 3. 3G 4. 4G

274. A boy can jump to a height 'h' on the ground level. What should be the radius of a sphere of density δ such that on jumping on it, he escapes out of the gravitational field of the sphere?

1. $\sqrt{\frac{4\pi G\delta}{3gh}}$ 2. $\sqrt{\frac{4\pi gh}{3G\delta}}$ 3. $\sqrt{\frac{3gh}{4\pi G\delta}}$ 4. $\sqrt{\frac{3G\delta}{4\pi gh}}$

275. A satellite is revolving around a planet of mass 'm' in an elliptical orbit of semi major axis 'a'. The orbital velocity of the satellite at a distance 'r' from the focus will be

1. $\sqrt{GM\left(\frac{2}{r}-\frac{1}{a}\right)}$ 2. $\sqrt{GM\left(\frac{1}{r}-\frac{2}{a}\right)}$ 3. $\sqrt{GM\left(\frac{2}{r^2}-\frac{1}{a^2}\right)}$ 4. $\sqrt{GM\left(\frac{1}{r^2}-\frac{2}{a^2}\right)}$

276. A small body of super dense material, with mass equal to half of that of earth but whose size is very small compared to that of earth, starts from rest at the height h<<R above the earth's surface. It reaches the earth's surface in time given by

1. $\sqrt{\frac{2h}{g}}$ 2. $\sqrt{\frac{4h}{3g}}$ 3. $\sqrt{\frac{2h}{3g}}$ 4. $\sqrt{\frac{h}{g}}$

277. A planet in some solar system has a mass double that of earth and density equal to that of earth. An object weight 'W' on the earth, will weight on the planet as W^1.

Then

1. $W^1 = W$ 2. $W^1 = 2W$ 3. $W^1 = \frac{W}{2}$ 4. $W^1 = 2^{1/3}$ W

278. The escape velocity from a planet is 'V_e'. A tunnel is dug along along a diameter of the planet and a small body is dropped into it. The sped of the body at the centre of the planet will be

1. V_e 2. $\frac{V_e}{2}$ 3. $2V_e$ 4. $\frac{V_e}{\sqrt{2}}$

279. In the above problem, the time taken by the body to reach the centre of the planet will be

1. $\frac{\pi}{2}\sqrt{\frac{R}{g}}$ 2. $\pi\sqrt{\frac{R}{g}}$ 3. $2\pi\sqrt{\frac{R}{g}}$ 4. $\sqrt{\frac{R}{g}}$

280. The angular velocity of earth's rotation about its axis is 'ω'. An object weighed by a spring balance gives the same reading at the equator as at a height 'h' above the poles. The value of 'h' will be

1. $\frac{\omega^2 R^2}{g}$ 2. $\frac{\omega^2 R^2}{2g}$ 3. $\frac{2\omega^2 R^2}{g}$ 4. $\frac{2\omega^2 R^2}{3g}$

281. In the above problem, if the reading of the spring balance is same as that at depth 'd' below the earth's surface at poles. The value of 'd' will be

1. $\frac{\omega^2 R^2}{g}$ 2. $\frac{\omega^2 R^2}{2g}$ 3. $\frac{2\omega^2 R^2}{g}$ 4. $\frac{2\omega^2 R^2}{3g}$

282. Three particles of equal mass M are situated at the vertices of an equilateral triangle of side 'L'. What should be the velocity of each particle so that they move on a circular path without changing 'L'

1. $\sqrt{\frac{GM}{2L}}$ 2. $\sqrt{\frac{GM}{L}}$ 3. $\sqrt{\frac{2GM}{L}}$ 4. $\sqrt{\frac{GM}{3L}}$

283. If the moon describes a circular path of radius 'r' round the earth with uniform angular speed 'w', the period of revolution of the moon will be

1. $2\pi\sqrt{\frac{r^2}{gR^2}}$ 2. $2\pi\sqrt{\frac{gR^2}{r^3}}$ 3. $2\pi\sqrt{\frac{gR^3}{r^3}}$ 4. $2\pi\sqrt{\frac{r^3}{gR^2}}$

284. In the above problem, if the radius of moon's orbit is 60 times the earth's radius and period of revolution of moon is 27.3 days, then the radius of the orbit of moon is

1. $3.86X10^8 m$ 2. $3.86X10^6 m$ 3. $3.86X10^4 m$ 4. 3.86 Km

285. A small particle of mass 'm' lies on the axis of a ring of mass 'M' and radius 'a' at a distance 'a' from the centre. The particle reaches the centre under grav itational attraction only. Its speed at the centre will be

1. $\sqrt{\frac{2GM}{a}}$ 2. $\sqrt{\frac{2GM}{a}(\sqrt{2}-1)}$ 3. $\sqrt{\frac{2GM}{a}\left(1-\frac{1}{\sqrt{2}}\right)}$ 4. 0

286. The time period of a satellite very close to earth is 'T'. The time period of geo-synchronous satellite will be

1. $2\sqrt{2}(T)$ 2. $6\sqrt{6}(T)$ 3. $7\sqrt{7}(T)$ 4. $\frac{1}{7\sqrt{7}}(T)$

287. The work done in bringing three particles each of mass 10 gm from large distances to the vertices of an equilateral triangle of side 10 cm is

1. $10^{-13}J$ 2. $2X10^{-13}J$ 3. $4X10^{-11}J$ 4. $10^{-11}J$

288. What is the percentage change in the value of 'g' on shifting from equator to pole's on the earth's surface?
1.4.5% 2 0.65% 3 0.05% 4 0.43%

289. The escape velocity of a body from earth's surface is 'V_e'. The escape velocity of the same body from a height equal to 7R from the earth's surface will be

1. $\frac{V_e}{\sqrt{2}}$ 2. $\frac{V_e}{2}$ 3. $\frac{V_e}{2\sqrt{2}}$ 4. $\frac{V_e}{4}$

290. The gravitational field in X-direction due to some mass distribution is $E=\frac{k}{x^3}$, where k is a constant. assuming the gravitational potential to be zero at infinity, its value at a distance x will be

1. $\frac{k}{x}$ 2. $\frac{k}{2x}$ 3. $\frac{k}{x^2}$ 4. $\frac{k}{2x^2}$

291. A body is projected up with $\frac{3}{4}$ the escape velocity from earth's surface. The height reached by the body is

1. $\frac{7}{9}R$ 2. $\frac{9}{7}R$ 3. $\frac{7}{3}R$ 4. $\frac{3}{7}R$

292. A small body is at a distance 'r' from the centre of Mercury, where 'r' is greater than the radius of Mercury. The energy required to shift the body from r to 2r measured from the centre is E. The energy required to shift if from 2r to 3r will be

1. E 2. $\frac{E}{2}$ 3. $\frac{E}{3}$ 4. $\frac{E}{4}$

293. If the intensity of gravitational field at all places inside earth is presumed to be constant,then the relation between the density of earth (ρ) and distance (r) from the centre of the earth will be 1) $\rho \propto r$ 2) $\rho \propto \frac{1}{r}$ 3) $\rho \propto \sqrt{r}$ 4) $\rho \propto \frac{1}{\sqrt{r}}$

294. A sky laboratory of mass $2X10^3 Kg$ is raised from a circular orbit of radius 2R to a circular orbit of radius 3R. The work done is (approximately):

1 $10^{16} J$ 2. $2X10^{10} J$ 3. $10^6 J$ 4. $3X10^{10} J$

295. How far from earth must a particle be on the line joining earth to sun, in order that the gravitational pull on it due to sun is counter balanced by that due to earth. (Given orbit radius of earth is 10^8 KM and mass of sun is $3.24X10^5 M_E$) M_E= mass of the earth

1. $64X10^5 Km$ 2. $1.75X10^5 Km$ 3. $1.75X10^9 Km$ 4. 6400 Km

296. A satellite is projected with a velocity $\sqrt{1.5}$ times its orbital velocity just above the earth atmosphere. The initial velocity of the satellite is parallel to the surface. The maximum distance of the satellite from the earth will be

1. 2R 2. 8R 3. 4R 4. 3R

297. Two satellites of same mass are launched in the same orbit round the earth so as to revolve in mutually perpendicular directions. They soon collide inelastically and stick together. The total energy of the system before collision is

1. $\frac{-GMm}{2r}$ 2. $\frac{-GMm}{r}$ 3. $-\frac{2GMm}{r}$ 4. $\frac{-GMm}{4r}$

298. In the above problem, the total energy of the system after collision will be

1. $\frac{GMm}{2r}$ 2. $\frac{-GMm}{r}$ 3. $\frac{-2GMm}{r}$ 4. $\frac{-GMm}{4r}$

299. If 'V_e' is the escape velocity of a body from a planet of mass 'M' and radius 'R'. Then the velocity of the satellite revolving at height 'h' from the surface of the planet will be

1. $V_e\sqrt{\frac{R}{R+h}}$ 2. $V_e\sqrt{\frac{2R}{R+h}}$ 3. $V_e\sqrt{\frac{R+h}{R}}$ 4. $V_e\sqrt{\frac{R}{2(R+h)}}$

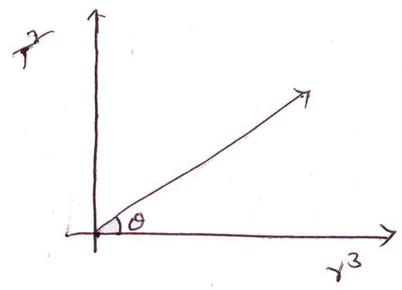
300. The moon revolves round the earth 13 times in one year. If the ratio of sun-earth distance to earth-moon distance is 392, then the ratio of masses of sun and earth will be

1. 365 2. 356 3. 3.56×10^5 4. 1

301. Imagine a geostationary satellite of earth which is used as an inter continental telecast station. At what height will it have to be established?

1. at $10^3 m$ 2. at $6.4X10^3 m$ 3. at $35.94X10^6 m$ 4. at infinity

302. If a graph is plotted between T^2 and r^3 for a planet,then its slope will be



1) $\frac{4\Pi^2}{GM}$ 2) $\frac{GM}{4\Pi^2}$ 3) $4\Pi GM$ 4)zero

303.Two uniform solid spheres of equal radii R, but mass M and 4M have a centre to centre separation 6 R, the two spheres are held fixed on a horizontal floor. A projectile of mass m is projected from the surface of the sphere of mass M directly towards the centre of the second sphere. Obtain an expression for the minimum speed v of the projectile so that it reaches the surface of the second sphere

1) $v=\left(\frac{5GM}{3R}\right)^{1/2}$ 2) $v=\left(\frac{3GM}{5R}\right)^{1/2}$ 3) $v=\left(\frac{3R}{5GM}\right)^{1/2}$ 4) $v=\left(\frac{8R}{5GM}\right)^{1/2}$

304.A homogeneous bar of lenght L and mass M is at a distance 'h' from a point mass 'm' as shown. The force on 'm' is F. Then

1) $F=\frac{GMm}{(h+L)^2}$ 2) $F=\frac{GMm}{h^2}$ 3) $F=\frac{GMm}{h(h+L)}$ 4) $F=\frac{GMm}{L^2}$

305.A planet is revolving round the sun. Its distance from the sun at Apogee is r_A and that at Perigee is r_P. The masses of plancet and sun are 'm' and M respectively, v_A is the velocity of planet at Apogee and v_P is at Perigee respectively and T is the time period fo revolution of planet round the sun, then identify the wrong answer.

1) $T^2=\frac{\pi^2}{2Gm}(r_A+r_P)^3$ 2) $T^2=\frac{\pi^2}{2Gm}(r_A+r_P)^2$

3) $v_A r_A = v_P r_P$ 4) $v_A < v_P; r_A > r_P$

306.A point $p\left(R\sqrt{3},0,0\right)$ lies on the axis of a ring of mass M and radius R. the ring is located in y - z plane with its centre at origin O. A small particle of mass 'm' starts from P and reaches O under gravitational attraction only. Its speed at O will be

1) $\sqrt{\frac{GM}{R}}$ 2) $\sqrt{\frac{GM}{2R}}$ 3) $\sqrt{\frac{GM}{\sqrt{2}R}}$ 4) $\sqrt{\frac{GM}{\sqrt{3}R}}$

307.A shell of mass m_2, radius r_2 lies inside and is concentric with a larger uniform shell of mass m_1, radius r_1. If E_P is the gravitational field at point P at distance 'r' from the common centre, then pick up the wrong option.

1) $E_p = G\left(\frac{m_1+m_2}{r^2}\right) for\, r > r_1 \,\&\, r > r_2$ 2) $E_p = G\frac{m_2}{r^2} for\, r > r_1 \,\&\, r > r_2$

3) $E_p = 0\, for\, r > r_2$ 4) $E_p \neq 0\, for\, r < r_2$

308.A "double star" is a composite system of two stars rotating about their centre of mass under their mutual gravitational attraction. Let us consider such a "double star" which has two stars of masses 'm' and '2m' at a separation 'l'. If T is the time period of rotation about their entre of mass then.

1) $T = 2\pi\sqrt{\frac{l^3}{mG}}$ 2) $T = 2\pi\sqrt{\frac{l^3}{2mG}}$ 3) $T = 2\pi\sqrt{\frac{l^3}{3mG}}$ 4) $T = 2\pi\sqrt{\frac{l^3}{4mG}}$

309 .The magnitude of the gravitational force between a particle of mass m_1 and another particle of mass m_2 is $F = Gm_1m_2/x^2$. The work required to increase the separation of the particles from $x - x_1$ to $(x_1 + d)$ is

1) $\frac{Gm_1m_2x_1}{d(x_1+d)}$ 2) $\frac{Gm_1m_2d}{x_1(x_1+d)}$ 3) $\frac{Gm_1m_2x_1^2}{d(x_1+d)}$ 4) $\frac{Gm_1m_2d^2}{x_1(x_1+d)}$

310.A planet of mass 'm' is moving in an elliptical orbit round the sun of mass M. If the maximum and minimum distances of the planet from the sun be l_1 and l_2, the angular momentum of the planet about the sun will be

1) $\frac{GMm}{\sqrt{(l_1+l_2)}}$ 2) $\sqrt{\frac{(l_1+l_2)}{GMl_1l_2}}$ 3) $\sqrt{\frac{GMl_1l_2}{(l_1+l_2)}}$ 4) 0

311.The gravitaional field in a region due to a certain mass distribution is given by $\overline{E} = (4\overline{i} - 3\overline{j})N/kg$. The work done by the field in moving a particle of mass 2 kg from (2m, 1m) to $\left(\frac{2}{3}m, 2m\right)$ along the line 3x+4y=10 is

1) $-\frac{25}{3}N$ 2) $-\frac{50}{3}N$ 3) $\frac{25}{3}N$ 4) zero

312.A planet of mass m revolves in elliptical orbit around the sun so that its maximum and minimum distances from the sun are equal to r_a and r_p respectively. Find the angular momentum of this planet relative to the sun

1) $L = m\sqrt{\frac{GMr_pr_a}{(r_p+r_a)}}$ 2) $L = m\sqrt{\frac{2GMr_pr_a}{(r_p+r_a)}}$ 3) $L = M\sqrt{\frac{Gmr_pr_a}{(r_p+r_a)}}$ 4) $L = M\sqrt{\frac{(r_p+r_a)}{Gmr_pr_a}}$

313.A solid sphere of uniform density and radius R applies a gravitational force of attraction equal to F_1 on a particle placed at A, distant 2R from the centre of the sphere. A spherical cavity of radius R/2 is now made on the sphere the sphere with cavity now applies a gravitational force F_2. Then $\frac{F_2}{F_1}$ will be

1) 1/2 2) 3/4 3) 7/8 4) 14/9

314.A particle is placed in a field characterized by a value of gravitational potential given by V = -kxy, where 'k' is a constant. If $\overline{E_g}$ is the gravitational field then.

1) $\overline{E_g} = k\left(x\,\bar{i} + y\,\bar{j}\right)$ and is conservative in nature

2) $\overline{E_g} = k\left(y\,\bar{i} + x\,\bar{j}\right)$ and is conservative in nature

3) $\overline{E_g} = k\left(x\,\bar{i} + y\,\bar{j}\right)$ and is non conservative in nature

4) $\overline{E_g} = k\left(y\,\bar{i} + x\,\bar{j}\right)$ and is non conservative in nature

315.A satellite is revolving round the earth in an orbit of radius 'r' with time period T. If the satellite is revolving round the earth in an orbit of radius $r + \Delta r(\Delta r << r)$with time period $T + \Delta T(\Delta T << T)$ then.

1) $\frac{\Delta T}{T} = \frac{3}{2}\frac{\Delta r}{r}$ 2) $\frac{\Delta T}{T} = \frac{2}{3}\frac{\Delta r}{r}$ 3) $\frac{\Delta T}{T} = \frac{\Delta r}{r}$ 4) $\frac{\Delta T}{T} = -\frac{\Delta r}{r}$

316.The gravitational field due to a mass distribution is $E = \frac{K}{x^3}$ in the x-direction, where K is a constant. Taking the gravitational potential to be zero at infinity, its value at a distance x is

1) $\frac{K}{x}$ 2) $\frac{K}{2x}$ 3) $\frac{K}{x^2}$ 4) $\frac{K}{2x^2}$

317.Two bodies of masses 'm' and 'M' are placed at a distance 'd' apart. The gravitational potential at the position where the gravitational field due to them is zero is V. Then

1) $V = -\frac{G}{d}(m + M)$ 2) $V = \frac{G}{d}$

3) $V = -\frac{G}{d}$ 4) $V = -\frac{G}{d}\left(\sqrt{m} + \sqrt{M}\right)^2$

318.An artificial satellite moving in circular orbit around the earth has a total (kinetic + potential) energy E_0,. Its potential energy and kinetic energy respectively are

1) $2E_o$ and $-2E_0$ 2) $-2E_0$ and $3E_o$ 3) $2E_0$ and $-E_0$ 4) $-2E_0$ and $-E_0$

319.The ratio of Earth's orbital angular momentum (about the sun) to its mass is 4.4 X 10^{15} m^2s^{-1}. The area enclosed by the earth's orbit is approximately

1) 1 X 10^{22} m^2 2) 3 X 10^{22} m^2 3) 5 X 10^{22} m^2 4) 7 X 10^{22} m^2

320.A particle of mass 1kg is placed at a distance of 4m from the centre and on the axis of a uniform ring of mass 5kg and radius 3m. The work done to increase the distance of the particle from 4m to $\sqrt{3}m$ is.

1) $\frac{G}{3}J$ 2) $\frac{G}{4}J$ 3) $\frac{G}{5}J$ 4) $\frac{G}{6}J$

321.Two metallic spheres each of mass M are suspended by two strings each of lenght L. The distance between the upper ends of the strings is L. The angle which the strings make with the vertical due to mutual attraction of the spheres is

1) $\tan^{-1}\frac{2GM}{gL^2}$ 2) $\tan^{-1}\frac{GM}{gL}$ 3) $\tan^{-1}\frac{GM}{gL^2}$ 4) $\tan^{-1}\frac{GM}{2gL}$

322.The gravitational field due to a mass distribution is $I=\frac{C}{x^2}$ in x-direction. Here C is constant. Taking the gravitational potential to be zero at infinity, potential at x is

1) $\frac{2C}{x}$ 2) $\frac{C}{x}$ 3) $\frac{2C}{x^2}$ 4) $\frac{C}{2x^2}$

323.. At a given place where acceleration due to gravity is $g\,m/\sec^2$, a sphere of lead of density $d\,kg/m^3$ is gently released in a column of liquid of density $\rho\,kg/m^3$. If d > ρ, the sphere will

1) fall vertically with an acceleration of $g\,m/\sec^2$

2) fall vertically with no acceleration

3) fall vertically with an acceleration $g\left(\frac{d-\rho}{d}\right)$

4) fall vertically with an acceleration $g\rho/d$

LEVEL-V

. Match the following

324. (Note that an item of Column-I can match with more than one item of Column-II.)

Column-I	Column-II
(A) Modulus of gravitational potential at curvature centre of a thin hemispherical shell of radius R and mass M.	P. $\frac{GMm}{R}$
(B) Modulus of gravitational potential at curvature centre of a thin uniform wire, bent into a semicircle of radius R.	Q. $\frac{GM}{R}$
(C) Modulus of gravitational potential at curvature centre of a thin non-uniform wire, bent into a semicircle of radius R.	R. $\frac{GM}{R^2}$

The matching grid

A) P,Q,R B) P,Q,R C) P,Q,R

325. Match the following

Note that an item of Column-I can match with more than one item of Column-II.)
If our planet suddenly shrinks in size, still remaining perfectly spherical with mass remaining unchanged.

Column-I	Column-II
A) Duration of the day	P. increase
B) Kinetic energy of rotation	Q. unchanged
C) Duration of the year	R. decrease

The matching grid

A) P,Q,R B) P,Q,R C) P,Q,R

326. Match the following

(Note that an item of Column-I can match with more than one item of Column-II.)
When a planet moves around the sun

Column-I	**Column-II**
(A) Its angular momentum	P. increases
(B) When it is near the sun its	Q. constant speed
(C) When it is near the sun its	R.decreases potential energy

The matching grid

A) P,Q,R B) P,Q,R C) P,Q,R

327. Match the following

(Note that an item of Column-I can match with more than one item of Column-II.)
A satellite is revolving round the earth in an elliptical orbit.

Column-I	Column-II
(A) Gravitational force exerted by earth and centripetal force at some points only can be	P. Zero
(B) Work done by gravitational force in some small parts of orbit can be	Q. Equal
(C) In comparision of centripetal force at some point magnitude of gravitational force can be	R. Greater

The matching grid

A) P,Q,R B) P,Q,R C) P,Q,R

328. Match the following

(Note that an item of Column-I can match with more than one item of Column-II.)
Two satellites S_1 and S_2 revolve round a planet in coplanar circular orbits in same sense. Their periods of revolution are 1hr. and 8hrs. respectively. The radius of

orbit of S_1 is 10^4 km.

Column-I	Column-II
A) Speed of Ist satellite	P. $\pi \times 10^4 km/h$
(B) Speed of IInd satellite	Q. $3\pi \times 10^4 km/h$
(C) Minimum magnitude of relative velocity between the two satellites	R. $2\pi \times 10^4 km/h$

The matching grid

A) P,Q,R B) P,Q,R C) P,Q,R

329. Match the Columns

Column-I	**Column - II**
A) Concept of surface of earth	1) at the poles on the elliptical path
B) Gravitational attraction go upwards from surface of earth	2) Decreases as we force.
C) Acceleration due to gravity	3) Keppler's 1st law
D) Acceleration due to gravity is maximum.	4) Kepper's 2nd law
	5) Newton's Law

330.A satellite of mass m is moving in a circular orbit of radius r = (R_e+h) around earth of radius R_e and mass M_e, and density of earth ρ. Match the following

Column-I	**Column - II**
A) Orbital velocity of the	1) $T = \sqrt{\frac{2\pi}{GM_e}} r^{3/2}$ satellit
B) Kinetic energy of the satellite.	2) $\frac{GM_e m}{2r}$
C) Potential energy of the satellite	3) $\frac{GM_e m}{2r}$
D) Total energy of the satellite	4) $\frac{GM_e m}{r}$
E) Time period of the satellite.	5) $\frac{GM_e}{r}$

Assertions and Reasons

331. **Assertion:** If earth suddenly stops rotating about its axis, then the value of acceleration due to gravity will become same at all the places.

Reason: The value of acceleration due to gravity is independent of rotation of earth.

1) Both Assertion and Reason are true and 'Reason' is the correct explanation of 'Assertion'
2) Both Assertion and Reason are true and 'Reason' is not the correct explanation of 'Assertion'
3) 'Assertion' is true but 'Reason' is false
4) B oth 'Assertion' and 'Reason' are false
5) 'Assertion' is false but 'Reason' is true

332. **Assertion:** Orbital velocity of a satellite is greater than its escape velocity.
Reason: Orbit of a satellite is within the gravitational field of earth whereas escaping is beyond the gravitational field of earth.
1. Both Assertion and Reason are true and 'Reason' is the correct explanation of 'Assertion'
2. Both Assertion and Reason are true and 'Reason' is not the correct explanation of 'Assertion'
3. 'Assertion' is true but 'Reason' is false
4. Both 'Assertion' and 'Reason' are false
5. 'Assertion' is false but 'Reason' is true

333. **Assertion:** The time period of revolution of a satellite close to surface of earth is smaller than that revolving away from surface of earth.
Reason: The square of time period of revolution of a satellite is directly proportional to cube of its orbital radius.
1. Both Assertion and Reason are true and 'Reason' is the correct explanation of 'Assertion'
2. Both Assertion and Reason are true and 'Reason' is not the correct explanation of 'Assertion'
3. 'Assertion' is true but 'Reason' is false
4. Both 'Assertion' and 'Reason' are false
5. 'Assertion' is false but 'Reason' is true

334. **Assertion:** Generally the path of projectile from the earth is parabolic but it is elliptical for projectiles going to a very large height.
Reason: The path of a projectile is
independent of the gravitational force of earth.
1. Both Assertion and Reason are true and 'Reason' is the correct explanation of 'Assertion'
2. Both Assertion and Reason are true and 'Reason' is not the correct explanation of 'Assertion'
3. 'Assertion' is true but 'Reason' is false
4. Both 'Assertion' and 'Reason' are false
5. 'Assertion' is false but 'Reason' is true

335. **Assertion:** We can not move even a finger without disturbing all the stars.
Reason: Everybody in this universe attracts every other body with a force which is inversely proportional to the square of distance between them.
1. Both Assertion and Reason are true and 'Reason' is the correct explanation of 'Assertion'

2. Both Assertion and Reason are true and 'Reason' is not the correct explanation of 'Assertion'
3. 'Assertion' is true but 'Reason' is false
4. Both 'Assertion' and 'Reason' are false
5. 'Assertion' is false but 'Reason' is true

objectives with ONE or MORE than one correct cho ice

336. Which of the following is correct
a) An astronaut in going from Earth to Moon will experience weightlessness once.
b) When a thin uniform spherical shell gradully shrinks maintaining its shape, the gravitational potential at its center decreases.
c) In the case of spherical shell, the plot of V versus r is continuous.
d) In the case of spherical shell, the plot of gravitational field intensity I versus r is continuous

337. An object is weighed at the North pole by a beam balance and a spring balance, giving readings of W_B and W_S respectively. It is again weighed in the same manner at the equator, giving reading of W'_B and W'_S respectively. Assume that the acceleration due to gravity is the same every where and that the balances are quite sensitive.
a) $W_B = W_S$ b) $W'_B = W'_S$ c) $W_B = W'_B$ d) $W'_S < W_S$

338. For a planet moving around the sun in an elliptical orbit, which of the following quantities remain constant ?
a) The total energy of the 'sun planet' system
b) The angular momentum of the planet about the sun.
c) The force of attraction between the two
d) The linear momentum of the planet

339. If a satellite orbits as close to the earth's surface as possibel
a) its speed is maximum
b) time period of its rotation is minimum
c) the total energy of the earth plus satellite system minimum
d) the total energy of the earth plus satellite system is maximum

340. A satellite to be geo-stationary, which of the following are essential condition?
a) it must always be stationed above the equator
b) it must be rotate from west to east
c) it must be about 36,000km above the earth surface
d) it orbit must be circular, and not elliptical

STATEMENTS

341. A : When a body is projected with velcoity $v = v_0$ (where v_0 is orbital velocity) then path of the projectile is circular.
R : Gravitional force between body and the earth provides the centripetal force.
1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
3) Statement-1 is True, Statement-2 is False

4) Statement-1 is False, Statement-2 is True

342.. Statement - 1 : For a mass M kept at the centre of a cube of side ‘a’, the flux of gravitational field passing through its sides is 4π GM.

Statement - 2 : If the direction of a field due to a point source is radial and its dependence on the distance ‘r’ from the source is given as $\frac{1}{r^2}$. It flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface

1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
3) Statement-1 is True, Statement-2 is False
4) Statement-1 is False, Statement-2 is True

343. A: Orbiting satellite or body has K.E. of always less than that of Potential energy.

R : For any bound state, the magnitude of potential energy is always twice that of kinetic energy (K.E.)

1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
3) Statement-1 is True, Statement-2 is False
4) Statement-1 is False, Statement-2 is True

344. A : There is almost no effect of rotation of earth at poles.

R : Because rotation of earth is about polar axis.

1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
3) Statement-1 is True, Statement-2 is False
4) Statement-1 is False, Statement-2 is True

345.A: If the Earth suddenly contracts to 1/n th of its present size without any change in its mass. B:The duration of the new day will be $\frac{24}{n}$ hrs.

1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1
3) Statement-1 is True, Statement-2 is False
4) Statement-1 is False, Statement-2 is True

346. **Statement-1:** For a mass M kept at the centre of a cube of side ‘a’, the flux of gravitational field passing through its sides is $4\pi GM$.

Statement-2: If the direction of a field due to a point source is radial and its dependence on the distance ‘r’ from the source is given as $\frac{1}{r^2}$ .its flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface.

1) Statement-1 is true, Statement-2 is true; Statement-2 is not a correct explanation for Statement-1
2) Statement-1 is true, Statement-2 is false.
3) Statement-1 is false, Statement-2 is true.
4) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1

Linked comprehension type ::1

(write up 1)(347-- 349)

You’re involed in the design of a mission carrying humans to the surface of the planet Mars, which has a radius r_M = 3.40 X 10^6 m and a mass m_M = 6.42 X 10^{33}Kg. The earth weight of the mars (lift) is 39,200N.

In solving the following questions neglect the gravitational effects of the (very small) moons of Mars.

347. Calculate approximately its weight, 6.0 X 10^6 m above the surface of mars (the distance at which the moon phobos orbits Mars)

1) 20,000N 2) 6000N 3) 2000N 4) 1000N

348. Calculate its acceleration g_m due to the gravity of Mars 6.0 X 10^6 m above the surface of Mars

1) 0.48 m/s^2 2) 5.8 m/s^2 3) 7.2 m/s^2 4) 0.32 m/s^2

349. Calculate its weight F_8 approximately due to gravity of Mars at the surface of Mars

1) 15000N 2) 1500 N 3) 2000N 4) 25000N

(write up :: 2)(350--352)

Consider a binary system of stars X of mass M_x and Y of mass M_Y. Their masses are different and they revolve about their centre of mass. Separation between the stars is R. Orbital speed of star X is 48 km/s and its distance from the centre of mass is four times the distance of star Y from the centre of Y from the centre of mass.

Again assuming the dimensions of the stars to be much smaller than their seperation, answer the following questions.

350. consider the centre of mass as the origin. At any instant, position vectors of X and Y are $\overrightarrow{R_x}$ and $\overrightarrow{R_y}$ respectively. Dot product of $\overrightarrow{R_x}$ and $\overrightarrow{R_y}$ will be

1) -0.16R^2 2) -0.32R^3 3) -0.5R^2 4) 2R^2

351. Orbital speed of star Y is

1) 60 km/s 2) 4 km/s 3) 12 km/s 4) 16 km/s

352. Orbital time period of star X can be expressed as

1) $\frac{4\pi R^{3/2}}{\sqrt{5GM_Y}}$ 2) $\frac{4\pi R^{3/2}}{\sqrt{5GM_X}}$ 3) $\frac{2\pi R^{3/2}}{\sqrt{GM_X}}$ 4) $\frac{2\pi R^{3/2}}{\sqrt{3GM_Y}}$

(write up:: 3) (353--355)

A solid sphere of mass M and redius R is surrounded by a spherical shell of same mass M and radius 2R as shown. A small particle of mass m is released from rest a heigh h (<<R) above the shell. There is a hole in the shell.

353.In what time will it enter the hole at A

1) $2\sqrt{\frac{hR^2}{GM}}$ 2) $\sqrt{\frac{2hR^2}{GM}}$ 3) $\sqrt{\frac{hR^2}{GM}}$ 4) $\frac{1}{2}\sqrt{\frac{hR^2}{GM}}$

354.What time will it take to move from A to B

1) $=\frac{R^2}{\sqrt{GMh}}$ 2) $>\frac{R^2}{\sqrt{GMh}}$ 3) $<\frac{R^2}{\sqrt{GMh}}$ 4) $=\frac{2R^2}{\sqrt{GMh}}$

355.With what approximate speed will it collide at B ?

1) $\sqrt{\frac{2GM}{R}}$ 2) $\sqrt{\frac{GM}{2R}}$ 3) $\sqrt{\frac{3GM}{2R}}$ 4) $\sqrt{\frac{GM}{R}}$

KEY

1.2	2.1	3.3	4.4	5.2	6.3	7.2	8.3	9.1	10.3
11.4	12.2	13.2	14.4	15.1	16.3	17.3	18.1	19.1	20.2
21.4	22.4	23.4	24.2	25.3	26.1	27.4	28.1	29.2	30.3
31.1	32.3	33.2	34.1	35.1	36.2	37.3	38.4	39.2	40.1
41.4	42.2	43.3	44.1	45.3	46.3	47.3	48.3	49.1	50.1
51.1	52.3	53.4	54.1	55.1	56.1	57.1	58.3	59.1	60.2
61.2	62.2	63.2	64.3	65.3	66.1	67.4	68.1	69.3	70.4
71.2	72 .2	73.2	74.3	75.1	76.1	77.3	78.4	79.2	80.1
81.3	82.1	83 .2	84.3	85.2	86.3	87.1	88.4	89.3	90.3
91.2	92.3	93.3	94.2	95.2	96.1	97.1	98.2	99.1	100.2
101.1	102.2	103.3	104.3	105.1	106.1	107.1	108.2	109.4	110.1
111.1	112.1	113.3	114.1	115.3	116.3	117.3	118.4	119.2	120.2
121.3	122.2	123.2	124.3	125.1	126.3	127.1	128.3	129.2	130.1
131.1	132.2	133.4	134.4	135.2	136.2	137.2	138.2	139.2	140.1
141.1	142.1	143.2	144.4	145.2	146.4	147.3	148.1	149.4	150.2
151.3	152.4	153.1	154.3	155.1	156.2	157.3	158.4	159.4	160.2
161.2	162.4	163.2	164.1	165.3	166.3	167.2	168.3	169.4	170.2
171.2	172.1	173.1	174.2	175.3	176.1	177.1	178.1	179.3	180.1
181.4	182.2	183.1	184.4	185.4	186.2	187.3	188.2	189.1	190.2
191.3	192.4	193.2	194.1	195.2	196.3	197.2	198.2	199.2	200.3
201.1	202.3	203.2	204.4	205.3	206 .1	207.2	208.1	209.4	210.4
211.2	212.3	213.4	214.2	215.2	216.1	217.1	218.1	219.1	220.1
221.1	222.3	223.1	224.1	225.3	226.3	227.3	228.1	229.4	230.2
231.4	232.2	233.2	234.2	235.1	236.4	237.3	238.1	239.2	240.3
241.3	242.3	243.4	244.2	245.2	246.1	247.2	248.4	249.3	250.3
251.1	252.4	253.4	254.4	255.4	256.3	257.3	258.2	259.2	260.3
261.1	262.1	263.3	264.1	265. 2	266.4	267.1	268.1	269.3	270. 3
271.3	272.2	273.4	274.3	275. 1	276.2	277.4	278.4	279.1	280. 2
281.1	282.2	283.4	284.1	285. 3	286.3	287. 2	288.2	289.3	290.4

291.2 292.3 293.2 294.2 295.2 296.4 297.2 298.3 299.4 300.3
301.3 302.1 303.2 304.3 305.1 306.1 307.4 308.3 309.2 310.3
311.2 312.2 313.4 314.2 315.1 316.4 317.4 318.3 319.4 320.4
321.3 322.2 323.3

MATHCH THE FOLLOWING

324.A-Q, B-Q,C-Q 325. A-R,B-P,C-Q
326. A-Q, B-P, C-R 327. A-Q, B-P, C-R
328. A-R, B-P, C-P 329.A-4,B-5,C-2,D-1
330. A-5,B-2,C-4,D-3,E-1

ASSERTION & RESIONING

331.3 332. 3 333.1 334.3 335.1

MORE THAN ONE CHOICE

336. A,B,C 337. A,C,D 338. A,B 339. A,B,C 340. A,B,C,D

STATEMENTS

341.2 342. 2 343.1 344.1 345.4 346.4

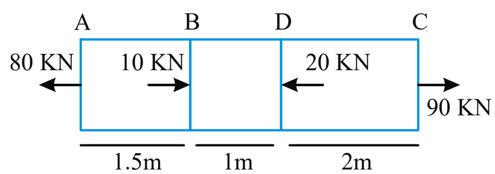
LINKED

347.3 348.2 349.1 350.1 351.3 352.1 353.1 354.3 355.4

EXERCISE - I

SINGLE ANSWER TYPE QUESTIONS

1. **A steel rod of cross-sectional area 1 m^2 is acted upon by forces shown in figure. Determine the elongation of the length BC of the bar. Take $Y = 2.0\times10^{11} N/m^2$.**

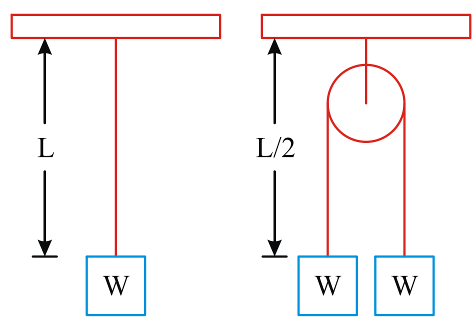


A) $13\times10^{-7} m$ B) $4.5\times10^{-7} m$ C) $5\times10^{-7} m$ D) $3.5\times10^{-7} m$

2. **A 30.0 kg hammer,moving with speed20.0m/s,strikes a steel spike 2.30 cm in diameter. The hammer rebounds with speed 10.0 m/s after 0.110s. what is the average stress in the spike during the impact?**

A) $1.97\times10^{7} N/m^2$ B) $3.2\times10^{7} N/m^2$ C) $4.6\times10^{7} N/m^2$ D) $8.2\times10^{7} N/m^2$

3. **When a weight W is hung from one end of a wire of length L (other end being fixed), the length of the wire incerases by l.If the same wire is passed over a pulley and two weights W each are hung at the two ends, what will be the total elongation in the wire?**

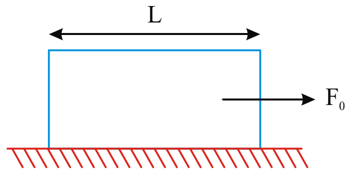


A) l B) $2l$ C) $3l$ D) $\frac{l}{2}$

4. **A rod of uniform cross-sectional area A and length L has a weight W. It is suspended vertically from a fixed support. If the material of the rod is homogeneous Then the elongation of the wire is**

A) $\frac{1}{2}\frac{WL}{YA}$ B) $\frac{1}{3}\frac{WL}{YA}$ C) $2\frac{WL}{YA}$ D) $3\frac{WL}{YA}$

5. **A constant force F_0 is applied on a uniform elastic string placed over a smooth horizontal surface as shown in figure. Young's modulus of string is Y and area of cross -section is S.The strain produced in the string in the direction of force is**



A) $\frac{F_0Y}{S}$ B) $\frac{F_0}{SY}$ C) $\frac{F_0}{2SY}$ D) $\frac{F_0Y}{2S}$

6. A pendulum bob of mass m hangs from a massless elastic string. The potential energy (elastic+gravitational) of the system (bob + string + earth) measured relative to the position of the bob corresponding to the normal length of the string is:(where x=static deformation(elongation) of the string.)

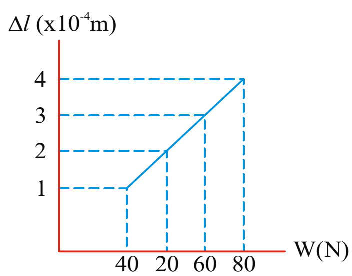
A) mgx B) $-\frac{1}{2}mgx$ C) $2mgx$ D) $-mgx$

7. The elastic limit of an elevator cable is $2\times10^9 N/m^2$. The maximum upward acceleration that an elevator of mass $2\times10^3 kg$ can have when supported by a cable whose cross-sectional area is $10^{-4} m^2$, provided the stress in cable would not exceed half of the elastic limit would be

A) $10m/s^2$ B) $50m/s^2$

C) $40m/s^2$ D) Not possible to move up

8. The adjacent graph shows the extension (Δl) of a wire of length 1m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is $10^{-6} m^2$, Calculate the Young's modulus of the material of the wire. [2004]



A) $2\times10^{11} N/m^2$ B) $2\times10^{-11} N/m^2$ C) $3\times10^{-12} N/m^2$ D) $2\times10^{-13} N/m^2$

9. Two rods of different materials having coefficient of thermal expansion α_1, α_2 and Young's moduli Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $\alpha_1 : \alpha_2 = 2:3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to :[1989]

A) $2:3$ B) $1:1$ C) $3:2$ D) $4:9$

10. The following four wires are made of the same material. Which of these will have the largest extension when the same force is applied? [1981]

A) Length = 50cm, diameter = 0.5mm B) Length = 100cm, diameter = 1mm

C) Length = 200cm, diameter = 2mm D) Length = 300cm, diameter = 3mm

11. When temperature of a gas is $20°C$ and pressure is changed from

$P_1 = 1.01\times10^5\ Pa$ **to** $P_2 = 1.165\times10^5\ Pa$ **then the volume changed by 10%. the bulk modulus is:[2005]**

A) $1.55\times10^5\ Pa$ B) $0.115\times10^5\ Pa$ C) $1.4\times10^5\ Pa$ D) $1.01\times10^5\ Pa$

12. **Two rods of equal cross-sections, one of copper and the other of steel are joined to form a composite rod of length 2.0 m at** $20^\circ C$ **, the length of the copper rod is 0.5m.When the temperature is raised to** $120^\circ C$ **, the length of composite rod increases to 2.002m. If the composite rod is fixed between two rigid walls and thus not allowed to expand, it is foundthat the length of the component rods also do not change with increase in temperature. calculate the Young's modulus of steel. Given Young's modulus of copper** $= 1.3\times10^{11}\ N/m^2$ **,the coefficient of linear expansion of copper** $\alpha_c = 1.6\times10^{-5}/^\circ c$ **.**

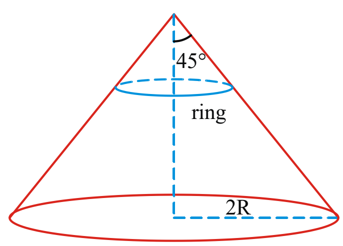
A) $2.6\times10^{11}\ Pa$ B) $1.6\times10^{10}\ Pa$ C) $1.3\times10^{10}\ Pa$ D) $0.9\times10^{10}\ Pa$

13. **A highly rigid cubical block A of small mass M and side L is fixed rigidly onto another cubical block B of same dimensions and of low modulus of rigidly** η **such that lower lower face of A completely covers the upper face of B. The lower face of B is rigidly held on a horizontal surface. A small force F is applied perpendicular to one of the side face of A. After the force is withdrawn, block A executes small oscillations, the time period of which is given by**

A) $2\pi\sqrt{M\eta L}$ B) $2\pi\sqrt{\frac{M}{\eta L}}$ C) $2\pi\sqrt{\frac{ML}{\eta}}$ D) $\sqrt{\frac{M\eta}{L}}$

MULTIPLE ANSWER QUESTIONS

14. **A uniform metallic ring of mass m, radius R, cross sectional area '** a **' and young's modulus Y is kept on a smooth cone of radius 2R and semivertical angle** 45^0 **as shown. [Assume that extension in the ring is small]**



A) The tension in the ring will be same throughout.
B) The tension in the ring will be independent of radius of ring.
C) The extension in the ring will be $\frac{mgR}{aY}$
D) Elastic potential energy stored in the ring will be $\frac{m^2g^2R}{8\pi Ya}$

15. **The torque required to produce a unit twist in a solid bar of length L and radius r is**

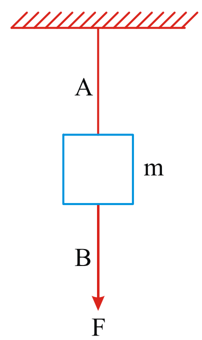
A) directly proportional to r^2 B) directly proportional to r^4

C) inversely proportional to l D) inversely proportional to r^2

16. A small cube of liquid of surface area A is considerd at a depth of '*h*' from the surface of liquid .If its density is ρ , bulk modulus isB,the elastic energy density inside the cube is proportional to:"

A) h^2 B) A C) $\frac{1}{B}$ D) ρ

17. The wires A and B shown in the figure are made of the same material and have radii r_A and r_B, respectively.The block between them has a mass m. When the force F is $mg/3$,one of the wires breaks. Then



A) A will break before B if $r_A = r_B$ B) A will break before B if $r_A < 2r_B$

C) Either AorB may break if $r_A = 2r_B$

D) The lengths of A and B must be known to predict which wire will break.

18. A uniform plank is resting over a smooth horizontal surface it is subjected to a horizontal force at its one end.Which of the following statements are not correct?

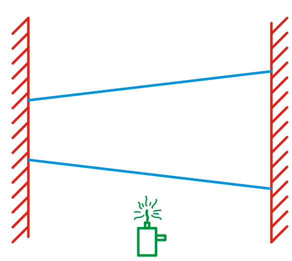
A) Stress developed in plank material is maximum at the end at which force is applied and decrease linearly to zero at the other end.

B) A uniform tensile stress is developed in the plank material.

C) since plank is pulled at one end only plank starts to accelerate along direction of the force.Hence no stress is developed in the plank material.

D) Stress at the ends is the same but it changes in between.

19. A rod is made of uniform material and has non-uniform cross section.It is fixed at both the ends as shown and heated at mid-section.Which of the following statements are not correct?



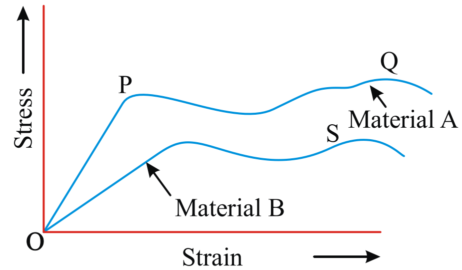
A) Force of compression in the rod will be maximum at mid-section.

B) Compressive stress in the rod will be maximum at left end.

C) Since rod is fixed at both the ends, its length will remain unchanged. Hence, no strain will be induced in it.

D) Force of compression is the same throughout the rod.

20. The figure shows the stress-strain graphs for materials A and B. From the graph it follows that



A) material A has a higher Young's modulus
B) material B is more ductile
C) material A can withstand greater stress
D) material B can withstand greater stress

21. Which of the following are correct?
A) For a small deformation of a material,the ratio (stress/strain) constant.
B) For a large deformation of a material, the ratio (stress/strain)decreases.
C) Two wires made of different materials, having the same diameter and length are connected end to end. A force is applied. This stretches their combined length by 2mm. Now they have same strength but different stress
D) none

22. Which of the following are correct ?
A) The shear modulus of a liquid is infinite.
B) Bulk modulus of a perfectly rigid body is infinite.
C) When length of a bar is increased by stretching it, it's volume must decrease.
D) When length of a bar is increased by stetching it, its volume must remain same.

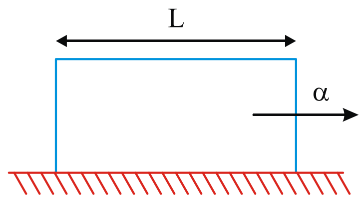
23. when a body of mass M is attached to lower end of a wire (of length L) whose upper end is fixed, then the elongation of the wire is l.In this situation, mark out the correct statement(s)
A) Loss in gravitational potential energy of M is Mgl.
B) Elastic potential energy stored in the wire is $\frac{Mgl}{2}$.
C) Elastic potential energy stored in the wire is Mgl.
D) Elastic potential energy stored in the wire is $Mgl/3$

FILL IN THE BLANKS

24. A wire of length L and cross-sectional area A is made of a material of Young's modulus. If the wire is stretched by an amount x, the work done is _____ [1987]

25. A solid sphere of radius R made of a material of bulk modulus K is surrounded by a liquid in the cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid, the fractional change in the radius of the sphere, $\delta R/R$, is ______ [1988]

26. A uniform rod of length L and density ρ is being pulled along a smooth floor with a horizontal acceleration α (see the figure). The magnitude of the stress at the transverse cross-section through the midpoint of the rod is _____[1993]



COMPREHENSION TYPE QUESTIONS

Comprehension - 1:

A stationary uniform string of modulus Y, density ρ and length 'l' is hanging from a rigid support.

27. The stress at a distance x from the point of its suspension.

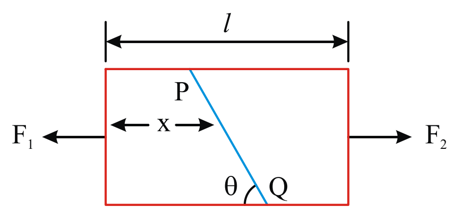
A) ρxg B) $\rho(l-x)g$ C) ρlg D) $\frac{\rho x^2 g}{l}$

28. The elongation of the string is

A) $\Delta l = \frac{\rho g l^2}{2Y}$ B) $\Delta l = \frac{\rho g l^2}{3Y}$ C) $\Delta l = \frac{2\rho g l^2}{Y}$ D) $\Delta l = \frac{3\rho g l^2}{Y}$

Comprehension - 2:

Two forces $F_1\, and\, F_2$ are applied at the ends of a metal rod of Young's Modulus Y, length l as shown.



29. Tension at a distence x from left end of the rod

A) $\left(F_1 + (F_1 - F_2)\frac{x}{l}\right) = T$ B) $\left(F_1 - (F_1 + F_2)\frac{x}{l}\right) = T$

C) $\left(F_1 + (F_1 + F_2)\frac{x}{l}\right) = T$ D) $\left(F_1 - (F_1 - F_2)\frac{x}{l}\right) = T$

30. Longitudinal stress at the given cross-section PQ if the cross-section of the rod is A_0 and tension is T

A) $\frac{T\sin^2\theta}{A_0}$ B) $\frac{T\sin\theta}{A_0}$ C) $\frac{T\sin\theta}{2A_0}$ D) $\frac{2T\sin\theta}{A_0}$

31. Shearing stress at the given cross-section PQ if the cross-section of the rod is A_0 and tension is T

A) $\frac{T\sin 2\theta}{A_0}$ B) $\frac{T\sin\theta\cos\theta}{A_0}$ C) $\frac{T\cos 2\theta}{A_0}$ D) $\frac{T\sin\theta\cos\theta}{2A_0}$

32. Conditions for maximum longitudinal stresses at the given cross-section PQ.

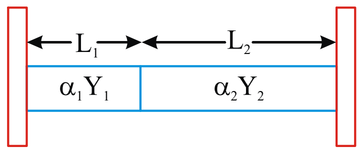
A) $\theta = 45^0$ B) $\theta = 90^0$ C) $\theta = 30^0$ D) $\theta = 60^0$

33. Conditions for maximum shearing stresses at the given cross-section PQ.

A) $\theta = 45^0$ B) $\theta = 90^0$ C) $\theta = 30^0$ D) $\theta = 60^0$

Comprehension - 3:

Two rods of different metals, having the same area of cross-section A, are placed end to end between two massive walls as shown in fig. The first rod has a length L_1, coefficient of linear expansion α_1, and Young's modulus Y_1. The corresponding quantities for second rod are L_2, α_2 and Y_2. The temperature of both the rods is now raised by T degrees.



34. Find the force with which the rods act on each other at the higher temperature in terms of the given quantities

A) $F = \dfrac{A(L_1\alpha_1 + L_2\alpha_2)T}{\left[\dfrac{L_1}{Y_1} + \dfrac{L_2}{Y_2}\right]}$ B) $F = A(Y_1\alpha_1 + Y_2\alpha_2)T$

C) $F = \dfrac{A(Y_1\alpha_1 + Y_2\alpha_2)T}{2}$ D) $F = \dfrac{A\left(\dfrac{L_1}{Y_1} + \dfrac{L_2}{Y_2}\right)T}{L_1\alpha_1 + L_2\alpha_2}$

35. Find the length of the rods at the higher temperature, F is the compressive force from the walls.

A) $L_1^1 = L_1\left(1 + \alpha_1 T - \dfrac{F}{AY_1}\right)$, $L_2^1 = L_2\left[1 + \alpha_2 T - \dfrac{F}{AY_2}\right]$

B) $L_1^1 = L_1\left(1 - \alpha_1 T + \dfrac{F}{AY_1}\right)$, $L_2^1 = L_1\left[1 - \alpha_2 T + \dfrac{F}{AY_2}\right]$

C) $L_1^1 = L_1\left(1 + \alpha_1 T + \dfrac{F}{AY_1}\right)$, $L_2^1 = L_1\left[1 + \alpha_2 T + \dfrac{F}{AY_2}\right]$

D) $L_1^1 = L_1\left(1 - \alpha_1 T - \dfrac{F}{AY_1}\right)$, $L_2^1 = L_1\left[1 - \alpha_1 T - \dfrac{F}{AY_2}\right]$

EXERCISE - I - KEY

SINGLE ANSWER TYPE

1) D 2) A 3) A 4) A 5) C 6) B 7) C 8) A 9) C 10) A
11) A 12) A 13) B

MULTIPLE ANSWER TYPE

14) ABC 15) BC 16) AC 17) ABC 18) BCD
19) AC 20) AC 21)AB 22) AB 23) AB

FILL IN THE BLANKS

24) $\frac{YAx^2}{2L}$ 25) $\frac{Mg}{3Ak}$ 26) $\frac{1}{2}\rho\alpha L$

COMPREHENSION TYPE

27) B 28) A 29) D 30) A 31) B 32) B 33) A 34) A 35) A

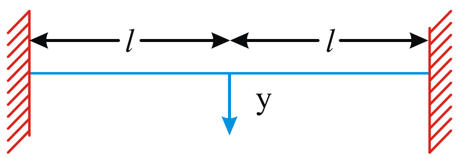
EXERCISE - II

SINGLE ANSWER TYPE QUESTIONS

1. **A rubber ball of bulk modulus B is taken to a depth h of a liquid of density ρ. The fractional change in radius of the ball is**

A) $\frac{\delta r}{r} = \frac{\rho gh}{3B}$ B) $\frac{\delta r}{r} = \frac{\rho gh}{2B}$ C) $\frac{\delta r}{r} = \frac{3\rho gh}{B}$ D) $\frac{\delta r}{r} = \frac{2\rho gh}{B}$

2. **A wire of length 2l, radius r and Young's modulus Y pulled perpendicular to its mid point by a distance y. Find the tension in the wire**



A) $= \frac{\pi r^2 y^2 Y}{l^2}$ B) $= \frac{\pi r^2 y^2 Y}{2l^2}$ C) $= \frac{r^2 y^2 Y}{2l^2}$ D) $= \frac{r^2 y^2 Y}{l^2}$

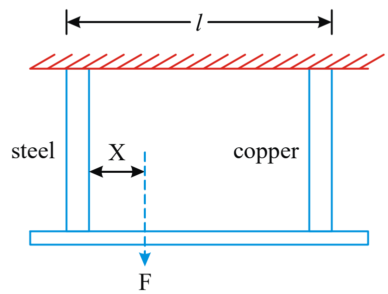
3. **A smooth uniform string of natural length '*l*', cross-sectional area A and Young's modulus Y is pulled along its length by a force F on a horizontal surface. Find the elastic potential energy stored in the string.**

A) $U = \frac{F^2 l}{AY}$ B) $U = \frac{F^2 l}{3AY}$ C) $U = \frac{F^2 l}{6AY}$ D) $U = \frac{F^2 l}{2AY}$

4. **A ring of radius R made of lead wire breaking strength σ and density δ, rotated about a stationary vertical axis passing through its center and perpendicular to the plane of the ring. calculate the number of rotations per second at which the ring ruptures**

A) $n = \frac{1}{2\pi R}\sqrt{\frac{\sigma}{\delta}}$ B) $n = \frac{1}{\pi R}\sqrt{\frac{\sigma}{\delta}}$ C) $n = \frac{1}{2R}\sqrt{\frac{\sigma}{\delta}}$ D) $n = \frac{1}{R}\sqrt{\frac{\sigma}{\delta}}$

5. **Two vertical rods of equal lengths, one of steel and the other of copper, are suspended from the ceiling,at a distance l apart and are connected rigidly to a rigid horizontal bar at their lower ends. If A_s and A_c be their respective crosssectional areas Y_s & Y_c their respective Young's moduli of elasticities, where (x) should a vertical force F be applied to horizontal bar in order that the bar remains horizontal?**



A) $\dfrac{l}{1-(A_s/A_c)(Y_s/Y_c)}$ B) $\dfrac{2l}{1+(A_s/A_c)(Y_s/Y_c)}$

C) $\dfrac{l}{(A_s/A_c)(Y_s/Y_c)}$ D) $\dfrac{l}{1+(A_s/A_c)(Y_s/Y_c)}$

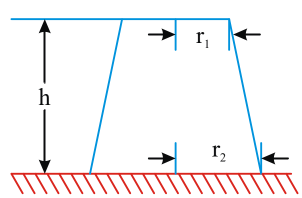
6. **A circular ring of radius R and mass m made of a uniform wire of cross - sectional area A is rotated about a stationary vertical axis passing through its centre and prependicular to the plane of ring. If the breaking stress of the material of the ring is σ_b ,then determine the maximum angularspeed $\omega_{\max}$ at which the ring may be rotated without failure.**

A) $\sqrt{\dfrac{2\pi\sigma A}{mR}}$ B) $\sqrt{\dfrac{2\pi\sigma A}{mR}}$ C) $\dfrac{3\pi\sigma A}{mR}$ D) $\dfrac{\pi\sigma A}{2mR}$

7. **A copper rod of length L and cross-section radius r is suspended from the ceiling by one of its ends.Density of copper is ρ and Young"s modulus isY. The potential energy stored in the rod due to its own weight is:**

A) $\dfrac{\rho^2 g^2 L^3 \times \pi r^2}{3Y}$ B) $\dfrac{\rho^2 g^2 L^3 \times \pi r^2}{6Y}$ C) $\dfrac{\rho^2 g^2 L^3 \times \pi r^2}{2Y}$ D) $\dfrac{\rho^2 g^2 L^3 \times \pi r^2}{5Y}$

8. **A truncated cone of solid rubber of mass M is placed vertical. if its linear dimensions are given and Y= Young's modulus of the cone, find the deformation of the cone.**



A) $\Delta l = \dfrac{FH}{2\pi r_1 r_2 Y}$ B) $\Delta l = \dfrac{FH}{6\pi r_1 r_2 Y}$ C) $\Delta l = \dfrac{FH}{3\pi r_1 r_2 Y}$ D) $\Delta l = \dfrac{FH}{\pi r_1 r_2 Y}$

9. **A uniform ring of mass M of outside raduis r_2 is fitted tightly with a shaft of raduis r_1. If the shaft is rotated with a constant angular accelaration a about it's axis, the moment of the elastic force in the ring about the axes of rotation is**

A) $\dfrac{M\left(r_2^4 - r_1^4\right)\alpha}{2\left(r_2^2 - r_1^2\right)}$ B) $\dfrac{M\left(r_2^4 + r_1^4\right)\alpha}{2\left(r_2^2 + r_1^2\right)}$ C) $\dfrac{M\left(r_2^4 - r_1^4\right)\alpha}{2\left(r_2^2 + r_1^2\right)}$ D) $\dfrac{M\left(r_2^4 + r_1^4\right)\alpha}{2\left(r_2^2 - r_1^2\right)}$

10. Estimate the pressure deep inside the sea at a depth h below the surface. Assume that the density of water is ρ_0 at sea level and its bulk modulus is B. P_0 is the atmosphere pressure at sea level P is the pressure at depth 'h'

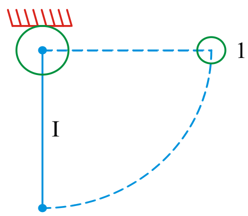
A) $P = P_0 - B\ln\left(1 - \frac{\rho_0 gh}{B}\right)$ B) $P = P_0 + B\ln\left(1 - \frac{\rho_0 gh}{B}\right)$

C) $P = P_0 - B\ln\left(1 + \frac{\rho_0 gh}{B}\right)$ D) $P = P_0 + B\ln\left(1 + \frac{\rho_0 gh}{B}\right)$

COMPREHENSION TYPE QUESTIONS

Comprehension - 1:

A sphere of mass m attached with the free end of a steel wire of a length l swings in the vertical plane from the horizontal position.



11. Elongation of the wire in the vertical position is

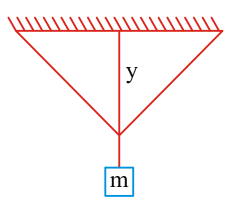
A) $\frac{mgl}{Y(\pi r^2)}$ B) $\frac{2mgl}{Y(\pi r^2)}$ C) $\frac{mgl}{3Y(\pi r^2)}$ D) $\frac{3mgl}{Y(\pi r^2)}$

12. Elastic energy stored in the wire in the vertical position is

A) $\frac{9m^2g^2l}{2Y\pi r^2}$ B) $\frac{7m^2g^2l}{2Y\pi r^2}$ C) $\frac{9m^2g^2l}{Y\pi r^2}$ D) $\frac{9m^2g^2l}{4Y\pi r^2}$

Comprehension - 2:

A body hangs from the mid-point of a light wire of length $2l$ and cross-sectional area A such that the wire sags through a vertical distance y(y $<< l$). If the youngs's modulus of the wire is Y.



13. The elongation (Δl) of the wire is

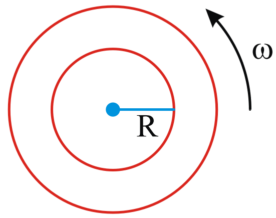
A) $\frac{y^2}{l}$ B) $\frac{y^2}{3l}$ C) $\frac{y^2}{4l}$ D) $\frac{2y^2}{l}$

14. What is the elastic energy stored?

A) $\frac{YA\Delta l^2}{2l}$ B) $\frac{YA\Delta l^2}{6l}$ C) $\frac{YA\Delta l^2}{4l}$ D) $\frac{YA\Delta l^2}{3l}$

Comprehension-3:

A thin wire of cross section a is made to form a flexible circular loop of radius R. If the loop spins with angular speed ω, the (Assume ρ = density and y = Young's modulus of wire



15. Tension developed in the wire is

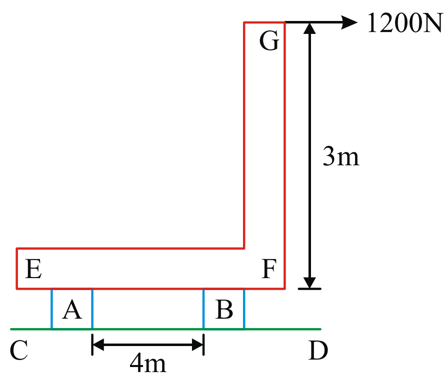
A) $\frac{mR\omega^2}{2\pi}$ B) $\frac{2mR\omega^2}{\pi}$ C) $\frac{mR\omega^2}{4\pi}$ D) $\frac{1}{2}mR\omega^2$

16. Stress in the wire is

A) $\rho R^2\omega^2$ B) $\rho R\omega$ C) $\frac{R^2\omega^2}{\rho}$ D) $\frac{R^2\omega^2}{2\rho}$

Comprehension-4:

In the figure shown, Aand B are two short steel rods each of cross-sectional area $5cm^2$. The lower ends of A and B are welded to a fixed plate CD. The upper end of A is welded to the L- shaped piece EFG, which can slide without friction on upper end of B. A horizontal pull of 1200N is exerted at G as shown. Neglect the weight of EFG wire



17. Mark out the correct statements(s).

A) Shearing stress in A is zero. B) Shearing stress in B is zero

C) Shearing stress in both Aand B is zero.

D) Shearing stress in bothA and B is non-zero.

18. Longitudinal stress in A is

A) Tensile in nature and having magnitude $180N/cm^2$

B) Tensile in nature and having magnitude $240N/cm^2$

C) Compressive in nature and having magnitude $180 N/cm^2$

D) Compressive in nature and having magnitude $240 N/cm^2$

19. Longitudinal stress in B is

A) Tensile in nature and having magnitude $180 N/cm^2$

B) Tensile in nature and having magnitude $240 N/cm^2$

C) Compressive in nature and having magnitude $180 N/cm^2$

D) Compressive in nature and having magnitude $240 N/cm^2$

INTEGER TYPE QUESTIONS

20. A ring of radius r made of wire of density ρ is rotated about a stationary vertical axis passing through its centre and perpendicular to the plane of the ring. Determine the angular velocity (in rad/s) of ring at which the ring breaks. The wire breaks at tensile stress σ. Ignore gravity. Take $\sigma/\rho = 4$ and $r = 1m$.

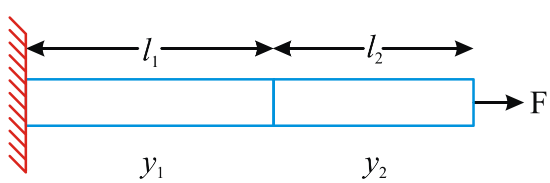
21. A 0.1 kg mass is suspended from a wire of negligible mass. The length of the wire is 1m and its cross-sectional area is $4.9\times10^{-7} m^2$. If the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency 140 rad s^{-1}. If the Young's modulus of the material of the wire is $n\times10^9 Nm^{-2}$, the value of n is :

22. Find the

(i) Net elongation of composite rod approximately. $\left(x\times10^{-11} m\right)$ **then** $x =$

(ii) Y_{eq} **of the composite rod (**$x\times10^{11} N/m^2$**) (assume A = area of cross section of each rod), then** $x =$

$l_1 = l_2 = 1m,\ F = 2N/m^2,\ A = 1sq.m^2 \qquad y_1 = 2\times10^{11} N/m^2, y_2 = 3\times10^{11} N/m^2$



EXERCISE - II - KEY

SINGLE ANSWER TYPE

1) A 2) B 3) C 4) A 5) D 6) A 7) B 8) D 9) A 10) A

COMPREHENSIVE TYPE

11) D 12) A 13) A 14) C 15) A 16) A 17) B 18) A 19) C

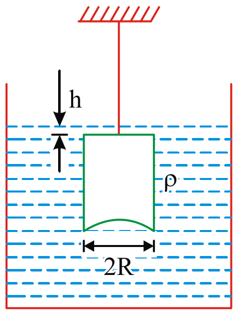
INTEGER TYPE

20) 2 21) 4 22) (i) 2 (ii) 2

EXERCISE - III

SINGLE ANSWER TYPE QUESTIONS

1. A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and mass M. It is suspended by a string in a liquid of density ρ, where it stays vertical. The upper surface of cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder by the liquid is



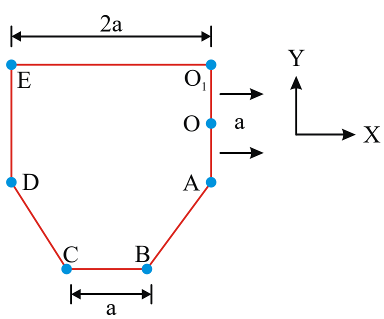
a) $\rho g\left(V+\pi R^2 h\right)$

b) Mg

c) $Mg-V\rho g$

d) $Mg+\pi R^2 h\rho g$

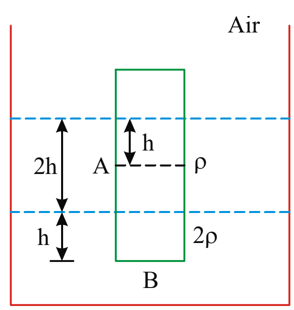
2. The top view of closed compartment containing liquid is moving with an acceleration along x - axis as shown. Find the incorrect statement.



a) The pressure at A and O is same b) The pressure at O and O_1 is same

c) The pressure at B and C is same d) The pressure at D and E is same

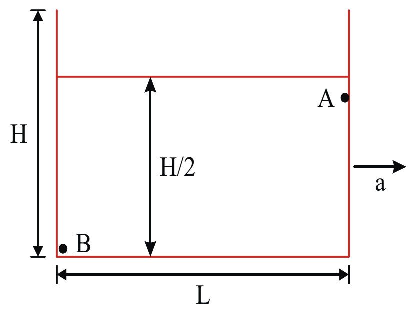
3. A cylinder stands vertical in two immiscible liquids of densities ρ and 2ρ as shown. Find the difference in pressure at point A and B:



a) $2\rho gh$ b) $3\rho gh$ c) $4\rho gh$ d) None

4. A vessel of height H and length L contains a liquid of density ρ upto height H/2. The vessel starts accelerating horizontally with acceleration 'a' towards right. If A is the point at the surface of the liquid at right end while the vessel is accelerating and B is the point at bottom of the vessel on the other end, the

difference of pressures at B and A will be



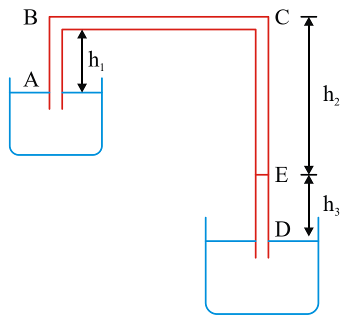
a) $\frac{\rho}{2}(gH + aL)$

b) $\frac{\rho}{2}(gH - aL)$

c) $2\rho(gH - aL)$

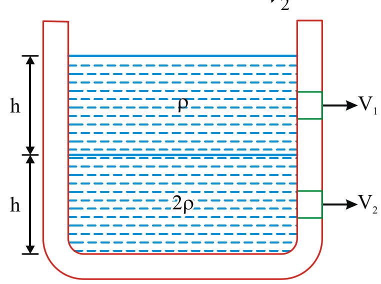
d) $\frac{3\rho}{2}(gH + aL)$

5. In the syphon as shown, which of the option is not correct, if $h_2 > h_1$ and $h_3 < h_1$?



a) $p_E < p_D$ b) $p_E > p_C$ c) $p_B > p_C$ d) $p_B < p_E$

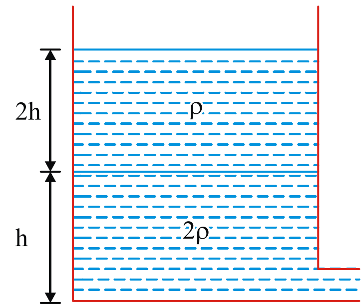
6. Equal volumes of two immiscible liquids of densities ρ and 2ρ are filled in a vessel as shown in figure. Two small holes are punched at depth $\frac{h}{2}$ and $\frac{3h}{2}$ from the surface of lighter liquid. If v_1 and v_2 are the velocities of efflux at these two holes, then $\frac{v_1}{v_2}$ is



a) $\frac{1}{2\sqrt{2}}$ b) $\frac{1}{2}$

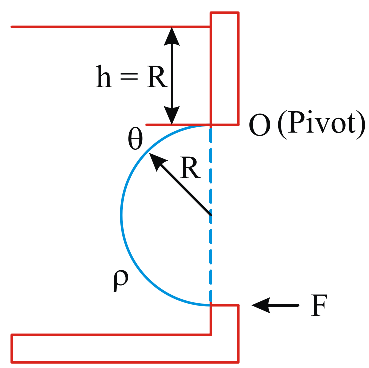
c) $\frac{1}{4}$ d) $\frac{1}{\sqrt{2}}$

7. The velocity of the liquid coming out of a small hole of a vessel containing two different liquids of densities 2ρ and ρ as shown in fig is



a) $\sqrt{gh}$ b) $2\sqrt{gh}$ c) $2\sqrt{2gh}$ d) $\sqrt{6gh}$

8. **The fig shows a semi-cylindrical massless gate of unit length perpendicular to the plane of the page and is pivoted at the point O holding a stationary liquid of density ρ. A horizontal force F is applied at its lowest position to keep it stationary. The magnitude of the force is :**



a) $\frac{3}{2}\rho g R^2$ b) $\frac{9}{2}\rho g R^2$ c) $\rho g R^2$ d) $2\rho g R^2$

9. **A wooden block is floating in a water tank. The block is pressed to its bottom. During this process work done is equal to**

a) Work done against upthrust exerted by the water
b) Work done against upthrust plus loss of gravitational potential energy of the block
c) Work done against upthrust minus loss of gravitational potential energy of the block
d) all the above

10. **A sphere of solid material of specific gravity 8 has a concentric spherical cavity and just sinks in water. The ratio of radius of cavity to that of outer radius of the sphere must be**

a) $\frac{7^{1/3}}{2}$ b) $\frac{5^{1/3}}{2}$ c) $\frac{9^{1/3}}{2}$ d) $\frac{3^{1/3}}{2}$

11. **A cylindrical tank of height H is open at the top end and it has a radius R. water is filled in it up to a height of h. The time taken to empty the tank through a hole of radius r at its bottom is**

a) $\sqrt{\frac{2h}{g}\frac{R^2}{r^2}}$ b) $\sqrt{\frac{2H}{g}\frac{R^2}{r^2}}$. c) $\sqrt{h}H$ d) $\sqrt{\frac{2H}{g}\frac{R}{r}}$

12. Two unequal blocks of densities σ_1 and σ_2 placed over each other are immersed in fluid of density σ. The block of density σ_1 is fully submerged and the block of density σ_2 is partly submerged so that ratio of their masses is 1/2 and $\sigma/\sigma_1 = 2$ and $\sigma/\sigma_2 = 0.5$. Find the degree of submergence of the upper block of density σ_2.

a) 50% submerged b) 25% submerged c) 75% submerged d) Fully submerged

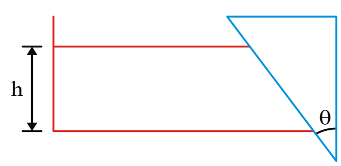
13. A thin uniform cylindrical shell, closed at both ends, is partially filled with water. It is floating vertically in water in half-submerged state. If ρ_c is the relative density of the material of the shell with respect to water, then the correct statement is that the shell is

1. more than half-filled if ρ_c is less than 0.5
2. more than half-filled if ρ_c is more than 1.0
3. half-filled if ρ_c is more than 0.5
4. less than half-filled if ρ_c is less than 0.5

14. Two balls of same size but different masses m_1 and $m_2\left(m_2 > m_1\right)$ are attached to the two ends of a thin light thread and dropped from a certain height. It is known that the viscous drag of air depends on the size and velocities of the balls. Other than the gravitational pull from the earth and the viscous drag, the buoyant force from air also act on the balls. The buoyant force on a ball equals to the weight of air displaced by the ball. After sufficiently long time from the instant the balls were dropped both of them acquire uniform velocity known as terminal velocity. When the balls have acquired terminal velocity, the tension in the thread is

1. Zero 2. $\left(m_2 - m_1\right)g$ 3. $0.5\left(m_2 + m_1\right)g$ 4. $0.5\left(m_2 - m_1\right)g$

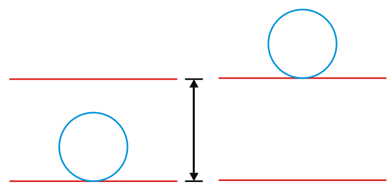
15. A slit is cut at the bottom, along the right bottom edge of a rectangular tank. The slit is closed by a wooden wedge of mass m and apex angle θ as shown in figure. The vertical plane surface of the wedge is in contact with the right vertical wall of the container. Coefficient of static friction between these two surfaces is μ. To what maximum height, can water be filled in the tank without leakage from the slit? The width of tank is b and density of water is ρ.



1. $\sqrt{\frac{2m}{\rho b\left(\tan\theta - \mu\right)}}$ 2. $\sqrt{\frac{4m}{\rho b\left(\tan\theta - \mu\right)}}$

3. $\sqrt{\dfrac{2m}{\rho b(\sin\theta-\mu\cos\theta)}}$ 4. $\sqrt{\dfrac{2m\cos\theta}{\rho b(\tan\theta-\mu\cos\theta)}}$

16. In figure-I is shown a sphere of mass m and radius r resting at the bottom of a large container filled with water. Depth of the container is h. Density of material of the sphere is the same as that of water. Now the whole sphere is slowly pulled out of water as shown in figure-II

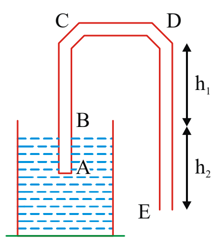


Work done by the agent in pulling the sphere is equal to

1. mgr 2. 0.5mgr 3. mg(0.5r+h) 4. mg(r+h)

MORE THAN ONE CORRECT

17. In the siphon system shown v refers to velocity and P refers to pressure. Then:



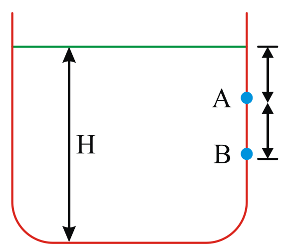
a) $v_E > v_A$

b) $P_D = P_0 - \rho g(h_1+h_2)$

c) $v_A = v_B = v_E$

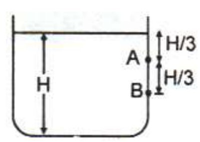
d) $v_E = 5v_A + v_B$

18. Three different liquids are filled in a U-tube as shown in Fig. Their densities are ρ_1, ρ_2 and ρ_3 respectively. From the Fig. we may conclude that:



a) $\rho_2 > \rho_1$ b) $\rho_1 > \rho_2$ c) $\rho_3 = 2(\rho_2 - 2\rho_1)$ d) $\rho_3 = \dfrac{\rho_2+\rho_1}{2}$

19. The area of two holes A and B are 2a and a respectively. The holes are at heights (H/3) and (2H/3) from surface of water



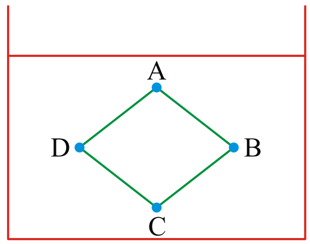
a) The velocity of efflux at hole B is 2 times the velocity of efflux at hole A

b) The velocity of efflux at hole B is $\sqrt{2}$ times the velocity of efflux at hole A

c) The discharge is same through both the holes

d) The discharge through hole A is $\sqrt{2}$ times the discharge through hole B.

20. The figure shows a container filled with a liquid of density ρ. Four points A, B, C and D lie on the vertices of a vertical square. Points A and C lie on a vertical line and points B and D lies on a horizontal line. Choose the correct statement(s) about the pressure at the four points.



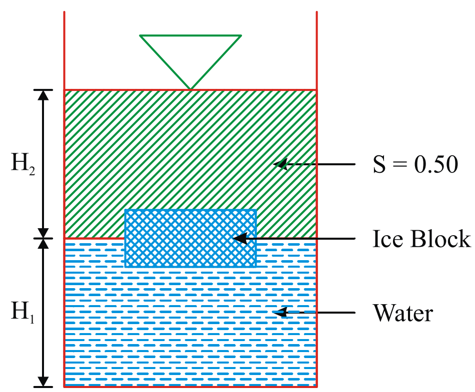
a) $P_D = P_B$

b) $P_A < P_B = P_D < P_C$

c) $P_D = P_B = \dfrac{P_C - P_A}{2}$

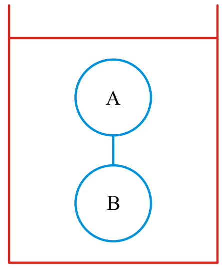
d) $P_D = P_B = \dfrac{P_C + P_A}{2}$

21. A block of ice (specific gravity S_{i} = 0.90) is floating in a container having two immiscible liquids (one of specific gravity S_1 = 0.50 and other is water) as shown in the figure. (H_1, H_2 are heights of water, other liquid columns respectively.) Now the ice block melts completely, then



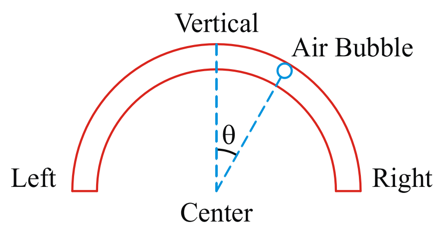
1. H_2 will decrease
2. H_1 will increase
3. H_1+H_2 will remains unchanged
4. H_1+H_2 decreases

22. Two solid spheres A and B of equal volumes but of different densities d_A and d_B are connected by a string. They are fully immersed in a fluid of density d_F. They get arranged into an equilibrium state as shown with tension in the string. The arrangement is possible only if



1. $d_A < d_F$ 2. $d_B > d_F$ 3. $d_A > d_F$ 4. $d_A + d_B = 2d_F$

23. A glass tube filled with colored water, sealed at both the ends is bent into an arc. There is a small air bubble inside. The tube is held with its plane vertical. When the tube moves with constant acceleration either to left or right the bubble shifts and settles at some plane either to the left or right of the highest point. For the situation shown , what can you conclude about acceleration vector of the tube?

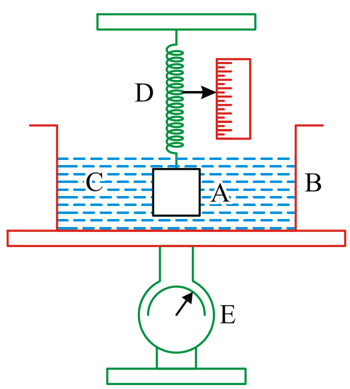


1. It points towards the right 2. it points towards the left.
3. Its magnitude is $g\tan\theta$ 4. Its magnitude is $g\cot\theta$

COMPREHENSION TYPE QUESTIONS

Comprehension : I

Block A in the fig hangs from a spring balance D and is submerged in a liquid C contained in beaker B. The weight of beaker is 1kg, and the weight of the liquid is 1.5kg. The balance D reads 2.5kg and balance E reads 7.5kg. The volume of the block is 0.003 m^3.



24. What is the density of the liquid?

a) $1666.7 kg/m^3$ b) $1500 kg/m^3$ c) $2500 kg/m^3$ d) $1750 kg/m^3$

25. When A is taken out, what will be the reading of D?

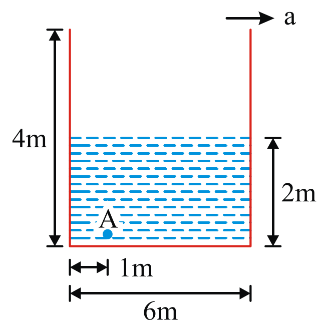
a) 7.5Kg b) 2kg c) 3.5kg d) 2.1kg

26. When A is taken out, what will be the reading of E?

a) 2.5 kg b) 2kg c) 1.5 kg d) 3 kg

Comprehension : II

An open rectangular tank of dimensions 6m x 5m x 4m contains water upto a height of 2m. The vessel is accelerated horizontally with an acceleration of $a\ \ m/s^2$ as shown. Take $\rho_{\text{water}} = 10^3 kg/m^3$, $g = 10m/s^2$, atmospheric pressure = $10^5 N/m^2$. Base on above information answer the following questions:



27. Determine the maximum value of a so that no water comes out from tank.

a) g b) $\frac{2g}{3}$ c) $\frac{g}{3}$ d) $2g$

28. Determine the height to which the water should be filled in the tank so that when $a = 5m/s^2$, no water comes out from the tank

a) 2m b) 3m c) 2.5m d) 3.5m

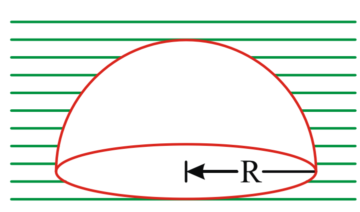
29. Instead of open top if the vessel is closed, then absolute pressure at point A would be

[Take $a = \frac{20}{3} m/s^2$ and initially height of water in tank is 2m]

a) $1.33 \times 10^5 N/m^2$ b) $1.0 \times 10^5 N/m^2$ c) $3.33 \times 10^{45} N/m^2$ d) None

Comprehension : III

. A solid hemisphere of radius R is made to just sink in a liquid of density ρ. Find the



30. vertical thrust on the curved surface

a) $\frac{\pi R^3 \rho g}{3}$ b) $\frac{\pi R^3 \rho g}{2}$ c) 0 d) $\pi R^3 \rho g$

31. Vertical thrust on the flat surface

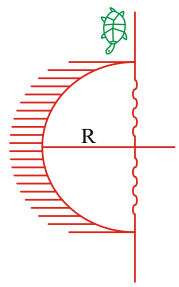
a) $\frac{\pi R^3 \rho g}{3}$ b) $\frac{\pi R^3 \rho g}{2}$ c) 0 d) $\pi R^3 \rho g$

32. Side thrust on the hemisphere

a) $\frac{\pi R^3 \rho g}{3}$ b) $\frac{\pi R^3 \rho g}{2}$ c) 0 d) $\pi R^3 \rho g$

Comprehension : IV

A tortoise is just sinking in water of density ρ. The tortoise is assumed to be a hemisphere of radius R.



33. Find Vertical thrust

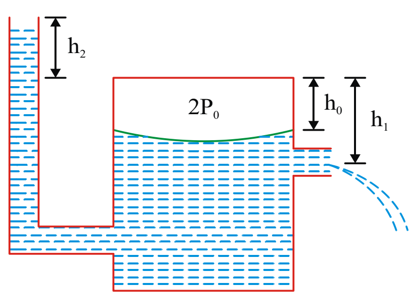
a) $\rho g \pi R^3$ b) $\frac{1}{3}\rho g \pi R^3$ c) $\frac{2}{3}\rho g \pi R^3$ d) 0

34. Fint the total hydrostatic force

a) $\rho g \pi R^3$ b) $\sqrt{\frac{13}{3}}\rho g \pi R^3$ c) $\frac{2}{3}\rho g \pi R^3$ d) $\sqrt{\frac{16}{3}}\rho g \pi R^3$

Comprehension-V:-

Figure shows a large closed cylindrical tank containing water. Initially, the air trapped above the water surface has a height h_0 and pressure $2p_0$ where p_0 is the atmospheric pressure. There is a hole in the wall of the tank at a depth h_1 below the top from which water comes out. A long vertical tube is connected as shown.



35. Find the height h_2 of the water in the long tube above the top initially

a) $\frac{3p_0}{\rho g}-\frac{h_0}{3}$ b) $\frac{2p_0}{\rho g}-\frac{h_0}{2}$ c) $\frac{p_0}{\rho g}-h_0$ d) $\frac{p_0}{2\rho g}-2h_0$

36. Find the speed with which water comes out of the hole.

a) $\frac{1}{\rho}\left[p_0-\rho g\left(h_1-2h_0\right)\right]^{1/2}$ b) $\left[\frac{2}{\rho}\left[p_0+\rho g\left(h_1-h_0\right)\right]\right]^{1/2}$

c) $\left[\frac{3}{\rho}\left[p_0+\rho g\left(h_1+h_0\right)\right]\right]^{1/2}$ d) $\left[\frac{4}{\rho}\left[p_0-\rho g\left(h_1-h_0\right)\right]\right]^{1/2}$

37. **Find the height of the water in the long tube abvoe the top when the water stops coming out of the hole.**

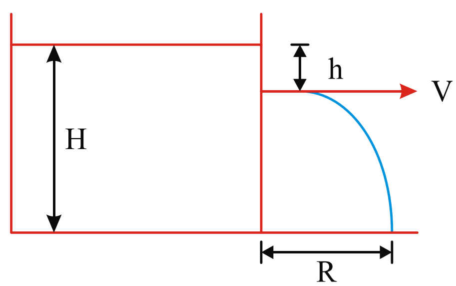
a) $-2h_0$ b) h_0 c) h_2 d) $-h_1$

MATRIX MATCHING TYPE QUESTIONS

38. **A piece of ice is floating in water in a vessel. Match the options of two columns:**

Column -I		Column -II	
(A)	When all ice melts, level of water will	(P)	increase
(B)	When half of the ice melts, level of water will	(Q)	Decrease
(C)	When vesser is filled with liquid denser than water and all ice melts, level of water will	(R)	Remain un changed
(D)	When vessel is filled with liquid lighter than water and all ice melts, level of water will	(S)	unperdicatble

39. **In the figure shown, V, t, R and h are velocity of incoming fluid from hole, time taken by fluid to reach ground, range and height of liquid column above the hole respectivley. Match the options of the two columns.**



Column -1

a) R will remain same b) t will increase

c) V will increase d) R will be maximum

Column - II

p) For a decrease in g

q) For any variation of g,"positive or negative"

r) If h increases and g decreases

s) None of the above

40. **Column-I**

a) Magnus effect b) Loss of energy

c) Pressure is same at the same level in a liquid

d) Hydraulic machines

Column-II

p) Pascal's law q) Archimedes' principle
r) Viscous force s) Lifting of asbestos roofs

STATEMENT TYPE QUESTIONS

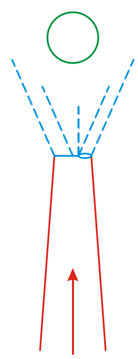
a) Statement 1 is true, statement-2 true and statement-2 is a correct explanation for statement-1

b) Statement 1 is true, statement 2 is true, statement-2 is not a correct explanation for statement 1

c) Statement 1 is true; statement 2 is false

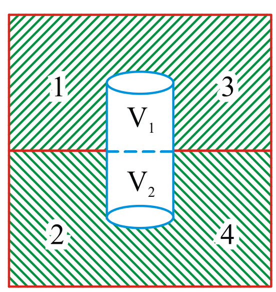
d) Statement 1 is false; statement 2 is true.

41. **Statement-1:** A light celluloid ball placed in a stream of gas or water issuing at a high velocity from a tube with a narrow neck, the ball floats freely however in this stream (Fig)



Statement -2: The gas in the stream has a high velocity, the pressure inside the stream is above atmospheric.

42. **Statement -1:** When a body floats such that its parts are immersed into two immiscible liquids then the force exerted by liquid 1 is of magnitude $\rho_1 v_1 g$.



Statement -2: Total buoyant force = $\rho_1 v_1 g + \rho_2 v_2 g$

43. **Statement-1:** When a soda water bottle falls freely from a height h, the gas bubble rises in water from the bottom.

Statement -2: Air is lighter than liquid

44. **Statement - 1:** A soft plastic bag weights the same when empty or when filled with air and measured in vacuum.

Statement -2 : The same results will be observed when measured in air.

45. **Statement -1:** The speed of liquid coming out of the orifice is independent of the

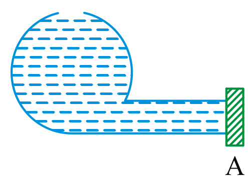
nature and quality of liquid in the container.

Statement -2: The speed of liquid coming out of orifice will depend upon the quality of liquid in the container.

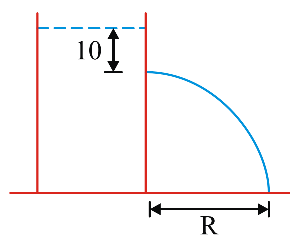
INTEGER TYPE QUESTIONS

46. **A sphere falls from rest into water from a height of 2m. The relative density of the sphere is 0.80. Find the depth to which ball will sink (in m)**

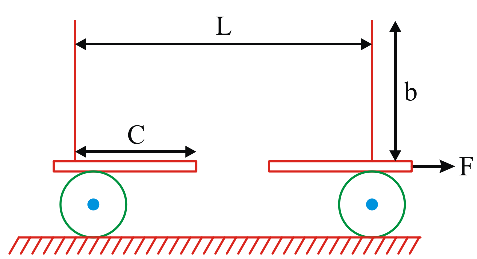
47. **In a vessel as shown, the opening has a cross - sectional area A. F_1 is the net force applied on the plate by liquid and air, which is kept to close the opening. The plate is now displaced a short distance away from the opening in which case liquid strikes the plate inelastically with a force F_2. Find F_2 / F_1**



48. **The range of water flowing out of a small hole made at a depth 10m below water surface in a large tank is R. Find the extra force applied on water surface so that range becomes 2R (in atm, an approximate value)**

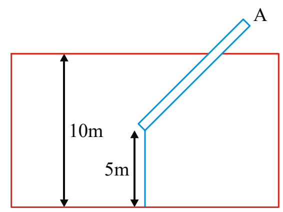


49. **A vessel with a symmetrical hole in its bottom is fastened on a cart. The mass of the vessel and the cart is 1.5kg. With what force F(in $\times 10^2$ N) should the cart be pulled so that the maximum amount of water remains in the vessel. The dimensions of the vessel are as shown in figure. Given that b=50cm, c=10cm, area of base A=40 cm^2, L=20cm, g =10 m/s^2.**

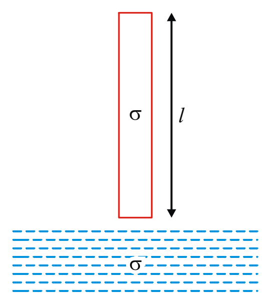


50. **A liquid of density $\rho = \rho_0 [1 + \alpha y]$ is stored in a container where y is the distance from the the liquid surface and $\alpha = \frac{2}{3} m^{-1}$. A small hole is made at the bottom of the container. Find nearest integer of velocity of efflux (in m/s) when the liquid height is 1m. Assume flow is laminar. $\left(g = 10\, m/s^2\right)$**

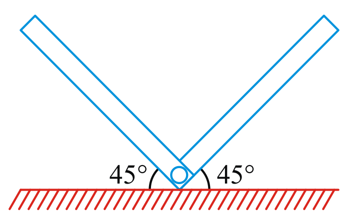
51. **A rod is of length 6 m and of specific gravity $\rho = 25/36$. One end of the rod is tied to a 5 m long light rope which in turn is tied to the floor of a pool 10 m deep as shown. Find the length of the part of rod in metres which is out of water.**



52. **A uniform vertical cylinder is released from rest with its lower end just touching the liquid surface of a deep lake. Calculate the maximum displacement of the cylinder in meters. Take** $\ell = 4m \ and \ \frac{\sigma}{\rho} = \frac{1}{2}$



53. **A thin V-shaped glass tube is fixed in the vertical plane as shown. Initially, the left part of the tube contains a column of water of length d = $\sqrt{2}$ m. A valve at the bottom of the tube prevents the water from moving to right part. At some time, the valve is quickly opened. Neglecting friction, find the time (in seconds) it takes for the water to move completely into the right part of the tube. (Take g=π^2 m/s^2)**

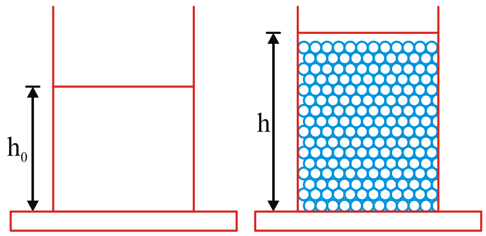


Fixed horizontal surface

54. **A cylindrical vessel of height 500 mm has an orifice at its bottom. The orifice is initially closed and water is filled in it upto a height H. Now the top is sealed with a cap and the orifice at the bottom is opened. Some water comes out from the orifice and the water level in the vessel becomes steady with height of water column being 200 mm. Find the fall in height (in mm) of water level due to opening of the orifice. (Take atmospheric pressure $= 1.0 \times 10^5 N/m^2$. denisty of water $1000 kg/m^3$ and $g = 10 m/s^2$. Neglect any effect of surface tension.)**

55. **In a cylindrical container water is filled up to a height of $h_0 = 1.0 m$. Now a large**

number of small iron balls are gently dropped one by one into the container till the upper layer of the balls touches the water surface. If average density of the contents is $\rho = 4070 kg/m^3$, density of iron is $\rho_i = 7140 kg/m^3$ and density of water is $\rho_0 = 1000 kg/m^3$, find the height h of the water level (in S.I units) in the container with the iron balls.



EXERCISE - III - KEY

SINGLE ANSWER TYPE

1\. a 2. C 3. b 4. a 5. d 6. d 7. b 8. d 9. c 10. A
11\. A 12.D 13.A 14. 4 15. A 16. A

MORE THAN ONE CORRECT

17\. b,c 18. c 19. b,d
20\. A,B,D 21. 1,2,4 22. 1,2,4 23. 1,3

COMPREHENSION TYPE

24\. a 25. a 26. a 27. b 28. c 29. a 30. a
31.d 32. c 33. c 34. b 35. C 36. B 37. D

MATRIX MATCHING TYPE

38\. a$\rightarrow$r: b$\rightarrow$r; c$\rightarrow$p: d$\rightarrow$q
39\. a$\rightarrow$p,q: b$\rightarrow$p,r; c$\rightarrow$s: d$\rightarrow$s
40\. (a-s), (b-r), (c-p), (d-p)

ASSERTION AND REASON TYPE

41\. c 42. d 43. d 44. d 45. c

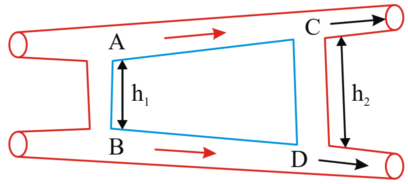
INTEGER TYPE

46\. 8 47. 2 48. 3 49. 1 50. 4 51.1 52. 4 53.1 54.6 55.2

EXERCISE - IV

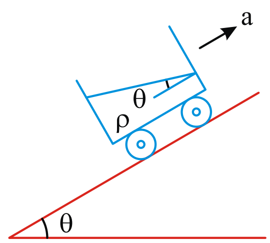
SINGLE ANSWER TYPE QUESTIONS

1\. **An ideal liquid is flowing in two pipes, AC is inclined and BD is horizontal. Both the pipes are connected by two vertical tubes of length h_1 and h_2 as shown in the Fig. The flow is streamlined in both the pipes. If velocity of liquid at A, B and C are 2m/s, 4m/s and 4m/s respectively, the velocity at D will be**



a) $4m/s$ b) $\sqrt{14}m/s$ c) $\sqrt{28}m/s$ d) None

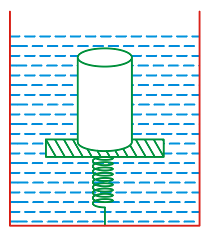
2. **A fluid container is containing a liquid of density ρ is accelerating upward with acceleration a along the inclined plane of inclination α as shown in the figure. Then the angle of inclination θ of free surface is**



a) $\tan^{-1}\left[\frac{a}{g\cos\alpha}\right]$ b) $\tan^{-1}\left[\frac{a+g\sin\alpha}{g\cos\alpha}\right]$

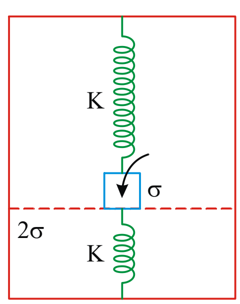
c) $\tan^{-1}\left[\frac{a-g\sin\alpha}{g(1+\cos\alpha)}\right]$ d) $\tan^{-1}\left[\frac{a-g\sin\alpha}{g(1-\cos\alpha)}\right]$

3. **A cylindrical block of area of cross - section A and of material of density ρ is placed in a liquid of density one third of density of block. The block compresses a spring and compression in the spring is one - third of the length of the block. If acceleration due to gravity is g, the spring constant of the spring is**



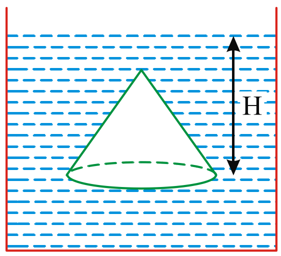
1) ρAg 2) $2\rho Ag$ 3) $2\rho Ag/3$ 4) $\rho Ag/3$

4. **A cubic block of side a is connected with two similar vertical springs as shown. Initially bottom surface of block of density σ touches the surface of the fluid of density 2σ while floating. A weight of negligble volume is placed on the block so that it is immersed half in the fluid. Find the weight.**



a) $a\left(\frac{K}{2}+a^2\sigma g\right)$ b) $a\left(K+a^2\sigma g\right)$ c) $a\left(K+\frac{a^2}{2}\sigma g\right)$ d) $\frac{a}{2}\left(K+a^2\sigma g\right)$

5. **A cone of radius r and height r is under a liquid of density d. Its base is parallel to the free surface of the liquid at a depth H from it as shown . What is the net force due to liquid on its curved surface? (neglect atmospheric pressure)**

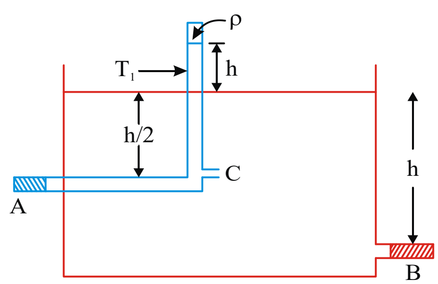


1. $\pi r^2 dg\left(H-\frac{r}{3}\right)$
2. $2\pi r^2 dg\left(H-\frac{2r}{3}\right)$
3. $\pi r^2 dg\left(2H-\frac{r}{3}\right)$
4. $\pi r^2 dg\left(2H-\frac{2r}{3}\right)$

6. **A wooden stick of length L, radius R and density ρ has a small metal piece of mass m (of negligible volume) attached to its one end. Find the minimum value for the mass m that would make the stick float vertically in stable equilibrium in a liquid of density σ.**

1. $2\pi R^2 L\rho\left(\sqrt{\frac{\sigma}{\rho}}-1\right)$ 2. $\pi R^2 L\rho\left(\sqrt{\frac{2\sigma}{\rho}}-1\right)$ 3. $\pi R^2 L\rho\left(\sqrt{\frac{\sigma}{\rho}}-1\right)$ 4. $\pi R^2 L\rho\left(\sqrt{\frac{\sigma}{2\rho}}-1\right)$

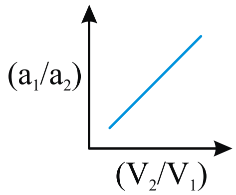
7. **The cross - sectional areas of a tube T_1 and the hole in the vessel at B are a and $a/2$ respectively. There is a hole in the tube at C (at the level of A) through which liquid in the vessel rises by a height h in the tube. The other liquid heights are shown in the diagram. The plugs at A and B are removed simultaneously. How much horizontal force is required to keep vessel in equilibrium, if p is the pressure in the tube and p_0 is the atmospheric pressure? Hole C is closed when plugs are removed.**



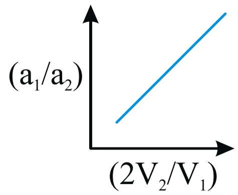
a) $a\left(p_0-p\right)$ b) $\frac{a}{2}\left(p_0-p\right)$ c) $2a\left(p_0-p\right)$ d) $4a\left(p_0-p\right)$

8. **A large open tank has two holes in the wall. The top hole is a square hole of side L at a depth y from the surface of water. The bottom hole is a circular hole of radius R at a depth 4y from surface of water. If $R=L/2\sqrt{\pi}$, find the correct graph . V_1 and V_2 are the velocities in top and bottom holes. Areas of the square & circular holes are a_1 and a_2**

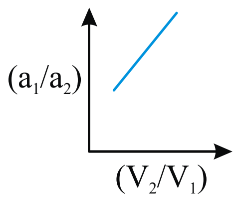
(a)



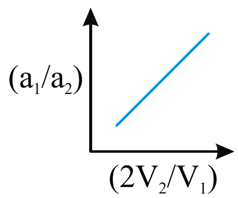
(b)



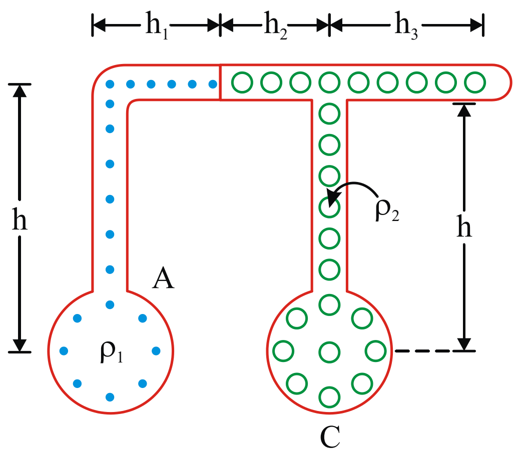
(c)



(d)



9. The difference in pressures in bulbs A and C having fluids of densities ρ_1 and ρ_2 when tube B is horizontal will be



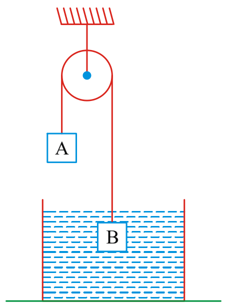
a) $(\rho_2 - \rho_1)gh$

b) $\rho_2 g(h_2 + h_3) - \rho_1 g h_1$

c) $\rho_2 g(h + h_2) - \rho_1 g(h + h_1)$

d) $(\rho_1 - \rho_2)gh$

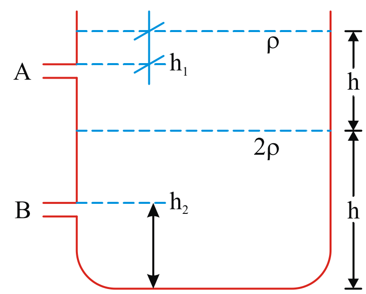
10. In the arrangement shown, $m_B = 3m$, density of liquid is ρ and density of block B is 2ρ. The system is released from rest so that block B moves up when in liquid and moves down when out of liquid with the same acceleration. Find the mass of block A.

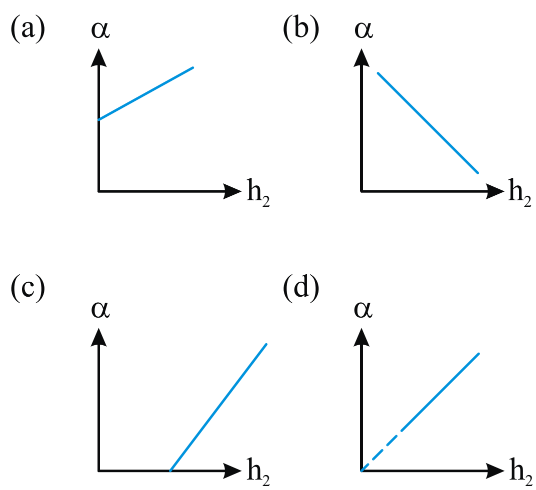


a) $\frac{7}{4}m$ b) $2m$

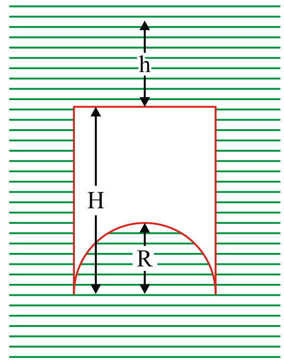
c) $\frac{9}{2}m$ d) $\frac{9}{4}m$

11. **In the arrangement shown two liquids of density ρ and 2ρ are filled in a container. The height of both liquids is h. There are two holes A and B at heights h_1 and h_2 from top liquid surface and bottom of the vessel. If V_1 and V_2 are the velocities of efflux at the two holes A and B respectively, find the correct graph. Take $\alpha = (V_2 / V_1)^2$.**





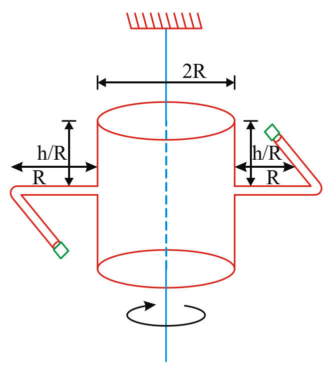
12. **A cylinder of radius R, height H and density σ has a hemispherical cut at its bottom. The top of the cylinder is kept at depth h from the liquid surface. If the density of liquid is ρ, find the hydrostatic force acting on the hemispherical surface of the cylinder.**



a) $F_2 = \pi R^2 \rho g\left(H + h - \frac{2}{3}R\right)$ b) $F_2 = \pi R^2 \rho g\left(H - h + \frac{2}{3}R\right)$

c) $F_2 = \pi R^2 \rho g\left(H - h - \frac{2}{3}R\right)$ d) $F_2 = \pi R^2 \rho g\left(H + h + \frac{2}{3}R\right)$

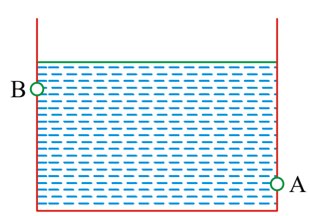
13. A cylindrical container of radius 'R' and height 'h' is completely filled with a liquid. Two horizontal L-shaped pipes of small cross-sectional area 'a' are connected to the cylinder as shown . Now the two pipes are opened and fluid starts coming out of the pipes horizontally in opposite directions. Then the torque due to ejected liquid on the sytem is



a) $4agh\rho R$ b) $8agh\rho R$ c) $2agh\rho R$ d) $6agh\rho R$

MULTI ANSWER TYPE QUESTIONS

14. A container carrying some liquid shown in the diagram is given some acceleration $\vec{a}$.



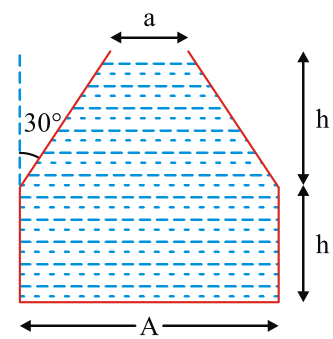
a) If $\vec{a}$ is directed upwards, $P_A - P_B$ increases

b) If $\vec{a}$ is directed towards right $P_A - P_B$ decreases

c) If $\vec{a}$ is directed downwards, $P_A - P_B$ remain same.

d) If $\vec{a}$ is directed towards left, $P_A - P_B$ remain same.

15. **The vessel shown in the figure has two sections. The lower part is a rectangular vessel with area of cross - section A and height h. The upper part is a conical vessel of height h with base area 'A' and top area 'a' and the walls of the vessel are inclined at an angle 30^0 with the vertical. A liquid of density ρ fills both the sections upto a height 2h. Neglect atmospheric pressure.**



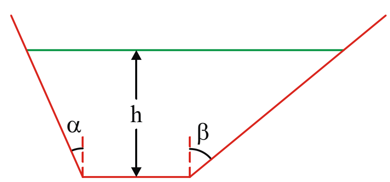
a) The force F exerted by the liquid on the base of the vessel is $2h\rho g\frac{(A+a)}{2}$

b) The pressure P at the base of the vessel is $2h\rho g\frac{A}{a}$

c) The weight of the liquid W is greater than the force exerted by the liquid on the base

d) The walls of the vesel exert a downward force on the liquid

16. **A liquid is filled upto height h in a vessel, as shown. find correct option (s);**



a) If $\alpha = \beta$, horizontal component of forces on left and right side of inclined faces will be equal and opposite.

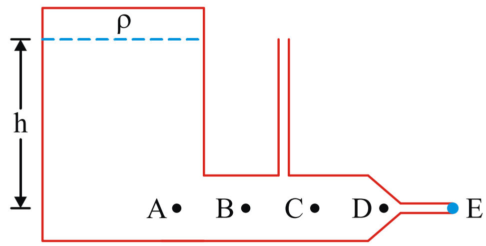
b) If $\alpha \neq \beta$, horizontal component of forces on left and right side of inclined faces will be equal and opposite.

c) If A is the area of the base of the vessel, then force exerted by liquid on walls of the vessel is greater than $(P_{atm} + \rho gh)$ A.

d) As above, the force exerted by liquid on walls is equal to $(P_{atm} + \rho gh)$ A.

17. **As shown in figure, a liquid of density ρ is standing in a sealed container to a height h. The container contains compressed air at a gauge pressure of p. The**

horizontal outlet pipe has a cross-sectional area A at C and D. The cross - sectional area is A/2 at E. Find correct options:



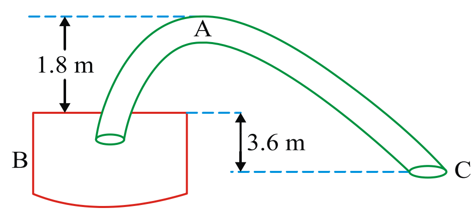
a) The velocity of liquid at C will be $\left[\frac{(P+\rho gh)}{4\rho}\right]^{1/2}$

b) The velocity of liquid at C will be $\left[\frac{2(P+\rho gh)}{\rho}\right]^{1/2}$

c) The discharge rate is given by $\frac{A}{2\rho}(p+\rho gh)^{1/2}$

d) The discharge rate is given by $\frac{A}{2\sqrt{\rho}}(p+\rho gh)^{1/2}$

18. **A siphon has a uniform circular base of diameter $8/\sqrt{\pi}$ cm with its crest A, 1.8m above the water level vessel B is of large cross section (g =10 m/s^2 and atmospheric pressure $P_0 = (10^5 N/m^2)$.**



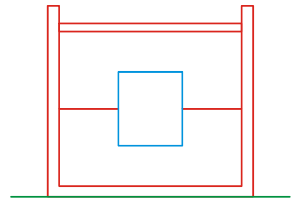
a) Velocity of flow through pipe is $6\sqrt{2}$ m/s.

b) Discharge rate of flow through pipe is $96\sqrt{2}\times10^{-4} m^3/s$

c) Velocity of flow through pipe is 6 m/s.

d) Pressure of A is $0.46\times10^{-5} N/m^2$

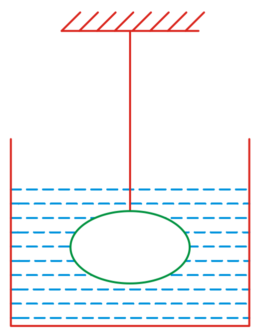
19. **An incompressible liquid is kept in a long conducting cylindrical container, which is closed at its top by an airtight light piston. A cylinder of length 10cm made of material of density $0.65 g/cm^3$ floats with half-length submerged in the liquid as shown in the figure. Air trapped in the cylinder has density** $1.30 kg/m^3$.



On placing extra weight on the piston, pressure of the air in the cylinder is increased to 100 times of the initial pressure. What can you conclude? ($\because$ Use Boyle's law for air ie., $P_1V_1 = P_2V_2$ at constant temperature)

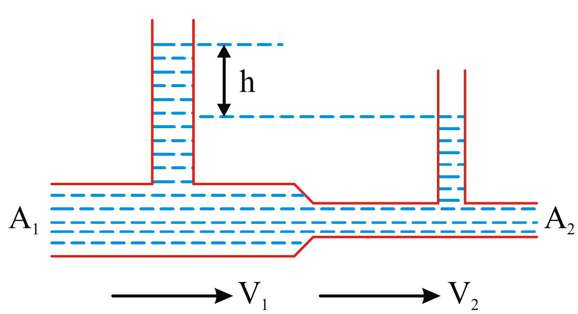
1. Cylinder moves downwards
2. Cylinder moves upwards
3. Displacement of the cylinder is 0.55cm
4. Displacement of the cylinder is 0.6cm

20. A solid sphere of mass m, is suspended by means of a string in a liquid as shown. The string has some tension. Magnitudes of net force due to liquid on upper hemisphere and that on lower hemisphere are F_A and F_B respectively. Which of the following is/are true.



1. Density of material of the sphere is greater than density of liquid
2. Difference of F_B and F_A is dependent of atmospheric pressure
3. $F_B - F_A = mg$ 4. $F_B - F_A < mg$

21. A liquid flows through a horizontal tube. The velocities of the liquid in the two sections which have areas of cross section A_1 and A_2 are v_1, v_2 respectively. The difference in the levels of liquid in the two vertical tubes is h.



1. The volume of liquid flowing through the tube in unit time is A_1v_1

2. $v_2 - v_1 = \sqrt{2gh}$ 3. $v_2^2 - v_1^2 = 2gh$

4. The energy per unit mass of liquid is the same in both the sections of the tube

COMPREHENSION TYPE QUESTIONS

Comprehension 1

A wooden cylinder of length L is partly submerged in a liquid of specific gravity ρ_1 with n^{th} $(n<1)$ part of it inside the liquid. Another immiscible liquid of density ρ_2 is poured to completely submerge the cylinder. Density of cylinder ρ is the geometric mean of the densities of the two liquids.

22. Express the density of upper liquid in terms of density of cylinder

a) ρ / n b) ρn c) $\frac{n}{(n+1)}\rho$ d) None

23. Calculate the fraction of the cylinder submerged in the lower liquid after the upper liquid is poured in the vessel

a) $\frac{n}{(n+1)}$ b) $\frac{(n-1)}{(n+1)}$ c) $\frac{n(n-1)}{(n+1)}$ d) $\frac{(n+1)}{(n-1)}$

24. When the cylinder is slightly depressed and released, it oscillates. Let there be a mean position. Find the time period of small oscillations below the mean position.

a) $\pi\left[\frac{(n+1)L}{g(n-1)}\right]^{1/2}$ b) $\pi\left[\frac{n^2L}{g(1-n)^2}\right]^{1/2}$ c) $\pi\left[\frac{nL}{g(n^2-1)}\right]^{1/2}$ d) $\pi\left[\frac{nL}{g(1-n^2)}\right]^{1/2}$

25. Similarly as above, find the time period of small oscillations above the mean position.

a) $\pi\left[\frac{nL}{g}\right]^{1/2}$ b) $\pi\left[\frac{L}{ng}\right]^{1/2}$ c) $\pi\left[\frac{(n-1)L}{g}\right]^{1/2}$ d) $\pi\left[\frac{nL}{(n-1)g}\right]^{1/2}$

PARAGRAH – 3

A tank of height 'H' and base area 'A' is half filled with water and there is a small orifice at the bottom and there is a heavy solid cylinder having base area $\frac{A}{3}$ and height of the cylinder is same as that of the tank. The water is flowing out of the orifice. Here cylinder is put into the tank to increase the speed of water flowing out.

26. The speed of water flowing out of the orifice after the cylinder is kept inside it is

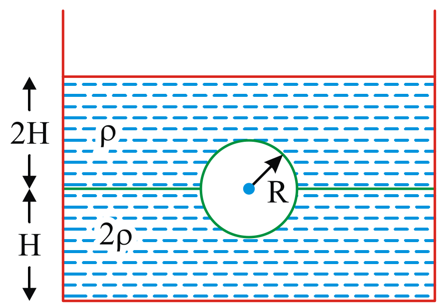
1. $\sqrt{\frac{gH}{2}}$ 2. $\sqrt{\frac{3gH}{2}}$ 3. $\sqrt{2gH}$ 4. $\sqrt{3gH}$

27. **After long time, when the height of water inside the tank again becomes equal to $\frac{H}{2}$, the solid cylinder is taken out. Then the velocity of liquid flowing out of the orifice (just after removing the cylinder) will be**

1. $\sqrt{\frac{gH}{3}}$ 2. $\sqrt{\frac{3gH}{2}}$ 3. $\sqrt{2g\left(\frac{H}{3}\right)}$ 4. $\sqrt{2g\left(\frac{H}{2}\right)}$

PARAGRAPH 4

. **A spherical ball of radius R is floating at the interface of two liquids with densities ρ and 2ρ. The volumes of the ball immersed in two liquids are equal. Answer the following questions :**



28. **Find the force exerted by the liquid with density 2ρ on the ball**

1. $\pi R^2 \rho g\left(H+\frac{2R}{3}\right)$ 2. $\frac{2}{3}\pi R^2 \rho g$

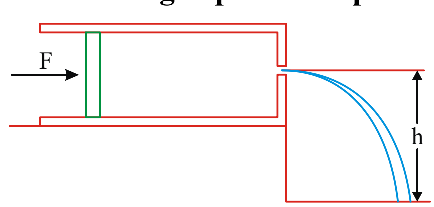
3. $\frac{4}{3}\pi R^2 \rho g$ 4. $2\pi R^2 \rho g\left(H+\frac{2R}{3}\right)$

29. **If a hole is drilled at the bottom of the vessel then volume of the ball immersed in liquid with density ρ will**

1. remain same 2. decrease 3. increase
4. decrease first then increases

Paragraph 5

An ideal liquid of density ρ is filled in a horizontally fixed syringe fitted with a piston. There is no friction betwween the piston and the inner surface of the syringe. Cross-sectional area of the syringe is A. At one end of the syringe, an orifice is made. When the piston is pushed into the syringe, the liquid comes out of the orifice and then following a parabolic path falls on the ground.



30. **With what velocity does the liquid come out of the orifice?**

1. $\sqrt{\dfrac{F}{\rho A}}$ 2. $\sqrt{\dfrac{2F}{\rho A}}$ 3. $\sqrt{\dfrac{F+2\rho ghA}{\rho A}}$ 4. $\sqrt{\dfrac{F+\rho ghA}{\rho A}}$

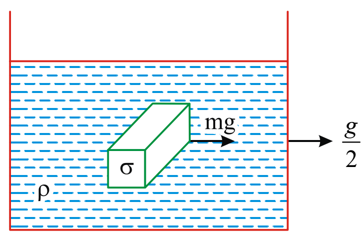
31. **With what velocity the liquid strikes the ground?**

1. $\sqrt{\dfrac{F+\rho ghA}{\rho A}}$ 2. $\sqrt{\dfrac{F+2\rho ghA}{\rho A}}$ 3. $\sqrt{\dfrac{2F+\rho ghA}{\rho A}}$ 4. $\sqrt{\dfrac{2(F+\rho ghA)}{\rho A}}$

MATRIX MATCHING TYPE QUESTIONS

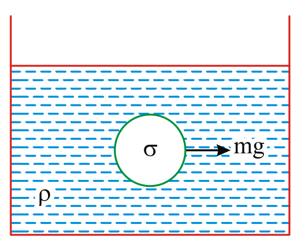
32. **Match the following columns:**
Column - I

a) A cube of mass m and density σ is pulled by a force $\vec{F}_x = mg\,\hat{i}$ in an accelerating liquid of density ρ. The value of $\dfrac{a_x}{a_y}$ is

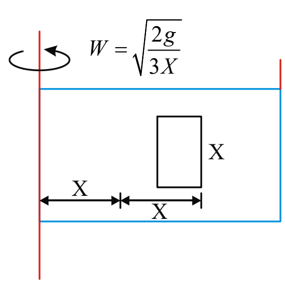


b) The sphere of mass m is pulled horizontally by a force $F_x = mg$ in a non - accelerating liquid.

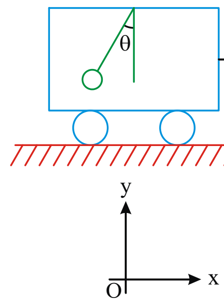
The value of $\dfrac{a_x}{a_y}$ is



c) A closed tube of length x is placed in a rotating liquid. The value of a_x/g, where a_x is the horizontal acceleration of the cube, is



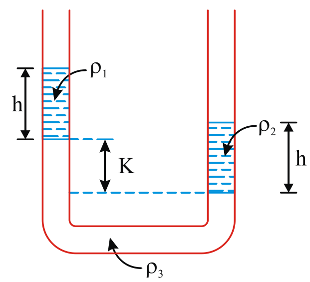
d) The string of a pendulum makes an angle θ with vertical when the cart moves with an acceleration a. If the cart is filled with liquid of density $\rho < \sigma$ (density of the bob), the value of the angle of inclination with vertical becomes 'θ', then $\frac{\tan\theta}{\tan\theta'}$ is



Column-II:

p) $\frac{\rho}{\sigma}$ q) 1 : 1 r) $\frac{\sigma}{\rho-\sigma}$ s) $\frac{2\sigma+\rho}{2(\sigma-\rho)}$

33. **Three liquids of densities ρ_1, ρ_2 and ρ_3 and heights as shown are in equilibrium in a U-tube. Match the columns.**



	Column-I		Column-II
(a)	$P_3 = 2(P_2 - P_1)$	(p)	$K = 2h$
(b)	$P_3 = \frac{(P_2 - P_1)}{2}$	(q)	$K = h/2$
(c)	$P_1 = P_2$	(r)	$K = 0$
(d)	$P_3 = \frac{(P_2 - P_1)}{2}$	(s)	None of these

STATEMENT TYPE QUESTIONS

A) Statement I is true, Statement II is true and Statement II is correct explanation for Statement I

B) Statement I is true, Statement II is true and Statement II is not the correct explanation for Statement I

C) Statement I is true, Statement II is false

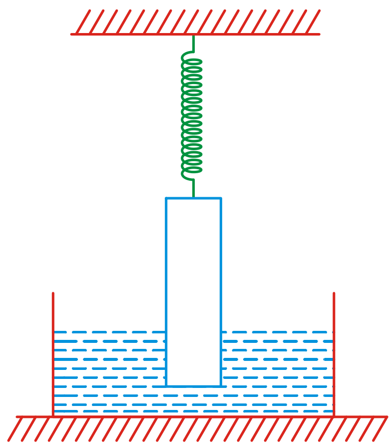
D) Statement I is false, Statement II is true

34. **Statement-1:** If P is the pressure of gas inside the exhaust chamber of a rocket and P_0 is the pressure of the gas outside the chamber. The forward thrust on the rocket is $2a(P-P_0)$ instead of $a(P-P_0)$ where a is the area of orifice.

Statement -2: The formula thrust = $a(P-P_0)$ holds good for fluids at rest. In the case of rocket the fluids are in motion and we have to use Bernoulli's principle for calculating the thrust.

35 **Statement - 1:** A smooth block of mass 2kg and specific gravity 2.5 is attached with a spring of force constant $k = 100 N/m$ and is half dipped in water. If the extension in the spring is 1cm, the force exerted by the bottom of tank on the block is 19N.

Statement-2: In the arrangement shown, the buoyant force acting on the block is equal to weight of liquid displaced.



36. **Statement -1:** A boy carrying a fish in one hand a bucket full of water in the other hand, places the fish in the bucket. He now carries comparatively lesser weight as the weight of the fish will be reduced due to upthrust.

Statement -2: The boy will carry still the same weight.

37. **Statement -1:** For rotational equilibrium of floating bodies, meta centre must always be lower than centre of gravity of the body

Statement -2: When a floating body is slightly tilted from equilibrium, centre of buoyance shifts. The vertical line passing through new centre of buoyance and initial vertical line meet at a point, which is called meta centre.

EXERCISE - IV - KEY

SINGLE ANSWER TYPE

1. c 2. b 3.b 4.b 5. a 6.c 7.c 8.b 9.d 10.d
11.b 12.a 13. A

MULTIPLE ANSWER TYPE

14. a,b 15.d 16.a,b,c 17.a,d 18. A,B,D 19. 2,3
20. 1,4 21. 1,3,4

COMPREHENSION TYPE

22. b 23. a 24. d 25. a 26. 2 27. 3 28. 4 29.1 30. 2 31. 4

MATRIX MATCHING TYPE

32. a$\rightarrow$s: b$\rightarrow$r; c$\rightarrow$p: d$\rightarrow$q 33. a$\rightarrow$q: b$\rightarrow$p; c$\rightarrow$r: d$\rightarrow$s

STATEMENT TYPE

34. a 35. c 36. d 37. d

EXERCISE - V

SINGLE ANSWER QUESTIONS

1. **A marble of mass x and diameter $2r$ is gently released in a tall cylinder containing honey. If the marble displaces mass. y $(< x)$ of the liquid, the terminal velocity is proportional to**

a. $x+y$ b. $x-y$ c. $\frac{x+y}{r}$ d. $\frac{x-y}{r}$

2. **A small metal ball of diameter 4 mm and density 10.5g/ cm^3 in dropped in glycerine of density1.5 g/ cm^3. The ball attains a terminal velocity of 8/cm/sec. The coefficient of viscosity of glycerine is**

a. 4.9 posie b. 9.8 posie c. 98 posie d. 980 poise

3. **A sphere of brass released in a long liquid column attains a terminal speed v_0. If the terminal speed is attained by a sphere of marble of the same radius and released in the same liquid is $n\, v_0$, then the value of n will be (Given: The specific gravities of brass, marble and liquid are 8.5, 2.5 and 0.8,respectively)**

a. $\frac{5}{17}$ b. $\frac{17}{77}$ c. $\frac{11}{31}$ d. $\frac{17}{5}$

4. **Between a plate of area 100 cm^2 and another plate of area 100 m^2 there is a 1 mm, thick layer of water, if the coefficient of viscosity of water is 0.01 poise, then the force required to move the smaller plate with a velocity 10 cm/s with reference to large plate is.**

a. 100 dyn b. $10^4\, dyn$ c. $10^6\, dyn$ d. $10^9\, dyn$

5. **A spherical ball falls through viscous medium with terminal velocity v. If this ball is replaced by another ball of the same mass but half the radius, then the terminal velocity will be (neglect the effect of buoyancy.)**

a. v b. $2v$ c. $4v$ d. $8v$

6. **Neglecting the density of air, the terminal velocity obtained by a raindrop of radius 0.3mm falling through the air of viscosity $1.8\times10^{-5}\, N/m^2$ will be**

a. $10.9m/s$ b. $8.3m/s$ c. $9.2m/s$ d. $7.6m/s$

7. **Water is flowing in a river. If the velocity of a layer at a distance of 10 cm from the bottom is 20 cm/s. Find the velocity of layer at a height of 40 cm from the bottom**

a. $10\, m/s$ b. $20\, m/s$ c. $30\, m/s$ d. $80\, m/s$

8. **A horizontal plate $(10\, cm \times 10\, cm)$ moves on a layer of oil of thickness 4 mm with constant speed of $10 cm/s$. The coefficient of viscosity of oil is 4 poise. The tangential force applied on the plate to maintain the constant speed of the plate is**

a. $10^3\, dyne$ b. $10^4\, dyne$ c. $10^5\, dyne$ d. none of these

9. **A liquid is flowing through a narrow tube. The coefficient of viscosity of**

liquid is 0.1308 poise. The length and inner radius of tube are 50 cm and 1 mm respectively. The rate of flow of liquid is 360 $cm^3/\min$. Find the pressure difference betweeen ends of tube.

a. $10^6\ dyne/cm^2$ b. $10^4\ dyne/cm^2$ c. $10\ dyne/cm^2$ d. none of these

10. **Find the terminal velocity of solid sphere of radius 0.1 m moving in air in vertically downward direction. $\left(\eta = 1.8\times10^{-5}\ Ns/m^2\right.$, density of sphere $=1000 kg/m^3$ and $\left. g = 10 m/s^2\right)$**

a. 2 m/s b. 1.2 cm/s c. 4 cm/s d. none of these

11. **Eight equal drops of water each of radius $r = 2\ mm$ are falling through air with a terminal velocity of 16 cm/s. The eight drops combine to form a big drop. Calculate the terminal velocity of big drop**

a. 16 cm/s b. 32 cm/s c. 64 cm/s d. none of these

12. **At $20^0 C$, to attain the terminal velocity how fast will an aluminium sphere of radil 1 mm fall through water. Assume flow to be laminar flow and specific gravity (Al)**

a. 5 m/s b. 4.6 m/s c. 4 m/s d. 2 m/s

13. **Water flows at a speed of 6 cm s^{-1} through a tube of radius 1 cm. coefficient of viscosity of water at room temperature is 0.01 poise. the Reynolds number is**

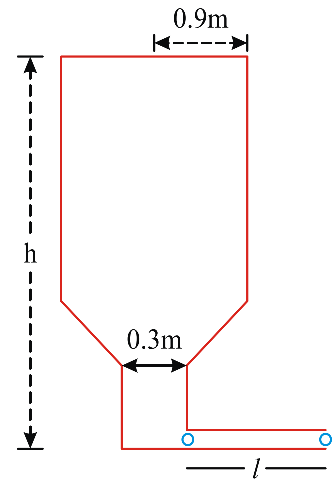
a. 100 b. 110 c. 120 d. 140

14. **A metal sphere of radius 1 mm and mass 50 mg falls vertically in glycerine. the viscous force exerted by the glycerine on the sphere when the speed of the sphere is 1 m s^{-1} is (density of glycerine is 1260kg $/m^3$ coefficient of viscosity at room temperature is 8 poise**

a) $3\times10^{-4} N$ b) $1.5\times10^{-4} N$ c) $4.5\times10^{-4} N$ d) $0.5\times10^{-4} N$

15. **A liquid of density 900 kg/m^3 is fillled in a cylindrical tank of upper radius 0.9m and lower radius 0.3m A capillary tube of length l is attached at the bottom of the tank as shown in fig. The capillary has outer radius 0.002m and inner radius a. When pressure P is applied at the top of the tank volume flow rate of liquid is $8\times10^{-6} m^3/s$ and if capillary tube is detached, the liquid comes out from the tank with a velocity $10 m/s$. Then the coefficient viscosity of liquid is**

($\pi a^2 = 10^{-6} m^2\ a^2/l = 2\times10^{-6} m$.)



a) $\eta = 1.25 \times 10^{-3} N - s/m^2$.   b) $\eta = 2.50 \times 10^{-3} N - s/m^2$

c) $\eta = 5.00 \times 10^{-3} N - s/m^2$ d) $\eta = 7.25 \times 10^{-3} N - s/m^2$

16. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid.

a. 0.2 m/s   b. 0.4 m/s   c. 0.133 m/s   d. 0.1m/s

17. A cylindrical vessel of area of cross-section A and filled with liquid to a height of h_1 has a capillary tube of length *l* and radius r protuding horizontally at its bottom. If the viscosity of liquid is η and density ρ. Find the time in which the level of water in the vessel falls to h_2.

a. $\frac{8\eta l A}{\pi \rho g r^4} \ln \frac{h_1}{h_2}$ b. $\frac{8\eta l A}{\pi \rho g r^4}$ c. $\frac{\eta A}{g}\left(\sqrt{h_1} - \sqrt{h_2}\right)$ d. $\frac{8\eta l A}{\pi \rho g r^4} \ln \frac{h_2}{h_1}$

18. **When water flows at a rate Q through a tube of radius r placed horizontally, a pressure difference p develops across the ends of the tube. If the radius of the tube is doubled and the rate of flow halved, the pressure difference will be**

a) $8p$ b) p c) $p/8$ d) $p/32$

19. **A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density $\rho_2 \left(\rho_2 < \rho_1\right)$. Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed v, i.e., $F_{viscous} = -kv^2 \left(k > 0\right)$. The terminal speed of the ball is:**

a) $\sqrt{\frac{Vg\left(\rho_1 - \rho_2\right)}{k}}$ b) $\frac{Vg\rho_1}{k}$ c) $\sqrt{\frac{Vg\rho_1}{k}}$ d) $\frac{Vg\left(\rho_1 - \rho_2\right)}{k}$

20. **A volume V of a viscous liquid flows per unit time due to a pressure head ΔP along a pipe of diameter d and length l. Instead of this pipe, a set of four pipes each of diameter $d/2$ and length $2l$ is connected to the same pressure head ΔP. Now the volume of liquid flowing per unit time is:**

a) $V/16$ b) $V/8$ c) $V/4$ d) V

21. **Two capillary tubes of same radius r but of lengths l_1 and l_2 are fitted in parallel to the bottom of a vessel. The pressure head is P. What should be the length of a single tube of same radius that can replace the two tubes so that the rate of flow is same as before ?**

a) $l_1 + l_2$ b) $\frac{1}{l_1}+\frac{1}{l_2}$ c) $\frac{l_1 l_2}{l_1 + l_2}$ d) $\frac{1}{l_1 + l_2}$

22. **$L, L/2$ and $L/3$ are connected in series. Their radii are $r, r/2$ and $r/3$ respectively. Then, if stream-line flow is to be maintained and the pressure across the first capillary is P, then:**

a) the pressure difference across the ends of second capillary is $8P$

b) the pressure difference across the third capillary is $43P$

c) the pressure difference across the ends of second capillary is $16P$

d) the pressure difference across the third capillary is $59P$

MULTIPLE CORRECT ANSWER QUESTIONS

23. **Water flows through a capillary tube of radius 'r' and length at a rate of 40 ml per second, when connected to a pressure difference of 'h' cm of water. Another tube of the some length but radiud . r/2 is connected in series with this tube and the combination is connected to the same pressure head. [density of water is ρ]**

a) The pressure difference accross each tube is $p_1 = \frac{\rho g h}{17} and\ P_2 \frac{16}{17}\rho g h$

b) The pressure difference accross each tube is $p_1 = \frac{\rho g h}{16} and\ P_2 \frac{17}{16}\rho g h$

c) The rate of flow of water through the combination is $\frac{40}{17} c.c/\sec.$

d) The rate of flow of water through the combination is $\frac{17}{40} c.c/\sec.$

24. **An oil drop falls through air with a terminal velocity of $5 \times 10^{-4}/\sec$. Viscosity of air is $1.8 \times 10^{-5} N-s/m^2$ and density of oil is 900 kg m^3 neglect density of air as compared to that of oil.**

a) The radius of drop is $4.18 \times 10^{-6} m.$

b) The radius of drop is $2.14 \times 10^{-6} m.$

c) The terminal velocity of a drop of half of this radius is $1.25 \times 10^{-4} m/\sec.$

d) The terminal velocity of a drop of half of this radius is $2.5 \times 10^{-4} m/\sec.$

25. **A tube of length l and radius R carries a steady flow of fluid whose density is ρ and viscos ity η. The velocity v of flow is given by $v = v_0(1 - r^2/R^2)$, Where r is the distance of flowing fluid from the axis.**

a) The volume of fluid, flowing across the section of the tube, in unit time is $2\pi v_0 (R^2/4)$

b) The kinetic energy of the fluid within the volume of the tube is

$K.E. = \pi \rho l {v_0}^2 (R^2/6)$

c) The frictional force exerted on the tube by the fluid is $F = 4\pi\eta k v_0$

d) The pressure difference at the ends of tube is $P = \frac{4\eta l v_0}{R^2}$

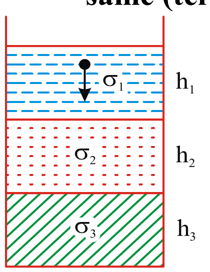
26. Viscous force is somewhat like friction as it opposes the motion and is non-conservative but not exactly so, because;

a) It is velocity dependent while friction not
b) It is velocity independent while friction is
c) It is temperature dependent while friction not
d) It is independent of area like surface tension while friction depends.

27. A solid sphere moves at a terminal velocity of 20 ms^{-1} in air at a place where g = 9.8 ms^{-2}. The sphere is taken in a gravity-free hall having air at the same pressure and pushed down at a speed of 20 ms^{-1} [Consider density of air to be negligible]

a) Its initial acceleration will be 9.8 ms^{-2} downward.
b) Its initial acceleration will be 9.8 ms^{-2} upward
c) The magnitude of acceleration will decrease as the time passes.
d) It will eventually stop.

28. A ball moves successively through three liquids, at rest as shown, of densities σ_1, σ_2 and σ_3 nd viscosity coefficient η_1, η_2 and η_3 and respectively with the same (terminal) velocity. Then



a) $\eta_3 > \eta_2 > \eta_1$ b) $\frac{\sigma_1}{\eta_1} = \frac{\sigma_2}{\eta_2} = \frac{\sigma_3}{\eta_3}$

c) $\frac{\eta_1}{\eta_3} > \frac{\eta_3}{\eta_2}$ d) $\frac{\eta_2\sigma_1 - \eta_1\sigma_2}{\eta_3\sigma_1 - \eta_1\sigma_3} = \frac{\eta_2 - \eta_1}{\eta_3 - \eta_1}$

29. A spherical solid body is dropped inside a vast expanse of viscous liquid of large depth and of coefficient of viscosity η. The density of the solid is greater than that of the liquid. The time taken by the body to attain the 90% of the steady state velocity is dependent on

a) density of the liquid b) density of the solid
c) diameter of the sphere d) coefficient of viscosity

30. A small sphere of mass m is dropped from a height. After it has fallen 100m, it has attained its terminal velocity and continues to fall at that speed. Then the modulus of work done.

a)by viscosity of air is lesser in first 100m than in the second 100 m
b) by buoyancy of air is in first 100m is equal to that in the second 100m
c) by viscosity of air is greater in first 100m than in the second 100m
d) by buoyancy of air is lesser in first 100m than that in the second 100m

31. A spherical solid body is dropped inside a vast expanse of viscous liquid of large depth and of coefficient of viscosity η. The density of the solid is greater

than that of the liquid. The time taken by the body to attain the 90% of the steady state velocity is dependent on

a) density of the liquid b) density of the solid
c) diameter of the sphere d) coefficient of viscosity.

32. **Pick out the wrong statement from the following**
a) Viscosity depends upon the nature of the liquids
b) Generally viscosity of liquids is more than that of gases
c) In case of gases, viscosity decreases with increase in temperature
d) In case of liquids, viscosity decreases with increase in temperature

EXERCISE -V - KEY

1.d	2.b	3.b	4.a	5.b	6.a	7.d	8.b	9.a	10.b
11.c.	12.b	13.c	14.b	15.a	16.d	17. a	18. d	19. a	20. b
21. c	22. a		23. A,C		24. B,C		25.A,B,C,D		26.A,C
27.B,C,D		28. c,d		29. b,c,d		30. a,b	31. b,c,d		32. c

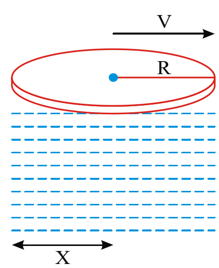
$\rho\alpha\frac{x}{r^3}$; $\rho^1\alpha\frac{y}{r^3}$; $v_0\alpha\frac{x-y}{r}$

EXERCISE - VI

PARAGRAPH TYPE QUESTIONS

Paragraph - 1

Consider a disk of mass m, radius R lying on a liquid layer of thickness T and coefficient of viscosity η as shown in the Fig.

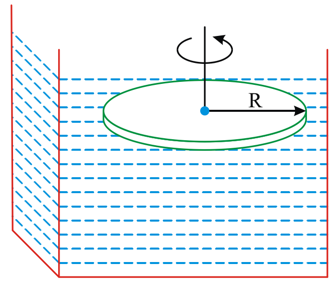


Answer the following questions.

1. **The coefficient of viscosity varies as $\eta = \eta_0 x$ (x measured as shown in the figure) at the given instant the disk is floating towards right with a velocity v as shown. Find the force required to move the disk slowly at the given instant.**

a) $\frac{2\eta_0 R^2 v}{T}$ b) $\frac{8\eta_0 R^2 v}{T}$ c) $\frac{\pi\eta_0 R^3 v}{T}$ d) $\frac{16\eta_0 R^3 v}{T}$

2. **The torque required to rotate the disk at a constant angular velocity ω given the viscosity is uniformly η.**



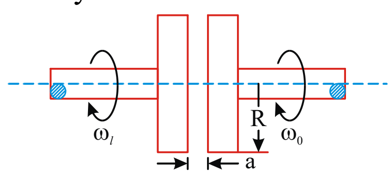
a) $\frac{4\pi\omega\eta R^4}{T}$ b) $\frac{\pi\omega\eta R^4}{2T}$ c) $\frac{2\pi\omega\eta R^4}{T}$ d) $16\pi\omega\eta R^4$

3. **A disc rotating with angular velocity ω is placed on a viscous liquid of thickness T. Find the angle rotated by the disc before it comes to rest. (Viscosity = η, mass of disc = M, radius of disc = R)**

a) $\frac{4\omega_0 TM}{\eta\pi R^2}$ b) $\frac{2\omega_0 TM}{\eta\pi R^2}$ c) $\frac{\omega_0 TM}{\eta\pi R^2}$ d) $\frac{\omega_0 TM}{2\eta\pi R^2}$

Paragraph - 2

A viscous clutch as shown in figure transmits torque. Radius of each clutch plate is R and separation between the plates is a and is completely filled with liquid of coefficient of viscous μ. If ω_i and ω_0 are angular velocities of plates connected to input and output respectively.



4. **The torque transmitted is**

a) $\frac{\pi\mu\left(\omega_i^2-\omega_0^2\right)R^4}{\omega_i a}$ b) $\frac{\pi\mu\left(\omega_i^2-\omega_0^2\right)R^4}{\omega_0 a}$

c) $\frac{\pi\mu\left(\omega_i^2-\omega_0^2\right)R^4}{2\omega_0 a}$ d) $\frac{\pi\mu\left(\omega_i-\omega_0\right)R^4}{2a}$

5. **If efficiency of transmission is ratio of output power to input power, then efficiency is given by**

a) $1-\frac{\omega_0}{\omega_i}$ b) $\frac{\omega_0}{\omega_i}$ c) $\frac{\omega_0^2}{\omega_i^2}$ d) $1-\frac{\omega_0^2}{\omega_i^2}$

INTEGER TYPE QUESTIONS

6. **When a sphere of radius $r_1=1.2$ mm moves in glycerine, the laminar flow is observed if the velocity of the sphere does not exceed $v_1=23$ cm/s. At what minimum velocity v_2 of a sphere of radius $r_2=5.5cm$ will the flow in water become turbulent? The viscosities of glycerine and water are equal to $\eta_1=13.9P\, and\, \eta_2=0.011P$ respectively.(in $\mu m/s$)**

7. **A lead sphere is steadily sinking in glycerine whose viscosity is equal to $\eta=13.9$ P. What is the maximum diameter of the sphere at which the flow around that**

sphere still remains laminar? It is known that the transition to the turbulent flow correspond to Reynolds number $R_e = 0.5$. **(Here the charactrstic length is taken to be the sphere diameter).** $(in\,mm)$

8. **The time of survival of a soap bubble of radius of R connected with atmosphere through a capillary of length l and radius r. The surface tension is T and the cofficient of viscosity of air is** η**. in terms of** $\frac{\eta l R^4}{T r^4}$ **is**

9. **An air bubble of radius 1 mm is allowed to rise through a long cylindrical column of a viscous liquid of radius 5 cm and travels at a steady rate of 2.1 cm per sec. If the density of the liquid is 1.47g/cc. Its viscosity is nearly** $\frac{n}{2}$ **poise. Then find the value of n. Assume g=980** $cm/\sec^2$ **and neglect the density of air**

10. **A spherical ball of radius** 3.0×10^{-4} **m and density** $10^4 kg/m^3$ **falls freely under ravity through a distance** $H = n\times 324m$ **before entering a tank of water. If after enerting the water the velocity of the ball does not change, and n. Viscosity of water is** $10\times10^{-6} N-s/m^2, g=10m/s$

11. **The speed of a vertically falling raindrops (in m/s) for from the following data. Radius of the drops = 0.02 cm, viscostiy of air** $=1.8\times10^{-4}$ **poise,** $g = 9.9\times10\,m\,s^{-2}$ **and density of water** $=1000 kg\, m^{-3}$.

12. **A small spherical ball falling under gravity in a viscous medium heat the medium due to viscous drage force. The rate of heating is proportional to** r^n**. (r = radius of the sphere) Find** n**.**

EXERCISE - VI - KEY

1) c 2) b 3) c 4) d 5) b 6) 5 7) 5 8) 2 9) 3 10) 5
11) 5 12) 5

SURFACE TENSION

EXERCISE - VII

SINGLE ANSWER TYPE QUESTIONS

1. **Find the maximum possible mass of a greased needle floating on water surface. T is the surface tension of water,** l **is the length of the needle**

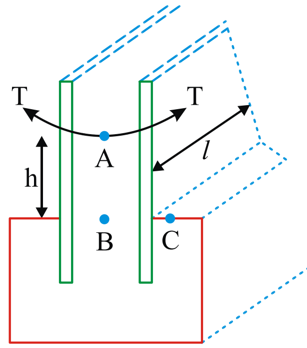
A) $m_{\max} = \frac{2Tl}{g}$ B) $m_{\max} = \frac{g}{2Tl}$ C) $m_{\max} = \frac{2Tg}{l}$ D) $m_{\max} = \frac{Tl}{g}$

2. **A vertical glass capillary with inside diameter 0.50mm is submerged into water so that the length of its part emerging outside the water surface is equal to 25 mm.Find the radius of curvature of the meniscus.Surface tension of water is** $73\times10^{-3} N/m$.

A) $R = 0.6m$ B) $R = 6mm$ C) $R = 0.6mm$ D) $R = 0.6Km$

3. **Expression for the height of capillary rise between two parallel plates dipping in a liquid of density** σ **separated by a distance d. The surface tension of the**

liquid is T. [Take angle of contact to be zero]

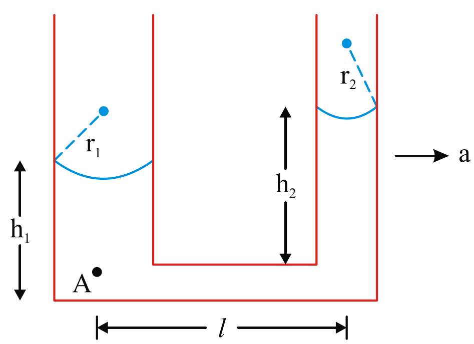


A) $h=\dfrac{2T}{\sigma dg}$ B) $h=\dfrac{2d}{\sigma T}$ C) $h=\dfrac{\sigma T}{d}$ D) $h=\dfrac{2T^2}{\sigma d}$

4. **A glass capillary sealed at the upper end is of length 0.11m and internal diameter 2×10^{-5} m. The tube is immersed vertically into a liquid of surface tension $5.06\times10^{-2}\,N/m$. To what length the capillary has to be immersed so that liquid level inside and outside the capillary becomes the same.?**

A) 5cm B) 3cm C) 1cm D) 7cm

5. **A vertical communicating tube contains a liquid of density ρ .If it moves with a horizontal acceleration "a", pressure at 'A' is equal to;**



A) $\rho gh_2+P_0+\dfrac{2T}{r_2}+\rho al$ B) $\rho gh_2+\rho al+P_0+\dfrac{2T}{r_2}$

C) $\rho gh_1+P_0-\dfrac{2T}{r_1}$ D) $\rho gh_1-P_0-\dfrac{2T}{r_1}$

6. **A glass rod of diameter d = 2mm is inserted symmetrically into a glass capillary tube of radius r=2mm. Then the whole arrangement is vertically dipped into liquid having surface tension 0.072 Nm.The height to which liquid will rise on capillary is**

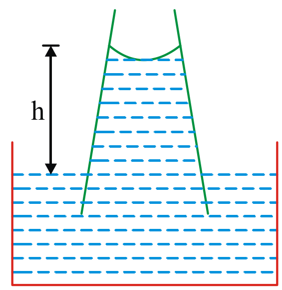
($\left(Take g=10m/s^2, density_{liq}=1000kg/m^3\right)$**.**

Assume contact angle to be zero. capillary tube to be long enough)

A) 1.44cm B) 6cm C) 4.86cm D) $5.26cm$

7. **A capillary of the shape as shown is dipped in a liquid. Contact angle between the liquid and the capillary is 0^0 and mass of liquid inside the meniscus is to be**

neglected. T is surface tension of the liquid, r is raidus of the meniscus, g is acceleration due to gravity and ρ is density of the liquid then height h in equilibrium is



A.Greater than $\frac{2T}{r\rho g}$ B.Equal to $\frac{2T}{r\rho g}$

C. less than $\frac{2T}{r\rho g}$

D) of any value depending upon actual values

8. **In the bottom of a vessel with mercury there is a round hole of diameter $d = 70\mu m$. At what maximum thickness of the mercury Layer will the liquid still not flow out through this hole?** $\left[\rho_{mercury} = 13600 kg/m^3\right]$

(A) 11cm (B) 21 cm (C) 42cm (D) 32cm

9. **An air bubble of diameter, $d = 4\mu m$ is located in water at a depth $h = 5.0m$ Considering standard atmospheric prssure as 1 atm, find the pressure in the air - bubble?**

(A) 2.2 atm (B) 1.2 atm (C) 3.2 atm (D) 1.6 atm

10. **Water rises to a height of 10 cm in a capillary tube and mercury falls to a depth of 3.42 cm in the same capillary tube. If the denisty of mercury is 13.6 g/c.c. and the angles of contact for mercury and water are 135^0 and 0^0, respectively, the ratio of surface tension for water and mercury is**

(A) $1:0.15$ (B) $1:3$ (C) $1:6.5$ (D) $1.5:1$

11. **A glass rod of radius r_1 is inserted symmetrically into a vertical capillary tube of radius r_2 such that their lower ends are at the same lebel. The arrangement is now dipped in water. The height to which water will rise into the tube will be σ = surface tension of warer , ρ = density of water)**

A. $\frac{2\sigma}{(r_2 - r_1)\rho g}$ B. $\frac{\sigma}{(r_2 - r_1)\rho g}$ C. $\frac{2\sigma}{(r_2 + r_1)\rho g}$ D. $\frac{2\sigma}{(r_2^2 + r_1^2)\rho g}$

12. **A large number of droplets, each of radius a, Coalesce to from a bigger drop of radius b. Assume that the energy released in the process is converted into the kinetic energy of the drop. The velocity of the drop is (σ =surface tension, ρ = density)**

A. $\left[\frac{\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{1/2}$ B. $\left[\frac{2\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{1/2}$ C. $\left[\frac{3\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{1/2}$ D. $\left[\frac{6\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{1/2}$

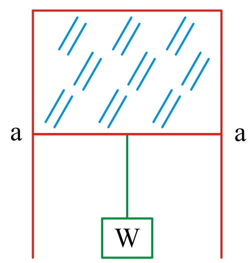
13. Two glass plates are separated by water. If surface tension of water is 75 dync/cm and the area of each plate wetted by water is $8cm^2$ and the distance between the plates is $0.12mm$, then the force applied to separate the two plates is

A. $10^2 dyne$ B. $10^4 dyne$ C. $10^5 dyne$ D. $10^6 dyne$

14. The lower end of a capillary tube is at a depth of $12cm$ and water rises $3cm$ in it. The mouth pressure required to blow an air bubble at the lower end will be x cm of water column, where x is

A. 12 B. 15 C. 3 D. 9

15. A film of soap solution is trapped between a vertical frame and a light wire ab of length $0.1m$. If $g=10m/s^2$. Then the load W that should be suspended from the wire to keep it in equilibrium is



A. 0.2 g B. 0.3g C. 0.4 g D. 0.5g

16. The angle of contact between glass and water is 0^0 and water (surface tension 70 dyn/cm) rises in a glass capillary up to 6 cm. Another liquid of surface tension 140dyn/cm. Angle of contact 60^0 and relative density 2 will rise in the same capillary up to

A. 12cm B. 24 cm C. 3cm D. 6cm

17. Work W is required to from a bubble of volume V from a given solution. What amount of work is required to be done to form a bubble of volume $2V$?

A. W B. $2W$ C. $2^{1/3}W$ D. $4^{1/3}W$

18. Two verical parallel glass plates are particly submerged in water. The distance between the plates is d and the length is l. Assume that the water between the plates does not reach the upper edges of the plates and that the wetting is complete. the water will rise to height (ρ - density of water and σ = surface tension of water)

A. $\frac{2\sigma}{\rho g d}$ B. $\frac{\sigma}{2\rho g d}$ C. $\frac{4\sigma}{\rho g d}$ D. $\frac{5\sigma}{\rho g d}$

19. A drop of liquid of density ρ is floating half - immersed in a liquid of density d. If ρ is the surface tension, the diameter of the drop of the liquid is:

A. $\sqrt{\frac{\sigma}{g(2\rho-d)}}$ B. $\sqrt{\frac{2\sigma}{g(2\rho-d)}}$ C. $\sqrt{\frac{6\sigma}{g(2\rho-d)}}$ D. $\sqrt{\frac{12\sigma}{g(2\rho-d)}}$

MULTIPLE ANSWER QUESTIONS

20. Excess pressure can be (2T/R) for

A. spherical drop B. spherical meniscus

C. cylindrical bubble in air

D. spherical bubble in water

21. If n drops of a liquid, each with surface energy E, join to from a single drop, then

A. Some energy will be released in the process

B. Some energy wil be released in the process

C. the energy released or ansorbed wil be $E\left(n-n^{2/3}\right)$

D. the energy released or absorbed will be $nE\left(2^{2/3}-1\right)$

22. When a capillary tube is dipped in a liqiud, the liquid rises to a height h in the tube. the free liquid surface inside the tube is hemispherical in shape. The tube is now pushed down so that the height of the tube outside the liquid is less than h. Then

A. The liquid will come out of the tube like in a small fountain

B. The liquid will ooze out of the tube slowly

C. The liquid will fill the tube but not come out of its upper end

D. The free liquid surface inside the tube will not be hemispherical

23. A capillary tube of radius' r' is lowered into water whose surface tension is $'\alpha'$ and density 'd'.The liquid rises to a height. Assume that the contact angle is Zero. Choose the correct statement(s):

A) Magnitude of work done by force of surface tension is $\dfrac{4\pi\alpha^2}{dg}$

B) Magnitude of work done by force ofsurface tension is $\dfrac{2\pi\alpha^2}{dg}$

C) Potential energy acquired by the water is $\dfrac{2\pi\alpha^2}{dg}$

D) The amount of heat developed is $\dfrac{2\pi\alpha^2}{dg}$

MATRIX MATCHING TYPE

This section contains 4 questions. Each question contains statements given in two column which have to be matched. Statements (A, B, C, D) in Column I have to be matched with statements (p, q, r, s) in Column II.

The answers to these questions have to be appropriately bubbles as illustrated in the following example. If the correct matches are A–p, A–s, B–q, B–r, C–p, C–q and D–s, then the correctly bubbled 4 × 4 matrix should be as follows :

24. A column of alcohol is raised in a capillary tube of internal radius of r = 0.6mm. The lower meniscus of the column hangs from the bottom end of the tube. Match the height h of the alcohol column given in Column II with the

radius of curvature R of the lower meniscus given in Column I. Consider that wetting is complete Surface tension of alcohol $T = 0.02N/m$ **and density of alcohol** $\rho = 790kg/m^3$.

Column I	**Column II**
A) if R= 3r	p) 8.3 mm
B) if R = 2r	q) 12.5 mm
C) if R = 4r	r) 5.5 mm
D) if R = -3r	s) 22.2 mm

25. **Capillary rise and shape of droplets on a plate due to surface tension are shown in Column - II match the following**

Column - I

a) Adhesive force is greater than cohesive force

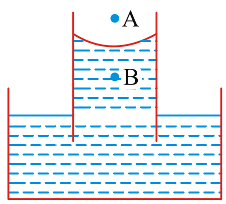
b) Cohesive force is greater than adhesive force

c) Pressure at A > pressure at B

d) Pressure at B > pressure at A

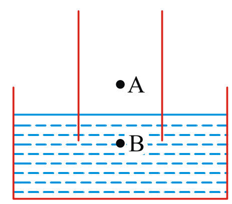
Column - II

(p)



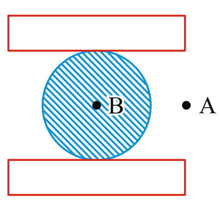
Capillary in water

(q)



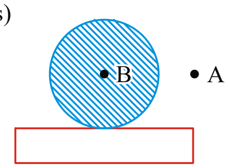
Capillary in water

(r)



Mercury drop between glass plates

(s)



Mercury drop on glass plates

STATEMENT TYPE QUESTIONS

A) ***Both Statement 1 and Statement 2 are true and Statement 2 is the correct explanation of Statement 1.***

B) ***Both Statement1 and Statement2 are true but Statement 2 is not the correct explanationof Statement 1.***

C) ***Statement 1 is true but Statement 2 is false.***

D) ***Statement 1 is false but Statement 2 is true.***

26. **Statement I:** Tiny drops of liquid resist deforming forces better than bigger drops.
StatementII: Excess pressure inside a drop is directly proportional to surface tension.

27. **Statement I:** A needle placed carefully on the surface of water may float, whereas the ball of the same material will always sink.
Statement II: The buoyancy of an object depends both on the material, shape of the object.

28. **Statement I:** Droplets of liquid are usually more spherical in shape than large drops of the same liquid.
StatementII: Force of surface tension predominates the force of gravity in case of small drops.

29. **Statement I:** Spraying of water causes cooling.
StatementII: For an isolated system, surface energy increase at the expence of internal energy.

30. **Statement I**: Finer the capillary, greater is the height to which the liquid rises in the tube.
Statement II: This is in accordance with the ascent formula.

31. **Statement I** : A needle placed carefully on the surface of water may float, whereas the ball of the same material will always sink.
Statement II: The buoyancy of an object depends both on the meterial and shape of the object

32. **Statement I**: As radius of soap bubble increases, the insude pressure increases.
Statement II: Excess pressure in soap bubble is inversely proportional to radius.

EXERCISE - VII - KEY

SINGLE ANSWER TYPE

1) A 2) C 3) A 4) C 5) C 6) A 7). C 8) B 9). A 10) C
11) A 12) D 13) C 14) B 15) D 16) C 17) D 18) A 19) D

MULTIPLE ANSWER TYPE

20) A,B,C,D 21) A.C 22) C.D 23) ACD

MATRIX MATCHING TYPE

24) A-r; B-p; C-s; D-q

25) $a \longrightarrow p\ ;\ b \longrightarrow q,r,s\ ;\ c \longrightarrow p,r,s\ ;\ d \longrightarrow q$

STATEMENT TYPE

26) B 27)C 28) A 29) A 30) A 31) C 32)D

EXERCISE - VIII

SINGLE ANSWER TYPE QUESTIONS

33. Vessel filled with air under pressure p_0 contains a soap bubble of diameter d.The air pressure have been reduced n-fold,and the bubble diameter increased r-fold isothermally. Find the surface tension of the soap-water solution.

A) $T = \frac{1}{2} p_0 d \times \frac{1 - \frac{r^3}{n}}{r^2 - 1}$

B) $T = \frac{1}{8} p_0 d \times \frac{1 - \frac{r^3}{n}}{r^2 - 1}$

C) $T = \frac{1}{4} p_0 d \times \frac{1 - \frac{r^3}{n}}{r^2 - 1}$

D) $T = \frac{1}{6} p_0 d \times \frac{1 - \frac{r^3}{n}}{r^2 - 1}$

34. The high domes of ancient buildings have structural value (besides beauty).It arises from pressure difference on the 2 faces due to curvature (as in soap

bubbles).There is a dome of radius 5 m and uniform (but small) thickness. The surface tension of its masonry structure is about 500 N/m. Treated as hemispherical, the maximum load that the dome can support is nearest to

A) $1500 kg-Wt$ B) $3000 kg-Wt$

C) $6000 kg-Wt$ D) $12000 kg-Wt$

35. **A barometer contains two uniform capillaries of radii** $1.44\times10^{-3} m$ **and** $7.2\times10^{-4} m.$ **If the height of liquid in narrow tube is 0.2 m more than that in wide tube, calculate the pressure difference. Density of liquid** $=10^3 kg/m^3$, **surface tension** $=72\times10^{-3} N/m$ **and** $g=9.8 m/s^2$

A) $1360 N/m^2$ B) $1260 mm$

C) $860 N/m^2$ D) $1860 N/m^2$

36. **In a capillary rise, find the heat developed taking all standard notations as described in the foregoing section.**

A) $Q=\dfrac{2\pi T\cos^2\theta}{\rho g}$ B) $Q=\dfrac{2\pi^2 T\cos^2\theta}{\rho g}$

C) $Q=\dfrac{2\pi T^2\sin^2\theta}{\rho g}$ D) $Q=\dfrac{2\pi T^2\cos^2\theta}{\rho g}$

37. **A vertical U- tube contains a liquid of density** ρ **and surface tension T. If the radius of the meniscus of liquid in the limbs of the U- tube are** $R_1 and R_2$ **, find the difference in the liquid column in the limbs.**

A) $\Delta h=\dfrac{T(R_1-R_2)}{\rho g R_1 R_2}$ B) $\Delta h=\dfrac{2T(R_1-R_2)}{\rho g R_1 R_2}$

C) $\Delta h=\dfrac{2T(R_1+R_2)}{\rho g R_1 R_2}$ D) $\Delta h=\dfrac{4T(R_1-R_2)}{\rho g R_1 R_2}$

38. **A mercury drop shaped as a round tablet of radius R and thickness h is located between two horizontal glass plates. Assuming that h<<R,find the mass m of a weight which has to be placed on the copper plate to diminish the distance between the plates by n-times The contact angle is equal to** θ**. calculate m if T is surface tension of the liquid.**

A) $m=\dfrac{2\pi RT^2|COS\theta|}{gh}\left(n^2-1\right)$ B) $m=\dfrac{2\pi R^2 T|\sin\theta|}{gh}\left(n^2-1\right)$

C) $m=\dfrac{2\pi R^2 T|COS\theta|}{gh}\left(n^2+1\right)$ D) $m=\dfrac{2\pi R^2 T|COS\theta|}{gh}\left(n^2-1\right)$

39. **Apair of thin plates partially submerged in water. The distance between the plates is d and their width is l. Assuming that the water between the plates does**

not reach the upper edges of the plates and that the wetting is complete, find the force of their mutual attraction.

A) $F = \frac{2T^2 l}{\rho g d^2}$ B) $F = \frac{4Tl^2}{\rho g d^2}$ C) $F = \frac{2T^2 l}{\rho g d}$ D) $F = \frac{8T^2 l}{\rho g d^2}$

40. **An air bubble of radius R is formed in a narrow tube having a radius r where $R >> r$ .Air of density ρ is blown inside the tube with velocity V. The air molecules collide perpendicularly with the wall of the bubble and stop.Find the radius at which the bubble separates from the tube.Take surface tension of the bubble as T.**

A) $\frac{4T}{\rho V^2}$ B) $\frac{2T}{\rho V^2}$ C) $\frac{T}{\rho V^2}$ D) $\frac{2T}{\rho V}$

41. **The diameter of an air - bubble formed at the bottom of a pond is $d = 4\mu m$, when the bubble rises to the surface, its diameter increases $n = 1.1$ times. If expansion of air bubble is assumed to be isothermal and atmospheric pressure to be standard. how deep the pond at the spot is**

(a) 2.5 m (b) 10 m (c) 7.5 m (d) 5 m

42. **A glass capillary of length $l = 11cm$ and inside diameter, $d = 20\mu m$ is submerged vertically into water. The upper end of the capillary is sealed. the outside pressure is considered to be $1 \times 10^5 N/m^2$. To what length, has the capillary to be submerged to make the water levels inside and outside the capaillary coincide?**

(a) 1.2cm (b) 2.4cm (c) 1.4cm (d) 2.8cm

43. **Two verticl parallel glass plates are partially submerged in water. The distance between the plates is $d = 0.10mm$, and their width is $l = 12cm$. Assuming that the water between the plates does not reach the upper edges of the plates and the wetting is complete. Find the force of their mutual attraction**

(a) 13N (b) 26N (c) 39N (d) 6.5N

COMPREHENSION TYPE QUESTIONS

Comprehension : 1

molecular forces exist between the molecules of a liquid in a container. The molecules on the surface have unequal force leading a tension on the surface. if this is not compensated by a force, the equilibrium of the liquid will be a difficult task. This leads to an excess pressure on the surface. The nature of the meniscus can inform us of the direction of the excess pressure. The angle of contact of the liquid decided by the forces between the molecules, air and cotainer can make the angle of contact.

44. **The direction of the excess pressure in the meniscus of a liquid of anfle of contact $2\pi/3$ is**

A. upward B downward C. horizontal D. connot be determined

45. **If the excess pressure in a soap bubble is p, the excess in an air bubble is**

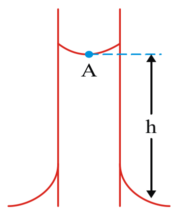
A. $\frac{p}{2}$ B. p C. $2p$ D. $4p$

46. In a meniscus of radius r .with excess pressure p in atmospheric pressure p_0, the force experiended is

A. $(p-p_0)\pi r^3$ B. $(p-p_0)2\pi r$ C. $p\pi r^2$ D. $p_0 2\pi r$

Comprehension -2

The figure shows a caillary tube of radius r dipped into water. The atmospheric pressure is P_0 and the capillary rise of water is h.s is the surface tension for water - glass.



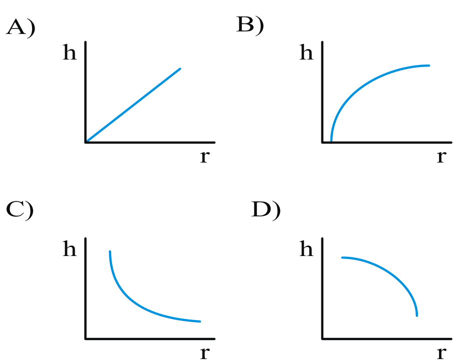
47. The pressure inside water at the point A (lowest point of the meniscus) is

A. P_0 B. $P_0+\frac{2s}{r}$ C. $P_0-\frac{2s}{r}$ D. $P_0-\frac{4s}{r}$

48. Initially, $h=10cm$. If the capillary tube is now inclined at 45^0, the length of water rising in the tube will be

A. $10cm$ B. $10\sqrt{2}cm$ C. $\frac{10}{\sqrt{2}}cm$ D. None of these

49. Which of the following graphs may represent the relation between the capillary rise h and the radius r of the capillary?



Comprehension - 3:

Surface tension arises from the cohesive force between the surface molecules.Interplay between

cohesion and adhesion forces make the surface inclined at acute or obtuse angle with the contacting solid surfaces. This causes a capillary rise (or fall) given as; $h=\frac{2T\cos\theta}{\rho gr}$, where θ= angle of contact,T= surface tension, ρ = density of the liquid,g=acceleration due to gravity and r= radius of the capillary tube.

50. In capillary action, θ can be:

A) 0^o B) 90^o C) $90^0<\theta<180^0$ D) all of these

51. In capillary rise;

A) heat is evolved B) U_{gr} decrease C) U_{total} increase D) heat is absorbed

52. If the vessel accelerates up, capillary rise;

A) increases B) decreases C) remains the same D) becomes zero

Comprehension-4:

When liquid medicine of density ρ is to be put in the eye, it is done with the help of a dropper. As the bulb on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop.We first assume that the drop formed at the opening is spherical because that requires a minimum increase in its surface energy. To determine the size, we calculate the net vertical force due to the surfacetension T when the radius of the drop is R. When this force becomes smaller than the weight of the drop ,the drop gets detached from the dropper.

53. If the radius of the opening of the dropper is r, the vertical force due to the surface tension on the drop of radius R (assuming r << R) is

A) $2\pi rT$ B) $2\pi rRT$ C) $\frac{2\pi r^2 T}{R}$ D) $\frac{2\pi R^2 T}{r}$

54. If r = 5 ×10⁻⁴ m, ñ = 10³ kgm⁻³, g = 10 ms⁻², T = 0.11 Nm⁻¹, the radius of the drop when it detaches from the dropper is approximately

A) 1.4×10^{-3} m B) 3.3×10^{-3} m C) 2.0×10^{-3} m D) 4.1×10^{-3} m.

INTEGER TYPE QUESTIONS

55. A conical glass capillary tube of length 0.1m has diameter 10^{-3} and 5×10^{-4} m respectively at its ends. When it is just immersed in a liquid at $0^0 C$ with larger diameter in contact with liquid, the liquid rises to $8\times10^{-2} m$ in the tube.If another cylindrical glass capillary tube B is immersed in the same liquid at $0^0 C$,the liquid rises to 6×10^{-2} m height.The rise of liquid in the tube B is only 5.5×10^{-2} m when the liquid is at $50^0 C$.Density of the liquid is $(1/14)\times10^4 kg/m^3$ and angle of contact is zero.Effect of temperature on the density of liquid and glass is negligible.The rate at which the surface tension changes with temperature considering the change to be linear is given by $-1.4\times10^{-n} N/m^0C$.What is the value of n?

56. There is a soap bubble of radius $2.4\times10^{-4} m$ in air cylinder which is originally at a pressure of $10^5 N/m^2$ .The air in the cylinder is now compressed isothermally untill the radius of the bubble is halved.(The surface tension of the soap film is $0.08 Nm^{-1}$).The pressure of air in the cylinder is found to be $8.08\times10^n N/m^2$. What is the value of n?

57. Two vertical parallel glass plates are partially submerged in water.The distance between the plates is $d = 0.10 mm$ and their width is $l = 12 cm$.Assuming that the water between the plates does not reach the upper edges ofthe plates and that wetting is complete,it is found that the force of their mutual attraction,is (n+20)N. What is the value of n? (T=0.073N/m)

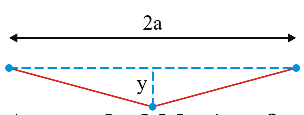
58. A vertical water jet flows out of a round hole.one of the horizontal sections of the jet has a diameter d=2.0mm while the other section located $l = 20 cm$ lower has the diameter which is $n = 1.5$ times less.The volume of the water flowing

from the hole each second is found to be $9\times10^{-n}cm^3/s$. What is the value of n? (Surface tension T=0.073N/m,and density of water $=10^3 kg/m^3$).

59. **a glass rod of diameter $d_1=1.5mm$ is inserted symetrically into a glass capillary with inside daimeter $d_2=2.0mm$. Then the whole arrange ment is vertically oriented and brought in contant with the surface of water. To what Leight in cm will be water rise in the capillary?**

60. **Find the attractive force is newton between two paralhl glass plates, separated by a distance, $h=0.10mm$, after a water drop of mass $m=70mg$ was introduced between them. Assume wetting to be complete and surface tension of water, $T=70dyne/cm$**

61. **A thin film of a liquid is maintained between two very long, thin, parallel, horizontal wires separated by a distance 2a. A long wire of mass per unit length λ is gently placed over the liquid film at the middle parallel to the wires. As a result the liquid surface is depresed by a vertical distance y(y <<a) at equilibrium. The suraface tension of the liquid is $\frac{\lambda ga}{ky}$ then k is**



62. **A soap bubble (surface tension T) is charged to a uniform charged density σ. At equilibrium, the radius of the bubble is given by $\frac{N\varepsilon_0 T}{\sigma^2}$. The value of N is [Assume that atmosphere is not present]**

EXERCISE - VIII - KEY

SINGLE ANSWER TYPE

33) B 34) B 35) D 36) D 37) B 38) D 39) A 40) A 41) D. 42)C 43) A

COMPREHENSION TYPE

44) A 45) A 46) C 47)C 48)B 49)B 50) D 51) A 52) B 53) C 54) A

INTEGER TYPE

55) 4 56) 5 57) 4 58) 1 59) 6 60) 1 61) 2 62) 8

EXERCISE - I

THERMODYNAMICS

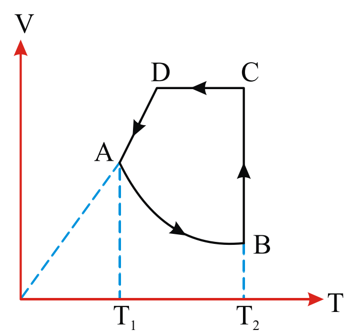
SINGLE ANSWER QUESTIONS

1. **An amount Q of heat is added to a mono atomic ideal gas in a process in which the gas performs a work Q/2 on its surrounding. Find equation of the process.**

(A) $PV^{1/3} = constant$ (B) $PV^{-1/4} = constant$

(C) $PV^{1/4} = constant$ (D) $PV^{-1/3} = constant$

2. **Figure shows a cycle ABCDA undergone by 2 moles of an ideal diatomic gas. The curve AB is a rectangular hyperbola and T_1 = 300 K and T_2 = 500 K. Determine the work done by the gas in the process A → B.**



(A) -3.326 kJ (B) 4.326 kJ (C) 2.326 kJ (D) 3.326 kJ

3. **One mole of an ideal monoatomic gas undergoes a process defined by $U = a\sqrt{V}$ where U is internal energy and V is its volume. The molar specific heat of the gas for this process is found to be $\frac{*}{12}R$. The number in the numerator is not readable. What may be this number ?**

(A) 25 (B) 21 (C) 41 (D) 42

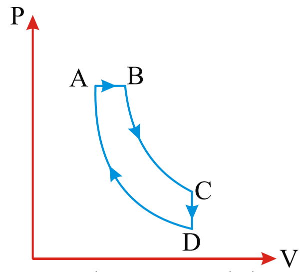
4. **An ideal gas can be expanded from an initial state to a certain volume through two different processes,**
(I) $PV^2 = K$ and (II) $P = KV^2$, where K is a positive constant. Then, choose the correct option from the following.

(A) Final temperature in (I) will be greater than in (II)
(B) Final temperature in (II) will be greater than in (I)
(C) Work done by the gas in both the processes would be equal
(D) Total heat given to the gas in (I) is greater than in (II)

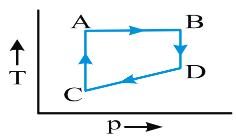
5. **Monoatomic , diatomic and triatomic gases whose initial volume and pressure are same, each is compressed till their pressure becomes twice the initial pressure. Then :**

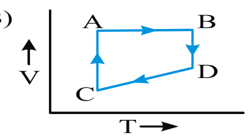
(A) if the compression is isothermal, then their final volumes will be same
(B) if the compression is adiabatic, then their final volumes will be different
(C) if the compression is adiabatic , then monoatomic gas will have maximum final volume
(D) All of these

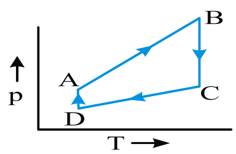
6. A cyclic process ABCD is shown in the $p-V$ diagram. Which of the following curves represent the same process ?

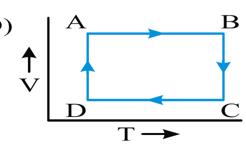


BC and DA are Hyperbolas

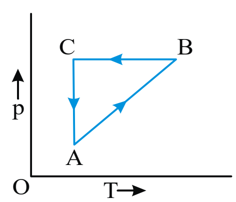
A) 

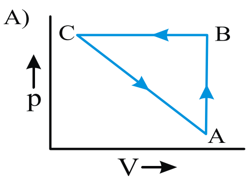
B) 

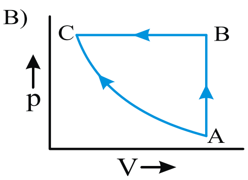
C) 

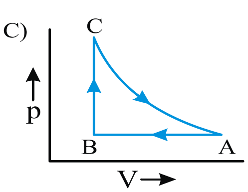
D) 

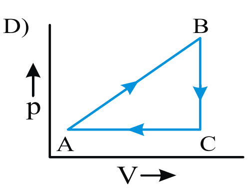
7. A cyclic process is shown in the *P-T* diagram. Which of the curves show the same process on aP-*V* diagram ?



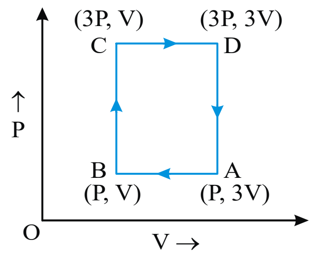
A) 

B) 

C) 

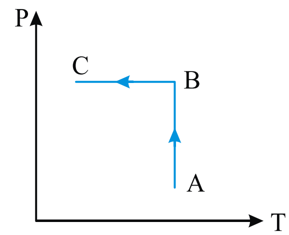
D) 

8. An ideal monoatomic gas is taken round the cycle ABCDA as shown in following *P-V* diagram. The work done during the cycle is



(A) PV (B) 2PV (C) 4PV (D) 3PV

9. Ideal gas is taken through the process shown in the figure :

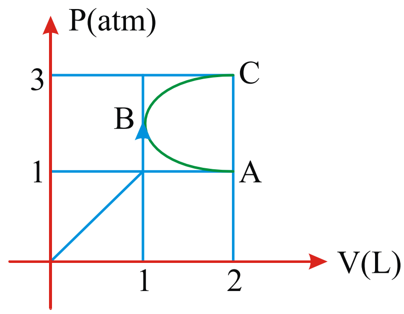


(A) in process AB, work done by system is positive
(B) in process AB, heat is rejected
(C) in process AB, internal energy increases
(D) in process AB internal energy decreases and in process BC, internal energy increases.

10. The specific heat of solids at low temperatures varies with absolute temperature T according to the relation S = AT^3, where A is a constant. The heat energy required to raise the temperature of a mass m of such a solid from T = 0 to T = 20 K is :

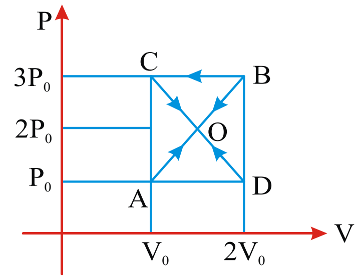
(A) 4×10^4 mA (B) 2×10^3 mA
(C) 8×10^6 mA (D) 2×10^6 mA.

11. In the P–V diagram shown in figure ABC is a semicircle. The work done in the process ABC is



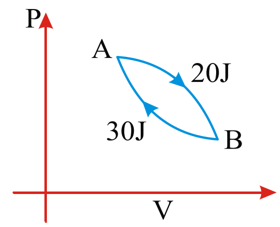
(A) zero (B) $\frac{\pi}{2}$ atm – L (C) $-\frac{\pi}{2}$ atm – L (D) 4 atm–L.

12. A thermodynamic system undergoes cyclic process ABCDA as shown in figure. The work done by the system is



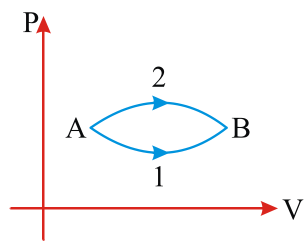
(A) $P_0 V_0$ (B) $2 P_0 V_0$ (C) $\frac{P_0 V_0}{2}$ (D) zero.

13. **In a cyclic process shown in the figure an ideal gas is adiabatically taken from B to A, the work done on the gas during the process B to A is 30 J, when the gas is taken from A to B the heat absorbed by the gas is 20 J. The change in internal energy of the gas in the process A to B is :**



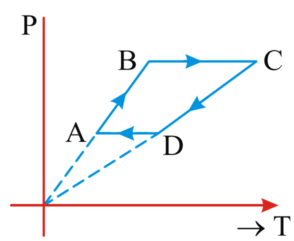
(A) 20 J (B) –30 J (C) 50 J D) –10 J

14. **The figure shows two paths for the change of state of a gas from A to B. The ratio of molar heat capacities in path 1 and 2 is :**



(A) > 1 (B) < 1 (C) 1 (D) data insufficient

15. **3 moles of an ideal mono atomic gas performs a cycle as shown in fig. If gas temperature** $T_A = 400$ K $T_B = 800$K, $T_C = 2400$ K, **and** **T_D = 1200K. Then total work done by gas is**



(A) 2400 R (B) 1200 R (C) 2000 R (D) Zero

16. **A metal block of density 5000 kg/m^3 and mass 2 kg is suspended by a spring of force constant 200 N/m. The spring block system is submerged in water vessel. Total mass of water in vessel is 300 gm and in equilibrium the block is at a height 40 cm above the bottom of vessel. The specific heat of material of block**

is 250J/kg/k and that of water is 4200 J/kg/k. Neglect the heat capacities of vessel end the spring. If the support is broken the rise in temperature of water, when block reaches bottom of vessel is

(A) 0.0012°C (B) 0.0049°C (C) 0.0028°C (D) 0.0°C

17. **One mole of Argon undergoes a process given by $PV^{3/2}$ = const. If heat obtained by gas is Q and molar specific heat of gas in the process is C then which of the following is correct if temperature of gas changes by -26 K (assume Argon as an ideal gas)**

(A) C = 0.5 R, Q = 13 R (B) C = -0.5 R, Q = 1.3 R
(C) C = -0.5 R, Q = 13 R (D) C = 0, Q = 13 R

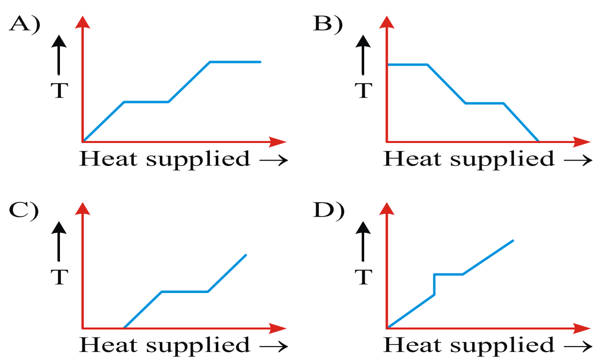
18. **2 kg of ice at –20°C is mixed with 5 kg of water at 20°C in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water and ice are 1 kcal/kg°C and 0.5 kcal/kg°C while the latent heat of fusion of ice is 80 kcal/kg [IIT - 2003]**

(A) 7kg (B) 6kg (C) 4 kg (D) 2 kg

19. **Steam at 100°C is passed into 1.1 kg of water contained in a calorimeter of water equivalent 0.02 kg at 15°C till the temperature of the calorimeter and its contents rise to 80°C. The mass of the steam condensed in kilogram is**

(A) 0.130 (B) 0.065 (C) 0.260 (D) 0.135

20. **A block of ice at –10°C is slowly heated and converted to steam at 100°C. which of the following curves represents the phenomenon qualitatively ? [IIT - 2000]**



21. **The mass of Hydrogen molecule is $3.32\times10^{27}\,kg$. If 10^{23} hydrogen molecules strikes a fixed wall of area $2cm^2$ at angle of 45^0 to the normal persecond and rebound elastically with a speed of $10^3\,ms^{-1}$ then the pressure on the wall**

A) $2.45\times10^3\,Nm^{-2}$ B) $2.347\times10^3\,Nm^{-2}$ C) $3.264\times10^3\,Nm^{-2}$ D) $1.864\times10^3\,Nm^{-2}$

22. **A closed container of volume $0.02m^2$ contains a mixture of Neon and Argon gases, at a temperature of 27^0C and pressure of $1\times10^5\,Nm^{-2}$. The total mass of the mixture is 28g. If the gram molecular weights of Neon and argon are 20 and 40 respectively, masses of the individual gass are [IIT- 1994]**

A) 4g,24g B) 8g,20g C) 12g,16g D) 6g, 22g

23. **In an adiabetic process, $R=\frac{2}{3}Cv$. The pressure of the gas will be proportional**

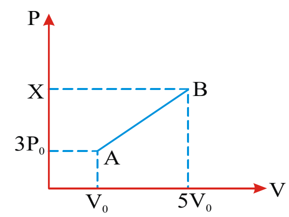
to

A) $T^{5/3}$ B) $T^{5/2}$ C) $T^{5/4}$ D) $T^{5/6}$

24. **The heat supplied to one mole of an ideal monoatomic gas in increasing temepreature from T_0 to $2T_0$ is $2RT_0$. Find the process to which the gas follows**

A) PV = constant B) P/V = constant C) V /P = constant D) $PV^2 =$ constant

25. **One mole of monoatomic ideal gas follows a proces AB, as shown. The specific heat of the process is $\frac{13R}{6}$. find the value of x on P - axis.**



A) $4P_0$ B) $5P_0$ C) $6P_0$ D) $8P_0$

26. **5.6 Litre of helium gas at STP is adiabatically compressed to 0.7 litre. Taking the initial temperature to be T_1, the work done in the process is (IIT JEE-2011)**

(a) $\frac{9}{8}RT_1$ (b) $\frac{3}{2}RT_1$ (c) $\frac{15}{8}RT_1$ (d) $\frac{9}{2}RT_1$

27. **Two moles of ideal helium gas are in a rubber balloon at 30^0C. The balloon is fully expandable and can be assumed to require no energy in its expansion. The temperature of the gas in the balloon is slowly changed to 35^0C. The amount of heat required in raising the temperature is nearly (take R = 8.31 J/mol.K) (IIT JEE-2012)**

(A) 62 J (B) 104 J (C) 124 J (D) 208 J

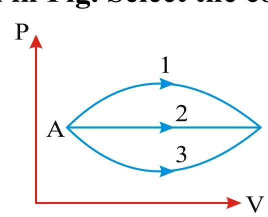
MULTIPLE ANSWER QUESTIONS

28. **Molar heat capacity of an ideal gas varies as $C = C_v + \alpha T, C = C_v + \beta V$ and $C = C_v + ap$, where α, β and a are constants. Find the equations of the process for an ideal gas in terms of the variables T and V.**

(A) $Ve^{-(\alpha T/R)} = const$ (B) $T.e^{(R/\beta V)} = const$

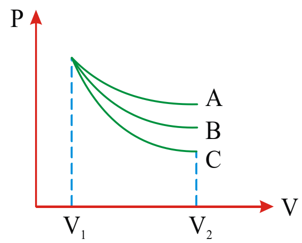
(C) $V = anT$ (D) $Va = nT$

29. **A gas undergoes change in its state from position A to position B via three different paths as shown in Fig. Select the correct alternatives:**



(A) Change in internal energy in all the three paths is equal.
(B) In all the three paths heat is absorbed by the gas.
(C) Heat absorbed/released by the gas is maximum in path (1).
(D) Temperature of the gas first increases and then decreases continously in path (1).

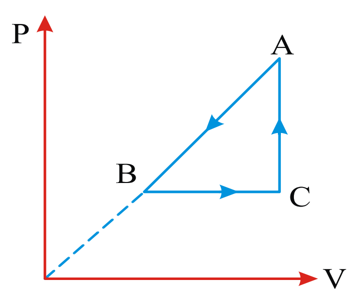
30. **An ideal gas undergoes an expansion from a state with temperature T_1 and volume V_1 through three different polytropic processes A, B and C as shown in the P–V diagram. If $|\Delta E_A|, |\Delta E_B|$ and $|\Delta E_C|$ be the magnitude of changes in internal energy along the three paths respectively, then:**



(A) $|\Delta E_A| < |\Delta E_B| < |\Delta E_C|$ if temperature in every process decreases
(B) $|\Delta E_A| > |\Delta E_B| > |\Delta E_C|$ if temperature in every process decreases
(C) $|\Delta E_A| > |\Delta E_B| > |\Delta E_C|$ if temperature in every process increases
(D) $|\Delta E_B| < |\Delta E_A| < |\Delta E_C|$ if temperature in every process increases

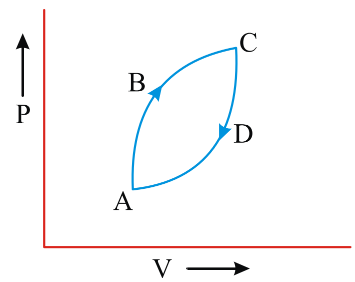
31. **Select the correct alternatives for an ideal gas:**
(A) The change in internal energy in a constant pressure process from temperature T_1 to T_2 is equal to $nC_v (T_2 - T_1)$, where C_v is the molar specific heat at constant volume and n the number of moles of the gas.
(B) The change in internal energy of the gas and the work done by the gas are equal in magnitude in an adiabatic process.
(C) The internal energy does not change in an isothermal process.
(D) No heat is added or removed in an adiabatic process.

32. **Diagram of a cyclic process ABCA is as shown in fig. Choose the correct alternative.**



(A) $\Delta Q_{A \to B}$ is negative
(B) $\Delta U_{B \to C}$ is positive
(C) $\Delta U_{C \to A}$ is negative
(D) ΔW_{CAB} is negative

33. **Figure shows the P-V diagram of a cyclic process. If dQ is the heat energy supplied to the system, dU is change in the internal energy of the system and dW is the work done by the system, then which of the following relations is/are correct**



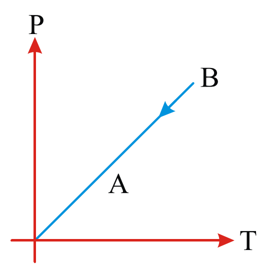
(A) $dQ = dU - dW$ (B) $dU = 0$ (C) $dQ = dW$ (D) $dQ = - dW$

34. Two gases have the same initial pressure, volume and temperature. They expand to the same final volume, one adiabatically and the other isothermally

(A) the final temperature is greater for the isothermal process
(B) the final pressure is greater for the isothermal process
(C) the work done by the gas is greater for the isothermal process
(D) all the above options are incorrect

35. During the process A–B of an ideal gas :

(A) work done on the gas is zero
(B) density of the gas is constant
(C) slope of line AB from the T–axis is inversely proportional to the number of moles of the gas
(D) slope of line AB from the T–axis is directly proportional to the number of moles of the gas.



36. 1 kg of ice at 0ºC is mixed with 1.5 kg of water at 45ºC [latent heat of fusion = 80 cal/g]. Then

(A) the temperature of the mixture is 0ºC
(B) mixture contains 156.25 g of ice
(C) mixture contains 843.75 g of ice
(D) the temperature of the mixture is 15ºC.

37. In a thermodynamic process helium gas obeys the law $TP^{-2/5}$ = constant. If temperature of 2 moles of the gas is raised from T to 3T, then

(A) heat given to the gas is 9RT
(B) heat given to the gas is zero
(C) increase in internal energy is 6RT
(D) work done by the gas is –6RT.

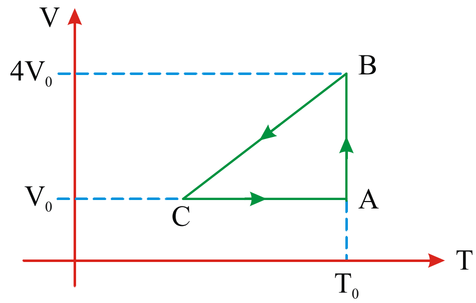
38. A gas is found to obey the law P^2V = constant. The initial temperature and volume are T_0 and V_0. If the gas expands to a volume $3V_0$, then

(A)final temperature become $\sqrt{3}\,T_0$
(B) internal energy of the gas will increase

(C) final temperature becomes $\frac{T_0}{\sqrt{3}}$

(D) internal energy of the gas decreases.

39. **The figure shows the P-V plot of an ideal gas taken through a cycle ABCDA. The part ABC is a semi-circle and CDA is half of an ellipse. Then [IIT-JEE-2009]**



(A) The process during the path $A \rightarrow B$ is isothermal

(B) Heat flows out of the gas during then path $B \rightarrow C \rightarrow D$

(C) Work done during the path $A \rightarrow B \rightarrow C$ is zero

(D) Positive work is done by the gas in the cycle ABCDA

40. **C_V and C_P denote the molar specific heat capacities of a gas at constant volume and constant pressure, respectively, Then [IIT-2009]**

(A) $C_P - C_V$ is larger for a diatomic ideal gas then for a monoatomic ideal gas

(B) $C_P + C_V$ is larger for a diatomic ideal gas then for a monoatomic ideal gas

(C) C_P / C_V is larger for a diatomic ideal gas then for a monoatomic ideal gas

(D) $C_P \,.\, C_V$ is larger for a diatomic ideal gas then for a monoatomic ideal gas

41. **An ideal gas is taken from state A (pressure, P volume V) to the state B (preesure P / 2), volume2V) along a straight line path in P-V diagram. Select the correct statement from the following**

a) The work done by the gas in the process A to B exceeds the work that would be done by it if the system were taken from A to B along an isotherm

b) In T-V diagram, the path AB becomes a part of a parabola

c) In P - T diagram, path AB becomes a part of a hyperbola

d) In going from A to B, the temeprature T of the first increases to a maximum value and then decrases

42. **During melting of a slab of ice at 273 K at atmospheric pressure.**

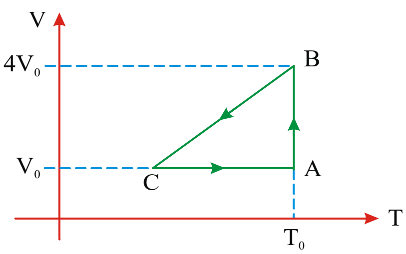
a) positive work is done by ice-water system on the atmosphere

b) positive work is done on ice-water system by the atmoshpere

c) the internal energy of the ice-water system increases

d) the internal energy of the ice-water system decreases

43. **One mole of an ideal gas in inital state A undergoes a cyclic process ABCA, as shown in figure. Its pressure at A is P_0. Choose the correct option(s) from the following : (IIT JEE-2010)**



(a) internal energies at A and B are the same

(b) work done by the gas in process AB is $P_0V_0\ell n\ 4$

(c) pressure at C is $\frac{P_0}{4}$ (d) temperature at C is $\frac{T_0}{4}$

MATRIX TYPE QUESTIONS

44. In Column I some statements or expressions related to first law of thermodynamics are given and in column II some processes are mentioned. Match the entries of column I, with the entries of column II.

Column I

(A) $dU = nC_VdT$ is valid for

(B) Temperature of the system can change in

(C) $Q = dU + W$ is valid for

(D) The process in which heat exchange

Column II

(p) Adiabatic process

(q) Isothermal process

(r) Polytropic process

(s) Free expansion between the system and surroundings is zero

45. There is an ideal gas sample. The ratio of C_P and C_V for gas sample is γ. In its initial state its pressure is P_1 and volume is V_1. Now it is expanded isothermally from volume V_1 to V_2. Then it is compressed adiabatically from volume V_2 to V_1 again

Regarding the above situation, match the following

Column I

(A) Heat given to system (i.e. ideal gas sample)

(B) Work done by gas during adiabatic

(C) Change in internal energy of gas sample

(D) Change in internal energy of gas sample

Column II

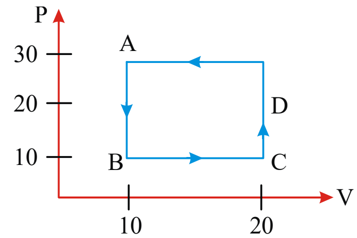
(p) positive during isothermal expansion.

(q) $\frac{P_1 V_1}{(\gamma - 1)}\left[\left(\frac{V_2}{V_1}\right)^{\gamma-1} - 1\right]$ compression

(r) $\frac{P_1 V_1}{(1 - \gamma)}\left[\left(\frac{V_2}{V_1}\right)^{\gamma-1} - 1\right]$ during adiabatic process

(s) Negative from most initial state to the final state.

46. The figure shows a cyclic process ABCDA.

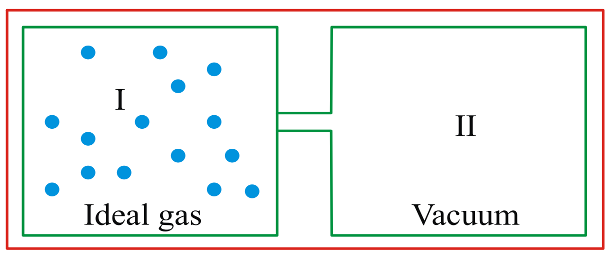


Column I (Process)	**Column II**
A) AB	(p) $W < 0$
B) BC	(q) $Q > 0$
C) CD	(r) $W > 0$
D) DA	(s) $Q < 0$

47. Column I contains a list of processes involving expansion of an ideal gas. Match this with Column II describing the thermodynamic change during this process. (IIIT 2008)

Column I

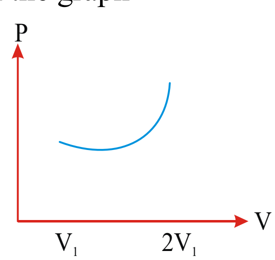
A) An insultated container has two chambers separated by a valve chamber I contains an ideal gas and the chamber II has vacuum.



B) An ideal monoatomic gas expands to twice its original volume such that or remains constant its pressure $P\alpha\frac{1}{V^2}$, where V is the volume of the gas

C) An ideal moniatomic gas expands to twice its original volume such that its pressure $P\alpha\frac{1}{V^{4/3}}$ Where V is its volume

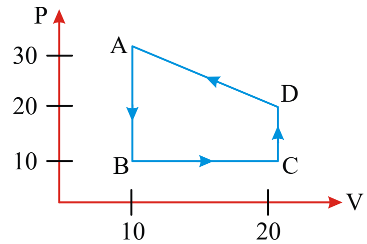
D) An ideal monoatomic gas expands such that its pressure P and volume V followsthe behaviour shown in the graph



Column II

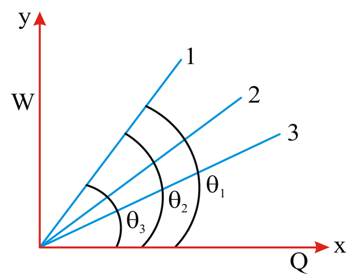
p) The temperature of the gas decreases
q) The temperature of the gas increases
r) The gas loses heat
s) The gas gains heat

48. The figure shows a cylic process ABCDA.



Column I (Process)	**Column II**
A) AB	(p) $W < 0$
B) BC	(q) $Q > 0$
C) CD	(r) $W > 0$
D) DA	(s) $Q < 0$

49. **Work done and heat supplied are represented on y and x-axes respectively for two gases showing an isotherm and two isobars. The scales of two axes are same. The initial state of two gases aresame.** $\tan\theta_1 = 1,\ \tan\theta_2 = 2/5\ and\ \tan\theta_3 = 2/7$ **. match the options of the two columns.**



COLUMN - I

a) straight line 1 corresponds to

b) straight line 2 corresponds to

c) straight line 3 corresponds to

d) y - axis corresponds to

COLUMN - II

P) isothermal process

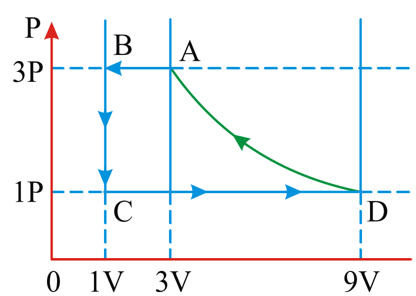
Q) monoatomic gas

R) diatomic gas

S) adiabatic process

50. **One mole of a monatomic ideal gas is taken through a cycle ABCDA as shown in the P - V diagram. Column-II gives the characteristics involved in the cycle. Match them with each of the processes given Column-I.**

(IIT -2011)



Column-I
(A) Process A - B
(B) Process B - C
(C) Process C - D
(D) Process D - A
Column-II
(p) Internal energy decreases
(q) Internal energy increases
(r) Heat is lost
(s) Heat is gained
(t) Work is done on the gas.

COMPREHENSIVETYPE QUESTIONS

Passage : 1

A closed and isolated cylinder contains ideal gas. An adiabatic separator of mass m, cross sectional area A divides the cylinder into two equal parts each with volume V_0 and pressure P_0 in equilibrium Assume the separator to move without friction.

51. If the piston is slightly displaced by x, the net force acting on the piston is

(A) $\frac{P_0\gamma A^2 x}{V_0}$ (B) $\frac{2P_0\gamma A^2 x}{V_0}$ (C) $\frac{3P_0\gamma A^2 x}{V_0}$ (D) $\frac{P_0\gamma A^2 x}{(\gamma-1)V_0}$

52. Identify the correct statement

(A) The process is adiabatic only when the piston is displaced suddenly
(B) The process is isothermal when the piston is moved slowly
(C) The motion is periodic for any displacement of the piston
(D) The motion is SHM for any displacement of the piston

53. The time period of oscillation for small displacements of the piston is

(A) $2\pi\sqrt{\frac{mV_0}{2P_0\gamma A^2}}$ (B) $2\pi\sqrt{\frac{mV_0}{4P_0\gamma A^2}}$ (C) $2\pi\sqrt{\frac{mV_0(\gamma-1)}{2P_0\gamma A^2}}$ (D) none of these

Passage : 2

A calorimeter of mass m contains an equal mass of water in it. The temperature of the water and calorimeter is t_2. A block of ice of mass m and temperature $t_3 < 0^oC$ is gently dropped into the calorimeter. Let C_1, C_2 and C_3 be the specific heats of calorimeter, water and ice respectively and L be the latent heat of ice.

54. The whole maxture in the calorimeter becomes ice if

(A) $C_1t_2 + C_2t_2 + L + C_3t_3 > 0$ (B) $C_1t_2 + C_2t_2 + L + C_3t_3 < 0$

(C) $C_1t_2 + C_2t_2 - L - C_3t_3 > 0$ (D) $C_1t_2 + C_2t_2 - L - C_3t_3 < 0$

55. The whole mixture in the calorimeter becomes water if

(A) $(C_1 + C_2)t_2 - C_3t_3 + L > 0$ (B) $(C_1 + C_2)t_2 + C_3t_3 + L > 0$

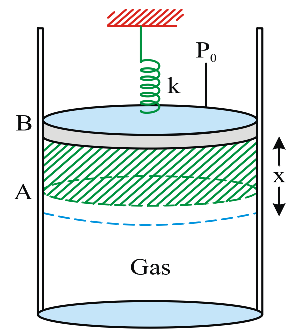
(C) $(C_1 + C_2)t_2 - C_3t_3 - L > 0$ (D) $(C_1 + C_2)t_2 + C_3t_3 - L > 0$

56. Water equivalent of calorimeter is

(A) mC_1 (B) $\frac{mC_1}{C_2}$ (C) $\frac{mC_2}{C_1}$ (D) None of these

Passage : 3

Two mole of an ideal monatomic gas are confined within a cylinder by a mass less spring loaded with a frictionless piston of negligible mass and crossectional area $4 \times 10^{-3} m^2$. The spring is initially in ill relaxed state. Now the gas is heated by a heater for some time. During this time the gas expands and does 50J of work in moving the piston through a distance of 0.01m. The temperature of gas increases by 50k.



57. The force constant of spring is

(A) 189.6 N m^{-1} (B) 18.96 N m^{-1} (C) 1896 N m^{-1} (D) 2896 N m^{-1}

58. Change in internal energy of the gas is

(A) 1246.5 J (B) 124.65 J (C) 200 J (D) 12.46 J

59. Heat supplied by heater during this process is

(A) 129.65 J (B) 1296.5 J (C) 12.96 J (D) 250 J

Passage : 4

A mercury barometer is defective. When an accurate barometer reads 770 mm, the defective one reads 760 mm. When the accurate one reads 750 mm, the defective one reads 742 mm. then

60. The length of air coloumn when accurate barometer reads 770mm is

A) 76 mm B) 74 mm C) 72mm D) 70mm

61. The reading of the accurate barometer, when defective are reads 752mm is

A) 760mm B) 764mm C) 758mm D) 761mm

ASSERTION & REASON TYPE QUESTIONS

Note : Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 5 choices (A), (B), (C), (D) and (E) out of which ONLY ONE is correct.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement -1 is True, Statement-2 is False.

(D) Statement -1 is False, Statement-2 is True.

(E) Statement -1 is False, Statement-2 is False

62. **Statement -1 :** If an ideal gas expands in vacuum in an insulated chamber, ΔQ, ΔU

and ΔW all are zero.

Statement -2 : Temperature of the gas remains constant.

63. **Statement -1 :** At a given temperature the specific heat of a gas at constant volume is always greater than its specific heat at constant pressure.

Statement -2 : When a gas is heated at constant volume some extra heat is needed compared to that at constant pressure for doing work in expansion.

64. **Statement -1 :** Internal energy change is zero if the temp is constant, irrespective of the process being cyclic or non-cyclic.

Statement -2 : $dU = n\,C_v dT$ for all process and is independent of path.

65. **Statement -1 :** As the temperature of the blackbody increases, the wavelength at which the spectral intensity (E_λ) is maximum decreases.

Statement -2 : The wavelength at which the spectral intensity will be maximum for a black body is proportional to the fourth power of its absolute temperature.

66. **Statement -1 :** The specific heat of a gas in an adiabatic process is zero but it is infinite in an isothermal process.

Statement -2 : Specific heat of a gas directly proportional to heat exchanged with the system and inversely proportional to change in temperature.

INTEGER TYPE QUESTIONS

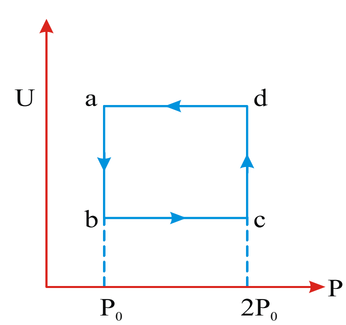
67. **A 50 gm lead bullet (sp. heat 0.020 cal/g) is initially at $30^0 C$. It is fired vertically upward with a speed 84 m/s. On returning to the starting level, it strikes a slab of ice at $0^0 C$. $(A \times 100)$ mg of ice is melted. Find the value of 'A'.**

68. **An ideal gas ($C_p/C_V = \gamma$) is taken through a process in which the pressure and the volume are related as $P = a V^b$. The value of b for which the specific heat capacity in the process is zero is $b = -\frac{x\gamma}{2}$. Find the value of x.**

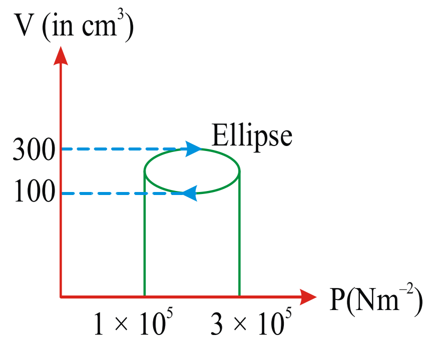
69. **A vessel contains helium, which expands at constant pressure when 15 kJ of heat is supplied to it. Wat will be the variation of the internal energy of the gas? (in kJ)**

70. **When a quantity of liquid bismuth at its melting point is transferred to a calorimeter containing oil, then the temperature of oil rises from 12.5°C to 27.6°C. The experiment is repeated under identical condition except that bismuth is solid, the temperature of the oil rises to 18.1°C. The specific heat of bismuth is 0.032 cal/g'C, The latent heat of fusion of bismuth is 6.7 *K* cal/g. Then determine the value of *K1* Melting point of bismuth is 271°C.**

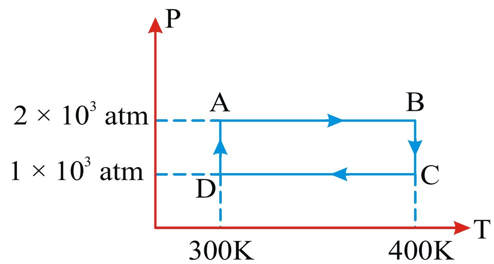
71. **Figure shows the variation of internal energy (U) with the pressure (P) of 2.0 mole gas in cyclic process abcda. The temperatures of gas at c and d are 300 and 500 K, respectively. The heat absorbed by the gas during the process is $x \times 100R \ln 2$. Find the value of x.**



72. **The heat absorbed by a system in going through the cyclic process shown in Fig is $x \times 5\pi J$. Find the value of x.**



73. **1/R (R is universal gas constant) moles of an ideal gas $(\gamma = 1.5)$ undergoes a cyclic process (ABCDA) as shown in figure. Assuming the gas to be ideal. If the net heat exchange is 10x Joules, find the value of x ? [In 2 = 0.7]**



74. **A metal rod AB of length 10x has its one end A in ice at 0°C and the other end B in water at 100°C . If a point P on the rod is maintained at 400°C, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 cal/g and latent heat of melting of ice is 80 cal/g. If the point P is at a distance of λx from the ice end A, find the value of λ. [Neglect any heat loss to the surrounding]**

75. **An ideal diatomic gas under goes a process in which its internal energy changes with volume as given $U = cV^{2/5}$ where c is constant. Find the ratio of molar heat capacity to universal gas constant R ?**

76. **An ideal gas is taken through a cyclic thermodynamic process through four steps. The amount of heat involved in four steps are $Q_1 = 6000J, Q_2 = -5000J, Q_3 = -3000J$ and $Q_4 = 4000J$ respectively. If efficiency of cycle is 10x% then find value of x?**

77. **A piece of ice (heat capacity $= 2100\ J\ kg^{-1}\ {}^0C^{-1}$ and latent heat $= 3.36 \times 10^5\ J\ kg^{-1}$) of mass m grams is at $5^0 C$ at atmospheric pressure. It is given 420 J of heat so that the ice starts melting. Finally when the ice water mixture is in equilibrium, it is found that 1 gm of ice has melted. Assuming there is no other heat exchange in the process, the value of m is(IIT JEE-2010)**

78. **A diatomic ideal gas is compressed adiabatically to $\frac{1}{32}$ of its initial volume. In the initial temperature of the gas is T_i (in Kelvin) and the final temperature is a**

T_i, the value of a is (IIT JEE-2010)

SUBJECTIVE TYPE QUESTIONS

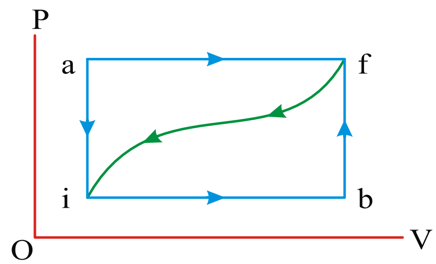
79. When a system is taken from state i to state f along the path iaf, it is found that Q = 50 cal and W = 20 cal. Along the path ibf, Q = 36 cal (figure)

(a) What is W along the path ibf ?

(b) If W = - 13 cal for the curved return path f i, what is Q for this path ?

(c) Take U_i = 10 cal. What is U_f ?

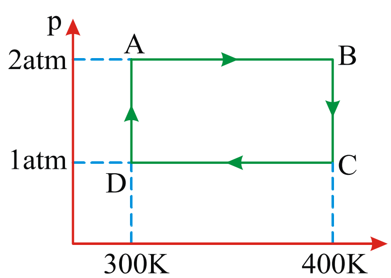
(d) If U_b = 22 cal, what is Q for the process ib and for the process bf ?



80. Two moles of helium gas undergo a cyclic process as shown in the figure. Assume the gas to be ideal calculate net

(a) net change in the heat energy (b) net work done

(c) net change in internal energy. (d) Take R = 8.32 Jmol^{-1}.



81. 0.05 kg steam at 373 K and 0.45 kg of ice at 253 K are mixed in an insulated vessel. Find the equilibrium temperature of the mixture.

Given, L_{fusion} = 80 cal/g = 336 J/g

$L_{vaporisation}$ = 540 cal/g = 2268 J/g,

S_{ice}=2100 J/kg K = 0.5 cal g/g K

and s_{water} =4200 J/gk K = 1 cal/gK [IIT-2006]

82. An ice cube of mass 0.1 kg at 0°C is placed in an isolated container which is at 227°C. The specific heat capacity *c* of the container varies with temperature *T* according to the empirical relation *c* = *A* + *BT*, where *A* = 100 cal/kg-K and $B = 2\times10^{-2}$ cal/kg-K^2. If the final temperature of the container is 27°C, determine the mass of the container. (Latent heat of fusion for water $= 8\times10^{4}$ cal/kg, specific heat capacity of water $= 10^{+3}$ cal/kg-K).

83. A diatomic gas is enclosed in a container by a movable piston of cross-sectional area A = 1 m^2 at 300 K, as shown in the figure. The length of the gas column is 1 m. The gas is now heated to 400 K isobarically. (i) Find the new

height of the piston. (ii) Now the gas is compressed to its initial volume adiabatically. Find the final temperature of the gas.

84. **Two moles of an ideal monatomic gas is taken through a cycle ABCA as shown in the *P-T-* diagram (figure). During the process AB, pressure and temperature of the gas vary such that *PT* = constant. If $T_1 = 300$ K, calculate.**

(a) The work done on the gas in the process AB and

(b) The heat absorbed or released by gas in each of the process.

Give answers in terms of the gas constant *R*.

EXERCISE - I - KEY

SINGLE ANSWER QUESTIONS

1)A 2)A 3) D 4)B 5)D 6)B 7)B 8)C 9)B 10)A
11)B 12)D 13)B 14)B 15)A 16)B 17)C 18)B 19)A 20) A
21)A 22)A 23)B 24)B 25)C 26) A 27) D

MULTIPE ANSWER QUESTIONS

28) A,B,C 29) (A, B, C) 30) (A, C) 31) (A, B, C, D) 32) (A, B, D)
33) (B, C) 34) (A, B, C) 35) (A, B, D) 36) (A, B) 37) (B, C, D)
38) (A, B) 39) (B, D) 40) (b) (d) 41) A,B,D
42) B,C 43) (a), (b), (c), (d)

MATRIX MATCHING TYPE

44)(A $\rightarrow$ p, q, r, s), (B $\rightarrow$ p, r),
(C $\rightarrow$ p, q, r, s), (D $\rightarrow$ p, s)
45)(A $\rightarrow$ p),(B $\rightarrow$ q,r, s),(C $\rightarrow$ p, q),(D $\rightarrow$ p, q)
46) (A) $\rightarrow$ (s) ; (B) $\rightarrow$ (q,r)
(C) $\rightarrow$ (q) ; (D) $\rightarrow$ (p,s)
47) $A \rightarrow q,(b) \rightarrow p,q(c) \rightarrow p,s(d) \rightarrow q,s$
48) (A $\rightarrow$ s, B $\rightarrow$ r, C $\rightarrow$ q, D $\rightarrow$ p, s)
49) (A $\rightarrow$ P, B $\rightarrow$ Q, C $\rightarrow$ R, D $\rightarrow$ S)
50) A $\rightarrow$ p,r,t ; B $\rightarrow$ p,r ; C $\rightarrow$ q,s ; D $\rightarrow$ r,t

COMPREHENSION TYPE QUESTIONS

P-I 51) B 52) C 53) A **P-II** 54) D 55) D 56) B
P-III 57) C 58) A 59) B **P -IV** 60) C 61) D

ASSERTION REASON TYPE QUESTIONS

62) B 63) D 64) A 65) C 66) A

INTEGER TYPE QUESTIONS

67) 9 68) 2 69) 9 70) 6 71) 4 72) 2 73) 7 74) 9 75) 5 76) 2
77) 8 78) 4

SUBJECTIVE TYPE QUESTIONS

79) (a) 6 cal (b) –43 cal (c) 40 cal (d) 18 cal
80) A) 1153.4 J (B) 1153.4 J (C) 0
81) 273 K 82) 0.49 kg
83) (A) 4/3 m (B) 448.4 k 84) (A) 1200 R (B) 1200 R *l*n 2

EXERCISE - II

THERMODYNAMICS & KTG

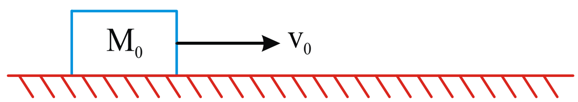
SINGLE ANSWER QUESTIONS

1. **Molar specific heat at constant volume for an ideal gas is given by $C_v = a + bT$ (a and b are constants), T is temperature in Kelvin, then equation for adiabatic process is (R is universal gas constant)**

(A) $T^a e^{bT} V^R = \text{constant}$ (B) $T^R e^{bT} V^a = \text{constant}$

(C) $T^b e^{aT} V^R = \text{constant}$ (D) $T^a e^R V^{bT} = \text{constant}$

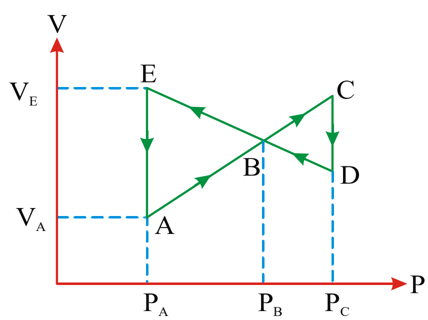
2. **An ice cube of mass M_0 is given a velocity v_0 on a rough horizontal surface with coefficient of friction μ. The block is at its melting point and latent heat of fusion of ice is L. The block receives heat only due to the friction forces and all work is converted into heat. Find the mass of the remaining ice block after time t.**



(A) $m = m_0 e^{-\frac{2\mu g}{L}\left(v_0 t + \frac{1}{2}\mu g t^2\right)}$ (B) $m = m_0 e^{-\frac{\mu g}{L}\left(v_0 t - \frac{1}{2}\mu g t^2\right)}$

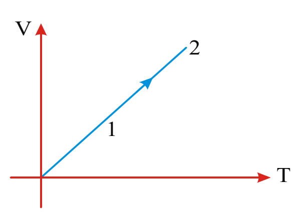
(C) $m = m_0 e^{-\frac{3\mu g}{L}\left(v_0 t - \frac{1}{2}\mu g t^2\right)}$ (D) $m = m_0 e^{-\frac{2\mu g}{L}\left(v_0 t - \mu g t^2\right)}$

3. **Figure shows a cyclic process ABCDBEA performed on an ideal cycle. If $P_A = 2$ atm, $P_B = 5$ atm and $P_C = 6$ atm, $V_E - V_A = 20$ litre, find the work done by the gas in the complete process. (1 atm. pressure = 1×10^5 Pa)**



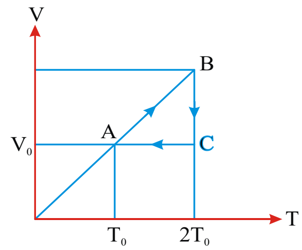
(A) 4..67 kJ (B) 3..67 kJ (C) 2..67 kJ (D) 1..67 kJ

4. **Volume versus temperature graph of two moles of helium gas is as shown in figure. The ratio of heat absorbed and the work done by the gas in process 1–2 is**



(A) 3 (B) 5/2 (C) 5/3 (D) 7/2.

5. An ideal monoatomic gas undergoes a cyclic process ABCA as shown in the figure. The ratio of heat absorbed during AB to the work done on the gas during BC is



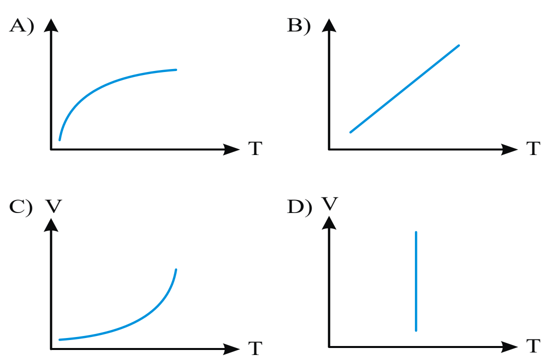
(A) $\frac{5}{2\ln 2}$ (B) $\frac{5}{3}$ (C) $\frac{5}{4\ln 2}$ (D) $\frac{5}{6}$.

6. A vessel of water equivalent W kg contains m kg of water of specific heat S. When water evaporates at the rate of α kgS^{-1}, the temperature of the vessel and water in it falls from $T_1°C$ to $T_2°C$ in t s. If m>> α t and a fraction Eof the heat needed for evaporation is taken from the vessel and the water then average rate of fall of temprature is
(L = average latent heat of vapourisation in J kg^{-1})

(A) $\frac{\in \alpha L}{ms + w}$°C/S (B) $\frac{\in \alpha}{L(ms + w)}$°C/s (C) $\frac{\in \alpha L}{w}$°C/s (D) $\frac{\in \alpha L}{ms}$°C/s

7. An ideal gas expands isothermally from a volume V_1 and V_2 and then compressed to original volume V_1 adiabatically. Initial pressure is P_1 and final pressure is P_3. The total work done is W. Then : (IIT - 2004)
(A) $P_3 > P_1, W > 0$ (B) $P_3 < P_1, W < 0$ (C) $P_3 > P_1, W < 0$ (D) $P_3 = P_1, W = 0$

8. The work done by a certain material when temperature changes from T_0 to $2T_0$ m while pressure remains constant is $3\beta T_0^2$ where β is a constant. Draw curve between volume (V) and temepreature (T) of the material.

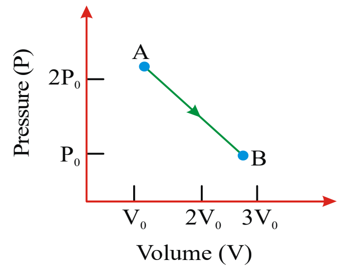


9. An ideal gas is made to undergo a thermodynamic process given by $V \propto T^2$; find the molar heat capacity of the gas for the above process.

(a) $\frac{R}{(\gamma-1)}$ (b) $\frac{\gamma R}{(\gamma-1)}$ (c) $\left(\frac{2\gamma-1}{\gamma-1}\right)R$ (d) $\left(\frac{\gamma-1}{\gamma+1}\right)R$

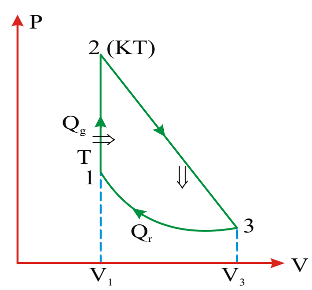
10. Determine the average molar heat capacity of an ideal gas under going a process

shown in fig.



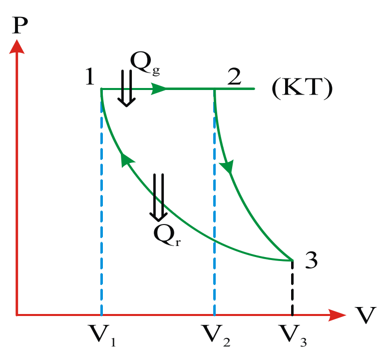
(a) $\left(\dfrac{\gamma-1}{\gamma-1}\right)R$ **(b)** $\left(\dfrac{3\gamma-2}{\gamma-1}\right)R$ **(c)** $\left(\dfrac{\gamma-2}{\gamma-4}\right)R$ **(d)** $\left(\dfrac{\gamma+1}{\gamma-1}\right)R$

11. **An ideal gas goes through a cycle consisting of isochoric adiabatic and isothermal lines. The isothermal process is perform at minimum temperature. If the absolute temperature varies *K* times withing the cycle then find out its efficiency.**



(a) $1-\dfrac{\ln K}{l}$ **(b)** $1+\dfrac{\ln K}{l}$ **(c)** $\dfrac{\ln K}{l}$ **(d)** $\dfrac{l}{\ln K}$

12. **A cycle is made of three process iso baric, adiabatic and isothermal. Isothermal process has minimum temperature. Absolute temperature charges by K times withing the cycle. Find out the efficiency.**



(a) $1-\dfrac{\ln K}{(K-1)}$ **(b)** $1+\dfrac{\ln K}{(K-1)}$ **(c)** $1+\dfrac{\ln K}{(K+1)}$ **(d) None**

13. **A calorimeter contains 4.00 kg of water at 20.0^0C. What amount of ice at -10^0C must be added to cause the resulting mixture to rach thermal equilib rium at 5.0^0C. Assume that heat transfer occurs only between the water and**

ice.

(a) $251 kJ$ **(b)** $2510 kJ$ **(c)** $2.51 kJ$ **(d)** $0.25 kJ$

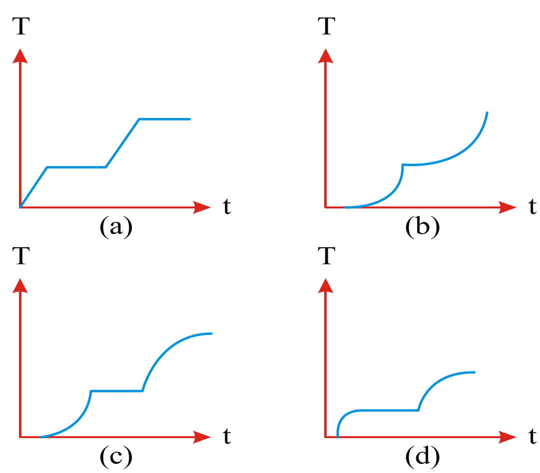
14. **A 0.50 kg ice cube at $-10^0 C$ is placed in 3.0 kg of coffee at $20^0 C$. What will be the final temperature of mixture? Assume that specific heat of tea is same as that of water.**

(a) $5.1^0 C$ **(b)** $8^0 C$ **(c)** $10^0 C$ **(d)** $6^0 C$

15. **A thermally insulated vessel contains some water at $0^o C$. The vessel is connected to a vacuum pump to pump out water vapour, as a result of this intense evaporation, some of the water gets freezed. If latent heat of vaporization at $0^o C$ are $L_V = 580\ cal/g$ and $L_f = 80\ cal/g$ the maximum percentage amount of water that can be solidified in this manner, is**

a) □ 12% b) □ 18% c) □ 88% d) □ 100%

16. **If specific heat capacity of a substance in solid and liquid state is proportional to the temperature of substance, then temperature Vs time plot for the substance is best present by [Assume heat is supplied to substance at constant rate and inital temperature is less than melting point of substance.]**

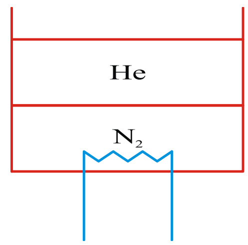


17. **450 g water at 40°C was kept in a calorimeter of water equivalent 50 g, 25 g ice at 0°C is added and simultaneously 5 g steam at 100°C was passed to the calorimeter. The final temperature of the calorimeter will be**

$(L_{ice} = 80\, cal/g, L_{steam} = 540\, cal/g)$

(a) 0°C (b) 100°C (c) 40°C (d) None of these

18. **5 moles of nitrogen gas are enclosed in an adiabatic cylindrical vessel. The piston itself is a rigid light cylindrical container containing 3 moles of helium gas. There is a heater which gives out a power 100cal to the nitrogen gas. A power of 30 cal is transferred to helium through the bottom surface of the piston. The rate of increment of temperature of the nitrogen gas assuming that the piston moves slowly, is**

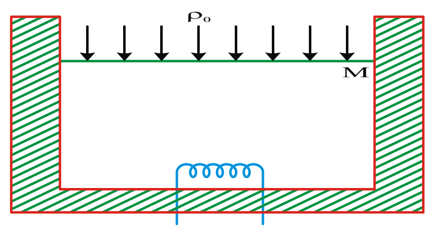


(a) 2 K/s (b) 4 K/s (c) 6 K/s (d) 8 K/s

19. When water is boiled at 2 atm pressure the latent heat of vapourization is 2.2×10^6 J/kg and the boiling point is 120°C. At 2 atm pressure 1 kg of water has a volume of $10^{-3}\,m^3$ and 1 kg of steam has volume of $0.824\,m^3$. The increase in internal energy of 1 kg of water when it is converted into steam at 2 atm pressure and 120°C is [1 atm *pressure* $=1.013\times10^5\ N/m^2$]

(a) 2.033 J (b) 2.033×10^6 J (c) 0.167×10^6 J (d) 2.267×10^6 J

20. A vertical cylinder of cross-section area *A* contains one mole of an ideal mono-atomic gas under a piston of mass M. At a certain instant a heater which supplies heat at the rate q J/s is switched ON under the piston. The velocity with which the piston moves upward under the condition that pressure of gas remains constant is *[Assume no heat transfer through walls of cylinder]*



(a) constant and equal to $\frac{2}{5}\times\frac{q}{p_0A+Mg}$

(b) constant and equal to $\frac{3}{5}\times\frac{q}{p_0A+Mg}$

(c) varying

(d) constant but can't be determined from given information

21. If C_V for an ideal gas is given by $C_v=3+2T$ where T is the absolute temperature of gas, then the equation of adiabatic process for this gas is

(a) $VT^2=$ constant (b) $VT^2e^{2T}=$ constant

(c) $VT^2e^{2T}=$ constant (d) $VT^3e^{2T}=$ constant

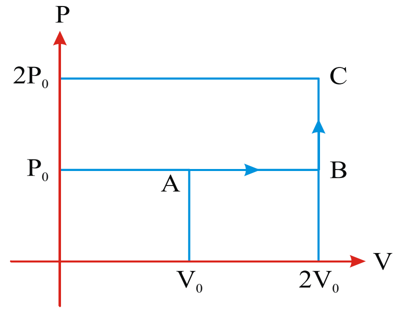
MULTIPLE ANSWER QUESTIONS

22. One mole of an ideal monoatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC :

(A) work done by the gas is RT_0

(B) change in internal energy of the gas is $\frac{11}{2}RT_0$

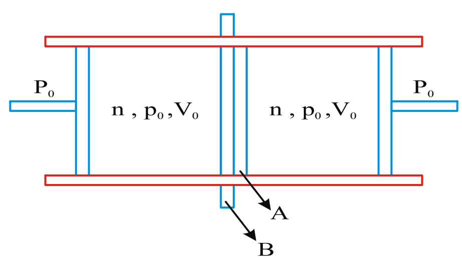
(C) heat absorbed by the gas is $\frac{11}{2}RT_0$



(D) heat absorbed by the gas is $\frac{13}{2}RT_0$.

(R = universal gas constant)

23. **Two cylinders are connected by a fixed diathermic partition A, and a removable adiabatic partition B is placed adjacent to A as shown in the figure. Initially n moles of an ideal monoatomic gas is present in both the cylinders at normal atmospheric pressure p_0. Both the gases occupy same volume V_0, initially. Now the piston of the left cylinder is compressed in adiabatic manner so that volume of the left portion becomes $\frac{V_0}{2}$ and then the left piston is clamped. Again the adiabatic slider B is removed so that the two cylinders come in thermal equilibrium. Assume all other surfaces except A to be adiabatic. For this situation, mark out the correct statement(s).**



a) Just after the removal of adiabatic separator B, the pressure in the left and right chambers are $2^{\gamma} p_0$ and p_0, respectively.

b) After the removal of adiabatic separator B, the gas in right chamber expands under constant pressure process.

c) Workdone by the gas of the right chamber on surroundings during its expansion is $0.22 p_0 V_0$.

d) During the expansion of gas in right chamber, the energy transferred from the left chamber to right chamber is $0.55 p_0 V_0$ where $\gamma = \frac{5}{3}$.

COMPREHENSION TYPE QUESTIONS

Comprehension - I

The molar specific heat of a gas is defined as $C = \frac{dQ}{ndT}$ Where dQ = heat absorbed n = mole number   dT = change in temperature

24. **A gas with adiabatic exponent 'γ' is expanded according to the law $p = \alpha V$. The initial volume is V_0. The final volume is ηV_0. ($\eta > 1$). The molar heat capacity of the gas in the process is**

(A) $\frac{R}{2}(\gamma+1)$ (B) $\frac{R}{2(\gamma-1)}$ (C) $\frac{R(\gamma+1)}{2(\gamma-1)}$ (D) $\frac{R(\gamma-1)}{2(\gamma+1)}$

25. **An ideal gas whose adiabatic exponent is γ. is expanded so that the heat transferred to the gas is equal to decrease in its internal energy. The molar heat capacity in this process is**

(A) $\frac{R}{\gamma-1}$ (B) $\frac{R}{1-\gamma}$ (C) $\frac{R}{\gamma+1}$ (D) $R(\gamma-1)$

26. **The equation of the above process in the variables T, V is**

(A) $TV^{(\gamma-1)} = constnat$ (B) $TV^{\left(\frac{\gamma-1}{2}\right)} = constnat$

(C) $TV^{\left(\frac{\gamma}{\gamma-1}\right)} = constnat$ (D) $TV^{\left(\frac{\gamma-1}{\gamma}\right)} = constnat$

Comprehension - II

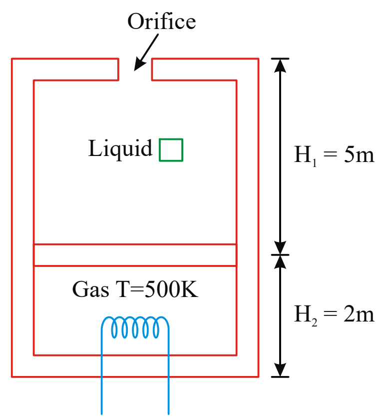
The system shown in the figure is in equilibrium. The piston is massless, frictionless and insulated. All walls of the chamber are also insulated. When heat is generated inside the lower chamber the piston slowly moves upwards by 2 m and the liquid comes out through an orifice so that it can rise to a maximum height of 5m above the orifice level. The lower chamber contains 2 moles of an ideal monoatomic gas at 500K.

Area of orifice a = 0.05 m^2

Area of the piston A = 1 m^2

Density of the liquid, $\rho = 10^3$ kg/m^3, g =10 m/s^2

Atmospheric pressure, $P_{atm} = 10^5$ N/m^2



27. **The speed of piston is**

(A) 0.05 m/s (B) 0.5 m/s (C) 5 m/s (D) None of these

28. **The final pressure of the gas is**

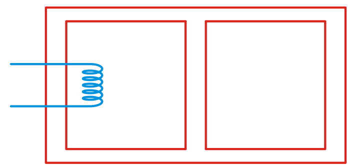
(A) 1.8 atm (B) 0.18 atm (C) 1.5 atm (D) None of these

29. **The average power of the heater is**

(A) 49.36 KW (B) 48.36 W (C) 4.936 KW (D) None of these

Comprehension - III

The rectangular box shown in the figure has a partition which can slide without friction along the length of the box. Initially each of two chambers of the box have one mole of a mono-atomic ideal gas (g = 5/3) at a pressure P_0, volume V_0 and temperature T_0. The chamber on the left is slowly heated by an electric heater. The walls of box and partition are thermally insulated. Heat loss through lead wire of heater is negligible. The gas in left chamber expands, pushing the partition until the final pressure in both chambers becomes $243p_0/32$.



30. Final temperature of the gas in right chamber is

(A) 2.25 T_0 (B) 4.5 T_0 (C) 8.75 T_0 (D) 12.93 T_0

31. Final temperature of the gas in left chamber is

(A) 2.25 T_0 (B) 4.5 T_0 (C) 8.75 T_0 (D) 12.93 T_0

32. The work done by the gas in the right chamber is

(A) 5.5 T_0 J (B) 10.5 T_0 J (C) 25.5 T_0 J (D) None of these

PASSAGE-IV:

An ideal monoatomic gas undergoes a pressure $pV^n =$ constant. The adiabatic constant for gas is y. During the process, volume of gas increases from V_0 to rV_0 and pressure decreases from p_0 to $\frac{p_0}{2r}$ Based on above information, answer the following questions:

33. The value of ***n*** **is**

(a) $\frac{2\log r}{\log 2r}$ (b) $\frac{\log 2r}{3}$ (c) $\frac{\log 2r}{\log r}$ (d) $\frac{\log 2r}{3\log r}$

34. The molar heat capacity of the gas for the process is

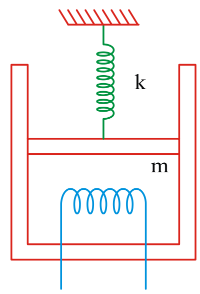
(a) $\frac{R(n-\gamma)}{(n-1)(\gamma-1)}$ (b) $\frac{R(n-1)}{(n-\gamma)(\gamma-1)}$ (c) $\frac{R}{\gamma-1}$ (d) $\frac{R}{n-1}+\frac{R}{\gamma}$

PASSAGE-V:

k-mol of an ideal diatomic gas is enclosed in a vertical cylinder fitted with a piston and spring as shown in the figure. Initially, the spring is compressed by 5 cm and then the electric heater starts supplying energy to the gas at constant rate of 100 *J/s* and due to conduction through walls of cylinder and radiation, 20 J/s has been lost to surroundings.

[$k = 1000\,\text{N}/m$, $g = 10\,m/s^2$, *Atmospheric pressure,* $p_0 = 10^5\,\text{N}/m^2$, *Cross-section* area of *piston* $A_0 = 50cm^2$ *Mass* of *piston* m = 1 *kg*, R = 8.3 *kJ / mol-K*]

Based on above information, answer the following questions:



35. The initial pressure of the gas is

(a) $1\,N/m^2$ (b) $1.02\,N/m^2$ (c) $1.10\,N/m^2$ (d) $1.12\,N/m^2$

36. Work done by the gas in $t = 5$ s is (a) 300 J (b) 400 J (c) 114.3 J (d) 153.6 J

37. Increase in temperature of gas in 5 s is

(a) $6.9\times10^{-3}K$ (b) $6.9\times K$ (c) $83\times10^{-4}K$ (d) $96\times10^{-4}K$

MATRIX MATCHING TYPE QUESTIONS

38. Column I shows certain thermodynamic system and column II represents thermodynamic properties.

Column -I

(A)An ideal gas is filled in a cylinderical vessel of height h which is enclosed by a massless thermally insulating piston. Mercury is filled above the piston as shown. Now gas is slowly supplied heat. Mercury does not spill.

(B) A cylindrical vessel is enclosed by a light piston. The piston is connected to ceiling by an ideal spring as shown in figure.

Spring is initially relaxed and then heat is supplied slowly to the ideal gas in the vessel. The system is kept in open atmosphere.

(C)A thermally insulated cylindrical vessel is enclosed by a light thermally insulated piston.

Some sand is kept on top of piston as shown in figure. The system is kept in open atmosphere. Now sand grains are removed slowly one by one.

(D)A good conducting cylindrical vessel is nclosed by a light thermally insulated piston.

Some sand iskept on top of piston as shown in figure. Now sand grains are added slowly one by one.

Column -II

(p)Internal energy of the gas is increasing

(q) Pressure of the gas is increasing.

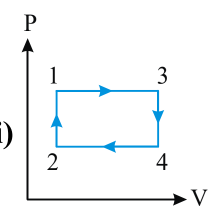
(r) Temperature e of the gas is decreasing

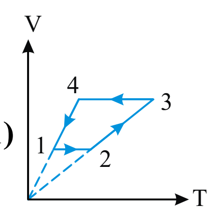
(s) Work done by as is positive e

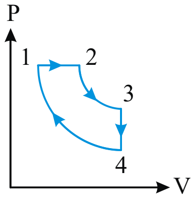
(t) Molar heat capacity of the gas is positive

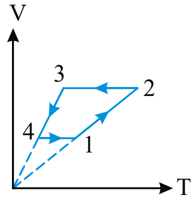
39. Match the entries of column I and II.

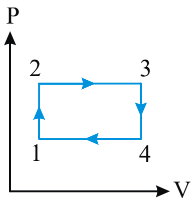
Column I **Column II**

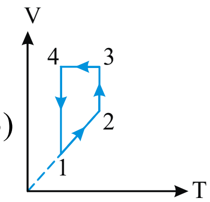
(i)


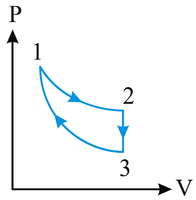
1)


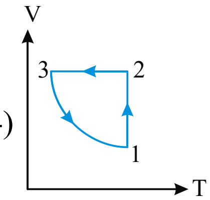
(ii) 

2) 

(iii) 

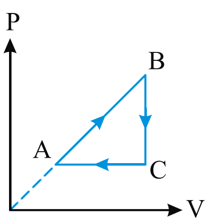
3) 

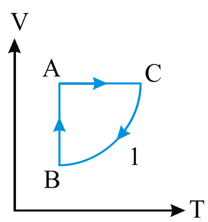
(iv) 

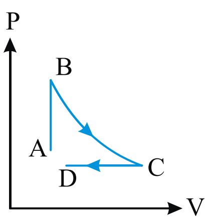
4) 

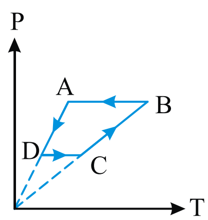
40. **Match the entries of column I and II**

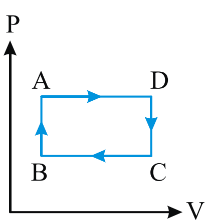
Column I | **Column II**

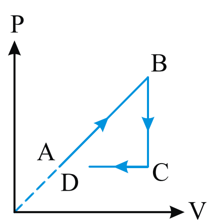


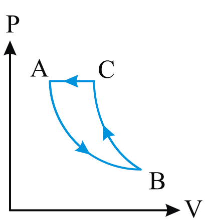


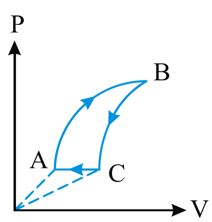






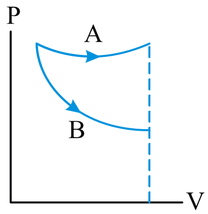




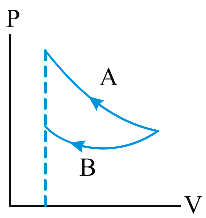


41 **An ideal gas undergoes two processes A and B. One of these is isothermal and the other is adiabatic.**

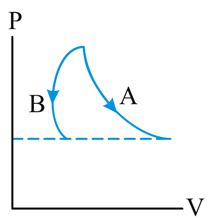
COLUMN-I **COLUMN-II**

(a)


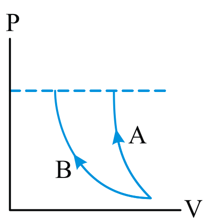
p) Heat supplied during curve A is positive

(b)


q) Work done by gas in both processes positive

(c)


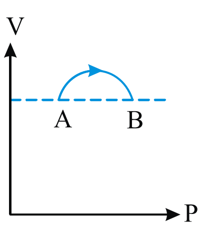
r) Internal energy increases in diabatic process

(d)


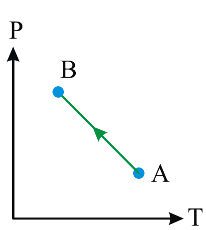
s) Temperature of gas in process *B* is constant

42. **A sample of gas goes from state A to state B in four different manners, as shown by the graphs. Let W be the work done by the gas and ΔU be change in internal energy along the path AB.**
Correctly match graphs with the statements provided.

COLUMN-I **COLUMN-II**

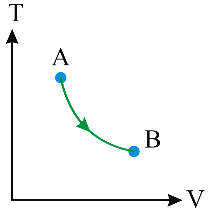
(a)


p) Both W and ΔU are positive

(b)


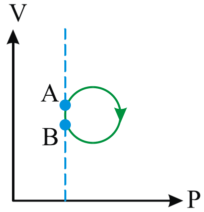
q) Both W and ΔU are negative

(c)



r) W is positive whereas ΔU is nagative

(d)



s) W is negative whereas ΔU is positive

INTEGER TYPE QUESTIONS

43. **One mole of an ideal monatomic gas undergoes the process P = aT, where a is a constant. The work done by the gas if its temperature increases by 50 K is $\frac{50R}{x}$. Find the value of x.**

44. **A hot body placed in air is cooled down according to Newton's law of cooling, the rate of decrease of temperature being k times the temperature difference from the surrounnding. Starting from t = 0, The time in which the body will lose half the maximum heat it can lose is $\frac{x \ln 2}{2k}$. Find the value of x.**

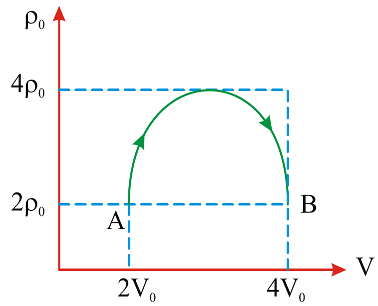
45. **A gaseous mixture enclosed in a vessel consisits of 1 g mole of gas A with $(\gamma_1 = 5/3)$ and another gas B with $(\gamma_2 = 7/5)$ at a temperature T. The gases A and B do not react with each other and assume to be ideal. Find the number of gram moles of the gas B, if γ for the gaseous mixture is (19/13).**

46. **A lead ball at 30°C is dropped from a height of h. The ball is heated due to the air resistance and it completely melts just before reaching the ground. The molten substance falls slowly on the ground. Latent heat of fusion of lead is 22200 J/kg. Specific heat capacity of lead = 126 J/kg–°C and melting point of lead = 330°C. Assume that all mechanical energy lost is used to heat the ball.**

Find the value of h in km ? (Use g=10 m/s2)

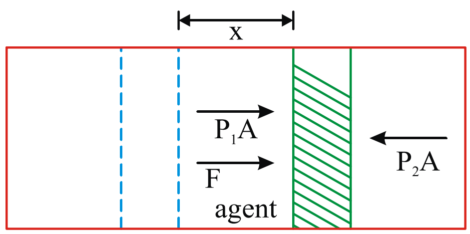
47. **One end of a uniform rod of length 1 m is placed in boiling water while its other end is placed in melting ice. *A* point *P* on the rod is maintained at a constant temperature of 800°C. The mass of steam produced per second is equal to the mass of ice melted per second. If specific latent heat of steam is 7 times the specific latent heat of ice, then the distance of *P* from the steam chamber is n/18 m. Find the value of *n?***

48. **One mole of an ideal *Po* monoatomic gas is taken 4po through a thermo dynamic process shown in the *p-V* diagram. The heat supplied to *2po* the system in this process is $K \times (\pi + 10)\, p_0 V_0$. Determine the value of *K.***

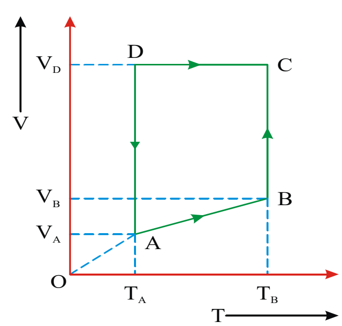


49. **One mole of an ideal gas whose pressure changes with volume as $P = \alpha V$, where α is a constant, is expanded so that its volume increase η times.**
Find the change in internal energy and heat capacity of the gas.

50. **A piston can freely move inside a horizontal cylinder closed from both ends. Initially, the piston separates the inside space of the cylinder into two equal parts each of volume V_0, in which an ideal gas is contained under the same pressure P_0 and at the same temperature. What work has to be performed in order to increase isothermally the volume of one part of gas η times compared to that of the other by slowly moving the piston ?**



51. **A monatomic ideal gas of two moles is taken through a cyclic process starting from A as shown in the figure. The volume ratios are $\frac{V_B}{V_A} = 2$ and $\frac{V_D}{A_A} = 4$. If the temperature T_A at A is 27°C, Calculate**



(A) The temperature of the gas at point B
(B) Heat absorbed or released by the gas in each process
(C) The total work done by the gas during the complete cycle
(Express your answer in terms of the gas constant *R*) **[IIT-2001]**

EXERCISE - II - KEY

SINGLE ANSWER QUESTIONS

1) A 2) B 3) C 4) B 5) C 6) A 7) C 8) C 9) C 10) B
11) C 12) A 13) B 14) A 15) C 16) D 17) C 18) A 19) B 20) A
21) D

MULTIPLE ANSWER QUESTIONS

22) A,C 23) A,B,C,D

COMPREHENSION TYPE QUESTIONS

PI: 24) C 25) B 26) B
P:II 27) B 28) C 29) A
PIII: 30) A 31) D 32) D
PIV: 33) C 34) A
PV: 35) D 36) C 37) A

MATRIX MATCHING TYPE QUESTIONS

38) A-PST, B-PQST, C-RS, D-Q
39) I-A, II-C, III-A, IV-D
40) I-A; II-C; III-B; IV-D
41) A-P,Q;B-R,S;C-P,Q; D-R,S
42) A-S; B-Q; C-R; D-Q

INTEGER ANSWER TYPE QUESTIONS

43) 2 44) 2 45) 246) 6 47) 2 48) 1

SUBJECTIVE TYPE QUESTIONS

49) $=\frac{nR}{2}\left[\frac{\gamma+1}{\gamma-1}\right]$

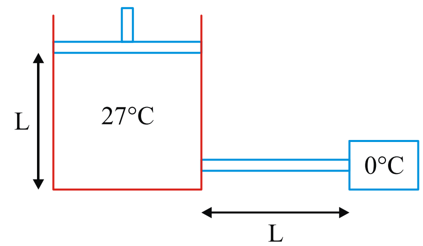
50) $=-P_0V_0\left[\ln\left\{V_0^2-\left(\frac{\eta-1}{\eta+1}\right)^2V_0^2\right\}-\ln V_0^2\right]$

51) A) 600 K B) 1500 R C) 600 R

EXERCISE - III

SINGLE ANSWER QUESTIONS

1. **0.5 mole of an ideal gas at constant temperature 27°C kept inside a cylinder of length L and cross-section area A closed by a massless piston. The cylinder is attached with a conducting rod of length L, cross-section area (1/9) m^2 and thermal conductivity k, whose other end is maintained at 0°C. If piston is moved such that rate of heat flow through the conducing rod is constant then find velocity of piston when it is at height L/2 from the bottom of cylinder. [Neglect any kind of heat loss from system]**



(A) $\frac{k}{50R}$ (B) $\frac{k}{100R}$ (C) $\frac{k}{110R}$ (D) $\frac{k}{90R}$

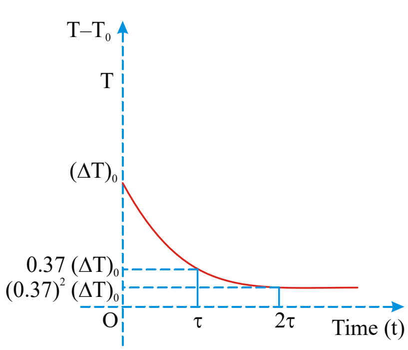
2. **Two thin walled spheres of different materials, one with double the radius and one-fourth wall thickness of the other, are filled with ice. If the time taken for complete melting of ice in the sphere of larger radius is 25 minutes and that for smaller one is 16 minutes, the ratio of thermal conductivities of the materials of larger sphere to the smaller sphere is :**

(A) 4 : 5 (B) 25 : 1 (C) 1 : 25 (D) 8 : 25

3. **The power radiated by a black body is P, and it radiates maximum energy around the wavelength λ_0. If the temperature of the black body is now changed so that it radiates maximum energy around a wavelength $3\lambda_0/4$,**
the power radiated by it will increase by a factor of

(A) 4/3 (B) 16/9 (C) 64/27 (D) 256/81

4. **A calorimeter of negligible heat capacity contains 100 cc of water at 40^0C. The water cools to 35^0C in 5 min. The water is now replaced by *k*-oil A equal volume at 40^0C, Find the time taken for the temp to become 35^0C (Given densities of water and K-oil are respectively 1000 and 800 kg.m^{-3}; and their specific heats are respectively: 420 and 2100 J/kg-^{0}C)**



(A) 1 min

(B) 2 min

(C) 3 min

(D) 4 min

5. **A and B are two points on a uniform metal ring whose centre is C. The angle ABC = θ . A and B are maintained at two different constant temperatures. When θ = 180°, the rate of total heat flow from A to B is 1.2 W. When θ = 90°, this rate will be**

(A) 0.6 W (B) 0.9 W (C) 1.6 W (D) 1.8 W

6. **Two metallic spheres S_1 and S_2 are made of the same material and have got identical surface finish. The mass of S_1 is thrice that of S_2. Both the spheres are heated to the same high temperature and placed in the same room having lower temperature but are thermally insulated from each other. The ratio of the initial rate of cooling of S_1 to S_2 is (IIT-95)**

(A) $\frac{1}{3}$ (B) $\frac{1}{\sqrt{3}}$ (C) $\frac{\sqrt{3}}{1}$ (D) $\left(\frac{1}{3}\right)^{1/3}$

7. **A black body is at a temperature of 2880 *K*. The energy of radiation emitted by this object with wavelength between 499 nm and 500 nm is U_1, between 999 nm and 1000 nm is U_2 and between 1499 nm and 1500 nm is U_3. The Wein constant, *b* = 2.88 × 10⁶ nm-*K*. Then (IIT - 1998)**

(A) $U_1 = 0$ (B) $U_3 = 0$ (C) $U_1 > U_2$ (D) $U_2 > U_1$

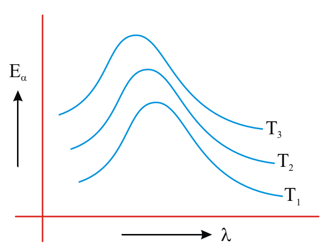
8. **Three discs, *A*, *B* and *C* having radii 2 m, 4 m and 6 m respectively are coated with carbon black on their outer surfaces. The wavelengths corresponding to maximum intensity are 300 nm, 400 nm and 500 nm respectively. The power radiated by them are Q_A, Q_B and Q_C respectively (IIT - 2004)**

(A) Q_A is maximum (B) Q_B is maximum (C) Q_C is maximum (D) $Q_A = Q_B = Q_C$

9. **In which of the following process, convection does not take place primarily ? (IIT-2005)**

(A) Sea and land breeze (B) Boiling of water
(C) Warming of glass bulb due to filament (D) heating air around a furnace

10. **Variation of radiant energy emitted by sun, filament of tungsten lamp and welding arc as a function of its wavelength is shown in figure. Which of the following option is the correct match?**



(A) Sun-T_1,tungsten filament-T_2, welding arc-T_3
(B) Sun-T_2,tungsten filament-T_1, welding arc-T_2
(C) Sun-T_3,tungsten filament-T_2, welding arc-T_1
(D) Sun-T_1,tungsten filament-T_3, welding arc-T_2

11. **A solid copper sphere (density ρ and specific heat C) of radius r at a n initial temeprature 200K is suspended inside a chamber whose walls are at almost 0K. The time required for the temeprature of the sphere to drop to 100K is**

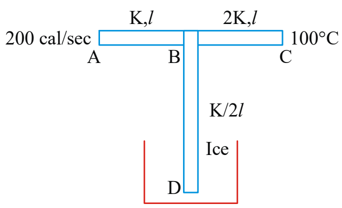
A) 1.7 ρrc B) 2.7 ρrc C) 3.3 ρrc D) 4.2 ρrc

12. **Three very large plates of same area kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity.**

The first and third plates are maintained at temperature 2T and 3T respectively. The temperature of the middle (i.e. second) plate under steady state condition is (IIT JEE-2012)

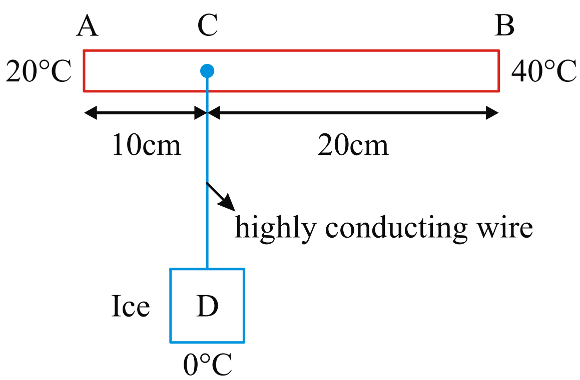
(a) $\left(\frac{65}{2}\right)^{\frac{1}{4}}T$ (b) $\left(\frac{97}{4}\right)^{\frac{1}{4}}T$ (c) $\left(\frac{97}{2}\right)^{\frac{1}{4}}T$ (d) $(97)^{\frac{1}{4}}T$

13. Three rods AB, BC and BD of same length l and cross-sectionsl area A are arranged as shown. The end D is immersed in ice whose mass is 440 gm. Heat is being supplied at constant rate of 200 cal/sec from the end . Time in which whole ice will melt (Latent heat of fusion of ice is 80 cal/gm)



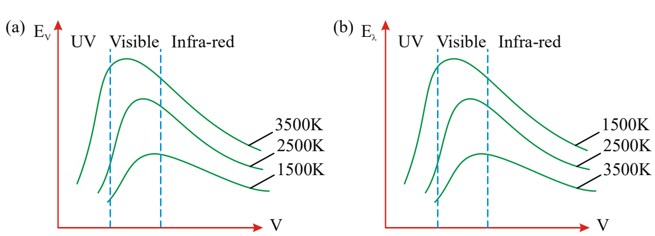
(A) 40/3 min (B) 700 sec (C) 20/3 min (D)indefiniely long time

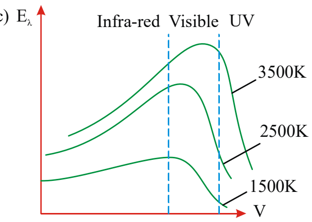
14. In the figure shown, AB is a rod of length 30 cm and area of cross-section 1.0 cm^2 and thermal conductivity 336 S.I. units. The ends A & B are maintained at temperatures 20^0 C and 40^0 C respectively. A point C of this rod is connected to a box D, containing ice at 0^0 C, through a highly conducting wire of negligible heat capacity. The rate at which ice melts in the box is

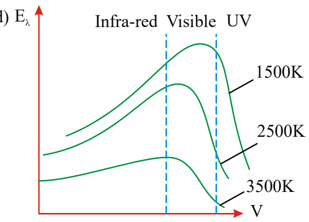


(a) 84 mg/s (b) 84 g/s (c) 20 mg/s (d) 40 mg/s

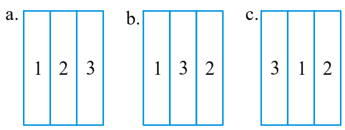
15. Which of the following graphs shows the correct variation in intensity of heat radiations by black body and frequency at a fixed temperature?



(c)


(d)


16. Three different arrangemnets of materials 1, 2 and 3 to from a wall. Thermal conductivities are $k_1 > k_2 > k_3$. The left side of the wall is 20^{0}C higher than the right side. Temperature difference ΔT across the material 1 has following relation in three cases:



(a) $\Delta T_a > \Delta T_b > \Delta T_c$
(b) $\Delta T_a = \Delta T_b = \Delta T_c$
(c) $\Delta T_a = \Delta T_b > \Delta T_c$
(d) $\Delta T_a = \Delta T_b < \Delta T_c$

MULTIPLE ANSWER TYPE

17. Two identical objects A and B are at temperatures T_A and T_B, respectively. Both objects are placed in a room with perfectly absorbing walls maintained at a temperature T ($T_A > T > T_B$). The objects A and B attain the temperature T eventually. Select the correct statements from the following.

(A) A only emits radiation, while B only absorbs it until both attain the temperature T
(B) A loses more heat by radiation than it absorbs, while B absorbs more radiation than it emits, until they attain the temperature T
(C) Both A and B only absorb radiation, but do not emit it,until they attain the temperature T
(D) Each object continuous to emit and absorb radiation even after attaiing the temperature T

18. Two solid spheres are heated to the same tempearature and allowed to cool under identical conditions. Compare; (i) initial rates of fall of temperature, and (ii) initial rates of loss of heat. Assume that all the surfaces have the same emissivity and ratios of their radii, specific heats and densities are respectively $1:\alpha, 1:\beta, 1:\gamma$.

(A) $\alpha\beta\gamma:1$ (B) $1:\alpha^2$ (C) $\beta = \alpha\gamma$ (D) $1:\alpha^3$

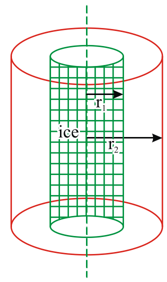
19. Two bodies A and B have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are the same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiancy in the radiation from B shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A, by 1.00 μm. If the temperature of A is 5802 K : (IIT - 1994)

(A) the temperature of B is 1934 K (B) $\lambda_B = 1.5\mu m$
(C) the temperature of B is 11604 K (D) the temperature of B is 2901 K

20. A 100 cm long cylindrical flask with inner and outer diameter 2 cm and 4 cm

respectively is completely filled with ice as shown in the figure. The constant temperature outside the flask is 40^{0}C.

(Thermal conductivity of the flask is $0.693\ W/m^0C, L_{ice} = 80 cal/gm \ \& \ ln2 = 0.693$ **).**



(a) Rate of heat flow from outside to the flask is $80\pi\ J/s$

(b) The rate at which ice melts is $\frac{\pi}{4200} kg/s$

(c) The rate at which ice melts is $100\pi\ kg/s$

(d) Rate of heat flow from outside to flask is $40\pi\ J/s$

21. A metal cylinder of mass 0.5 kg is heated electrically by a 12 W heater in a room at 15^{0}C. The cylinder temperature rises nuniformly to 25^{0}C in 5 min and finally becomes constant at 45^{0}C. Asuming that the rate of heat loss is proportional to the excess temperature over the surroundings

(a) The rate of loss of heat of the cylinder to surrounding ar 20^{0}C is 2 W

(b) The rate of loss of heat of the cylinder to surrounding at 45^{0}C is 2 W

(c) Specific heat capacity of metal is $\frac{240}{ln(3/2)} J/kg^0C$

(d) None fof these

22. When we consider convection with radiation in Newton's law of cooling while temperature of the object in consideration is sightly higher than the environment temperature. Choose correct statements about rate of heat loss.

(a) directly proportional to emissivity

(b) directly proportional to Stefan's constant

(c) directly proportional to surface area

(d) directly proportional to temperature difference of body and room.

MATRIX MATCHING TYPE QUESTIONS

23. Match the following Column I and II

Column I

(A) Wien's displacement explains

(B)Planck's law explains

(C) Kirchhoff's law explains

(D) Newton's law of cooling explains

Column II

(p) Why days are hot and nights cold in deserts

(q) Why a blackened platinum wire, when gradually heated, appears first dull red and then blue

(r) The distribution of energy in black body spectrum at shorter as well as longer wavelengths

(s) Why some stars are hot ter than other

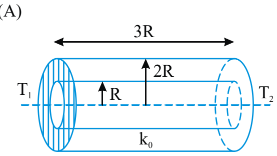
24. Column I

A) A perfect reflecting body
B) A perfect black body
C) An ordinary smooth body
D) An ordinary rough body

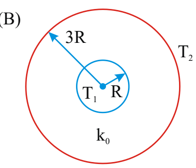
Column II

P) absorbs radiation Q) reflects radiation
R) emits radiations S) transfer heat

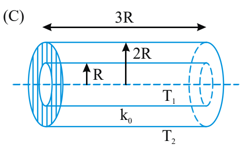
25. **Entries in cloumn I consists of diagrams of thermal conductors. The tupe of conductor & direction of heat flows are listed below.**
Entries column II consists of the magnitude of rate of heat flow belonging to any of the entries in column I. If temperature difference in all the cases is $(T_1\text{-}T_2)$
Column I

(A)


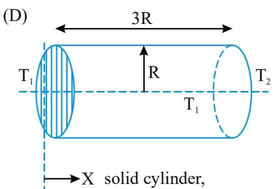
Thick cylindrical shell, flow along axis

(B)


Thick spherical shell, radical flow

(C)


Thick cylindrical shell, radical flow

(D)


solid cylinder, flow along axis, variable k as $k = k_0(1+x/(3R))$

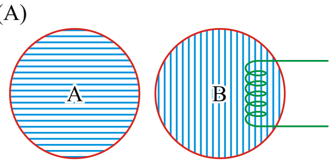
Column II

(P) $6\pi k_0 R(T_1 - T_2)$ (Q) $\dfrac{\pi k_0 R}{3\,\ell n 2}(T_1 - T_2)$

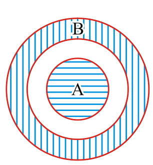
(R) $\pi k_0 R(T_1 - T_2)$ (S) $\dfrac{4\pi k_0 R}{\ell n 2}(T_1 - T_2)$

26. **A & B are two black bodies of radii r_A and r_B respectively, placed in surrounding of temperature T_0. At steady state the temperature of A & B is T_A & T_B respctively.**

Column I

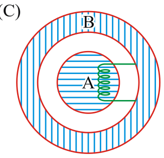
(A)


A & B are solid sphere $r_A = r_B$
Body 'B' is being heated by a heater of constant power 'P'

(B)


B is thin spherical shell A is a solid sphere $r_A < r_B$

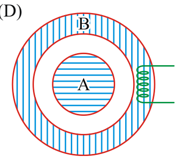
(C)



B is thin spherical shell, A is a solid sphere $r_A < r_B$

Body A is being heated by a heater of constant power 'P'

(D)



B is thin spherical shell, A is a solid sphere, $r_A \approx r_B$

Body A is being heated by a heater of constant power 'P'

Column II

(P) $T_A = T_B$

(Q) $T_A < T_B$

(R) Heat received by A is more than heat radiated by it at steady state.

(S) Radiation spectrum of A & B is distinguishable

(T) Steady state can't be achieved

COMPREHENSIVE TYPE QUESTIONS

Passage : 1

A body is kept inside a container the temeprature of the body is T_1 and the temeprature of the container is T_2. the rate at which body absorbs the energy is α. The emissivity of the body is e. The radiation striking the body is either absorbed or reflected.

27. After a long time, the temperature of the body will be

A) T_1 B) T_2 C) $T_1 + \frac{(T_1 - T_2)}{2}$ D) none of these

28. At what rate, the body will emit the radiant energy

A) If t is the time, rate is $(T_1 - T_2)t$ B) e

C) both of the above D) none of the above

29. At what rate the body will basorb the radiant energy

A) α, *but* $\alpha \neq e$ B) $(T_1 - T_2)/t$, where t is the time

C) e, but e = α D) None of the above

30. A good absorber is

A) good reflector B) poor reflector

C) average reflector D) assessment not possible

ASSERTION & REASON TYPE QUESTIONS

Note : Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 5 choices (A), (B), (C), (D) and (E) out of which ONLY ONE is correct.

(A) Statement-1 is True, Statement-2 is True;
Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.
(E) Statement -1 is False, Statement-2 is False

31. **Statement-1** : As the temperature of the blackbody increases, the wavelength at which the spectral intensity (E_λ) is maximum decreases.
Statement-2 :The wavelength at which the spectral intensity will be maximum for a black body is proportional to the fourth power of its absolute temperature.

32. **Take a test tube nearly filled with water and put in the bottom a piece of paraffin wax, round which a piece of thick copper wire has been wound so that wax remains at the bottom. Temperature required for melting wax is 52^0C.**
Statement -1: Heat the water at top where it will be seen to boil vigorously without melting wax.
Statement-2 : Convection currents are not set-up when water columm is heated from top amd water is poor conductor of heat.

INTEGER TYPE QUESTIONS

33. **A rod of length *l* with thermally insulated lateral surface is made of a material whose thermal conductivity varies as K = C/T. where C is a constant. The ends are kept at temperatures T_1 and T_2. The temperature at a distance x from the first end where the temperature is T_1, $T = T_1\left(\frac{T_2}{T_1}\right)^{nx/2l}$. Find the value of n?**

34. **A solid copper sphere of density ρ, specific heat c and radius r is at temperature T_1. It is suspended inside a chamber whose walls are at temperature 0 K. The time required for the temperature of sphere to drop to T_2 is $\frac{r\rho c}{xe\sigma}\left(\frac{1}{T_2^3}-\frac{1}{T_1^3}\right)$. Find the value of x? Take the emmissivity of teh sphere to be equal to *e*.**

35. **Two identical conducting rods are first, connected independently to two vessels, one containing water at 100°C and the other containing ice at 0°C. In the second case, rods are joined end to end and are connected to the same vessels. If q_1 and q_2 (in g/s) are the rates of melting of ice in two cases, then find the ratio of q_1/q_2.**

36. **Two spherical bodies A (radius 6 cm) and B (radius 18 cm) are at temperatures T_1 and T_2 respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500 nm. Considering them to be black bodies, what will be the ratio of total energy radiated by A to that of B?(IIT-2010)**

EXERCISE - III - KEY

SINGLE ANSWER QUESTIONS

1) B	2) D	3)D	4)B	5)C	6)D	7)D	8)B
9)C	10)D	11)A	12) C	13) A	14) D	15) C	16) B

MULTIPE ANSWER QUESTIONS

17) B, D 18) A,B 19) A,B 20) A,B 21) A,C 22) C,D

MATRIX MATCHING TYPE

23) $A \to Q; B \to S; C \to R; D \to P$

24) $A \to Q,S;\ B \to P,R,S; C \to P,Q,R,S;\ D \to P,Q,R,S)$

25) $A \to R; B \to P; C \to S; D \to Q$ 26) $A \to Q,S; B \to P; C \to S; D \to Q,S$

COMPREHENSION TYPE QUESTIONS

27) B 28) B 29) C 30) B

ASSERTION REASON TYPE QUESTIONS

31) C 32) A

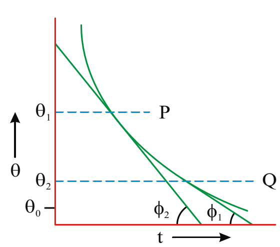
INTEGER TYPE QUESTIONS

33) 2 34) 9 35) 4 36) 9

EXERCISE - IV

SINGLE ANSWER QUESTIONS

1. A body cools in a surrounding which is at a constant temperature of θ_0. Assume that it obeys Newton's law of cooling. Its temperature θ is plotted against time t. Tangents are drawn to the curve at the points P $(\theta = \theta_1)$ and Q$(\theta = \theta_2)$. These tangents meet the time axis at angle of ϕ_2 and ϕ_1, as shown.



(A) $\dfrac{\tan\phi_2}{\tan\phi_1} = \dfrac{\theta_1 - \theta_0}{\theta_2 - \theta_0}$

(B) $\dfrac{\tan\phi_2}{\tan\phi_1} = \dfrac{\theta_2 - \theta_0}{\theta_1 - \theta_0}$

(C) $\dfrac{\tan\phi_1}{\tan\phi_2} = \dfrac{\theta_1}{\theta_2}$

(D) $\dfrac{\tan\phi_1}{\tan\phi_2} = \dfrac{\theta_2}{\theta_1}$

2. A body with an initial temperature θ_i is allowed to cool in a surrounding which is at a constant temperature of $\theta_0\,(\theta_0 < \theta_i)$. Assume that Newton's law of cooling is obeyed. Let k = constant. The temperature of the body after time t is best expressed by

(A) $(\theta_i - \theta_0)e^{-kt}$ (B) $(\theta_i - \theta_0)\ln\,(kt)$

(C) $\theta_0 + (\theta_i - \theta_0)e^{-kt}$ (D) $\theta_i\, e^{-kt} - \theta_0$

3. The intensity of radiation emitted by the sun has its maximum value at a wavelength of 510 nm and that emitted by the north star has the maximum value at 350 nm, If these stars behave like blackbodies, then the ratio of the surface temperature of the sun and the north star is :

(A) 1.46 (B) 0.69 (C) 1.21 (D) 0.83

4. A rod of uniform cross section is heated at temperature to at a print which is at n_1 times if its length $(n_1 < 1)$ from its one end in stready state. The temepratrure at

this end is t_1 and at other end is t_2. Rate of vapourisation of water at either end of the rod is same. The end at which temeprature is t_2 is how much more far away than the other end from the point at which the rod is heated.

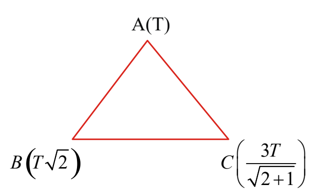
A) $\frac{n_1(t_0-t_2)}{t_0-t_1}$ B) $\frac{n_1(t_0-t_1)}{t_0-t_2}$ C) $\frac{2n_1t_0}{t_0-t_2}$ D) $\frac{2n_1(t_1-t_2)}{t_0-t_1}$

5. **A body obeying Newton's law of cooling cools in a surrounding which is at a constant temperature. Its temperature θ is plotted against time. There are two points on the curve with temperatures θ_2 and θ_1 $(\theta_2>\theta_1)$ such that tangents on these points make angles of 2ϕ and half of it with time axis respectively. Find the temperature of the surrounding**

A) $\theta_1\cos 2\phi-\theta_2(1+\cos 2\phi)$ B) $\theta_1(1+\cos 2\phi)-\theta_2\cos 2\phi$

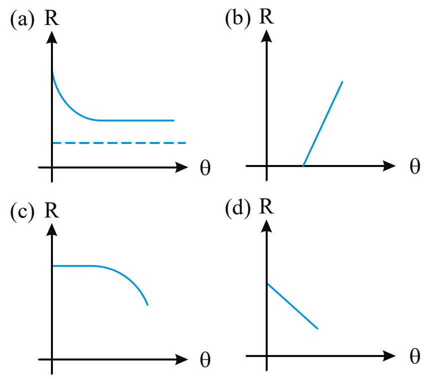
C) $(\theta_2-\theta_1)\cos 2\phi$ D) $\frac{2\theta_1+\theta_2(1+\tan^2\phi)}{(1-\tan^2\phi)}$

6. **The three rods of same material and cross-sectional area from the sides of a triangle ABC. The points A, B and C are maintained at temepratures T, $T\sqrt{2}$ and $\frac{3T}{(\sqrt{2}+1)}$ respectively. Assuming that only heat conducting takes place and the system is in steady state, find the angle at B. The temeprature difference per unit length along CB and CA is equal.**



A) 30^0 B) 45^0 C) 60^0 D) 90^0

7. **Temperature of a body θ is slightly more than the temperature of the surrounding θ_0, its rate of cooling (R) versus temperature of body (θ) is plotted, its shape would be:**



8. **A body cools from $80^0 C$ to $70^0 C$ in 10 minutes. Find the time required further for it to cool from $70^0 C$ to $60^0 C$. Assume the temerature of the surrounding to be $30^0 C$.**

(a) $10\log_e\left(\frac{4}{3}\right)$ **(b)** $10\log_e\left(\frac{5}{4}\right)$ **(c)** $10\times\frac{\log_e\left(\frac{4}{3}\right)}{\log_e\left(\frac{5}{4}\right)}$ **(d)** $10\times\frac{\log_e\left(\frac{5}{4}\right)}{\log_e\left(\frac{4}{3}\right)}$

9. **The emissive power of a black body at T=300K is $100W/m^2$. Consider a body B of area $A=10m^2$, coefficient of reflectivity $r=0.3$, and absorptivity $a=0.2$. If its temperature is 300K, then markout the correct statement.**

a) The emissive power of B is $20W/m^2$

b) The emissive power of B is $200W/m^2$

c) The power emitted by B is 20W

d) The power emitted by B is 180W

10. **A spherical shell of inner radius R_1 and outer radius R_2 is having variable thermal conductivity given by $K=a_0Tr$. Where 'r' is the distance from the centre. Two surfaces of the shell are maintained at temperature T_1 (inner surface) and T_2 (outer surface), respectively $(T_1>T_2)$. The heat current flowing through the shell would be**

a) $\frac{4\pi a_0\left(T_1^2-T_2^2\right)}{R_2-R_1}\times R_1R_2$ b) $\frac{4\pi a_0R_1^2R_2^2\left(T_1^2-T_2^2\right)}{R_2^2-R_1^2}$

c) $\frac{4\pi a_0\left(T_1-T_2\right)R_1R_2}{R_2-R_1}$ d) $\frac{4\pi a_0\left(T_1^2-T_2^2\right)\left(R_1+R_2\right)^2}{R_2-R_1}$

11. **A radiator whose temperature is T^0C, is used to heat the room in the cold weather. The radiator is able to maintain a room temperature of 30^0C when outside temperature is -10^0C and 15^0C when outside temperature is -30^0C. Determine the**

temperature of the radiator [Assume Newton's law of cooling to be valid]

a) **85^0C** b) **15^0C** c) **98.6^0C** d) **150^0C**

14. **Two thin walled spheres of different materials, one with double the radius and one-fourth wall thickness of the other, are filled with ice. If the time taken for complete melting of ice in the sphere of larger radius is 25 min and that for smaller one is 16 min, the ratio of thermal conductivities of the materials of larger sphere to the smaller sphere is**

(a) 4 : 5 (b) 25 : 1 (c) 1 : 25 (d) 8 : 25

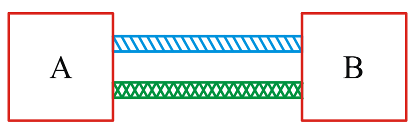
13. **An object is being heated by a heater supplying 60 W heat. Temperature of surrounding is 20°C and the temperature of object becomes constant at 50°C. Now the heater is switched off. What is the rate at which the object will lose heat when its temperature has dropped to 30°C**

(a) 20 W (b) 30 W (c) 40 W (d) 60 W

14. **The power radiated by a black body is Po and the wavelength corresponding to the maximum energy is around λ_0 On changing the temperature of the black body, it was observed that power radiated is increased to $\frac{256}{81}P_0$ The change in the wavelength corresponding to maximum intensity**

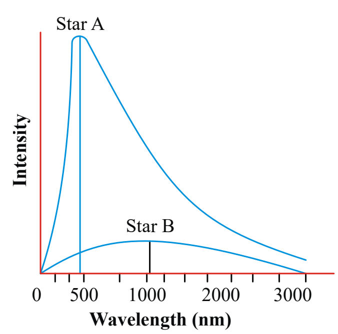
(a) increases by $\frac{\lambda_0}{4}$ (b) decreases by $\frac{\lambda_0}{4}$ (c) increases by $\frac{\lambda_0}{2}$ (d) decreases by $\frac{\lambda_0}{2}$

15. **The container A is constantly maintained at $100^0 C$ and insulated container B in the figure contains ice at $0^0 C$. Different rods are used to connect them. For a rod made of copper, it takes 30 minutes for the ice to melt and for a rod of steel of same cross-section taken in different experiment it takes 60 minutes for ice to melt. When these rods are simultaneously connected in parallel, the ice melts in:**



A) 15 minutes B) 20 minutes C) 45 minutes D) 90 minutes

16. **The spectra of radiation emitted by two distant stars are shown below.**

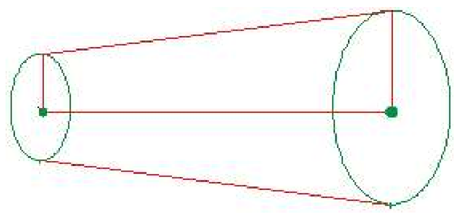


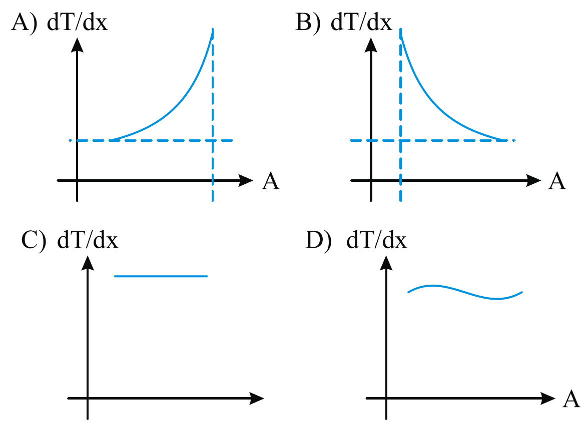
The ratio of the surface temperature of star A to that of star B, $T_A : T_B$, is approximately:

A) 2 : 1 B) 4 : 1 C) 1 : 2 D) 1 : 1

17. **An irregular rod of same uniform material as shown in figure is conducting heat at**

a steady rate. The temperature gradient at varoius sections versus area of cross section graph will be:



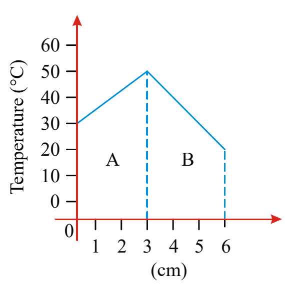


18. **A solid copper sphere of dimater 10mm, is cooled to a temperature of 150K and is then placed in an enclosure at 290 K. Assuming that all interchange of heat is by radiation, calculate the initial rate of rise of temperature of the sphere. The sphere may be treated as a black body** $\rho_{copper} = 8.93\times10^{3}\ kg/m^{3}$,

$s = 3.7\times10^{2}\ JKg^{-2}\ K^{-1}$; $\sigma = 5.7\times10^{-8}\ Wm^{-2}K^{-4}$

A) 0.68 K/s B) 0.068 K/sC) 0.34 K/s D) 0.034 K/s

19. **The temperatures across two different slabs A and B are in the steady state (as shown in Fig.) The ratio of thermal conductivities of A and B is**



A) 2:3

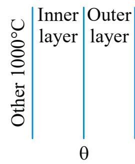
B) 3:2

C) 1:1

D) 5:3

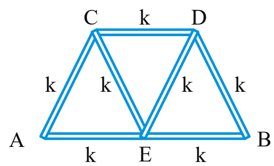
MULTIPLE ANSWER QUESTIONS

20. **The temperature drop through a two-layer furnace wall is 900°C. Each layer is of equal area of cross section. Which of the following actions will result in lowering the temperature** θ **of the interface?**



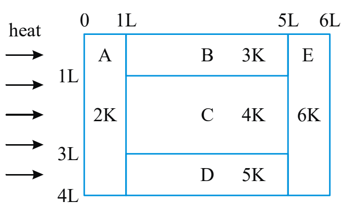
(A) By increasing the thermal conductivity of outer layer
(B) By increasing the thermal conductivity of inner layer
(C) By increasing thickness of outer layer
(D) By increasing thickness of inner layer

21. Seven identical rods of material of thermal conductivity k are connected as shown in Fig. All the rod are of identical length *l* and cross-sectional area A. If the one end B is kept at 100°C and the other end is kept at 0°C. The temperatures of the junctions C, D and $E(\theta_C, \theta_D \text{ and } \theta_E)$ be in the steady state?



(A) $\theta_C > \theta_E > \theta_D$
(B) $\theta_E = 50^\circ C$ and $\theta_D = 37.5^\circ C$
(C) $\theta_E = 50^0 C, \theta_C = 62.5^\circ C$ and $\theta_D = 37.5^\circ C$
(D) $\theta_E = 50^\circ C, \theta_C = 60^\circ C$ and $\theta_D = 40^\circ C$

22. A composite block is made of slabs A, B, C, D and E of different thermal conductivities (given in terms of a constant K) and sizes (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat Q flows only from left to right through the blocks. Then in steady state



(a) heat flow through A and E slabs are same
(b) heat flow through slab E is maximum
(c) temperature difference across slab E is smallest
(d) heat flow through C = heat flow through B + heat flow through D.

23. In Newton's law of cooling $\frac{d\theta}{dt} = -k(\theta - \theta_0)$, the constant k is proportional to:

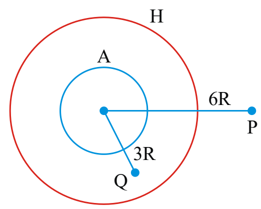
(A) A; surface area of the body
(B) S is the specific heat of the body
(C) $\frac{1}{m}$ being the mass of the body
(D) e is the emissivity of the body

COMPREHENSION TYPE QUESTIONS

Passage-I

Consider a spherical body A of radius R which is placed concentrically in a hollow enclosure H, of radius 4R as shown in the figure. The temperature of the body A and H are T_A and

T_H respectively. Emissivity, transmittivity and reflectivity of two bodies A and H are $(e_A, e_H), (t_A, t_H)$ and (r_A, r_H) respectively. (Assume no absorption of the thermal energy by the space in between the body and enclosure as well as outside the enclosure and all radiations to be emitted and absorbed nomral to the surface.) [Take $\sigma \times 4\pi R^2 \times 300^4 = \beta J/s$]



24. **The temperature of A (a perfect black body) is $T_A = 300K$ and temperature of H is $T_H = 0K$. For H take $e_H = 0.5$ and $t_H = 0.5$, For this situation mark out the correct statement(s).**

a) The rate at which A loses the energy is $\beta J/s$.

b) The rate at which spherical surface containing P receives the energy is $\frac{\beta}{2} J/s$.

c) The rate at which spherical surface containing Q receives the energy is $\beta J/s$.

d) All of the above

25. **In above question, if body A has $e_A = 0.5, r_A = 0.5$ and for H, $e_H = 0.5, r_H = 0.5$, then mark out the correct statement(s).**

a) The rate at which A loses energy is $\frac{\beta}{2}$

b) The rate at which the spherical surface containing P receives the energy is zero.

c) The rate at which the spherical surface containing Q receives the energy is β d) All of the above

26. **Consider two cases, first one in which A is a perfect black body and the second in which A is a non-black body. In both the cases, temperature of body A is same equal to 300K and H is at temperature 600K. For H, $t = 0$ and $a \neq 1$. For this situation, mark out the correct statement(s).**

a) The bodies lose their distinctiveness inside the enclosure and both of them emit the same radiation as that of the black body.

b) The rate of heat loss by A in both cases is the same and is equal to $\beta J/s$.

c) The rates of heat loss by A in both the cases are different.

d) From this information we can calculate exact rate of heat loss by A in different cases.

27. **In the previous question if the enclosure is considered as perfect black body and is maintained at same temperature as that of temperature of body A, then in the two cases**

a) the body A emits radiation at the same rate.

b) the body A emits radiation at different rates

c) the temperature of body A remains constant.

d) None of the above

Passage-II

A highly conducting solid sphere of radius R, density ρ and specific heat s is kept in an evacuated chamber. A parallel beam of thermal radiation of intensity I is incident on its surface. Consider the sphere to be a perfectly black body and its temperature at certain instant considered as $t = 0$ is T_0. [Take Stefan's constnat as σ]. Answer the following questions based on above information.

28. The equation which gives the temperature T of the sphere as a function of time, is

a) $\int_{T_0}^{T} \frac{dT}{I - 4\sigma T^4} = \int_0^t \frac{3dt}{4R\rho s}$ b) $\int_{T_0}^{T} \frac{dT}{4\sigma T^4} = \int_0^t \frac{3dt}{4R\rho s}$

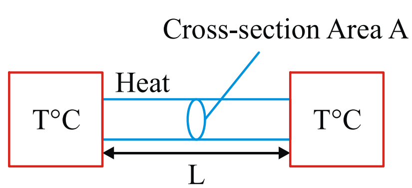
c) $\int_{T_0}^{T} \frac{dT}{I - 4\sigma T^4} = \frac{3t}{8R\rho s}$ d) $\int_{T_0}^{T} \frac{3dT}{I - 4\sigma T^4} = \frac{5t}{4R\rho s}$

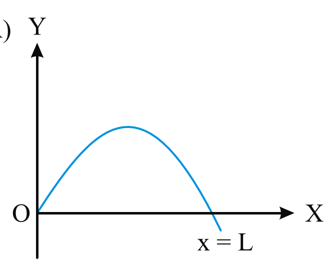
29. The maximum attainable temperature of the sphere is

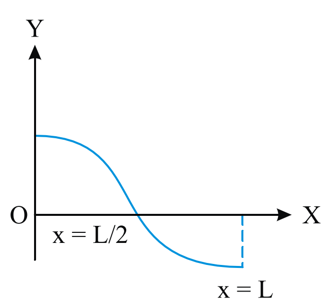
a) $\left(\frac{I}{4\sigma}\right)^{1/2}$ b) $\left(\frac{I}{2\sigma}\right)^{1/3}$ c) $\left(\frac{I}{4\sigma}\right)^{1/4}$ d) Never occurs

MATRIX MATCHING TYPE QUESTIONS

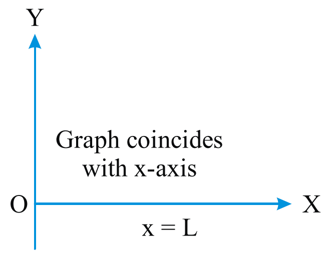
30. Suppose that both ends of the rod are kept at a temperature of T^0C, and that the initial temperature distribution along the rod is given by T = (100^{0}C) $\sin \pi x / L$, where x is measured from the left end of the rod. Let the rod be of copper, with length L and cross-section area A. Column I represents graph of certain physical quantities as we move from left to right end of rod. Column II represents those physical quantities.



(A)


(B)


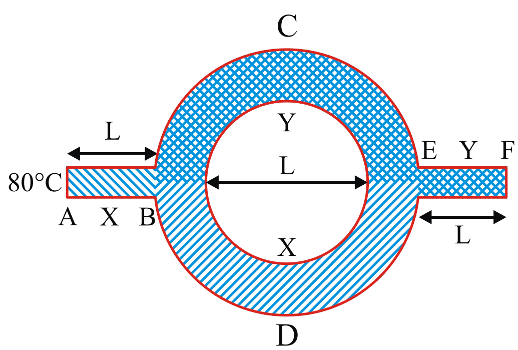
(C)



(p) Initial temperature gradient
(q) Initial temperature
(r) Finl temperature distribution along rod.
(s) Final rate of heat transfer along rod.

INTEGER TYPE QUESTIONS

31. **A few rods of materials X and Y are connected as shown in Fig. The cross-sectional areas of all the rods are same. If the end A is maintained at 80°C and the end F is maintained at 10°C. If the temperature of junctions B and E in steady state are $\frac{39.48\,^{o}C}{n_1}$ and $\frac{60.52\,^{o}C}{n_2}$. Find n_1 and n_2. Given that thermal conductivity of material X is double that of Y.**



32. **A hot body placed in air is cooled down according to Newton's law of cooling, the rate of decrease of temperature being k times the temperature difference from the surrounnding. Starting from t = 0, The time in which the body will lose half of the maximum heat is $\frac{x\ln 2}{2k}$. Find the value of x.**

33. **One end of a uniform rod of length 1 m is placed in boiling water while its other end is placed in melting ice. *A* point *P* on the rod is maintained at a constant temperature of 800°C. The mass of steam produced per second is equal to the mass of ice melted per second. If specific latent heat of steam is 7 times the specific latent heat of ice, then the distance of *P* from the steam chamber is *n*/18 m. Find the value of *n?***

34. **Two indentical conducting rods are first, connected independently to two vessels, one containing water at 100^0C and the other containing ice at 0^0C. In the second**

case, rods are joined end to end and are connected to the same vessels. If q_1 and q_2 (in g/s) are the rates of melting of ice in two cases, then the ratio of q_1 / q_2 is

35. **A metal rod AB of length 10x has its one end A in ice at 0^0C and the other end B in water at 100^0C. if a point P on the rod is maintained at 400^0C, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 cal/g and latent heat of melting of ice is 80 cal/g. If the point P is at a distance of λx from the ice end A, find the value of λ. (Neglect any heat loss to the surrounding.)**

EXERCISE - IV - KEY

SINGLE ANSWER QUESTIONS

1) B 2) C 3) B 4) D 5) B 6) D 7) B 8) C 9) A 10) B
11) D 12) D 13) A 14) B 15) B 16) A 17) B 18) B 19) B

MULTIPLE ANSWER QUESTIONS

20) A,B 21) A,C 22) A,B,C,D 23) A,C

COMPREHENSION TYPE QUESTIONS

24) D 25) D 26) C 27) B 28) A 29) C

MATRIX MATCHING TYPE QUESTIONS

30) A-Q, B-P, C-RS

INTEGER ANSWER TYPE QUESTIONS

31) 2 32) 2 33) 2 34) 4 35) 9

EXERCISE - I

THERMODYNAMICS & KTG

SINGLE ANSWER QUESTIONS

1. During an experiment, an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant [ρ=density of the gas]. The gas is initially at temperature T, pressure P and density ρ. The gas expands such that density changes to ρ /2 –

(A) The pressure of the gas changes to $\sqrt{2}P$

(B) The temperature of the gas changes to $\sqrt{2}T$

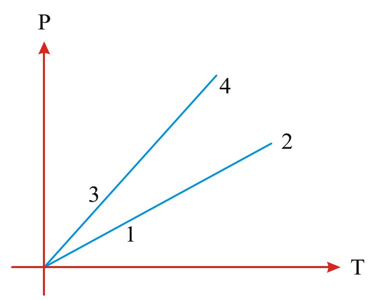
(C) The graph of the above process on the P-T diagram is parabola

(D) The graph of the above process on the P-T diagram is straight line

2. Pressure versus temperature graph of an ideal gas of equal number of moles of different volumes are plotted as shown in figure. Choose the correct alternative :

(A) $V_1 = V_2, V_3 = V_4$ and $V_2 > V_3$ (B) $V_1 = V_2, V_3 = V_4$ and $V_2 < V_3$

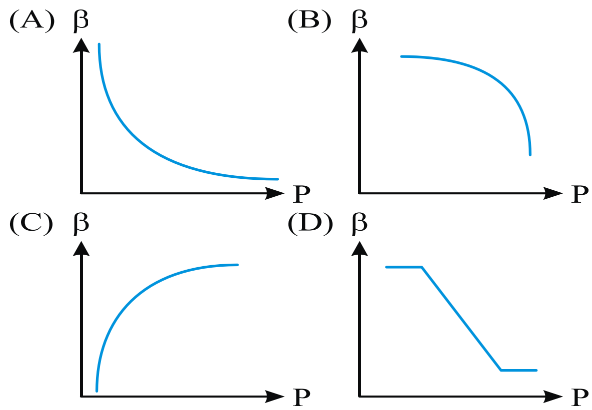
(C) $V_1 = V_2 = V_3 = V_4$ (D) $V_4 > V_3 > V_2 > V_1$.



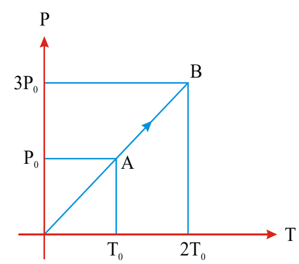
3. One mole of an ideal gas undergoes a process $P = \frac{P_0}{1+\left(\frac{V_0}{V}\right)^2}$. Here, P_0 and V_0 are constants. Change in temperature of the gas when volume is changed from $V = V_0$ to $V = 2V_0$ is :

(A) $-\frac{2P_0V_0}{5R}$ (B) $\frac{11P_0V_0}{10R}$ (C) $-\frac{5P_0V_0}{4R}$ (D) P_0V_0.

4. Which of the following graphs correctly represent the variation of $\beta = -\frac{dV/dP}{V}$ with *P* for an ideal gas at constant temperature? (IIT - 2002)

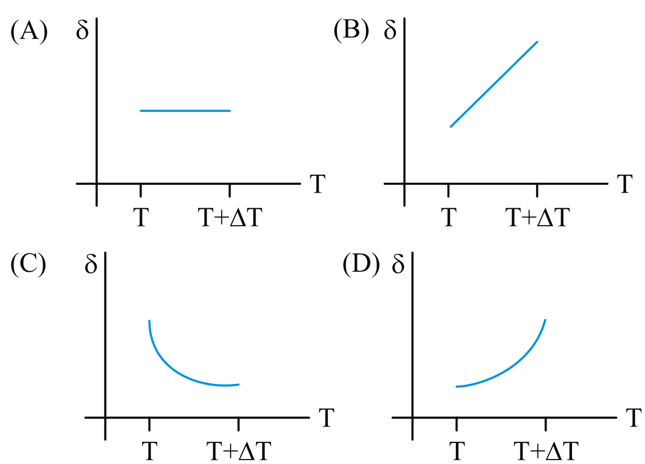


5. **Pressure versus temperature graph of an ideal gas is shown in figure. Density of the gas at point A is ρ_0. Density at B will be**



(A) $\frac{3}{4}\rho_0$ (B) $\frac{3}{2}\rho_0$ (C) $\frac{4}{3}\rho_0$ (D) $2\rho_0$

6. **An ideal gas is initially at temperature *T* and volume *V*. It volume is increased by ΔV due to an increase in temperature ΔT, pressure remaining constant. The quantity $\delta = \Delta V / V\Delta T$ varies with temperature as**
(IIT - 2000)



7. **The air tight and smooth piston of a cylinderical vessel are connected with a string, as shown. Initially pressure and temperature of the gas are P_0 and T_0.**

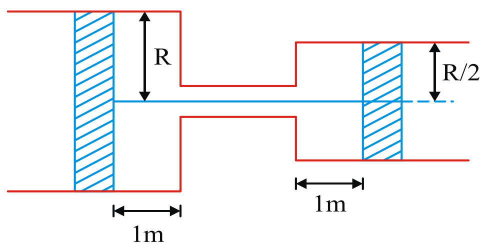
The atmospheric pressure is also P_0. At a later time, tension in the string is $\frac{3}{8}P_0A$

where A is the cross- sectional area of the cylinder. At this time, the temperature of the gas has become.

A) $\frac{3}{8}T_0$ B) $\frac{3}{4}T_0$ C) $\frac{11}{8}T_0$ D) $\frac{13}{8}T_0$

8. **A real gas behaves like an ideal gas if its**
(IIT JEE-2010)
(a) pressure and temperature are both high
(b) pressure and temperature are both low
(c) pressure is high and temperature is low
(d) pressure is low and temperature is high

9. **Two cylinders fitted with pistons and placed as shown, connected with string through a small tube of negligible volume, are filled with a gas at pressure P_0 and temperature T_0. The radius of smaller cylinder is half of the other. If the temperature is increased to $2T_0$, find the pressure, if the piston of bigger cylinder moves towards left by 1 metre?**



a) $\frac{4}{5}P_0$ **b)** $\frac{3}{5}P_0$ **c)** $\frac{2}{5}P_0$ **d)** $\frac{5}{4}P_0$

10. **One mole of an ideal gas undergoes a process** $P = P_0\left[1+\left(\frac{2V_0}{V}\right)^2\right]^{-1}$**, where P_0, V_0 are constants. Change in temperature of the gas when volume is changed from $V = V_0$ to $V = 2V_0$ is:**

a) $\frac{4}{5}\frac{P_0V_0}{nR}$ **b)** $\frac{3}{4}\frac{P_0V_0}{nR}$ **c)** $\frac{2}{3}\frac{P_0V_0}{nR}$ **d)** $\frac{7}{9}\frac{P_0V_0}{nR}$

EXERCISE -I-KEY

SINGLE ANSWER QUESTIONS

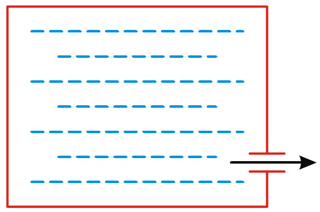
1) B	2) A	3)B	4)A 5)B
6)C	7)C	8) D	9) D 10) A

EXERCISE - II

THERMODYNAMICS & KTG

SINGLE ANSWER QUESTIONS

1. A vessel of volume V_0 contains an ideal gas at a pressure P_0. Gas is continuously pumped out of this vessel at a constant rate $\frac{dV}{dt}=r$, keeping the temperature constant. The pressure of the gas taken out equals the pressure inside the vessel. Find the pressure of the gas inside the vessel as a function of time.



(A) $2P_0 e^{-rt/V_0}$ (B) $3P_0 e^{-rt/V_0}$ (C) $-P_0 e^{-rt/V_0}$ (D) $P_0 e^{-rt/V_0}$

2. Assume that the temperature remains essentially constant in the upper parts of the atmosphere. The atmospheric pressure varies with height. If the mean molecular weight of air is M then P =

A) $P_0 e^{\frac{-3Mgh}{2RT}}$ B) $P_0 e^{\frac{-Mgh}{2RT}}$ C) $P_0 e^{\frac{-3Mgh}{RT}}$ D) $P_0 e^{\frac{-Mgh}{RT}}$

3. Assume a sample of a gas in a vessel. The speeds of molecules are between 2 m/s to 5 m/s, The number of molecules for speed *v* (m/s) is given by $n=7\upsilon^2-10$. The most probable speed in the sample is

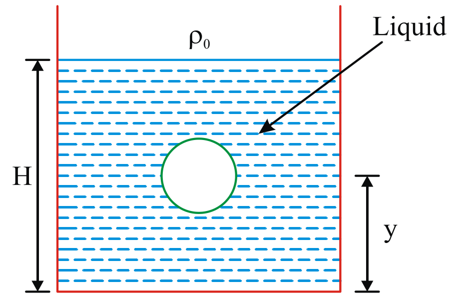
(a) 3.5 m/s (b) 5 m/s (c) 10 m/s (d) 4 m/s

4. Tyre of a bicycle has volume $2\times10^{-3}m^3$. Initially the tube is filled to 75% of its volume by air at atmospheric ressure of $p_0=10^5 N/m^2$. When a rider rides the bicycle the area of contact of tyre with road is $A=24\times10^{-4}m^2$. The mass of rider with bicycle is 120 kg. The number of strokes which delivers, $V=500\,cm^3$ volume of air in each stroke required to inflate the tyres is $[Take\, g = m/s^2]$

(a) 10 (b) 11 (c) 20 (d) 21

Comprehension - I

A small spherical monoatomic ideal gas bubble $\left(\gamma=\frac{5}{3}\right)$ is trapped inside a liquid of density ρ_ℓ (see figure). Assume that the bubble does not exchange any heat with the liquid. The bubble contains n moles of gas. The temperature of the gas when the bubble is at the battom is T_0 the height of the liquid is H and the atmospheric pressure is P_0 (Neglect surface tension). **(IIT - 2008)**



5. **As the air bubble moves upward, besides buoyancy force, the follwing forces are acting on it**

A) Only the force of gravity

B) The force due to gravity and the force due to pressure of the liquid

C) The force due to gravity, the force due to pressure of the liquid and the force due to viscosity of the liquid

D) The force due to gravity and the force due to viscosity of the liquid

6. **When the gas bubble is at height y from the bottom, its temperature is**

A) $T_0\left(\frac{P_0+\rho_l gh}{P_0+\rho_l gy}\right)^{2/5}$ B) $T_0\left(\frac{P_0+\rho_l g(H-y)}{P_0+\rho_l gH}\right)^{2/5}$

C) $T_0\left(\frac{P_0+\rho_l gH}{P_0+\rho_l gy}\right)^{3/5}$ D) $T_0\left(\frac{P_0+\rho_l g(H-y)}{P_0+\rho_l gH}\right)^{3/5}$

7. **The buoyancy force acting on the gas bubble is**

A) $\rho_l nRgT_0\frac{(P_0+\rho_l gH)^{2/5}}{(P_0+\rho_l gy)^{7/5}}$ B) $\frac{\rho_l nRgT_0}{(P_0+\rho_l gH)^{2/5}\{(P_0+\rho_l g(H-y)\}^{3/5}}$

C) $\rho_l nRgT_0\frac{(P_0+\rho_l gH)^{3/5}}{(P_0+\rho_l gy)^{8/5}}$ D) $\frac{\rho_l nRgT_0}{(P_0+\rho_l gH)^{3/5}\{(P_0+\rho_l g(H-y)\}^{2/5}}$

Comprehension - II

A very tall vertical cylinder is filled with a gas of molar mass M under isothermal conditions temperature T. The density and pressure of the gas at the base of the container is ρ_0 and p_0, respectively

8. **Select the incorrect statement**

(A) Pressure decreases with height

(B) The rate of decrease of pressure with height is a constant

(C) $\frac{dP}{dh}=-\rho g$ where ρ is density of the gas at a height h

(D) $P=\rho\frac{RT}{M}$

9. Select the incorrect statement if gravity is assumed to be constant throughout the container

(A) Both pressure and density decreases exponentially with height

(B) The variation of pressure is $P = P_0 e^{-\frac{Mgh}{RT}}$

(C) The variation of density $\rho = \rho_0 e^{\frac{Mgh}{RT}}$

(D) The molecular density decreases as one moves upwards.

10. Select the correct statement

(A) The density of gas cannot be uniform throughout the cylinder

(B) The density of gas cannot be uniform throughout the cylinder under isothermal conditions

(C) The rate of change of density $\left|\frac{d\rho}{dh}\right| = \frac{\rho Mg}{RT}$

(D) All of the above

EXERCISE II - KEY

SINGLE ANSWER QUESTIONS

1) D 2) D 3) A 4) D

COMPREHENSION TYPE QUESTIONS

P:I 5) D 6) B 7) B

PII: 8) B 9) C 10) D

EXERCISE - I

SINGLE ANSWER QUESTIONS

1. **Two simple pendulums of length 1 m and 16 m respectively are given small displacements at the same time in the same direction. The number of oscillations 'N' of the smaller pendulum for them to be in phase again is**

(A) $\frac{4}{3}$ (B) $\frac{3}{4}$ (C) 4 (D) $\frac{1}{16}$

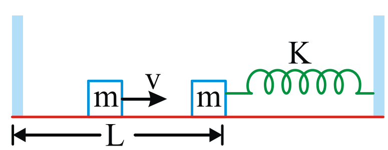
2. **The driver of a car records a period of $\frac{\pi}{3}$ seconds for a pendulum of 1m hung from the roof. The acceleration of the car is** ($g = 10ms^{-2}$)

(A) $10ms^{-2}$ (B) $15ms^{-2}$ (C) $17.2ms^{-2}$ (D) $34.5\ ms^{-2}$.

3. **A bob of mass M is hung using a string of length l. A mass m moving with a velocity u pierces through the bob and emerges out with velocity $\frac{u}{3}$ horizontally. The frequency of small oscillations of the bob, considering A as amplitude is,**

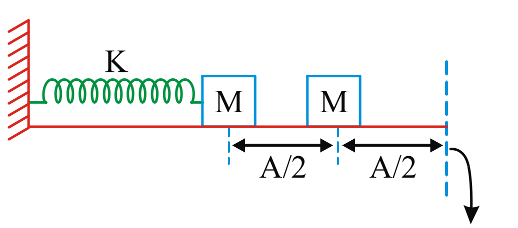
(A) $\frac{1}{2\pi}\sqrt{\frac{3mu}{2MA}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{2m}{3MA}}$ (C) $\frac{1}{2\pi}\left(\frac{2mu}{3MA}\right)$ (D) $\frac{1}{2\pi}\left(\frac{3mu}{2MA}\right)$

4. **A block of mass m moves with a speed v towards the right block which is in equilibrium with a spring attached to rigid wall. If the surface is frictionless and collisions are elastic, the frequency of collisions between the masses will be :**



(A) $\frac{v}{2L}+\frac{1}{\pi}\sqrt{\frac{K}{m}}$ (B) $2\left[\frac{v}{2L}+\frac{1}{\pi}\sqrt{\frac{K}{m}}\right]$ (C) $\frac{2}{\left[\frac{2L}{v}+\pi\sqrt{\frac{m}{K}}\right]}$ (D) $\frac{v}{2L}+\frac{1}{\pi}\sqrt{\frac{m}{K}}$

5. **A block of mass M is connected to a spring of force constant k and is placed on a smooth horizontal surface. The block is displaced and compressed the spring by "A". The block is left free to move from this position, when the block is at a distance A/2 from mean position it collides elastically with the identical block. Time to be taken by block to move from extreme position to mean position is....**



(A) $2\pi\sqrt{\frac{M}{K}}$ (B) $\frac{\pi}{2}\sqrt{\frac{M}{K}}$ (C) $\frac{\pi}{2}\sqrt{\frac{2M}{K}}$ (D) $\frac{5\pi}{6}\sqrt{\frac{M}{K}}$

6. **A uniform rod of length l is mounted so as to rotate about a horizontal axis perpendicular to the rod and at a distance x from the centre of mass. The time period will be the least when x is**

(A) $\frac{l}{\sqrt{4}}$ (B) $\frac{l}{\sqrt{2}}$ (C) $\frac{l}{\sqrt{3}}$ (D) $\frac{l}{\sqrt{12}}$

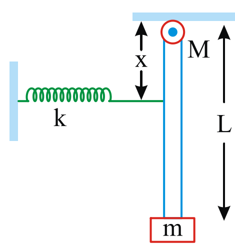
7. **A particle of mass m oscillating as given by U(y) = $K|y|^3$ with force constant K has an amplitude A. The maximum velocity during the oscillation is proportional to**

(A) A (B) A^3 (C) $A^{3/2}$ (D) $A^{1/2}$

8. **A particle at the end of a spring executes simple harmonic motion with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is T, then**

(A) $T = t_1 + t_2$ (B) $T^2 = t_1^2 + t_2^2$ (C) $T^{-1} = t_2^{-1} + t_2^{-1}$ (D) $T^{-2} = t_1^{-2} + t_2^{-2}$

9. **A body of mass m, is attatched to a vertical rod of mass M and length L, hung from a pivoted support. A spring of constant K fixed to a support on the left as shown and is attached to the rod at a distance from the pivot. The frequency of the oscillation is :**

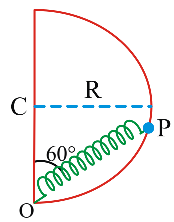


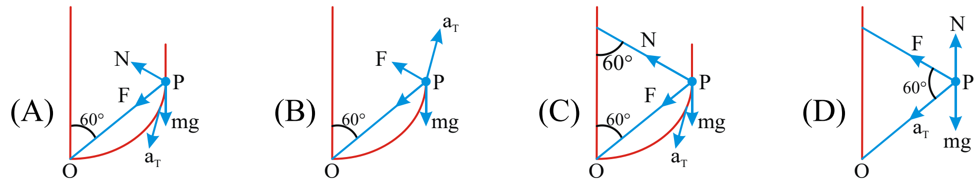
A) $\frac{1}{2\pi}\sqrt{\frac{K}{(M+2m)}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{K}{\left(\frac{M}{3}+2m\right)}}$

(C) $2\pi\sqrt{\frac{K}{\left(\frac{M}{3}+2m\right)}}$ (D) $2\pi\sqrt{\frac{M+2m}{K}}$

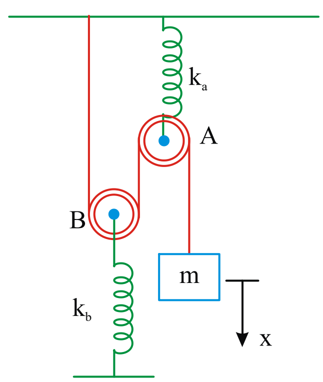
10. **A smooth semicircular wire track of radius R is fixed in a vertical plane. One end of massless spring of natural length $\frac{3R}{4}$ is attached to the lowest point O of the wire track . A small ring of mass m which can slide on the track is attached to the other end of the spring. The ring is held stationary at point P such that the spring makes an angle of 60° with the vertical. The spring constant is K=**

$\frac{mg}{R}$. Considering the instance when the ring is released , the free body diagram of the ring, when a_T is tangential acceleration, F is restoring force and N is normal reaction is





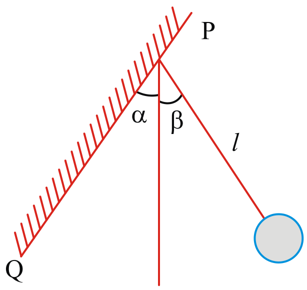
11. If the mass of the the pulleys shown in figure are small and the cord is inextensible, the angular frequency of oscillation of the system is



(A) $\sqrt{\frac{K_a + K_b}{m}}$ (B) $\sqrt{\frac{K_a K_b}{(K_a + K_b)m}}$

(C) $\sqrt{\frac{K_a K_b}{4m(K_a + K_b)}}$ (D) $\sqrt{\frac{4K_a K_b}{(K_a + K_b).m}}$

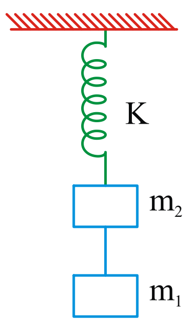
12. A ball is suspended by a thread of length l at the point O on an inclined wall as shown. The inclination of the wall with the vertical is α. The thread is displaced through a small angle $\beta\ (> \alpha)$ away from the vertical and the ball is released. The period of oscillation of pendulum(the collision between the wall and the ball is elastic) is



(A) $2\pi\sqrt{\frac{l}{g}}+2\sqrt{\frac{l}{g}}.\cos^{-1}\left(\frac{\alpha}{\beta}\right)$ (B) $2\pi\sqrt{\frac{l\sin\alpha}{g}}$

(C) $2\pi\sqrt{\frac{l\sin\alpha}{g\cos\beta}}$ (D) $2\pi\sqrt{\frac{l}{g}}-2\sqrt{\frac{l}{g}}.\cos^{-1}\left(\frac{\alpha}{\beta}\right)$

13. Two masses m_1 and m_2 are suspended together by a massless spring of spring constant k (Fig). When the masses are in equilibrium, m_1 is removed. Frequency and amplitude of oscillation of m_2 are



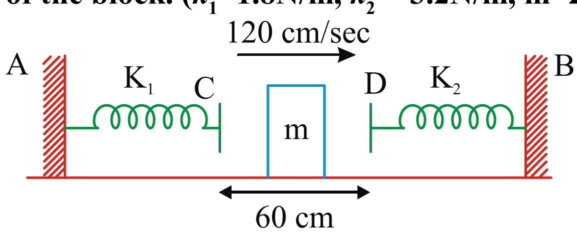
(A) $\omega=\sqrt{\frac{K}{m_1}};\ A=\frac{m_2g}{K}$

(B) $\omega=\sqrt{\frac{K}{m_2}};\ A=\frac{m_1g}{K}$

(C) $\omega=\sqrt{\frac{K}{m_1}};\ A=\frac{m_1g}{K}$

(D) $\omega=\sqrt{\frac{K}{m_2}};\ A=\frac{m_2g}{K}$

14. Two light springs of force constant k_1 and k_2 and a block of mass m are in one line AB on a smooth horizontal table such that one end of each spring is fixed on rigid supports and the other end is free as shown in the figure. The distance CD between the free ends of the spring is 60 cm. If the block moves along AB with a velocity 120 cm/s in between the springs, calculate the period of oscillation of the block. (k_1=1.8N/m, k_2 = 3.2N/m, m=200gm)



(A) 1.41 S (B) 2.82 S (C) 5.64 S (D) 1.92 S

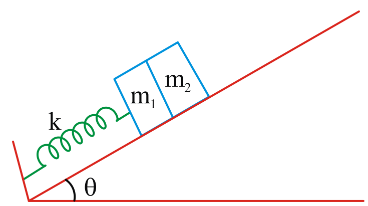
15. A solid sphere of radius R is floating in a liquid of density ρ with half of its volume submerged. If the sphere is slightly pushed and released, it starts performing simple harmonic motion. The frequency of these oscillations is

A) $\frac{1}{2\pi}\sqrt{\frac{3g}{2R}}$ B) $\frac{1}{2\pi}\sqrt{\frac{2R}{3g}}$ C) $\frac{1}{2\pi}\sqrt{\frac{R}{g}}$ D) $\frac{1}{2\pi}\sqrt{\frac{5g}{3R}}$

16. **A mass *m* is undergoing *SHM* in the vertical direction about the mean position y_0 with amplitude *A* and angular frequency ω. At a distance *y* from the mean position, the mass detaches from the spring. Assume that the spring contracts and does not obstruct the motion of *m*. The distance *y* (measured from the mean position) such that the height *h* attained by the block is maximum is ($Aw^2 > g$)**

A) $\frac{g}{\omega^2}$ B) $\frac{2g}{\omega^2}$ C) $\frac{3g}{\omega^2}$ D) $\frac{4g}{\omega^2}$

17. **The block of mass m_1 shown in figure is fastened to the spring and the block of mass m_2 is placed against it. The blocks are pushed a further distance $(2/k)(m_1+m_2)g\sin\theta$ from mean position against the spring and released. The common speed of blocks at the time of separation is**

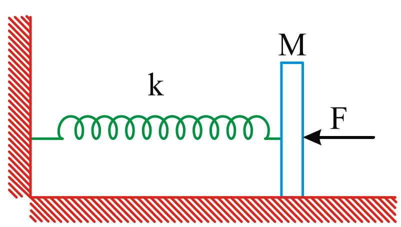


A) $\sqrt{\frac{2}{k}(m_1+m_2).g\sin\theta}$ B) $\sqrt{\frac{3}{k}(m_1+m_2).g\sin\theta}$

C) $\sqrt{\left(\frac{m_1+m_2}{k}\right).g\sin\theta}$ D) $\sqrt{\frac{5}{k}(m_1+m_2).g\sin\theta}$

18. **In figure a sharp blow by some external agent imparts a speed of 2 m/s to the block towards left when it is at equilibrium position The potential energy of the spring when the block is at the right extreme is**

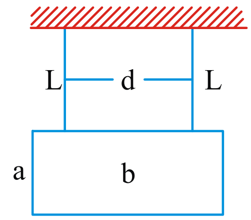
($k = 100\ N/m,\ M = 1 kg\ and\ F = 10N$)



A) 4.5 J B) 4 J C) 0.5 J D) 2.5 J

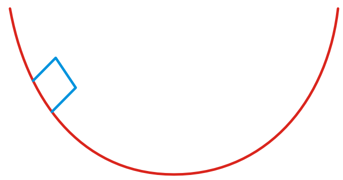
19. **A rectangular plate of sides a and b is suspended from a ceiling by two parallel strings of length L each (figure). The separation between the strings is d. The plate is displaced slightly in its plane keeping the strings tight. The time period**

of oscillation is



A) $2\pi\sqrt{\frac{L}{g}}$ B) $2\pi\sqrt{\frac{L+a}{g}}$ C) $2\pi\sqrt{\frac{La}{g.b}}$ D) $2\pi\sqrt{\frac{La}{g.d}}$

20. **A small block oscillates back and forth on a smooth concave surface of radius R (Figure). The time period of small oscillations is**

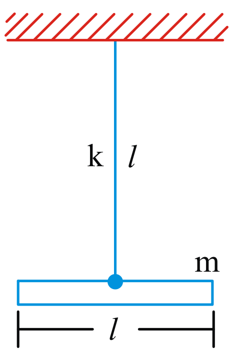


A) $2\pi\sqrt{\frac{R}{g}}$ B) $2\sqrt{\frac{R}{g}}$ C) $\pi\sqrt{\frac{R}{g}}$ D) $\sqrt{\frac{R}{g}}$

21. **Assume that a tunnel is dug across the earth. A ball is dropped into it. The time where it moves with a speed of $\sqrt{gR}$ is**

A) $2\pi\sqrt{\frac{R}{g}}$ B) $\pi\sqrt{\frac{R}{g}}$ C) $\frac{\pi}{2}\sqrt{\frac{R}{g}}$ D) $\frac{\pi}{\sqrt{2}}\sqrt{\frac{R}{g}}$

22. **A uniform rod of mass m and length l is suspended through a light wire of length l and torsional constant k as shown in figure. The time periods of the system for small oscillations in the vertical plane about the suspension point and angular oscillations in the horizontal plane about the centre of the rod are**



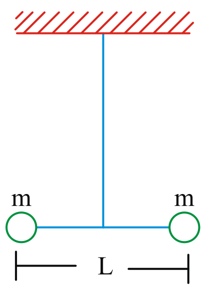
A) $2\pi\sqrt{\frac{13l}{12g}};2\pi\sqrt{\frac{ml^2}{12K}}$

B) $2\pi\sqrt{\frac{l}{g}};2\pi\sqrt{\frac{ml^2}{3K}}$

C) $2\pi\sqrt{\frac{13l}{12g}};2\pi\sqrt{\frac{ml^2}{3K}}$

D) $2\pi\sqrt{\frac{l}{g}};2\pi\sqrt{\frac{ml^2}{12K}}$

23. **Two small balls, each of mass m are connected by a light rigid rod of length L. The system is suspended from its centre by a thin wire of torsional constant k. The rod is rotated about the wire through an angle θ_0 and released. The tension in the rod as the system passes through the mean position is**

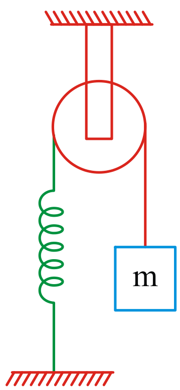


A) $\frac{\sqrt{k^2\theta_0^4 + 4m^2g^2L^2}}{2L}$

B) $\frac{\sqrt{k^2\theta_0^4 + m^2g^2L^2}}{L}$

C) $\frac{k\theta_0^2}{2L}$ D) $\frac{k\theta_0^2 + mgL}{L}$

24. In the fig the pulley has a mass M, radius r and the string does not slip over it. The time period of oscillation is



A) $2\pi\sqrt{\frac{2m+M}{2k}}$

B) $\frac{2\pi}{R}\sqrt{\frac{2m+3MR^2}{2k}}$

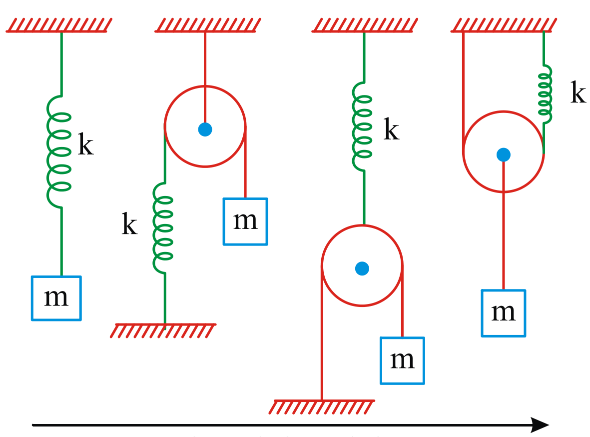
C) $2\pi\sqrt{\frac{m}{k}}$

D) $2\pi\sqrt{\frac{m+M}{k}}$

25. The average kinetic energy of a particle of mass m undergoing S.H.M with angular frequency ω and amplitude A, over half of one time period is

(A) $\frac{1}{2}m\omega^2A^2$ (B) $\frac{1}{4}m\omega^2A^2$ (C) $m\omega^2A^2$ (D) $2m\omega^2A^2$

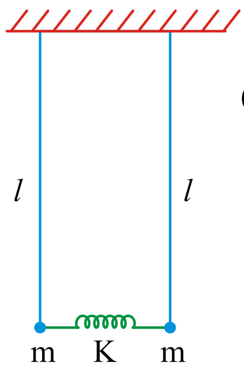
26. The time periods of systems depicted below under identical conditions are respectively



(i) $2\pi\sqrt{\frac{m}{k}}$; (ii) $2\pi\sqrt{\frac{4m}{k}}$; (iii) $2\pi\sqrt{\frac{m}{4k}}$

(A) ii,i,ii,iii (B) i,i,iii,ii (C) i,ii,ii,iii (D) i,i,ii,iii

27. Two identical simple pendulums each of length 'l' are connected by a weightless spring as shown.
In equilibrium, the pendulums are vertical and the spring is horizontal and undeformed. The time period of small oscillations of the linked pendulums, when they are deflected from their equilibrium positions through equal displacements in the same vertical plane in the opposite directions and released, is



(A) $2\pi\sqrt{\frac{l}{g}}$ (B) $2\pi\sqrt{\frac{l}{\left(g+\frac{2kl}{m}\right)}}$

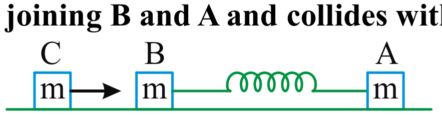
(C) $2\pi\sqrt{\frac{l}{\left(g+\frac{kl}{m}\right)}}$ (D) $2\pi\sqrt{\frac{2l}{g}+\frac{m}{k}}$

28. A mass of 0.98 kg suspended using a spring of constant k= 300 N m^{-1} is hit by a bullet of 20gm moving with a velocity of 3m/s vertically. The bullet gets embedded and oscillates with the mass in a vertical plane. The amplitude of oscillation will be :

(A) 0.15cm (B) 0.35 cm (C) 1.2cm (D) 12 m

MULTIPLE ANSWER QUESTIONS

29. Two blocks A and B each of mass m are connected by a massless spring of natural length l and spring constant K. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length as shown. A third identical block C also of mass m, moves on the floor with a speed v along line joining B and A and collides with B elastically. Then



(A) The frequency of oscillation of the system AB is $\frac{1}{2\pi}\sqrt{\frac{2K}{m}}$

(B) The K.E. of the system at maximum compression of the spring is $mv^2/4$

(C) The maximum compression of the spring is $v\sqrt{\frac{m}{K}}$

(D) The maximum compression of the spring is $v\sqrt{\dfrac{m}{2K}}$

30. A coin of mass m is placed on a horizontal platform which is undergoing S.H.M. about a mean position O in horizontal plane. The force of friction on the coin is f. While the coin does not slip on the platform f is

(A) directed towards O always.
(B) directed away from O always
(C) directed towards O when the coin moves in wards
(D) maximum when coin and platform are at rest

31. $x = A\sin^2 \omega t + B\cos^2 \omega t + C\sin \omega t \cos \omega t$ **represents S.H.M. for**

(A)any value of A, B and C (except C = 0)
(B) A = -B, C = 2B, amplitude = $|B\sqrt{2}|$
(C) A= B, C=0
(D) A=B, C=2B,amplitude= $|B|$

32. A simple pendulum of length L and mass m is vibrating with an amplitude a. Then the maximum tension in the string is not

(A) mg (B) $mg\left[1+\left(\dfrac{a}{L}\right)^2\right]$

(C) $mg\left[1+\left(\dfrac{a}{2L}\right)\right]^2$ (D) $mg\left[1+\left(\dfrac{a}{2L}\right)^2\right]$

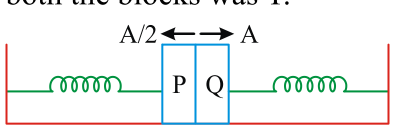
33. Three simple harmonic motions in the same direction having the same amplitude and same period are superposed. If each differ in phase from the next by 45°, then

(A) the resultant amplitude is $(1 + \sqrt{2})a$
(B) the phase of the resultant motion relative to the first is 90°
(C) the energy associated with the resulting motion is $(3 + 2\sqrt{2})$ times the energy associated with any single motion
(D) the resulting motion is not simple harmonic

COMPREHENSION TYPE QUESTIONS

Passage-I

Two identical blocks P and Q have mass m each. They are attached to two identical springs initially unstretched. Now the left spring (along with P) is compressed by A/2 and the right spring (along with Q) is compressed by A. Both the blocks are released simultaneously. They collide perfectly inelastically. Initially time period of both the blocks was T.



34. The time period of oscillation of combined mass is

(A) $\frac{T}{\sqrt{2}}$ (B) $\sqrt{2}T$ (C) T (D) $\frac{T}{2}$

35. The amplitude of combined mass is

(A) $\frac{A}{4}$ (B) $\frac{A}{2}$ (C) $\frac{2A}{3}$ (D) $\frac{3A}{4}$

36. The energy of oscillation of the combined mass is

(A) $\frac{1}{2}kA^2$ (B) $\frac{1}{4}kA^2$ (C) $\frac{1}{8}kA^2$ (D) $\frac{1}{16}kA^2$

Passage-II

For SHM to take place force acting on the body should be proportional to - x or F = -kx. If A be the amplitude then energy of oscillation is 1/2 KA^2.

37. Force acting on a block is F = (-4x + 8). Here F is in newton and x is the position of block on x-axis in meters

(A) Motion of the block is periodic but not simple harmonic
(B) Motion of the block is not periodic
(C) Motion of the block is simple harmonic about the origin, x=0
(D) Motion of the block is simple harmonic about x=2m

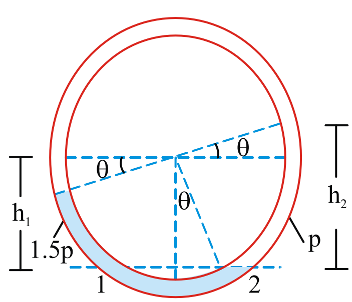
38. If energy of oscillation is 18 J, between what points does the block will oscillate?

(A) between x = 0 and x = 4 m (B) between x = -1m and x = 5 m
(C) between x = -2m and x = 6m
(D) between x = 1m and x = 3 m

39. The amplitude of oscillation is

(A) 4 cm (B) 2 cm (C) 1 cm (D) 3 cm

Passage-III Two non-viscous, incompressible and immiscible liquids of densities ρ and 1.5 ρ are poured into the two limbs of a circular tube of radius *R* and of small cross-section kept fixed in a vertical plane as shown in fig. Each liquid occupies one-fourth the circumference of the tube.



40. The angle θ as shown is

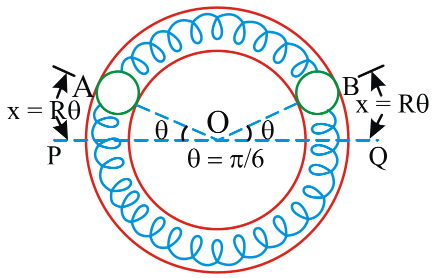
A) $\tan^{-1}\left(\frac{1}{5}\right)$ B) $\tan^{-1}\left(\frac{3}{2}\right)$ C) $\tan^{-1}\left(\frac{2}{3}\right)$ D) zero

41. If the whole liquid column is given a small displacement from its equilibrium position, the time period of these oscillations is

A) $2\pi\sqrt{\frac{R}{6.11}}$ B) $2\pi\sqrt{\frac{2R}{3}}$ C) $2\pi\sqrt{\frac{3R}{2}}$ D) $2\pi\sqrt{\frac{R}{9.8}}$

Passage-IV

Two identical balls A and B, each of mass 0.1 kg, are attached to two identical massless springs. The spring-mass system is constrained to move inside a rigid smooth pipe bent in the form of a circle as shown in figure. The pipe is fixed in a horizontal plane. The centers of the balls can move in a circle of radius 0.06 m. Each spring has a natural length of 0.06π meter and spring constant 0.1 N/m. Initially, both the balls are displaced by an angle $\theta = \frac{\pi}{6}$ radian with respect to the diameter PQ of the circle (as shown in fig.) and released from rest.



42. The frequency of oscillation of ball B is

(A) $\frac{1}{\pi} Hz$ (B) $\frac{1}{2\pi} Hz$ (C) $\frac{6}{\pi} Hz$ (D) $\frac{2}{\pi} Hz$

43. The speed of ball A when A and B are at the two ends of the diameter PQ is (in m/s)

(A) 0.0314 (B) 0.0628 (C) 0.1256 (D) zero

44. The total energy of the system is

(A) $3.9\text{x}10^{-4}$ J (B) 10^{-4} J (C) $6\text{x}10^{-4}$ J (D) $2\text{x}10^{-4}$ J

Passage-V

You are riding a four wheeler automobile of mass, 3000kg. Assume that you are examining the oscillation characteristics of its suspension system. The suspension sags by 15 cm when the automobile is placed on it. Also, the amplitude of oscillations decreases by 50% during one complete oscillation. Shock absorber supports 750 kg ($g=10\ m/s^2$)

45. The spring constant of the spring is (in N/m)

(A) $20\text{x}10^4$ (B) $10\text{x}10^4$ (C) $5\text{x}10^4$ (D) $40\text{x}10^4$

46. The time period of one oscillation is

(A) 0.77 s (B) 1 s (C) 2 s (D) 1.414 s

MATRIX MATCHING QUESTIONS

47. In case of seconds pendulum, match the following. Consider shape of earth also

Column - I	**Column - II**
(A) At pole	(p) $T > 2s$
(B) On a satellite	(q) $T < 2s$
(C) At mountain	(r) $T = 2s$
(D) At centre of earth	(s) $T = 0$
	(t) $T = \infty$

48. Match the following:

A spring block system executes SHM in such a way that the block is having velocity v when it crosses the mean position. Now the changes have been made in such a way that the velocity while crossing the mean position gets doubled without changing mass of the block. In Column-I some statements (incomplete) are given and corresponding completions are given in Column-II. Match the entries of Column-I with the entries of Column-II. Assume that the system is horizontal.

Column-I	**Column-II**
(A) The frequency of oscillation will change by a factor of	(p) 2
(B) The amplitude of oscillation will change by a factor of	(q) $\sqrt{2}$
(C) The magnitude of maximum acceleration will change by a factor of	(r) 1
(D) Maximum PE increases by a factor of	(s) 4

49. Match the following:

Column - I

(A) Linear combination of two SHMs

(B) $y = A\sin\omega_1 t + A\sin(\omega_2 t + \phi)$

(C) Time period of a pendulum of infinite length

(D) Maximum value of time period of an oscillating pendulum

Column-II

(p) $T = 2\pi\sqrt{\frac{R}{g}}$ (R is radius of the earth

(q) SHM for equal frequencies and amplitude

(r) Superposition may not always be an SHM

(s) Amplitude will be $\sqrt{2}$A for $\omega_1 = \omega_2$ and if phase difference of $\pi/2$

50. Match the following:

Column-I	**Column-II**
(A) A constant force acting along the line of SHM affects	(p) the time period
(B) A constant torque acting along the arc of angular SHM affects	(q) the frequency
(C) A particle falling on the block executing SHM when position it crosses the mean position affects	(r) the mean
(D) A particle executing SHM when kept on a uniformly accelerated car affects	(s) the amplitude

51. For a particle executing S.H.M. along a straight line, match the statements in column-I with statements in column-II. (Note that displacement given in column-I is to be measured from mean position.)

Column-I	Column-II
(A) Velocity-time graph will be	(p) Straight line
(B) Acceleration-velocity graph may be	(q) Circle
(C) Acceleration-displacement graph will be	(r) Ellipse
(D) Acceleration-time graph will be	(s) Sinusoidal curve

52. In column-I equations describing the motion of a particle are given and in column-II possible nature of the motions. Match the entries of column-I with the entries of column-II.

Column-I	Column-II
(A) $y = Ae^{(\omega t+\phi)}$	(p) Oscillatory
(B) $y = B\sin\omega t + C\cos\omega t$	(q) Periodic
(C) $y = A\sin(\omega t + kx)$	(r) S.H.M
(D) $y = kx$	(s) Rectilinear

53. A particle moves according to the law given below in the column-I where x, v and a are displacement, velocity and acceleration respectively and ω, A are +ve constants. Then match the following.

Column-I

(A) $a = -\omega^2 x^3$ (B) $a = -\omega^2 x^2$

(C) $a = -\omega^2 A\sin\frac{\pi x}{2A}$ where $(-A \le x \le A)$

(D) $v = a = -\omega^2\sqrt{A^2 - x^2}$

Column-II (Nature of motion of particle)

(p) Motion is periodic
(q) Motion is oscillatory
(r) Motion is not simple harmonic
(s) Mechanical energy is conserved

54. For a particle under going linear S.H.M. about $x = 0$, choose the correct possible combination. Symbols have their usual meanings.

Column-I	Column-II
(A) $\vec{v}\,.\,\vec{a} > 0$	(p) Extreme position
(B) Velocity may be negative	(q) Mean position
(C) Acceleration is negative	(r) $0 < x < A$
(D) $\vec{v} \times \vec{a} = \vec{0}$	(s) $-A < x < 0$

ASSERTION & REASON QUESTIONS

(A) Statement-I is true, Statement-II is true; Statement-II is a correct explanation for Statement-I.
(B) Statement-I is true, Statement-II is true; Statement-II is NOT a correct explanation for Statement-I.
(C) Statement-I is true; Statement-II is false
(D) Statement-I is false ; Statement-II is true

55. **Statement-I:** When a girl sitting on a swing stands up, the periodic time of the swing will increase.
Statement-II: In standing position of a girl, the length of the swing will decrease.

56. **Statement-I:** Two simple harmonic motions are given by $y_1 = 10\sin\left(3\pi t + \frac{\pi}{4}\right)$ and $y_2 = 5\left(\sin 3\pi t + \sqrt{3}\cos 3\pi t\right)$. These have amplitudes in the ratio 1 : 1.
Statement-II: y_1 & y_2 represents two waves of amplitudes 5& $5\sqrt{3}$ .So the resultant amplitude is 10.

57. **Statement-I:** During the oscillations of simple pendulum, the direction of its acceleration at the mean position is directed towards the point of suspension and at extreme position it is directed towards the mean position.
Statement-II: The direction of acceleration of a simple pendulum at the mean position or at the extreme position is decided by the tangential and radial components of force by gravity.

58. **Statement-I:** A particle is moving along $x-$axis. The resultant force F acting on it is given by $F = -ax - b$, where a and b are both positive constants. The motion of this particle is not S.H.M.
Statement-II: In S.H.M. resultant force must be proportional to the displacement from mean position.

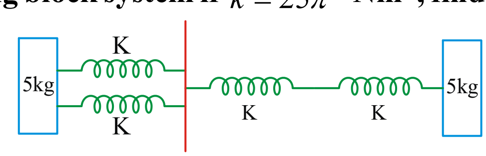
59. **Statement-I:** In a simple pendulum performing S.H.M. the net acceleration is always between tangential and radial accelerations except at lowest point.
Statement-II: At lowest point tangential acceleration is zero.

60. **Statement-I:** Time period of spring block system is the same whether in an accelerated or in an inertial frame of reference.
Statement-II: Mass of the block of spring block system and spring constant of the spring are independent of the acceleration of the frame of reference.

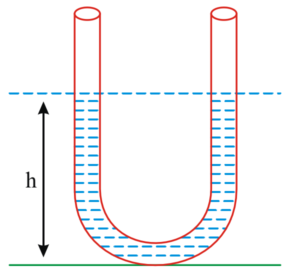
61. **Statement-I:** If the amplitude of a simple harmonic oscillator is doubled, its total energy becomes four times.
Statement-II: The total energy is directly proportional to the square of the amplitude of vibration of the harmonic oscillator.

INTEGER ANSWER QUESTIONS

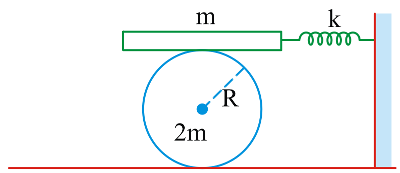
62. **In the given spring block system if $k = 25\pi^2$ Nm^{-1}, find time period of oscillation.**



63. **Consider a liquid which fills a uniform U-tube, as shown in the figure upto a height h = 10 m. The angular frequency of small oscillations of the liquid in the U-tube is (g = 10 ms^{-2})**

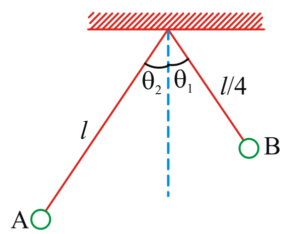


64. **A uniform plank of mass m = 1 kg, free to move in the horizontal direction only, is placed at the top of a solid cylinder of mass $2m$ and radius R. The plank is attached to a fixed wall by means of a light spring of spring constant k = 7 N/m². There is no slipping between the cylinder and the plank, and between the cylinder and the ground. The angular frequency of small oscillations of the system is**

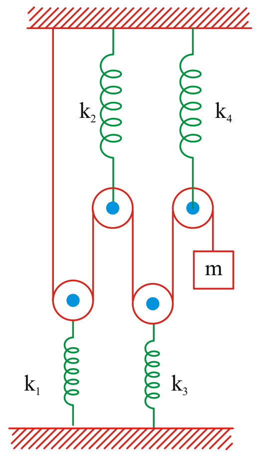


65. **Two simple pendulums A and B having lengths l and $l/4$ respectively are released from the position as shown in fig. Calculate the time (in seconds) after which the two strings become parallel for the first time.**

(Take $l = \dfrac{90}{\pi^2} m \text{ and } g = 10\, m/s^2$**)**



66. **In the arrangement shown in fig. pulleys are light, springs are ideal and** $K_1 = 25\pi^2\ N/m, K_2 = 2K_1, K_3 = 3K_1$ **and** $K_4 = 4K_1$ **are the force constants of the springs. Calculate the period of small vertical oscillations of block of mass** $m = 3kg$ **.**



EXERCISE - I - K E Y

SINGLE ANSWER TYPE

01) A 02) D 03) C 04) C 05) D 06) D 07) C 08) B 09) C 10) **C**
11) C 12) D 13) B 14) B 15) A 16) A 17) B 18) C 19) A 20) A
21) C 22) A 23) B 24) A 25) B 26) D 27) B 28) B

MULTIPLE ANSWER TYPE

29) A,B,D 30) A,C,D 31) A,B,D 32) **A,C,D** 33) A,C

COMPREHENSION QUESTIONS

34) C 35) A 36) D 37) D 38) B 39) A 40) A
41) A 42) A 43) B 44) A 45) C 46) A

MATRIX MATCH TYPE

47) A-q ; B-t ; C-p ; D-t 48) A - r; B - p; C-p; D-s
49) A-q,r;B-q,r,s;C-p;D-p 50) A-r,s ; B-r,s; C-p,q,s ; D-r,s
51) A - s; B - q,r ; C -p; D - s
52) A - p,q,r; B - p,q,r ; C - p,q,r; D - s
53) A-p,q,r,s; B-r, s ; C-p,q,r,s ; D-p,q,r,s
54) A - r, s; B - q,r,s ; C - p,r ; D - p,q,r,s

ASSERTION AND REASON TYPE

55) D 56) B 57) A 58) D 59) D 60) A 61) A

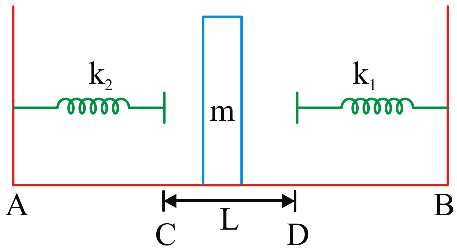
INTEGER TYPE QUESTIONS

62) 1 63) 1 64) 2 65) 1 66) 2

EXERCISE - II

SINGLE ANSWER QUESTIONS

1. **Two light springs of force constants k_1, k_2 and a block of mass m are in the line AB on a smooth horizontal table such that one end of each spring is fixed on rigid supports and the other end is free as shown: The given values are** $k_1 = 1.8\ N/m$; $k_2 = 3.2\ N/m$;
$m = 200 gm$; $L = 60\ cm$; **If the block moves along AB with a velocity 120 cm/sec in between the springs, then period of oscillation of the block is[$\because$ assume all collisions are elastic]:**



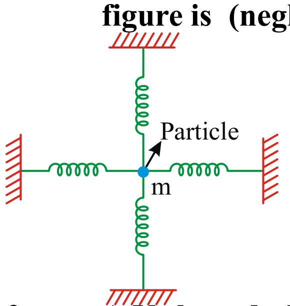
(A) 1.04 sec

(B) 0.785 sec

(C)1 sec

(D)2.82 sec

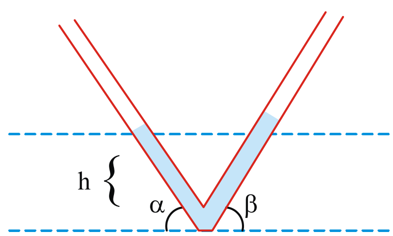
2. **The following figure shows a particle of mass, m, attached with four identical springs, each of length l. Initial tension in each spring is F_0. The period of small oscillations of the particle along a line perpendicular to the plane of the figure is (neglect gravity)**



(A) $\pi\sqrt{\frac{ml}{F_0}}$ (B) $2\pi\sqrt{\frac{ml}{F_0}}$

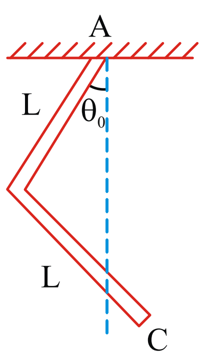
(C) $2\pi\sqrt{\frac{ml}{2F_0}}$ (D) $\pi\sqrt{\frac{ml}{4F_0}}$

3. **A V-shaped glass tube of uniform cross-section is kept in a vertical plane as shown. The angular frequency of small oscillations of liquid in a tube is**



(A) $\frac{g\sin\alpha.\sin\beta}{\sqrt{h}}$ (B) $\sqrt{\frac{g\sin\alpha.\sin\beta}{h}}$ (C) $\sqrt{\frac{g}{h}}$ (D) $\sqrt{\frac{g(\sin\alpha+\sin\beta)}{h}}$

4. **A L - shaped bar of mass M is pivoted at one of its end so that it can freely rotate in a vertical plane as shown. If it is slightly displaced from its equilibrium position then the frequency of oscillation is....**

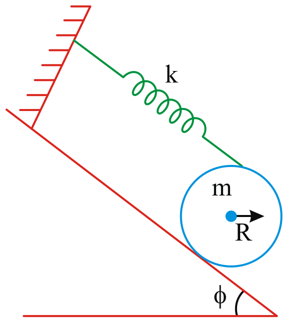


(A) $\frac{1}{2\pi}\sqrt{\frac{g}{L}\left(\frac{3\sqrt{10}}{4}\right)}$

(B) $\frac{1}{2\pi}\sqrt{\frac{g}{L}\left(\frac{\sqrt{10}}{4}\right)}$

(C) $\frac{1}{2\pi}\sqrt{\frac{g}{L}\left(\sqrt{2}\right)}$ (D) $\frac{1}{2\pi}\sqrt{\frac{g}{\sqrt{2}L}}$

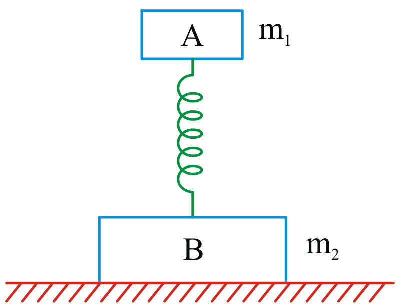
5. **A uniform cylinder of mass m and radius R is in equilibrium on an inclined plane by the action of a light spring of stiffness k, gravity and reaction force acting on it. If the angle of inclination of the plane is ϕ, then angular frequency of small oscillations of the cylinder is..............**



(A) $2\sqrt{\frac{k}{m}}$ (B) $2\sqrt{\frac{2k}{m}}$

(C) $2\sqrt{\frac{2k}{3m}}$ (D) $\sqrt{\frac{2k}{m}}$

6. **A body A of mass m_1 and body B of mass m_2 are interconnected by a massless spring as shown. The body A performs free vertical harmonic oscillations with the amplitude A and frequency f. The maximum value of f such that body B does not leave the surface is**



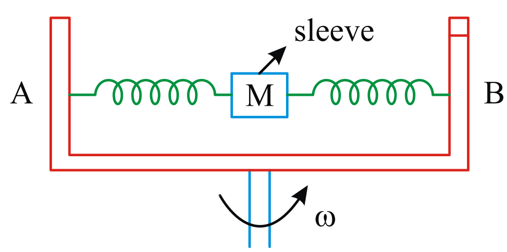
(A) $\frac{1}{2\pi}\sqrt{\left(\frac{m_1+m_2}{m_2}\right)\frac{g}{A}}$

(B) $\frac{1}{2\pi}\sqrt{\left(\frac{m_1+m_2}{m_1}\right)\frac{g}{A}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{g}{A}}$

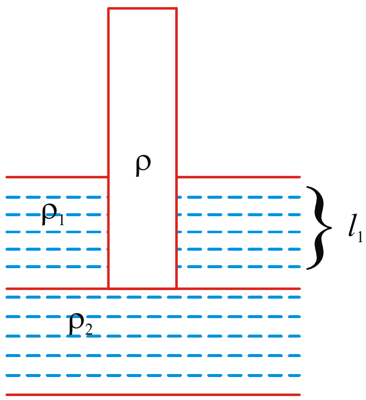
(D) $\frac{1}{2\pi}\sqrt{\frac{m_2}{m_1}\cdot\frac{g}{A}}$

7. **In the arrangement shown, the sleeve of mass M is fixed between two identical springs whose combined force constant is k. The sleeve can slide without friction over a horizontal bar AB. The arrangement rotates with a constant angular velocity ω about a vertical axis passing through the middle of the bar. The period of small oscillations of the sleeve is..............**



(A) $2\pi\sqrt{\frac{m}{k}}$ (B) $2\pi\sqrt{\frac{m}{k-m\omega^2}}$ (C) $\pi\sqrt{\frac{m}{k}}$ (D) $\pi\sqrt{\frac{m}{k-m\omega^2}}$

8. **A vertical pole of length l, density ρ, area of cross section A ,floats in two immiscible liquids of densities ρ_1 *and* ρ_2.In equilibrium position the bottom end is at the interface of the liquids. When the cylinder is displaced vertically, the time period of oscillation is...............**



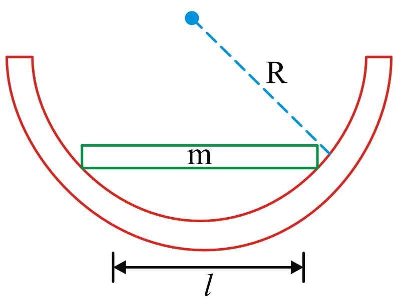
(A) $\pi\sqrt{\frac{\rho l}{(\rho_1+\rho_2)g}}$

(B) $\pi\sqrt{\frac{\rho l}{g}}\left(\frac{1}{\sqrt{\rho_1}}+\frac{1}{\sqrt{\rho_2}}\right)$

(C) $\pi\sqrt{\frac{(\rho_1+\rho_2)l}{\rho g}}$

(D) $\pi\sqrt{\frac{l}{\rho g}}\left(\sqrt{\rho_1}+\sqrt{\rho_2}\right)$

9. **A uniform rod of mass, m , and length l remains in equilibrium inside a smooth hemisphere of radius R as shown. The period of small oscillations of the rod is....**$\left[\because\ r^2=R^2-l^2/4\right]$



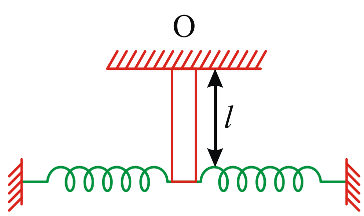
(A) $2\pi\sqrt{\frac{\frac{l^2}{12}+r^2}{gr}}$

(B) $2\pi\sqrt{\frac{\frac{l^2}{4}+r^2}{gr}}$

(C) $2\pi\sqrt{\frac{R}{g}}$

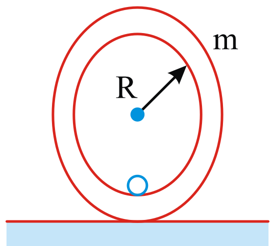
(D) $2\pi\sqrt{\frac{l+R}{g}}$

10. **A thin uniform vertical rod of mass m and length l pivoted at point O is shown in Fig. The combined stiffness of the springs is equal to k. The mass of the spring is negligible. The angular frequency of small oscillation is**



(A) $\sqrt{\frac{3k}{2m}+\frac{g}{l}}$ (B) $\sqrt{\frac{3k}{2m}+\frac{3g}{l}}$ (C) $\sqrt{\frac{3k}{m}+\frac{3g}{2l}}$ (D) $\sqrt{\frac{3k}{m}+\frac{2g}{3l}}$

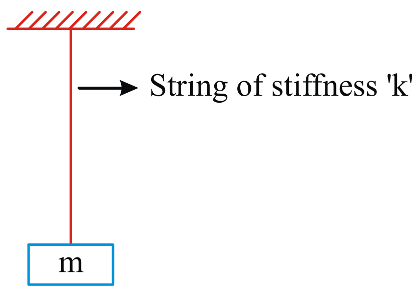
11. **A thin-walled tube of mass m and radius R has a rod of mass m and very small cross section soldered on its inner surface. The side-view of the arrangement is as shown**



The entire arrangement is placed on a rough horizontal surface. The system is given a small angular displacement from its equilibrium position, as a result, the system performs oscillations. The time period of resulting oscillations if the tube rolls without slipping is

(A) $2\pi\sqrt{\frac{4R}{g}}$ (B) $2\pi\sqrt{\frac{2R}{g}}$ (C) $2\pi\sqrt{\frac{R}{g}}$ (D) None of these

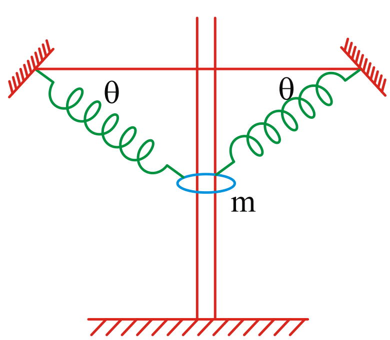
12. **An elastic string of constant k is attached to a block of mass m as shown. The block is given an extension of $\frac{2mg}{k}$ from the equilibrium position and released. The time period of oscillations of the block is**



(A) $2\pi\sqrt{\frac{m}{k}}$ (B) $4\sqrt{\frac{m}{k}}\left(\frac{\pi}{3}+\sqrt{3}\right)$

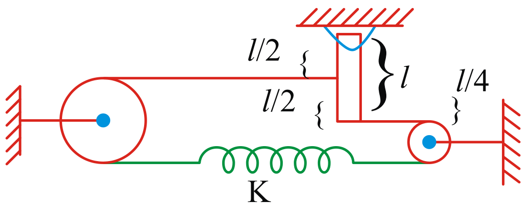
(C) $2\pi\sqrt{\frac{m}{k}}+2\sqrt{3}\sqrt{\frac{m}{k}}$ (D) $\pi\sqrt{\frac{m}{k}}+\sqrt{3}\sqrt{\frac{m}{k}}$

13. **A ring of mass m can freely slide on a smooth vertical rod. The ring is symmetrically attached with two springs, as shown, each of stiffness k. Ring is displaced such that each spring makes an angle θ with the horizontal. If the ring is slightly displaced vertically, then time period is............**



(A) $2\pi\sqrt{\frac{m}{k}}$ (B) $2\pi\sqrt{\frac{m\sin\theta}{2k}}$ (C) $\frac{2\pi}{\sin\theta}\sqrt{\frac{m}{2k}}$ (D) $\frac{\pi}{\sin\theta}\sqrt{\frac{m}{2k}}$

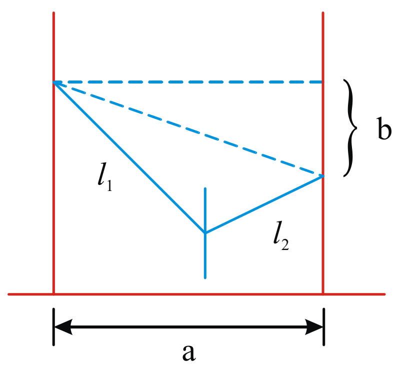
14. **A light inextensible string carrying a spring is passed over two smooth fixed pulleys as shown. If the rod is slightly displaced about the hinge from is equilibrium position, then time period is.**



(A) $\pi\sqrt{\frac{4ml}{3(kl+2mg)}}+\pi\sqrt{\frac{2l}{3g}}$ (B) $\pi\sqrt{\frac{2ml}{kl+2mg}}+\pi\sqrt{\frac{2l}{3}}$

(C) $\pi\sqrt{\frac{3ml}{kl+2mg}}+\pi\sqrt{\frac{l}{3}}$ (D) $\pi\sqrt{\frac{4ml}{kl+2mg}}+\pi\sqrt{\frac{l}{3}}$

15. **Consider a swing whose one end is fixed above the other rope by "b". The distance between the poles of the swing is a. The lengths l_1 and l_2 are such that $l_1^2+l_2^2=a^2+b^2$ as shown. The period of the small oscillations of the swing, by neglecting the height of the swinging person, is....**



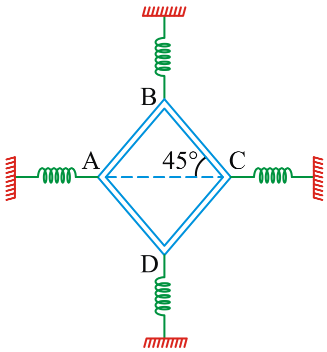
(A) $2\pi\sqrt{\frac{l_1+l_2}{g}}$ (B) $2\pi\sqrt{\frac{l_1l_2}{ga}}$ (C) $2\pi\sqrt{\frac{l_1l_2}{g(a+b)}}$ (D) $2\pi\sqrt{\frac{l_1^2+l_2^2}{g(a+b)}}$

16. **A thin uniform rod of mass m and length l is hinged at one end making an angle α from the horizontal on the ceiling of a room. The other end is supported by a vertical massless string. The angular frequency of small oscillations of this system is**

(A) $\sqrt{\frac{g}{l\sin\alpha}}$ (B) $\sqrt{\frac{3g}{l\sin\alpha}}$ (C) $\sqrt{\frac{3g}{5l\sin\alpha}}$ (D) $\sqrt{\frac{3g}{2l\sin\alpha}}$

17. **Four identical bars of mass m, length l are connected by pins at A,B,C and D. The bars are attached to four springs of same stiffness as shown. The entire**

system can move in horizontal plane. In the equilibrium position shown, $\theta = 45^0$. If the corners A and C are given small displacements toward each other and released, then time period of vibration is



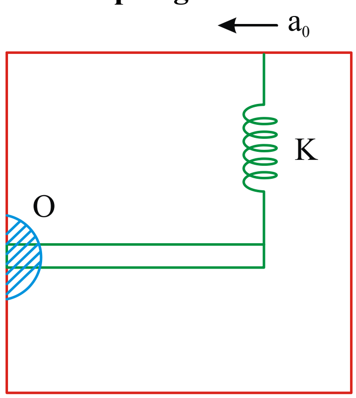
(A) $2\pi\sqrt{\frac{2M}{3K}}$

(B) $2\pi\sqrt{\frac{4m}{K}}$

(C) $2\pi\sqrt{\frac{M}{4K}}$

(D) $2\pi\sqrt{\frac{M}{K}}$

18. **A rod of mass m and length l is pivoted at a point O in a car whose acceleration towards left is a_0. The rod is free to oscillate in a vertical plane. In the equilibrium state the rod remains horizontal then other end is suspended by a spring of stiffness k. The time period of oscillations is....**



(A) $2\pi\sqrt{\frac{lm}{ma_0 + kl}}$

(B) $2\pi\sqrt{\frac{2lm}{ma_0 + kl}}$

(C) $2\pi\sqrt{\frac{lm}{3ma_0 + 4kl}}$

(D) $2\pi\sqrt{\frac{2lm}{3ma_0 + 6kl}}$

19. **A body A of mass moving with velocity v while passing through its mean position collides in perfect inelastically with a body B of same mass which is connected to a vertical wall through a spring whose spring constant is k. After collision it sticks to B and executes S.H.M. Find the amplitude of resulting motion:**

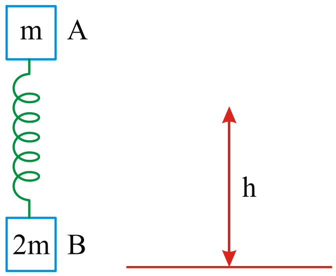
(A) $\sqrt{\frac{m}{k}}v$ (B) $\sqrt{\frac{m}{2k}}v$ (C) $\frac{m}{k}\sqrt{v}$ (D) $\frac{m}{2k}\sqrt{v}$

20. **Two particles move parallel to $x-$axis about the origin with same amplitude 'a' and frequency ω. At a certain instant they are found at a distance $a/3$ from the origin on opposite sides but their velocities are in the same direction. What is the phase difference between the two ?**

(A) $\cos^{-1}\frac{7}{9}$ (B) $\cos^{-1}\frac{5}{9}$ (C) $\cos^{-1}\frac{4}{9}$ (D) $\cos^{-1}\frac{1}{9}$

21. **From what minimum height h must the system be released when spring is**

unstretched so that after perfectly inelastic collision $(e=0)$ with ground, B may be lifted off the ground: (Spring constant = k)



(A) $mg/(4k)$

(B) $4mg/k$

(C) $mg/(2k)$

(D) None of the above

22. The mean velocity of a particle performing S.H.M. with time period of 0.6s and amplitude of 10 cm averaged over a time interval during which it travels a distance of 5 cm, starting from extreme position is

1)0.5 m/s 2)0.7 m/s 3)0.3m/s 4)1.04 m/s

23. The time period of small oscillations in a vertical plane performed by a ball of 40gm fixed at the middle of horizontally stretched string of 1m length when the constant tension 10N in wire is:

(A) 0.1 s (B) 0.2 s (C) 0.3 s (D) 0.4 s

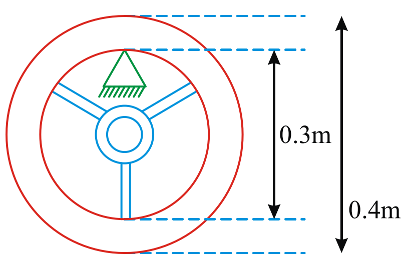
24. The maximum velocity of a point undergoing simultaneous two oscillations given by $x_1 = a\cos wt$ and $x_2 = a\cos 2wt$ is:

(A) $2.74aw$ (B) $2aw$ (C) $1.414aw$ (D) aw

25. A physical pendulum is positioned such that is centre of gravity is vertically above suspension point. From that position the pendulum started moving toward the stable equilibrium and passed it with an angular velocity ω. By neglecting the friction at point of suspension, the period of small oscillations of the pendulum is

(A) $\frac{2\pi}{\omega}$ (B) $\frac{4\pi}{\omega}$ (C) $\frac{\pi}{\omega}$ (D) $\frac{5\pi}{\omega}$

26. A fly wheel of mass 35kg swings as pendulum about a knife-edge as shown. The period of oscillation is 1.22s. , the moment of inertia of the fly wheel about its centre is



(A) $1.15\ kg.m^2$

(B) $2.4\ kg.m^2$

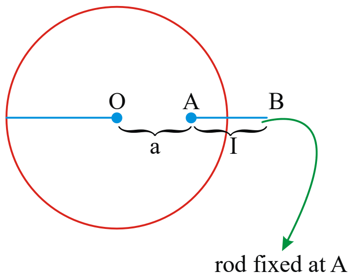
(C) $3.2\ kg.m^2$

(D) $0.75\ kg.m^2$

27. A thin uniform plate shaped as an equilateral triangle with a height 'h' performs small oscillations about the horizontal axis coinciding with one of its sides. The time period of oscillation is.....

(A) $2\pi\sqrt{\frac{h}{g}}$ (B) $\pi\sqrt{\frac{h}{g}}$ (C) $\pi\sqrt{\frac{2h}{g}}$ (D) $2\pi\sqrt{\frac{2h}{g}}$

28. **A smooth horizontal disc rotates about the vertical axis 'O' with constant angular velocity ω as shown. A thin uniform rod AB of length 'l' performs small oscillations about the vertical axis A fixed to the disc at a distance 'a' from axis of rotation of the disc. The angular frequency of the oscillations of rod is**

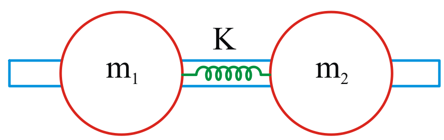


(A) $\sqrt{\frac{3a}{2l}}\,\omega$

(B) $\sqrt{\frac{a}{l}}\,\omega$

(C) $\sqrt{\frac{3a}{l}}\,\omega$ (D) $\sqrt{\frac{3a}{l}}\,\omega$

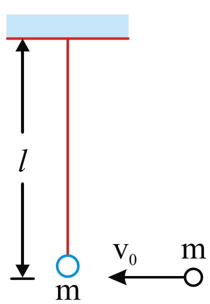
29. **Two balls with masses $m_1 = 1kg$ and $m_2 = 2kg$ are slipped on a thin smooth horizontal rod as shown. The balls are interconnected by a light spring of stiffness $K = 24\ N/m$. The left hand ball (m_1) is imparted the initial velocity 12 cm/s towards second ball. The amplitude of oscillations made by the arrangement is..................**



(A) 3 cm (B) 2 cm (C) 1 cm (D) 4 cm

MULTIPLE ANSWER QUESTIONS

30. **A simple pendulum consists of a bob of mass m and a light string of length l as shown. Another identical ball moving with the small velocity v_0 collides with the pendulum's bob and sticks to it. For this new pendulum of mass $2m$, mark out the correct statement(s).**



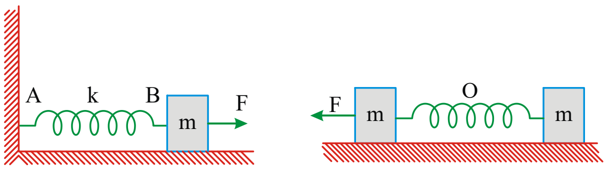
(A) Time period of the pendulum is $2\pi\sqrt{\frac{l}{g}}$

(B) The equation of motion for this pendulum is $\theta = \frac{v_0}{2\sqrt{gl}}\sin\left[\sqrt{\frac{g}{l}}t\right]$

(C) The equation of motion for this pendulum is $\theta = \frac{v_0}{2\sqrt{gl}}\cos\left[\sqrt{\frac{g}{l}}t\right]$

(D) Time period of the pendulum is $2\pi\sqrt{\frac{2l}{g}}$

31. **Figure (a) shows a spring of force constant k fixed at one end and carrying a mass m at the other end placed on a horizontal frictionless surface. The spring is stretched by a force F. Figure (b) shows the same spring with both ends free and a mass m fixed at each free end. Each of the spring is stretched by the same force F. The mass in case (a) and the masses in case (b) are then released. Which of the following statements are true ?**



(a)

(A) While oscillating, the maximum extension of the spring is more in case (a) than in case (b)

(B) The maximum extension of the spring is same in both cases.

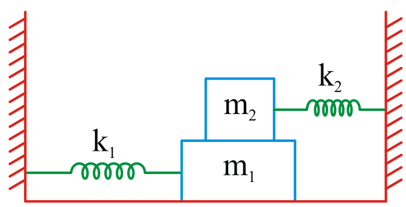
(C) The time period of oscillation is the same in both cases.

(D) The time period of oscillation in case (a) is $\sqrt{2}$ times that in case (b).

COMPREHENSION QUESTIONS

Passage-I

In the arrangement given below, both the springs are in their natural lengths. The coefficient of friction between m_2 and m_1 is μ. There is no friction between m_1 and the surface. If the blocks are displaced slightly, they together perform simple harmonic motion.



32. **The frequency of oscillations is**

(A) $\frac{1}{2\pi}\sqrt{\frac{(k_1+k_2)}{(m_1+m_2)}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{k_1k_2}{(m_1+m_2)(k_1+k_2)}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{(k_1+k_2)(m_1+m_2)}{m_1m_2}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{(m_1+m_2)}{(k_1+k_2)}}$

33. **If the frictional force on m_2 is acting in the same direction of its displacement from mean position, then**

(A) $\frac{m_1}{k_1} < \frac{m_2}{k_2}$ (B) $\frac{m_1}{m_2} > \frac{k_1}{k_2}$ (C) $m_1k_2 = m_2k_1$

(D) frictional force is never in the direction of displacement

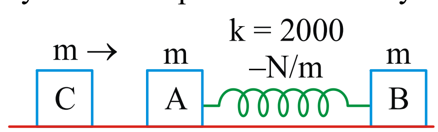
34. **If friction on m_2 acts in the direction of displacement, then maximum possible amplitude of SHM is**

(A) $\frac{\mu m_2 g(m_1+m_2)}{m_1k_2-m_2k_1}$ (B) $\frac{\mu m_1 g(m_1+m_2)}{m_2k_1-m_1k_2}$

(C) $\frac{\mu m_1 g(m_1+m_2)}{m_1k_1-m_2k_2}$ (D) $\frac{\mu m_2 g(m_1+m_2)}{m_1k_1-m_2k_2}$

Passage-II

Two identical blocks A and B, each of mass $m=3kg$, are connected with the help of an ideal spring and placed on a smooth horizontal surface as shown. Another identical block C moving with velocity $v_0 = 0.6\,m/s$ collides with A and sticks to it, as a result, the motion of system takes place in some way.



Based on this information, answer the following questions:

35. **After the collision of C and A, the combined body and block B would**

(A) oscillate about centre of mass of system and centre of mass is a rest.
(B) oscillate about centre of mass of system and centre of mass is moving
(C) oscillate but about different locations other than the centre of mass.
(D) not oscillate

36. **Oscillation energy of the system, i.e., part of the energy which is oscillating (changing) between potential and kinetic forms, is**

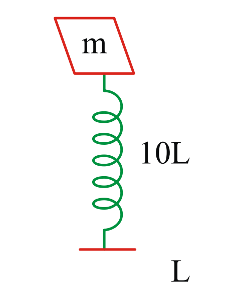
(A) 0.27 J (B) 0.09 J (C) 0.18 J (D) 0.45 J

37. **The maximum compression of the spring is**

(A) $3\sqrt{30}\ mm$ (B) $3\sqrt{20}\ mm$ (C) $3\sqrt{10}\ mm$ (D) $3\sqrt{50}\ mm$

Passage-III

A small block of mass m is fixed at upper end of a massive vertical spring of spring constant $k = 4mg/L$ and natural length '$10L$'. The lower end of spring is free and is at a height L from fixed horizontal floor as shown. The spring is initially unstreched and the spring-block system is released from rest in the shown position.



38. **At the instant the speed of block is maximum, the magnitude of force exerted by the spring on the block is**

(A) $\frac{mg}{2}$ (B) mg (C) $zero$ (D) None of these

39. As the block is coming down, the maximum speed attained by the block is

(A) $\sqrt{gL}$ (B) $\sqrt{3gL}$ (C) $\frac{3}{2}\sqrt{gL}$ (D) $\sqrt{\frac{3}{2}gL}$

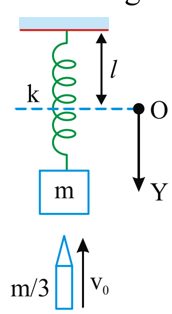
40. Till the block reaches its lowest position for the first time, the time duration for which the spring remains compressed is

(A) $\pi\sqrt{\frac{L}{2g}}+\sqrt{\frac{L}{4g}}\sin^{-1}\frac{1}{3}$ (B) $\frac{\pi}{4}\sqrt{\frac{L}{g}}+\sqrt{\frac{L}{4g}}\sin^{-1}\frac{1}{3}$

(C) $\pi\sqrt{\frac{L}{2g}}+\sqrt{\frac{L}{4g}}\sin^{-1}\frac{2}{3}$ (D) $\frac{\pi}{2}\sqrt{\frac{L}{2g}}+\sqrt{\frac{L}{4g}}\sin^{-1}\frac{2}{3}$

Passage-IV

A block of mass m is suspended from one end of a light spring as shown. The origin O is considered at distance equal to natural length of spring from ceiling and vertical downward direction as +ve y-axis. When the system is in equilibrium a bullet of mass $m/3$ moving in vertical upward direction with velocity v_0 strikes the block and embeds into it. As a result, the block (with bullet embedded into it) moves up and starts oscillating.



Based on above information, answer the following questions:

41. Select the correct statement(s):

(A) The block-bullet system performs S.H.M. about $y=\frac{mg}{k}$

(B) The block-bullet system performs oscillatory motion but not S.H.M. about $y=\frac{mg}{k}$

(C) The block-bullet system performs S.H.M. about $y=\frac{4mg}{3k}$

(D) The block-bullet system performs oscillatory motion but not S.H.M. about $y=\frac{4mg}{3k}$

42. The amplitude of oscillation would be:

(A) $\sqrt{\left(\frac{4mg}{3k}\right)^2+\frac{mv_0^2}{12k}}$ (B) $\sqrt{\frac{mv_0^2}{12k}+\left(\frac{mg}{3k}\right)^2}$

(C) $\sqrt{\frac{mv_0^2}{6k}+\left(\frac{mg}{k}\right)^2}$ (D) $\sqrt{\frac{mv_0^2}{6k}+\left(\frac{4mg}{3k}\right)^2}$

43. The time taken by block-bullet system to move from $y = \frac{mg}{k}$ initial equilibrium position) to $y = 0$ (natural length of spring) is: [A represents the amplitude of motion]

(A) $\sqrt{\frac{4m}{3k}}\left[\cos^{-1}\left(\frac{mg}{3kA}\right) - \cos^{-1}\left(\frac{4mg}{3kA}\right)\right]$

(B) $\sqrt{\frac{3k}{4m}}\left[\cos^{-1}\left(\frac{mg}{3kA}\right) - \cos^{-1}\left(\frac{4mg}{3kA}\right)\right]$

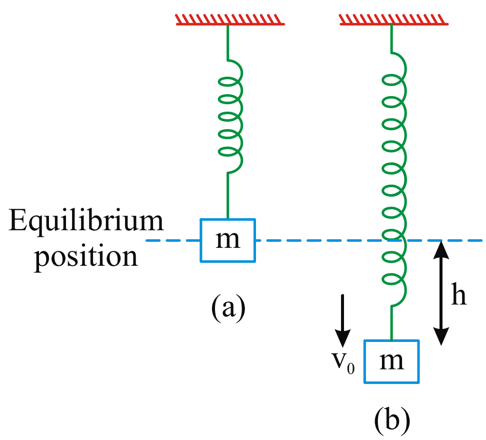
(C) $\sqrt{\frac{4m}{6k}}\left[\sin^{-1}\left(\frac{4mg}{3kA}\right) - \sin^{-1}\left(\frac{mg}{3kA}\right)\right]$

(D) None of the above

Passage-V

A block of mass m is connected to a spring of spring constant k and is at rest in equilibrium as shown in (a). Now, the block is displaced by h below its equilibrium position and imparted a speed v_0 towards down as shown in figure (b). As a result of the jerk, block executes simple harmonic motion about its equilibrium position. Based on above information answer the following questions:

[Where A is the amplitude of oscillation, $\delta = \sin^{-1}\left[\frac{h}{A}\right], \omega = \sqrt{\frac{k}{m}}$]



44. The amplitude of oscillation is:

(A) h (B) $\sqrt{\frac{mv_0^2}{k} + h^2}$ (C) $\sqrt{\frac{m}{k}}v_0 + k$ (D) None of these

45. The equation for the simple harmonic motion is:

(A) $y = -A\sin[\omega t + \delta]$ (B) $y = -A\cos[\omega t + \delta]$

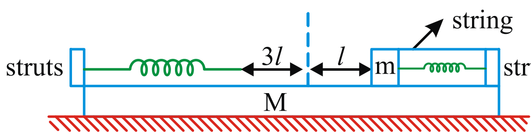
(C) $y = A\sin\left[\omega t + \delta + \frac{\pi}{2}\right]$ (D) $y = A\sin\left[\omega t + \delta + \frac{\pi}{4}\right]$

46. Find the time taken by block to cross the mean position for the first time:

(A) $\frac{\delta}{\omega}$ (B) $\frac{\frac{\pi}{2} - \delta}{\omega}$ (C) $\frac{\pi - \delta}{\omega}$ (D) $\frac{\pi - \delta}{2\omega}$

Passage-VI

A plank of mass M is placed on a smooth horizontal surface. Two light identical springs each of stiffness k are rigidly connected to struts at the ends of the plank as shown. When the springs are in their unextended position the distance between their free ends is $3l$. A block of mass m is placed on the plank and pressed against one of the springs so that it is compressed by l. To keep the blocks at rest it is connected to the strut by means of a light string, initially the system is at rest. Now the string is burnt.



47. Maximum displacement of plank is:

(A) $\frac{ml}{m+M}$ (B) $\frac{5ml}{m+M}$ (C) $\frac{3ml}{m+M}$ (D) $\frac{2ml}{m+M}$

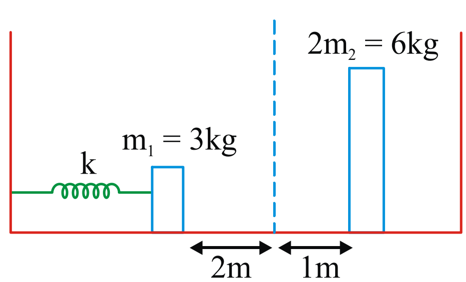
48. Time period of oscillation of block:

(A) $(2\pi+3)\sqrt{\frac{2Mm}{k(M+m)}}$ (B) $(\pi+6)\sqrt{\frac{2Mm}{k(M+m)}}$

(C) $(\pi+3)\sqrt{\frac{Mm}{k(M+m)}}$ (D) $(2\pi+6)\sqrt{\frac{Mm}{k(M+m)}}$

Passage-VII

Two blocks of masses 3kg block is attached to a spring with a force constant, k $k = 900\ N/ma$ which is compressed 2m initially from its equilibrium position. When 3kg mass is released, it strikes the 6kg mass and the two stick together in an inelastic collision.



49. The common velocity of the blocks after collision is

(A) 10 m/s (B) 30 m/s (C) 15 m/s (D) 2 m/s

50. The amplitude of resulting oscillation after the collision is:

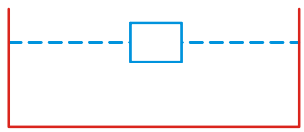
(A) $\frac{1}{\sqrt{2}}m$ (B) $\frac{1}{\sqrt{3}}m$ (C) $\sqrt{2}m$ (D) $\sqrt{3}m$

51. The velocities of a particle executing S.H.M. are 30 cm/s and 16 cm/s when its displacements are 8 cm and 15 cm from the equilibrium position. Then its amplitude of oscillation in cm is:

(A) 25 (B) 21 (C) 17 (D) 13

Passage-VIII

A cube made of wood having specific gravity 0.4 and side length a is floated in a large tank full of water.



52. Which action would change the depth to which block is submerged ? $\left(\gamma_{wood} < \gamma_{water}\right)$

(A)more water is added in the tank (B) atmospheric pressure increases
(C) the tank is accelerated upwards (D) A small coin is placed over the cube

53. If the cube is depressed slightly, it executes SHM from it's position. What is it's time period?

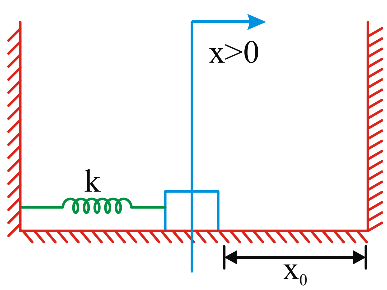
A) $2\pi\sqrt{\frac{a}{g}}$ B) $2\pi\sqrt{\frac{5a}{2g}}$ C) $2\pi\sqrt{\frac{2a}{5g}}$ D) $\frac{4\pi}{5}\sqrt{\frac{a}{g}}$

54. What can be maximum amplitude of it's vertical simple harmonic motion ?

(A) $\frac{a}{2}$ (B) $0.4a$ (C) $0.6a$ (D) $0.2a$

Passage-IX

A block is attached to a spring and is placed on a horizontal smooth surface as shown in which spring is unstretched. Now the spring is given an initial compression $2x_0$ and block is released from rest. Collisions with the wall PQ are elastic.



55. Find the time period of motion of the block:

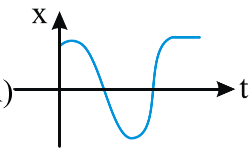
(A) $\frac{2\pi}{3}\sqrt{\frac{m}{k}}$ (B) $\frac{4\pi}{3}\sqrt{\frac{m}{k}}$ (C) $\frac{3\pi}{2}\sqrt{\frac{m}{k}}$ (D) $\frac{\pi}{2}\sqrt{\frac{m}{k}}$

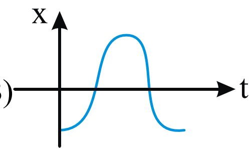
56. Write its equation of motion indicating position as a function of time:

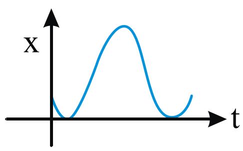
(A) $x=-2x_0\cos\omega t \quad 0<t<\frac{T}{2}$ (B) $x=-2x_0\cos\left(\omega t+\frac{2\pi}{3}\right) \quad \frac{T}{2}<t<T$

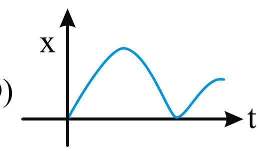
(C) $x=-x_0\cos\omega t \quad 0<t<\frac{T}{2}$ (D) $x=-2x_0\cos\left(\omega t+\frac{\pi}{3}\right) \quad \frac{T}{2}<t<T$

57. Draw $x-t$ (position-time) graph for one period. Treating position of block in unstretched position of spring as origin

(A) 

(B) 

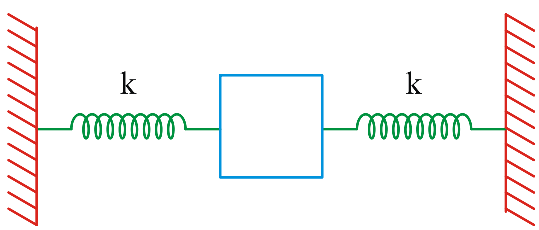
(C) 

(D) 

Passage-X

A block is tied within two springs, each having spring constant equal to k. Initially the springs are in their natural length and horizontal as shown. The block is released from rest.

The springs are ideal, acceleration due to gravity is g downwards. Air resistance is to be neglect. The natural length of spring is l_0.



58. If the decrease in height of the block till it reaches equilibrium is $\sqrt{3l_0}$ then the mass of the block is:

(A) $\frac{2kl_0}{g}$ (B) $\frac{\sqrt{2}kl_0}{g}$ (C) $\frac{\sqrt{3}kl_0}{g}$ (D) None of these

59. If the block is under equilibrium and the angle made by the spring with horizontal is 60^0 then the mass of the block is:

(A) $\frac{2gl_0}{\sqrt{2}}$ (B) $\frac{\sqrt{2}gl_0}{\sqrt{3}}$ (C) $\frac{4gl_0}{\sqrt{3}}$ (D) None of these

60. If the decrease in height of the block till its speed becomes zero is $\sqrt{8l_0}$ then the mass of the block is:

(A) $\frac{2kl_0}{g}$ (B) $\frac{\sqrt{2}kl_0}{g}$ (C) $\frac{\sqrt{3}kl_0}{g}$ (D) None of these

Passage-XI

For a particle oscillating along x-axis according to equation $x = A\sin\omega t$

61. The mean value of its velocity averaged over first 3/8 of the period is

(A) 0.3 Aw (B) 0.1 Aw (C) Aw (D)0.5 Aw

62. The magnitude of its mean velocity vector averaged over first 3/8 of the period is:

(A) 0.3Aw (B)0.55Aw (C) Aw (D) 0.1Aw

63. The mean value of its speed averaged over first 3/8 of the period is:

(A) 0.3Aw (B) 0.55Aw (C) Aw (D) 0.1Aw

Passage-XII

The distance travelled in a time, t by a particle moving along x-axis according to an equation $x = A\cos wt$ is given by $S = nA + S_0$, when time t can be written as $t = n\left(\frac{T}{4}\right) + t_0$ such that $t_0 < T/4$ and distance travelled in that t_0 is S_0.

64. The distance S is, when 'n' is even number:

(A) $S = A\left[(n+1) - \cos\left(\omega t + \frac{n\pi}{2}\right)\right]$ (B) $S = A\left[(n+1) - \cos\left(\omega t - \frac{n\pi}{2}\right)\right]$

(C) $S = A\left[n + \sin\left(\omega t - \frac{n\pi}{2}\right)\right]$ (D) $S = A\left[(n+1) - \sin\left(\omega t - \frac{n\pi}{2}\right)\right]$

65. The distance S is, when 'n' is odd number.

(A) $S = A\left[(n+1) - cos\left(\omega t + \frac{n\pi}{2}\right)\right]$ (B) $S = A\left[(n+1) - \cos\left(\omega t - \frac{n\pi}{2}\right)\right]$

(C) $S = A\left[n + \sin\left(\omega t - \frac{n\pi}{2}\right)\right]$ (D) $S = A\left[(n+1) - \sin\left(\omega t - \frac{n\pi}{2}\right)\right]$

66. The resultant amplitude of oscillations resulting from super position of $x_1 = 3\cos\omega t, x_2 = 5\cos(\omega t + \pi/4)$ and

$x_3 = 6\sin\omega t$ is

(A) 14 (B) 7 (C) 4 (D) 2

Passage-XIII

A point moves in the plane xy according to the law $x = A\sin\omega t$; $y = B\cos\omega t$; where A,B & ω are positive constant.

67. The equation for trajectory for path taken by particle is

(A) $x^2 + y^2 = A^2$ (B) $\frac{x^2}{A^2} + \frac{y^2}{B^2} = 1$.(C) y = Bx (D) $y = Ax + Bx^2$

68. The velocity of particle is given by

(A) $v = \sqrt{A^2 + B^2}\,\omega$ (B) $v = \sqrt{A^2\cos^2\omega t + B^2\sin^2\omega t}.\omega$

(C) $v = \omega\sqrt{(A^2 + B^2) - (x^2 + y^2)}$ (D) $v = \omega\sqrt{(A+B)^2 - (x+y)^2}$

69. The acceleration of particle is given by [$\because \bar{r}$ is position vector]

(A) $\bar{a} = -\omega^2\bar{r}$ (B) $\bar{a} = \omega^2\bar{r}$ (C) $\bar{a} = \omega\bar{r}$ (D) $\bar{a} = -\omega\bar{r}$

MATRIX MATCHING QUESTIONS

70. Two particles 'A' and 'B' start SHM at $t=0$. Their positions as function of time are given by $X_A = A\sin\omega t$ and $X_B = A\sin(\omega t + \pi/3)$

Column-I	Column-II
(A) Minimum time when x is same	(p) $\frac{5\pi}{6\omega}$
(B) Minimum time when velocity is same	(q) $\frac{\pi}{3\omega}$
(C) Minimum time after which $v_A < 0$ and $v_B < 0$	(r) $\frac{\pi}{\omega}$
(D) Minimum time after which $x_A < 0$ and $x_B < 0$	(s) $\frac{\pi}{2\omega}$

71. A particle of mass 2 kg is moving on a straight line under the action of force $F = (8-2x)N$. The particle is released from rest at $x = 6m$. For the subsequent motion, match the following (all the values in the Column-II are in their SI units):

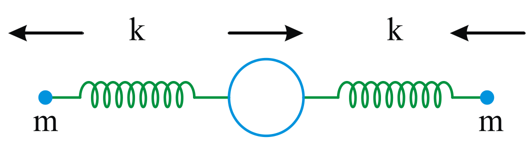
Column-I	Column-II
(A) Equilibrium position is at x	(p) $\pi/4$
(B) Amplitude of SHMs	(q) $\pi/2$
(C) Time taken to go directly from $x=2$ to $x=4$	(r) 4
(D) Energy of SHM is	(s) 6
(E) Phase constant of SHM assuming equation of the form $A\sin(\omega t+\phi)$	(t) 2

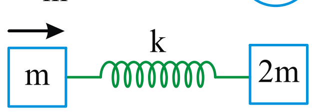
72. Match the following

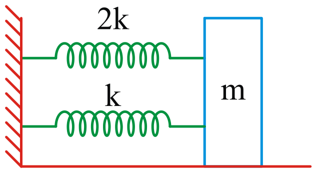
Column-I lists the various modes of oscillations of masses connected to springs. Column-II lists the corresponding frequencies of oscillations when executing S.H.M.

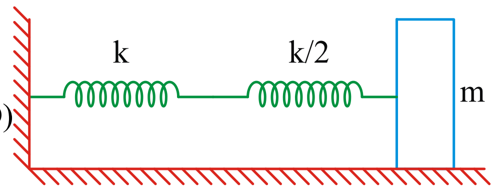
Match them properly.

Column-I

(A)


(B)


(C) 

(D) 

Column - II

(p) $\frac{1}{2\pi}\sqrt{\frac{3k}{2m}}$ (q) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$

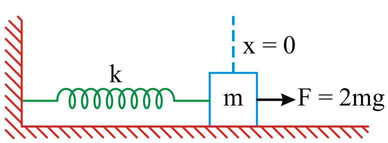
(r) $\frac{1}{2\pi}\sqrt{\frac{k}{3m}}$ (s) $\frac{1}{2\pi}\sqrt{\frac{3k}{m}}$

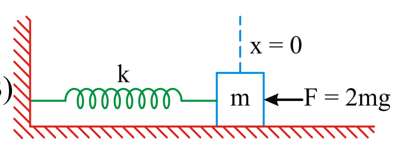
73. **A mass m is subjected to a force $F=(at-bx)\hat{i}$ initially the mass lies at the origin at rest. Here x refers to the x coordinate of the mass, t refers to the time elapsed. All the values are in S.I. unit (i.e. F, m, t, x, a and b are constants). Now match the column-I with column-II. (All values in column-II are in S.I.Units.)**

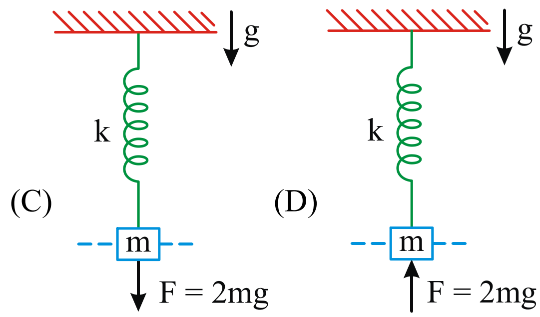
Column-I	**Column-II**
(A) Maximum velocity attained by the mass	(p) 1
(B) Average velocity of the particle during the subsequent motion	(q) 2
(C) Average acceleration of the particle during subsequent motion	(r) 0
(D) Position of particle at $t=\frac{\pi}{2}$	(s) $\frac{\pi}{2}-1$

74. **Column I shows spring block system with a constant force permanently acting on block match entries of column-I with column-II.**

Column-I

(A) 

(B) 



Column-II

(p) Time period of oscillation $T = 2\pi\sqrt{\frac{m}{k}}$ spring is initially relaxed when force is applied

(q) Amplitude of oscillation is $A = \frac{2mg}{k}$ spring is initially relaxed when force is applied

(r) Maximum velocity attained by block is before force is applied block is in equilibrium $2g\left[\sqrt{\frac{m}{k}}\right]$ position

(s) Maximum magnitude of acceleration of block
When force is applied block is in equilibrium is 2g.

(t) Velocity of block when spring is in natural length is zero. If block acquire natural length.

75. **In column-I, the projection of a particle moving along a circle (uniformly) in $x-y$ plane with its centre of origin along x and y axes, while in Column-II, the description of particle's motion is given. It is given that particle's angular velocity is constant and equal to ω and the radius of circle is $A, \delta \neq 0, \frac{\pi}{2}$ or π.**

For this situation match the column-I with column-II.

Column-I

(A) $x(t) = A\sin(\omega t + \delta - \pi/2)$; (B) $x(t) = A\sin(\omega t + \delta)$;

(C) $x(t) = A\sin(\omega t); x(t) = A\cos(\omega t)$ (D) $x(t) = A\cos(\omega t + \delta)$;

Column-II

(p) Uniform circular motion (clockwise)

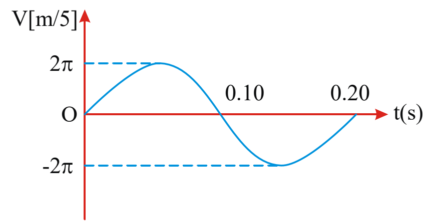
(q) Uniform circular motion (anti-clockwise)

(r) At $t = 0$ particle is neither on $x-$axis nor on y-axis

(s) At $t = 0$ particle is either on x-axis or on $y-$axis.

76. **A simple harmonic oscillator consists of a block attached to a spring with $k = 200\ N/m$. The block slides on a frictionless horizontal surface, with equilibrium point $x = 0$. A graph of the block's velocity v as a function of time t is shown. Correctly match the required information in Column-I with the**

values given in Column-II (use $\pi^2 = 10$)



Column-I	**Column-II**
(A) The block's mass in kg	(p) –0.20
(B) The block's displacement at $t = 0$ in maters	(q) -200
(C) The block's acceleration at $t = 0.10\, s$ in m/s^2	(r) 0.20
(D) The block's maximum kinetic energy in joules	(s) 4.0

STATEMENT MODEL

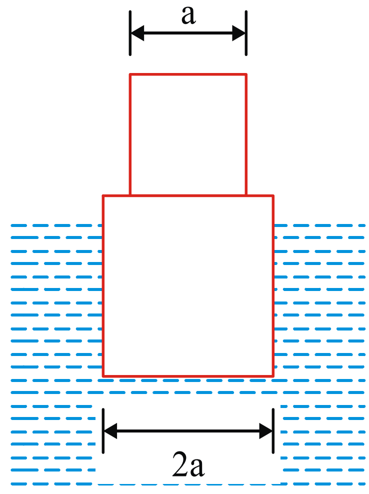
(A) If Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation for Statement-1.
(B) If Statement-1 is true, Statement-2 is true, Statement-2 is not a correct explanation for Statement-1.
(C) If Statement-1 is true; Statement-2 is false.
(D) If Statement-1 is false; Statement-2 is true.

77. **Statement-I:** During the oscillations of simple pendulum, the direction of its acceleration at the mean position is directed towards the point of suspension and at extreme position it is directed towards the mean position.
Statement-II: The direction of acceleration of a simple pendulum at the mean position or at the extreme position is decided by the tangential and radial components of force by gravity.

78. **Statement-I:** For a particle of mass 1 kg, executing S.H.M., if slope of restoring force vs displacement graph is = -1, then the time period of oscillation will be 6.28 s.
Statement-II: If 1 kg mass is replaced by 2 kg mass and rest of the information remains same as in statement-1, then the time period of oscillation will remain 6.28 s.

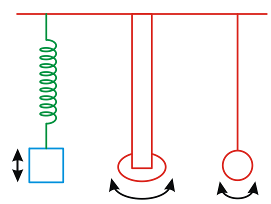
79. **Statement-I:** In simple harmonic motion, the graph between velocity and the displacement is an ellipse.
Statement-II: In simple harmonic motion the phase difference between velocity and displacement is $\pi/2$.

80. **Statement-I:** Two cubical blocks of same material and of sides a and $2a$, respectively are attached rigidly and symmetrically to each other as shown. The system of two blocks is floating in water in such a way that upper surface of bigger block is just submerged in the water. If the system of blocks is displaced slightly in vertical directions, then the amplitude of oscillation on either side of equilibrium position would be different.



Statement-II: The force constant on two sides of equilibrium position in the above-described situation is different.

81. **Statement-I:** Three pendulums are suspended from ceiling as shown.



These three pendulums are set to oscillate as shown by arrows, and it is found that all three have same time period. Now, all three are taken to a place where acceleration due to gravity changes to 4/9th of its value at the first place. If spring pendulum makes 60 cycles in a given time at this place, then torsion pendulum and simple pendulum will also make 60 oscillations in same (given) time interval.

Statement-II: Time period of torsional pendulum is independent of acceleration due to gravity.

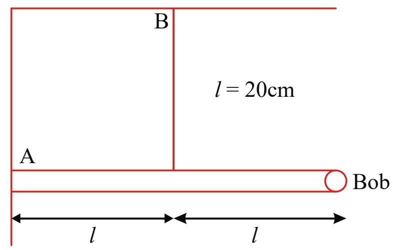
82. **Statement-I:** A circular metal hoop is suspended on the edge by a hook. The hoop can oscillate side to side in the plane of the hoop, or it can oscillate back and forth in a direction perpendicular to the plane of the hoop. The time period of oscillation would be more when oscillations are carried out in the plane of the hoop.

Statement-II: Time period of physical pendulum is more if moment of inertia of the rigid body about corresponding axis passing through the pivoted point is more.

INTEGER ANSWER QUESTIONS

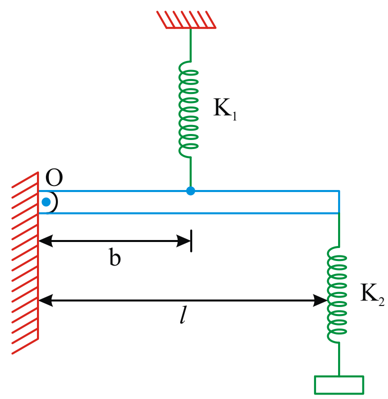
83. **A weightless rigid rod with a small iron bob at the end is hinged at point A to the wall so that it can rotate in all directions. The rod is kept in the horizontal position by a vertical inextensible string of length 20 cm, fixed at its midpoint. The bob is displaced slightly perpendicular to the plane of the rod and string.**

Find period of small oscillations of the system in the form $\frac{\pi X}{10}s$, the value of X is

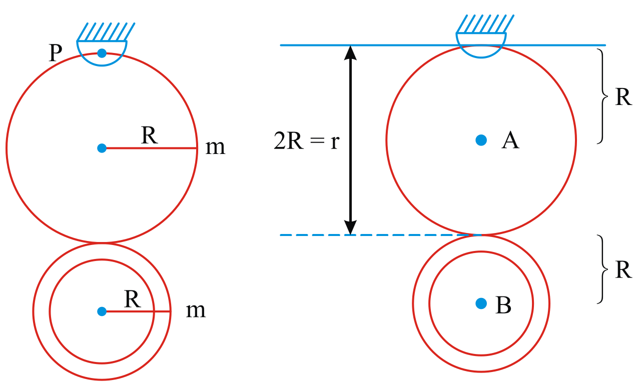


84. **A rod of mass m and length l hinged at one end is connected by two springs of spring constants k_1 and k_2 so that it is horizontal at equilibrium. What is the angular frequency of the system ? (in rad/s)**

$\left(\text{Take } l = 1m, b = 1/4m, K_1 = 16N/m, K_2 = 63N/m, m = 3kg\right)$

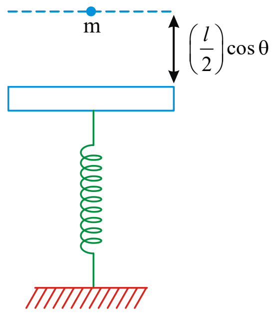


85. **A uniform disc of mass m and radius $R = \frac{80}{23\pi^2}m$ is pivoted smoothly at P. If a uniform ring of mass m and radius R is welded at the lowest point of the disc, find the period of SHM of the system (disc + ring). (in seconds)**

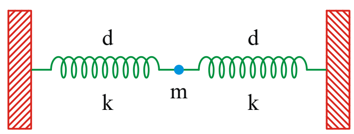


86. **In the figure shown a plate of mass 60g is at rest and in equilibrium. A particle of mass $m = 30g$ is released from height 4.5 mg/k from the plate. The particle**

sticks to the plate. Neglecting the duration of collision find the time from the collision of the particle and plate to the moment when the spring has maximum compression. Spring has force constant 1 N/m. Calculate the value of time in the form π / x and find the value of x.



87. **A small body of mass m is connected to two horizontal springs of elastic constant k, natural length $3d/4$. In the equilibrium position both springs are stretched to length d, as shown. What will be the ratio of period of the motion $\left(T_b / T_a\right)$ if the body is displaced horizontally by a small distance where T_a is the time period when the particle oscillates along the line of springs and T_b is time period when the particle oscillates perpendicular to the plane of the figure ? Neglect effects of gravity.**



EXERCISE - II - KEY

SINGLE ANSWER QUESTIONS

1) D 2) A 3) B 4)A 5) C 6) B 7) B 8) B 9) A 10) C
11) A 12) B 13) C 14) A 15) B 16) D 17) A 18) D 19) B 20) A
21) B 22) A 23) B 24) A 25) B 26) A 27) C 28) A 29) B

MULTIPLE ANSWER QUESTIONS

30) A,B 31) B,D

COMPREHENSION QUESTIONS

32) A 33) B 34) A 35) B 36) A 37) A 38) B 39) C 40) B 41) C
42) B 43) A 44) B 45) A 46) C 47) B 48) D 49) A 50) C 51) C
52) D 53) C 54) C 55) B 56) B,A 57) B 58) C 59) C 60) B 61) A
62) C 63) B 64) B 65) C 66) B 67) B 68) B 69) A

MATRIX MATCHING QUESTIONS

70) A-q; B-p; C-s ; D-r 71) A-r; B-t; C-q; D-r; E-q
72) A-q; B-p; C-s; D-r 73) A-q; B-p ; C-r ; D-s
74) A-p,q,r,s,t ; B-p,q,r,s,t ; C-p,q,r,s;D-p,q,r,s
75) A-p,q,r ; B - p,q,r ; C - p,q,s ; D -p,q,r 76) A - r ; B - p; C - q; D - s

ASSERTION & REASON QUESTIONS

77) A 78) C 79) B 80) A 81) D 82) A

INTEGER ANSWER QUESTIONS

83) 4 84) 8 85) 2 86) 5 87) 2

EXERCISE - III

CHARACTERISTICS OF PROGRESSIVE WAVE

1. **The equation y = 4 Sin π [200t-(x/25)] represents a transverse wave that travels in a stretched wire, where x, y are in cm and t in second. Its wavelength and velocity are**
1) 0.5m, $25ms^{-1}$ 2) 0.5m, $50ms^{-1}$ 3) 1m, $50ms^{-1}$ 4) 1m, $25ms^{-1}$

2. **The equation** $y = A\cos^2\left(2\pi nt - 2\pi\frac{x}{\lambda}\right)$ **represents a wave with**
1) amplitude $\frac{A}{2}$, frequency 2n and wavelength $\frac{\lambda}{2}$
2) amplitude $\frac{A}{2}$, frequency 2n and wavelength λ
3) amplitude A, frequency 2n, and wavelength 2λ
4) amplitude A, frequency n, and wavelength λ

3. **A transverse wave along a string is given by** $y = 2\sin\left(2\pi(3t - x) + \frac{\pi}{4}\right)$**, where** x **and** y **are in cm and 't' is in second. The acceleration of a particle located at** $x = 4cm$ **at t =1s is**
1) $36\sqrt{2}\pi^2\ cm/s^2$ 2) $36\pi^2\ cm/s^2$ 3) $-36\sqrt{2}\pi^2\ cm/s^2$ 4) $-36\pi^2\ cm/s^2$

4. **A transverse wave is described by the equation Y= Y_0 Sin 2π (ft-x/ λ). The maximum particle velocity is equal to four times the wave velocity if**
1) $\lambda = \pi Y_0/4$ 2) $\lambda = \pi Y_0/2$ 3) $\lambda = \pi Y_0$ 4) $\lambda = 2\pi Y_0$

5. **The frequency of a fork is 500 Hz. Velocity of sound in air is $350ms^{-1}$. The distance through which sound travel by the time the fork makes 125 vibrations is**
1) 87.5 m 2) 700 m 3) 1400m 4) 1.75 m

6. **A wave has a frequency of 120Hz. Two points at a distance of 9m apart have a phase difference of 1080°. The velocity of the wave is**
1) 340m/s 2) 300m/s 3) 330m/s 4) 360m/s

7. **Two simple harmonic motions are represented by the equations** $y_1 = 0.1\sin\left(100\pi t + \frac{\pi}{3}\right)$ **and** $y_2 = 0.1\cos\pi t$. **The phase difference of the velocity of particle 1 with respect to velocity of particle 2 at t = 0 is**
1) $-\frac{\pi}{6}$ 2) $\frac{\pi}{3}$ 3) $-\frac{\pi}{3}$ 4) $\frac{\pi}{6}$

SPEED OF A TRAVELLING WAVE

8. **The amplitude of a wave disturbance propagating in the positive x direction is given by** $y = \frac{1}{1+x^2}$ **at** $t = 0$ **in metres and** $y = \frac{1}{1+(x-1)^2}$ **at** $t = 2s$ **where x, y are in metres. If the shape of the wave does not changing with time, the velocity of the wave is**
1) $2ms^{-1}$ 2) $0.5ms^{-1}$ 3) $3ms^{-1}$ 4) $1ms^{-1}$

9. **If Young's modulus of the material of a rod is Y and density is** ρ **then time taken by sound wave to travel** ***l*** **length from bottom is**
1) $l\sqrt{\frac{\rho}{Y}}$ 2) $l\sqrt{\frac{Y}{\rho}}$ 3) $\frac{1}{l}\sqrt{\frac{Y}{\rho}}$ 4) $\frac{1}{l}\sqrt{\frac{\rho}{Y}}$

10. The velocity of a transverse wave in a stretched wire is 100ms^{-1}. If the length of wire is doubled and tension in the string is also doubled, the final velocity of the transverse wave in the wire is

1) 100 ms^{-1} 2) 141.4 ms^{-1} 3) 200 ms^{-1} 4) 282.8 ms^{-1}

11. A transverse wave propagating on a stretched string of linear density $3\times10^{-4}\,kgm^{-1}$ is represented by the equation $y = 0.2\,Sin(1.5x + 60t)$ where x is in metre and t is in seconds. The tension in the string in N.

1) 0.24 2) 0.48 3) 1.20 4) 1.80

12. The extension in a string, obeying Hooke's law is x. The speed of sound in the stretched string is V. If the extension in the string is increased to 1.5x the speed of the sound will be

1) 1.22V 2) 0.61V 3) 1.50V 4) 0.75V

PRINCIPLE OF SUPER POSITION, INTERFERENCE AND STATIONARY WAVES ON STRETCHED STRINGS.

13. Standing waves are produced in 10m long stret-ched wire. If the wire vibrates in 5 segments and wave velocity is 20m/s , then the freqency is

1) 2 Hz 2) 4 Hz 3) 5 Hz 4) 10Hz

14. The equation $y = 5\sin\left(\frac{\pi x}{25}\right)\cos(450t)$ represents the stationary wave setup in a vibrating sonometer wire, where x,y are in cm and t in second. The distances of second and third nodes from one end are(in cm).

1) 50, 75 2) 25, 50 3) 15, 50 4) 20, 50

15. A sonometer consists of two wires of lengths 1.5 m and 1m made up of different materials whose densities are 5 g/cc, 8g/cc and their respective radii are in the ratio 4:3. The ratio of tensions in those two wires if their fundamental frequencies are equal is

1) 5:3 2) 5:2 3) 2:5 4) 3:5

16. If the length of a stretched string is shortened by 40% and the tension is increased by 44%, then the ratio of the final and initial fundamental frequencies is:

1) 2:1 2) 3:2 3) 3:4 4) 1:3

17. The fundamental frequency of a stretched string with a weight of 9kg is 289 Hz. The weight required to produce its octave is

1) 9 kg wt 2) 16 kg wt 3) 25 kg wt 4) 36 kg wt

18. In an experiment it was found that string vibrates in n loops when a mass M is placed on the pan. The mass that should be placed on the pan to make it vibrate in 2n loops with same frequency (neglect the mass of pan) is

1) 2M 2) M/4 3) 4M 4) M/2

19. Transverse waves are generated in two uniform wires A and B of the same material by attaching their free ends to a vibrating source of frequency 200Hz. The area of cross section of A is half that of B while tension on A is twice than on B. The ratio of wavelengths of transverse waves in A and B is.

1) $1:\sqrt{2}$ 2) $\sqrt{2}:1$ 3) 1:2 4) 2:1

20. A string is stretched between fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. Then, the lowest resonant frequency for this string is

1) 105 Hz 2) 1.05 Hz 3) 1005 Hz 4) 10.5 Hz

SOUND AND VELOCITY OF SOUND

21. **The pressure of air increases by 100 mm of Hg and the temperature decreases by 1°C. The change in the speed of sound in air at STP is**

1)61 ms^{-1} 2)61 mms^{-1} 3)61 cms^{-1} 4)0.61 cms^{-1}

22. **The temperature at which the speed of sound will be same in oxygen as the speed in nitrogen at 15°C is (Densities are in the ratio 16:14)**

1) 561°C 2) 56.1°C 3) 5.61°C 4) 5.061°C

23. **The ratio of speed of sound in Nitrogen gas to that in Helium gas at 300 K is (assume both gases to be ideal)**

1) $\sqrt{2}:\sqrt{7}$ 2) $1:\sqrt{7}$ 3) $\sqrt{3}:5$ 4) $\sqrt{6}:5$

24. **A window whose area is 2 m^2 open on a street where the street noise results at the window an intensity level of 80 dB. How much acoustic power enters the window through sound waves?**

1) $100\mu W$ 2) $200\mu W$ 3) $300\mu W$ 4) $400\mu W$

ORGAN PIPES

25. **A cylindrical resonance tube open at both ends has a fundamental frequency 'f' in air. If half of the length is dipped vertically in water, the fundamental frequency of the air column will be (JEE-2012)**

1) f /2 2) f 3) 3f / 2 4) 2f

26. **A closed organ pipe is vibrating in first overtone and is in resonance with another open organ pipe vibrating in third harmonic. The ratio of lengths of the pipes respectively is**

1) 1 : 2 2) 4 : 1 3) 8 : 3 4) 3 : 8

27. **A glass tube 1.0 m length is filled with water. The water can be drained out slowly at the bottom of the tube. If a vibrating tuning fork of frequency 500 c/s, is brought at the upper end of the tube, and the velocity of sound is 330 m/s, then the total number of resonances obtained will be**

1) 4 2) 3 3) 2 4) 1

28. **An open pipe and a closed pipe have same length. The ratio of p^{th} overtones of two pipes is**

1) $\frac{1}{p}$ 2) p 3) $\frac{2(p+1)}{2p+1}$ 4) $\frac{2p+1}{2(p+1)}$

BEATS

29. **The natural frequency of a tuning fork P is 432 Hz. 3 beats/s are produced when tuning fork P and another tuning fork Q are sounded together. If P is loaded with wax, the number of beats increases to 5 beats/ s. The frequency of Q is**

1) 429 Hz 2) 435 Hz 3) 437 Hz 4) 427 Hz

30. **Two organ (open) pipes of lengths 50 cm and 51 cm produce 6 beats/s. Then the speed of sound is nearly**

1) 300 ms^{-1} 2)306 ms^{-1} 3)303 ms^{-1} 4)350 ms^{-1}

31. **A source x of unknown frequency produces 8 beats with a source of 250 Hz and 12 beats with a source of 270 Hz. The frequency of source x is**

1) 258 Hz 2) 242 Hz 3) 262 Hz 4) 282 Hz

32. **In an experiment it was found that when a sonometer in its fundamental mode of vibration and a tuning fork gave 5 beats when length of wire is 1.05 metre or 1 metre. The velocity of transverse waves in sonometer wire when its length is 1m**

1) 400 m/s 2) 210 m/s 3) 420 m/s 4) 450 m/s

33. **A sonometer has 25 forks. Each produces 4 beats with the next one. If the maximum frequency is 288 Hz, which is the frequency of last fork. The lowest frequency is**

1) 72 Hz 2) 96 Hz 3) 128 Hz 4) 192 Hz

34. **A tuning fork produces 6 beats/sec with sonometer wire when its tensions are either 169N or 196N. The freqency of that fork is**

1) 162 Hz 2) 190Hz 3) 200Hz 4) 80Hz

35. **In an open pipe when air column is 20 cm it is in resonance with tuning fork A. When length is increased by 2cm then the air column is in resonance with fork B. When A and B are sounded together 4 beats/sec are heard. Freqencies of A and B are respectively (in Hz)**

1) 40, 44 2) 88,80 3) 80,88 4) 44,40

DOPPLER EFFECT

36. **The speed at which a source of sound should move so that a stationary observer finds the apparent frequency equal to 11/12 of the original frequency**

1) V/2 2) 2V 3) V/4 4) V/11

37. **A whistling engine is approaching a stationary observer with a velocity of 110m/s. The velocity of sound is 330m/s. The ratio of frequencies as heard by the observer as the engine approaches and recedes is**

1) 4:3 2) 4:1 3) 3:6 4) 2:1

38. **Two aeroplanes 'A' and 'B' are moving away from one another with a speed of 720 kmph. The frequency of the whistle emitted by 'A' is 1100 Hz. The apparent frequency of the whistle as heard by the passenger of the aeroplane 'B' is.(velocity of sound in air is 350 ms^{-1}).**

1) 300Hz 2) 400Hz 3) 500Hz 4) 600H

39. **An engine is moving on a circular path of radius 100 metre with a speed of 20 metre per second. The frequency observed by an observer standing stationary at the centre of circular path when the engine blows a whistle of frequency 500 Hz is**

1) more than 500 Hz 2) less than 500 Hz
3) 500 Hz 4) no sound is heard

40. **The frequency of a radar is 780 MHz. The frequency of reflected wave from an aeroplane is increased by 2.6KHz. The velocity of the aeroplane is**

1)2 km/s 2) 1 km/s 3) 0.5 km/s 4) 0.25 km/s

41. **An observer moves towards a stationary source of sound, with a velocity one-fifth of the velocity of sound. The percentage increase in the apparent frequency is**

1) 5% 2) 20% 3) zero 4) 0.5%

42. **A train is moving at 30ms^{-1} in still air. The frequency of the locomotive whistle is 500 Hz and the speed of sound is 345 ms^{-1}. The apparent wavelengths of sound infront of and behind the locomotive are respectively**

1) 0.63 m, 0.80 m 2) 0.63 m, 0.75 m 3) 0.60 m, 0.85 m 4) 0.60 m, 0.75 m

43. **A vehicle, with a horn of frequency n is moving with a velocity of 30 m/s in a direction perpendicular to the straight line joining the observer and the vehicle. The observer perceives the sound to have a frequency $(n+n_1)$. If the velocity of sound in air is 300 m/s, then**

1) $n_1 = 10n$ 2) $n_1 = 0$ 3) $n_1 = 0.1n$ 4) $n_1 = -0.1n$

44. **a source of sound is travelling towards stationary observer. The freqency of sound heard by the observer is 25% more than that of the actual freqency if speed of sound is V, that of the source is**

1) V/5 2) V/4 3) V/3 4) V/2

45. A truck blowing horn of frequency 500 Hz travels towards a vertical mountain and driver hears echo of frequency 600Hz. If velocity of sound in air is 340m/s then speed of truck is

1) 31 m/s 2) 41m/s 3) 51m/s 4) 21m/s

EXERCISE - III - KEY

1) 2	2) 1	3) 3	4) 2	5) 1	6) 4	7) 1	8) 2	9) 1	10) 2
11) 2	12) 1	13) 3	14) 2	15) 2	16) 1	17) 4	18) 2	19) 4	20) 1
21) 3	22) 2	23) 3	24) 2	25) 2	26) 1	27) 2	28) 3	29) 2	30) 2
31) 1	32) 3	33) 4	34) 1	35) 4	36) 4	37) 4	38) 1	39) 3	40) 3
41) 2	42) 2	3) 2	44) 1	45) 1					

EXERCISE - IV

CHARACTERISTICS OF PROGRESSIVE WAVE

1. A longitudinal progressive wave is given by the equation y = 5x10^{-2} sin π (400 t + x). The amplitude and wave length of the wave are (y, x are in m)

1) A = 5x10^{-2}m, $\lambda = 2m$ 2) A = 5x10^{-2}m, $\lambda = 3m$
3) A = 5x10^{-2}m, $\lambda = 4m$ 4) A = 5x10^{-2}m, $\lambda = 5m$

2. The equation of a wave is $y = 4\sin\left\{\frac{\pi}{2}\left(2t + \frac{x}{8}\right)\right\}$ **where** y, x **are in cm and time in seconds. The acceleration of particle located at** $x = 8cm$ **and** $t = 1\sec$ **is**

1) $4\pi^2\ cm/s^2$ 2) $-4\pi^2\ cm/s^2$ 3) $16\pi^2\ cm/s^2$ 4) $-16\pi^2\ cm/s^2$

3. The equation of a transverse wave is y = a sin 2 π [t-(x/5)], then the ratio of maximum particle velocity and wave velocity is

1) $\frac{2\pi a}{\sqrt{5}}$ 2) $\frac{2\pi a}{5}$ 3) $\frac{a}{5}$ 4) $2\pi a\sqrt{5}$

4. The frequency of a tuning fork is 256Hz. The velocity of sound in air is $344ms^{-1}$**. The distance travelled (in metres) by the sound during the time in which the tuning fork completes 32 vibrations is**

1) 21 2) 43 3) 86 4) 129

5. A progressive wave moves with a velocity of 36 m/s in a medium with a freqency of 200 Hz. The phase difference between two particles separeted by a distance of 1 cm is

1) 40^0 2) $20rad$ 3) $\frac{\pi}{9}rad$ 4) $\left(\frac{\pi}{9}\right)^0$

6. A standing wave set up in a medium is $y = 4\cos\left(\frac{\pi x}{3}\right)\sin 40\pi t$ **where x, y are in cm and t in sec The velocity of medium particle at x =6cm at t=1/8 sec is**

1) 40π cm/s 2) 80π cm/s 3) 120π cm/s 4) -160π cm/s

SPEED OF A TRAVELLING WAVE

7. The equation of a wave pulse is given as $y = \frac{0.8}{(4x+5t)+4}$ **the amplitude and**

velocity of the pulse are

1) 0.2 units, 1.25 units along -ve x-axis
2) 0.2 units, 1.25 units along +ve x-axis
3) 0.4 units,1.25 units along -ve x-axis
4) 0.4 units, 1.25 units along +ve x-axis

8. **If Young's modulus of the material of a rod is $2\times10^{11}\,Nm^{-2}$ and density is 8000kg m^{-3}, the time taken by a sound wave to traverse 1m of the rod is**

1) 1.11×10^{-4}s 2) 3×10^{-4}s 3) 2×10^{-4} s 4) 1×10^{-4}s

9. **A string of length 10.0 m and mass 1.25 kg is stretched with a tension of 50 N. If a transverse pulse is created at one end of the string, the time taken by it to reach the other end is**

1) 0.5 s 2) 1.0 s 3) 1.5 s 4) 2.0 s

10. **The linear density of a vibrating string is 1.3×10^{-4} kg/m. The transverse wave propagating along the string is described by y = 0.021 sin (x+30t) where x is in meter and t is in second. The tension in the string is**

1)0.12 N 2) 0.48 N 3)1.2N 4) 4.8N

11. **The extension in a string, obeying Hooke's law is x. The speed of sound in the stretched string is V. If the extension in the string is increased to 2x then speed of sound will be**

1) 1.5V 2) 4.14 V 3) 1.414 V 4) 2V

PRINCIPLE OF SUPER POSITION, INTERFERENCE AND STATIONARY WAVES ON STRETCHED STRINGS.

12. **The speed of transverse waves in a stretched string is 700cm/s. If the string is 2m long, the frequency with which it resonates in fundamental mode is**

1) (7/12)Hz 2) (7/4)Hz 3) 14Hz 4) (2/7)Hz

13. **The length of a sonometer wire is 90 cm and the stationary wave setup in the wire is represented by an equation $y = 6\sin(\pi x/30)\cos(250\pi t)$ where x, y are in cm and t is in second. The distances of successive antinodes from one end of the wire are**

1) 22.5 cm, 67.5 cm 2) 15 cm, 30 cm, 60cm
3) 15 cm, 45 cm,75cm 4) 30 cm, 45 cm, 60cm

14. **A sonometer consists of two wires of same length, same material whose radii are in the ratio 2:3. The ratio of tension in two wire if their fundamental freqencies are equal is**

1) 1:4 2) 2:3 3) 9:4 4) 4:9

15. **The bridge of a sonometer is slightly displaced so that the length of wire is decreased by 0.5% and tension in the wire is increased by 1%. The fundamental frequency of wire**

1) increases by 1% 2) decreases by 1%
3) increases by 1.5% 4) decreases by 1.5%

16. **A segment of wire vibrates with a fundamental frequency of 450Hz under a tension of 9kg weight. Then tension at which the fundamental frequency of the same wire becomes 900Hz is**

1) 36 kg wt 2) 27 kg wt 3)18 kg wt 4)72 kg wt

17. **In an experiment, the string vibrates in 4 loops when 50 gm wt is placed in pan of weight 15 gm. To make the string vibrate in 6 loops the weight that has to be removed from the pan is approximately**

1) 72 gm 2) 36 gm 3) 21 gm 4) 29 gm

18. **Two vibrating strings of the same material but lengths L and 2L have radii 2r and r respectively. They are stretched under the same tension. Both the strings**

vibrate in their fundamental modes, the one of length L with frequency v_1 and the other with frequency v_2. The ratio $\frac{v_1}{v_2}$ is given by

1) 2 2) 4 3) 8 4) 1

19. **A stretched string of length 2m is found to vibrate in resonance with a tuning fork of frequency 420 Hz. The next higher frequency for which resonance occurs is 490 Hz. The velocity of the transverse wave along this string is**

1) 140 m/s 2) 360 m/s 3) 340 m/s 4) 280 m/s

20. **Two uniform stretched strings A and B, made of steel are vibrating under the same tension. If the first overtone of A is equal to the second overtone of B and if the radius of A is twice that of B, the ratio of the lengths of the strings is [E-2011]**

1) 2 : 3 2) 1 : 2 3) 1 : 3 4) 1 : 4

SOUND AND VELOCITY OF SOUND

21. **If the speed of sound is changed by 1 percent, the temperature of air near 0°C be changed is**

1) 5°C 2) 6°C 3) 5.5°C 4) 6.5°C

22. **The ratio of speed of sound wave in Neon to that in H_2O vapours at any temperature is**

1) 9/8 2) $3/2\sqrt{2}$ 3) 3/2 4) 3/4

23. **In a class of 100 students each shouting at 100 dB. Find noise level of class?**

1) 10dB 2) 100dB 3) 12dB 4) 120dB

ORGAN PIPES

24. **The air column in a pipe which is closed at one end will be in resonance with a vibrating tuning fork at a frequency 260Hz, if the length of the air column is (speed of sound in air = $330ms^{-1}$)**

1) 31.73cm 2) 62.5cm 3) 35.75cm 4) 12.5cm

25. **A cylinderical tube open both ends has a fundamental frequency ‘n’ in air. The tube is dipped vertically in water so that one - fourth of it is immersed in water. The fundamental frequency of air column is**

1) 3n 2) 2n/3 3) n/3 4) n

26. **An open pipe and a closed pipe are in resonance with each other with their first overtones. The ratio of their lengths are**

1) 4:3 2) 3:4 3) 1:3 4) 3:1

27. **A pipe of length 85cm closed from one end. Find then number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250Hz. The velocity of sound in air is 340 m/s. [JEE Main 2014]**

1) 12 2) 8 3) 6 4) 4

28. **A tuning fork of frequency 340 Hz is vibrated just above a cylindrical tube of length 120 cm. Water is slowly poured in the tube. If the speed of sound in air is 340 ms^{-1}, then the minimum height of water required for resonance is**

1) 25 cm 2) 45 cm 3) 75 cm 4) 95 cm

29. **An organ pipe P_1, closed at one end and containing a gas of density ρ_1 is vibrating in its first harmonic. Another organ pipe P_2, open at both ends and containing a gas of density ρ_2 is vibrating in its third harmonic. Both the pipes are in resonance with a given tuning fork. If the compressibility of gases is equal in both pipes, the ratio of the lengths of P_1 and P_2 is (assume the given gases to be monoatomic) [E-2010]**

1) $\frac{1}{3}$ 2) 3 3) $\frac{1}{6}\sqrt{\frac{\rho_1}{\rho_2}}$ 4) $\frac{1}{6}\sqrt{\frac{\rho_2}{\rho_1}}$

BEATS

30. When tuning forks A and B are sounded together 5 beats per second are heard. Frequency of A is 250 Hz. On loading A with wax 2 beats per second are produced with B. The frequency of B is

1) 255 Hz 2) 320 Hz 3) 245 Hz 4) 420 Hz

31. Two open pipes of length 20cm and 20.1cm produces 10 beats/s. The velocity of sound in the gas is

1) 804 ms^{-1} 2) 402 ms^{-1} 3) 420 ms^{-1} 4) 330 ms^{-1}

32. Two tuning forks have frequencies 200 Hz and x. When they are sounded together 4 beats / sec are heard. The value of x is

1) 200 Hz or 198 Hz 2) 196 Hz or 204 Hz
3) 205 Hz or 201 Hz 4) 200 Hz only

33. A tuning fork of frequency 480 Hz produces 10 beats per second when sounded with a vibrating sonometer string. What must have been the frequency of the string if a slight increase in tension produces fewer beats per second than before?

1) 460 Hz 2) 480 Hz 3) 490 Hz 4) 470 Hz

34. Five beats per second are produced on 21:20, then their frequencies will be

1) 105 Hz and 100 Hz 2) 105 Hz and 110 Hz
3) 100 Hz and 105 Hz 4) 110 Hz and 105 Hz

35. An accurate and reliable audio oscillator is used to standardise a tuning fork. When the oscillator reading is 514, two beats are hear per second. When the oscillator reading is 510, the beat frequency is 6Hz. The frequency of the tuning fork is

1) 506 2) 510 3) 516 4) 158

36. 25 tuning forks are arranged in decreasing order of frequency. Any two successive forks produce 3 beats/sec. If the freqency of the first tuning fork is the octave of last, then freqency of 21st fork is

1) 72Hz 2) 288Hz 3) 84Hz 4) 87Hz

37. A tuning fork produces 4 beats/s with a sonometer wire when its lengths are 50 cm, 51cm. The frequency of that tuning fork is

1) 400 Hz 2) 404 Hz 3) 408 Hz 4) 412 Hz

38. In a closed tube when air column is 20 cm it is in resonance with tuning fork A. When the length is increased by 2 cm then the air column is in resonance with tuning fork B. When A and B are sounded together they produce 8 beats per second. The frequencies of the tuning forks A and B are (in Hz)

1) 40, 44 2) 88, 80 3) 80, 88 4) 44, 40

DOPPLER EFFECT

39. A train is approaching a station with a uniform velocity of 72 kmph and the frequency of the whistle of that train is 480 Hz. The apparent increase in the frequency of that whistle heard by a stationary observer on the platform is (Velocity of sound in air is340m/s)

1) 60 Hz 2) 45 Hz 3) 30 Hz 4) 15 Hz

40. A train is travelling at 120 kmph and blows a whistle of frequency 1000Hz. The frequency of the note heard by a stationary observer if the train is approaching him and moving away from him are (Velocity of sound in air = 330 ms^{-1}).

1) 1112Hz,908Hz 2) 908Hz,1112Hz
3) 1080Hz,820Hz 4) 820Hz,1080Hz

41. A source and an observer move away from each other with speed of 10m/s with respect to ground. Apparent frequency of the source is 1950Hz. The natural frequency of the source is (velocity of sound is 340m/s)

1) 2068Hz 2) 1832Hz 3) 1950Hz 4) 1650Hz

42. An observer is moving on a circular path of radius r with speed V_0 around source kept at centre. The apparant freqency observed by observer is(n is actual freqency

1) greater than n 2) less than n 3) n 4) no sound is heard

43. A source of sound moves towards a listener with a velocity equal to that of sound. If the source emits n waves per second, then the listener moving away from the source with the same velocity receives

1) n waves per sec 2) 2n waves per sec 3) zero waves per sec 4) $n/2$

44. A source of sound and an observer are approaching each other with the same speed which is equal to $\frac{1}{10}$ times the speed of sound. The apparent change in the frequency of the source is

1) 22.2% increase 2) 22.2% decrease
3) 18.2% decrease 4) 18.2% decrease

45. A source of sound produces waves of wave legnth 48 cm. This source is moving towards north with speed 1/4 th that of sound .the apparent wave length of the waves to an observer standing south of the moving source will be

1) 60 cm 2) 72 cm 3) 48 cm 4) 96 cm

46. A whistle producing sound waves of frequencies 9500 Hz and above is approaching a stationary person with speed Vms^{-1}. The velocity of sound in air is 300 ms^{-1}. If the person can bear frequencies upto a maximum of 10,000 Hz, the maximum value of V upto which he can hear the whistle is

1) $15\sqrt{2}ms^{-1}$ 2) $\frac{15}{\sqrt{2}}ms^{-1}$ 3) $15ms^{-1}$ 4) $30ms^{-1}$

47. A whistle of frequency 540 Hz rotates in a horizontal circle of radius 2m at an angular speed of 15 rad/s. The highest frequency heard by a listener at rest with respect to the centre of circle (velocity of sound in air = $330ms^{-1}$) (E-2007)

1) 590Hz 2) 594Hz 3) 598Hz 4) 602Hz

48. If a source emitting waves of frequency f moves towards an observer with a velocity v/3 and the observer moves away from the source with a velocity v/4, the apparent frequency as heard by the observer will be (v = velocity of sound)

1) 9f/8 2) 8f/9 3) 3f/4 4) 4f/3

EXERCISE - IV - KEY

1) 1	2) 1	3) 2	4) 2	5) 3	6)4	7)1	8) 3	9) 2	10) 1
11) 3	12) 2	13) 3	14) 4	15) 1	16) 1	17) 2	18) 4	19) 4	20) 3
21) 3	22) 2	23) 4	24) 1	25) 2	26) 1	27) 3	28) 2	29)4	30) 3
31) 1	32) 2	33) 4	34) 3	35) 3	36) 3	37) 2	38) 2	39) 3	40) 1
41) 1	42) 3	43) 3	44) 1	45) 1	46) 3	47) 2	48) 1		

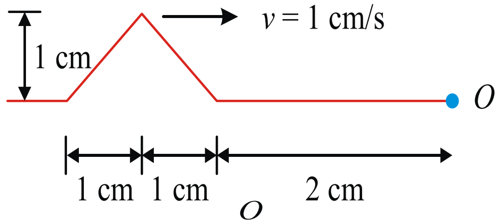
EXERCISE - V

CHARACTERISTICS OF PROGRESSIVE WAVE

1. The equation of progressive wave is $y = 0.01\sin(100t - x)$ where x,y are in meter and t in second, then

a) Velocity of wave is 50 m/s
b) Maximum velocity of particle is 1m/s
c) Wave length of wave is 2π meter.
1) only a,c are true 2) only a,b are true
3) only b,c are ture 4) a,b,c are true

2. A wave pulse on a string has the dimension shown in figure. The wave speed is $v = 1\ cm/s$. **If point O is a free end. The shape of wave at time** $t = 3s$ **is**



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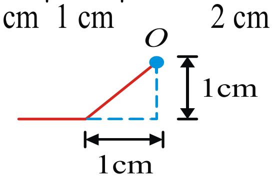
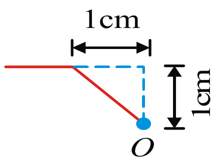
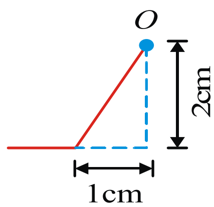
2) 

3) 

4) 

3. Two sound waves are represented by $y_1 = \sin\omega t + \cos\omega t$ **and** $y_2 = \frac{\sqrt{3}}{2}\sin\omega t + \frac{1}{2}\cos\omega t$ **. The ratio of their amplitudes is**

1) 1:1 2) $\sqrt{3}:2$ 3) $2:\sqrt{3}$ 4) $\sqrt{2}:1$

4. A wave of angular frequency ω **propagates so that a certain phase of oscillation moves along x-axis, y-axis and z-axis with speeds** c_1, c_2 **and** c_3 **respectively. The propagation constant k is**

1) $\frac{\omega}{\sqrt{c_1^2 + c_2^2 + c_3^2}}\left(\hat{i} + \hat{j} + \hat{k}\right)$ 2) $\frac{\omega}{c_1}\hat{i} + \frac{\omega}{c_2}\hat{j} + \frac{\omega}{c_3}\hat{k}$

3) $\left(\omega\hat{i} + \omega\hat{j} + \omega\hat{k}\right)\frac{1}{c}$ 4) $\frac{\omega}{\left(c_1 + c_2 + c_3\right)}\left(\hat{i} + \hat{j} + \hat{k}\right)$

SPEED OF A TRAVELLING WAVE

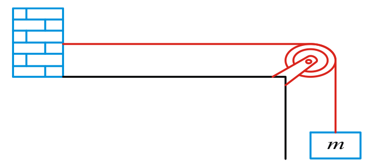
5. A uniform rope of length 12m and mass 6 kg angs vertically from a rigid support . A block f mass 2kg is attached at the free end of the rope. A transverse pulse of wavelength 0.06m is produced at the lower end of the rope. The wavelength of the pulse when it reaches the top of the rope is

1) 0.06 m 2) 0.12 m3) 0.24 m 4) 0.03 m

6. A string of length l **hangs freely from a rigid support. The time required by a transverse pulse to travel from bottom to half length of the string is**

1) $\sqrt{lg}$ 2) $\sqrt{\frac{l}{g}}$ 3) $\sqrt{\frac{2l}{g}}$ 4) $2\sqrt{\frac{l}{g}}$

7. **A transverse wave is passing through a light string shown in the figure. The equation of wave is $y = A\sin(\omega t - kx)$. The area of cross-section of string is A and density is ρ. The hanging mass is**



1) $A\omega$ 2) $\frac{\omega}{kg}$

3) $\frac{\rho A\omega^2}{k^2 g}$ 4) $\frac{k^2 g}{\omega}$

8. **The equatin of a wave on a stirng of linear mass density 0.04 kg m^{-1} is given by**

$y = 0.02\sin\left[2\pi\left(\frac{t}{0.04(s)} - \frac{x}{0.50(m)}\right)\right]$,

The tension in the string is (AIEEE 2010)

1) 6.25N 2) 4.0N 3) 12.5 4) 0.5N

9. **A string of length *l* is fixed at both ends and is μ. The ratio of magnitude of maximum velocity of particle and the magnitude of maximum acceleration is**

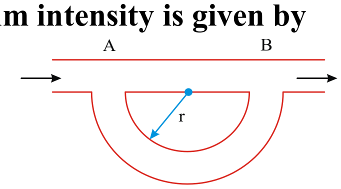
1) $\frac{1}{2\pi}\sqrt{\left(\frac{\mu l^2}{T}\right)}$ 2) $2\pi\sqrt{\left(\frac{\mu l^2}{T}\right)}$ 3) $\frac{1}{2\pi}\sqrt{\left(\frac{T}{\mu l^2}\right)}$ 4) $\frac{1}{4\pi}\sqrt{\left(\frac{\mu l^2}{T}\right)}$

PRINCIPLE OF SUPER POSITION, INTERFERENCE AND STATIONARY WAVES ON STRETCHED STRINGS.

10. **A Sound wave with an amplitude of 3 cm starts towards right from origin and gets reflected at a rigid wall after a second. If the velocity of the wave is 340 ms^{-1} and it has a wavelength of 2 m, the equations of incident and reflected waves respectively are:**

1) $y = 3\times10^{-2}\sin\ \pi(340\ t - x)$, $y = -3\times10^{-2}\sin\pi\ (340t + x)$ towards left
2) $y = 3\times10^{-2}\sin\ \pi(340\ t + x)$, $y = -3\times10^{-2}\sin\pi\ (340t + x)$ towards left
3) $y = 3\times10^{-2}\sin\ \pi(340\ t - x)$, $y = -3\times10^{-2}\sin\pi\ (340t - x)$ towards left
4) $y = 3\times10^{-2}\sin\ \pi(340\ t - x)$, $y = 3\times10^{-2}\sin\pi\ (340t + x)$ towards left

11. **Sound signal is sent through a composite tube as shown in figure. The radius of the semicircle is r. Speed of sound in air is V. The source of sound is capable to generate frequencies in the range f_1 to f_2 $(f_2 > f_1)$. If n is an integer then frequency for maximum intensity is given by**



1) $\frac{nV}{r}$ 2) $\frac{nV}{r(\pi-2)}$ 3) $\frac{nV}{\pi r}$ 4) $\frac{nV}{(r-2)\pi}$

12. **Four simple harmonic vibrations.**

$y_1 = 8\cos\omega t$, $y_2 = 4\cos\left(\omega t + \frac{\pi}{2}\right)$

$y_3 = 2\cos(\omega t + \pi)$, $y_4 = \cos\left(\omega t + \frac{3\pi}{2}\right)$

are superimposed on one another. The resulting amplitude and phase are respectively.

1) $\sqrt{45}$ and $\tan^{-1}\left(\frac{1}{2}\right)$ 2) $\sqrt{45}$ and $\tan^{-1}\left(\frac{1}{3}\right)$

3) $\sqrt{75}$ and $\tan^{-1}(2)$ 4) $\sqrt{75}$ and $\tan^{-1}\left(\frac{1}{3}\right)$

13. The length of a sonometer wire is 90 cm and the stationary wave setup in the wire is represented by an equation $y = 6\sin\left(\frac{\pi x}{30}\right)\cos(250t)$ where x, y are in cm and t is in second. The number of loops is

1) 1 2) 2 3) 4 4) 3

14. A sonometer is set on the floor of a lift. When the lift is at rest, the sonometer wire vibrates with fundamental frequency 256 Hz. When the lift goes up with acceleration $a = \frac{9g}{16}$, the frequency of vibration of the same wire changes to

1) 512 Hz 2) 320 Hz 3) 256 Hz 4) 204 Hz

15. Standing wave produced in a metal rod of length 1m is represented by the equation $y = 10^{-6}\sin\frac{\pi x}{2}\sin 200\pi t$ where x is in metre and t is in seconds. The maximum tensile stress at the mid-point of the rod is (Young's modulus of material of rod $=10^{12}\ N/m^2$).

1) $\frac{\pi}{2}\times10^6\ N/m^2$ 2) $2\pi\times10^6\ N/m^2$

3) $\frac{\pi}{2\sqrt{2}}\times10^6\ N/m^2$ 4) $\frac{2\pi}{\sqrt{3}}\times10^6\ N/m^2$

16. An additional bridge is kept below a sonometer wire so that it is divided into two segments of lengths in the ratio 2 : 3 and n_1, n_2 are their respective fundamental frequencies. If the additional bridge is removed then the fundamental frequency of that sonometer wire is n, the ratio of n, n_1, n_2 is

1) 2 : 3 : 5 2) 2 : 5 : 3 3) 4 : 9 : 25 4) 6 : 15 : 10

17. A piano wire 0.5m long and mass 5gm is stretched by a tension of 400N. The number of highest overtone that can be heared by a person is

1) 160 2) 99 3) 140 4) 120

18. An iron load of 2 kg is suspended in air from the free end of a sonometer wire of length 1m. A tuning fork of frequency 256 Hz, is in resonance with $1/\sqrt{7}$ times the length of the sonometer wire. If the load is immersed in water, the length of the wire in metre that will be in resonance with the same tuning fork is (specific gravity of iron is 8)

1) $\sqrt{8}$ 2) $\sqrt{6}$ 3) $1/\sqrt{6}$ 4) $1/\sqrt{8}$

SOUND AND VELOCITY OF SOUND

19. A pressure of 100 kPa causes a decrease in volume of water by 5×10^{-3} percent. The speed of sound in water is

1) 1414 ms^{-1} 2) 1000 ms^{-1} 3) 2000 ms^{-1} 4) 3000 ms^{-1}

20. The speed of sound in hydrogen at STP is V. The speed of sound in a mixture containing 3 parts of hydrogen and 2 parts of oxygen at STP will be

1) V/2 2) $V/\sqrt{5}$ 3) $\sqrt{7}V$ 4) $V/\sqrt{7}$

21. A mirror of diatomic gases is obtained by mixin m_1 and m_2 masses of two gases, with velocities of sound in them c_1 and c_2 respectively. Determine the velocity of sound in the mixture of gases.

1) $c=\sqrt{\frac{m_1c_1^2+m_2c_2^2}{m_1+m_2}}$ 2) $c=\sqrt{\frac{m_2c_1^2+m_1c_2^2}{m_1+m_2}}$ 3) $c=\sqrt{\frac{m_2c_2+m_1c_2}{m_1+m_2}}$ 4) $c=m_2\sqrt{\frac{c_2^2+c_1^2}{m_1+m_2}}$

ORGAN PIPES

22. A tube of certain diameter and of length 48cm is open at both ends. Its fundamental frequency of resonance is found to be 320Hz. If velocity of sound in air is 320ms^{-1} the diameter of the tube is

1) 1.33cm 2) 2.33cm 3) 3.33cm 4) 4.33cm

23. A closed organ pipe has length *l*. The air in it is vibrating in 3rd overtone with a maximum amplitude of A. Find the amplitude at a distance of $l/14$ from closed end of the pipe

1) A 2) zero 3) $A/\sqrt{2}$ 4) $\sqrt{3}/2A$

24. The freqency of a stretched uniform wire of certain length is in resonance with the fundamental frequency of closed tube. If length of wire is decreased by 0.5m, it is in resonance with first overtone of closed pipe. The initial length of wire is

1) 0.5m 2) 0.75m 3) 1m 4) 1.5m

25. An open pipe resonates to a frequency f_1 and a closed pipe resonates to a frequency f_2. If they are joined together to form a longer tube, then it will resonate to a frequency of (neglect end corrections)

1) $\frac{f_1f_2}{2f_2+f_1}$ 2) $\frac{f_1f_2}{f_2+2f_1}$ 3) $\frac{2f_1f_2}{f_2+f_1}$ 4) $\frac{f_1+2f_2}{f_1f_2}$

26. In a resonance air column experiment, first and second resonances are obtained at lengths of air columns l_1 and l_2,the third resonance will be obtained at a length of

1) $2l_2-l_1$ 2) l_2-2l_1 3) l_2-l_1 4) $3l_2-l_1$

27. A pop-gun consits of a cylindrical barrel 3cm^2 in cross section closed at one end by a cork and having a well fitting piston at the other. If the piston is pushed slowly in, the cork is finally ejected, giving a pop, the frequency of which is found to be 512 Hz. Assuming that the initial distance between the cork and the piston was 25 cm and that there is no leaking of air, calculate the force required to eject the cork. Atmospheric pressure = 1kg.cm^2, v = 340 m/s (in kg.wt)

1) 1.5 2) 3 3) 6 4) 8

BEATS

28. A closed organ pipe and an open pipe of the same length produce 4 beats when they are set into vibrations simultaneously. If he length of each of them were twice their initial lengths, the number of beats produced will be

1) 2 2) 4 3) 1 4) 8

29. An air column in a tube 32 cm long, closed at one end, is in resonance with a

tuning fork. The air column in another tube, open at both ends, of length 66 cm is in resonance with another tuning fork. When these two tuning forks are sounded together, they produce 8 beats per second. Then the frequencies of the two tuning forks are, (Consider fundamental frequencies only). [E - 2013]

1) 250 Hz, 258 Hz 2) 240 Hz, 248 Hz
3) 264 Hz, 256 Hz 4) 280 Hz, 272 Hz

30. **The string of a sonometer is divided into two parts using wedge. Total length of string is 1m and two parts differ by 2mm. When sounded together they produce 2 beats/sec. The freqencies of two parts are**

1) 501Hz, 503Hz 2) 501Hz, 499Hz
3) 499Hz, 497Hz 4) 497Hz, 495Hz

31. **The fundamental frequency of a sonometer wire of length ℓ is f_o. A bridge is now introduced at a distance of $\Delta \ell$ from the centre of the wire ($\Delta \ell << \ell$). The number of beats heard per second if both sides of the bridge are set to vibrate in their fundamental mode is**

1) $\frac{8f_o\Delta\ell}{\ell}$ 2) $\frac{f_o\Delta\ell}{\ell}$ 3) $\frac{2f_o\Delta\ell}{\ell}$ 4) $\frac{4f_o\Delta\ell}{\ell}$

32. **On vibrating an air column at 627^0 C and a tuning fork simultaneously, 6beats/sec are heard. The freqency of fork is less than that of air column. No beats are heard at -48^0 C. The freqency of fork is**

1) 3Hz 2) 6Hz 3) 10Hz 4) 15Hz

33. **A string 25cm long, having a mass 2.5gm is under tension. A pipe closed at one end is 40cm long. When the string is set vibrating in is in its fundamental frequency, 8 beats are heard per second. It is observed that decreasing the tension in the string decreases the beat frequency. If the speed of sound in air is $320ms^{-1}$, the tension in the string is nearly**

1) 27N 2) 54N 3) 13.5N 4) 108N

34 .Two identical piano wires have a fundamental frequency of 600 cycle per second when kept under the same tension. What fractional increase in the tension of one wires will lead to the occurrence of 6 beats per second when both wires vibrate simultaneously? [E-2009]

1) 0.01 2) 0.02 3) 0.03 4) 0.04

DOPPLER EFFECT

35. **One train is approaching an observer at rest and another is receding him with same velocity 4 m/s. Both the trains blow whistles of same frequency of 243 Hz. The beat frequency in Hz as heard by the observer is: (Speed of sound in air =320 m/s)**

1) 10 2) 6 3) 4 4) 1

36. **A tuning fork of frequency 328 Hz is moved towards a wall at a speed of 2 ms^{-1}. An observer standing on the same side as the fork hears two sounds, one directly from the fork and the other reflected from the wall. Number of beats per second is (Velocity of sound in air 330 ms^{-1}).**

1) 4 2) 5 3) 6 4) 7

37. **The frequency of the sound of a car horn as recorded by an observer towards whom the car is moving differs from the frequency of the horn by 10%. Assuming the velocity of sound in air to be $330ms^{-1}$, the velocity of the car is**

1) $36.7ms^{-1}$ 2) $40\ ms^{-1}$ 3) $30\ ms^{-1}$ 4) $33\ ms^{-1}$

38. **Two trains are approaching each other on parallel tracks with same velocity. The whistle sound produced by one train is heard by a passenger in another train. If actual frequency of whistle is 620Hz and apparent increase in its**

frequency is 100Hz, the velocity of one of the two trains is (Velocity of sound in air = 335 ms^{-1})

1) 90kmph 2)72 kmph 3)54kmph 4)36 kmph

39. A girl swings in a cradle with period $\pi/4$ second and amplitude 2m. A boy standing infront of it blows a whistle of natural frequency 1000 Hz. The minimum frequency as heard by the girl is (Velocity of sound in air is 320 ms^{-1})

1) 850 Hz 2) 1000 Hz 3) 750 Hz 4) 950 Hz

40. The difference between apparent freqencies of a source of sound as percieved by a stationary observer during its approach and recession is 2% of the actual freqency. The speed of source is (V = 340m/sec.)

1) 12m/s 2) 6.2m/s 3) 3.4m/s 4) 1.5m/s

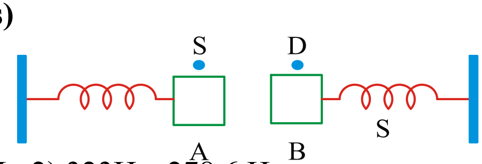
41. Two different sound sources $S_1 and\ S_2$ have freqencies in the ratio 1:2. Source S_1 is approaching towards observer and S_2 receding from same observer. Speeds of both $S_1 and\ S_2$ are V each and speed of sound air is 330 m/s. If no beats are heard by the observer then the value of V is

1) 50 m/s 2) 75 m/s 3) 110 m/s 4) 125m/s

42. A stationary source emitting sound of frequency 680Hz is at the origin. An observer is moving with the velocity $\sqrt{2}\left(\bar{i}+\bar{j}\right)m/s$ at a certain instant. If the speed of sound in air is 340 m/s, then the apparent frequency received by him at that instant is

1) 680Hz 2) 676Hz 3) 684Hz 4) either 676Hz or 684Hz

43. A source S emitting sound of frequency 300Hz is fixed on block A which is attached to the free end of a spring S_A as shown in figure. The dectector D fixed on block B attached to free end of spring S_B detects this sound. The blocks A and B are simultaneously displaced towards each other through a distance of 1.0m and then left to vibrate. The maximum and minimum frequencies of sound detected by D, if the vibrational frequency of each block is 2Hz are (Velocity of sound v = 340m/s)



1) 378.6Hz, 223 Hz 2) 323Hz, 278.6 Hz
3) 178 Hz, 276 Hz 4) 420Hz, 220 Hz

44. A locomotive approaching a crossing at a speed of 80 mile/hr. sounds a whistle of frequency 400 Hz when 1 mile from the crossing. There is no wind, and the speed of sound in air is 0.200mile/s. What frequency is heard by an observer 0.60 miles from the crossing on the straight road which crosses the railroad at right angles?

1) 440Hz 2) 442Hz 3) 444Hz 4) 446Hz

45. An observer is standing 500 m away from a verticall hill. Starting between the observer and the hill, a police van sounding a siren of frequency 1000 Hz moves towards the hill with a uniform speed. If the frequency of the sound heard directly from the siren is 970 Hz, the frequency of the sound heard after reflection from a hill (in Hz) is about (velocity of sound = 300 ms^{-1})

1) 1042 2) 1032 3) 1022 4) 1012

EXERCISE - V - KEY

1) 3	2) 4	3) 4	4) 2	5) 2	6) 3	7) 3	8) 1	9) 1	10) 1
11) 2	12) 1	13) 4	14) 2	15) 3	16)4	17)2	18)4	19) 1	20) 4
21) 1	22) 3	23) 3	24) 2	25) 1	26) 1	27) 1	28) 1	29)3	30) 2
31) 1	32) 2	33) 4	34) 2	35) 2	36) 1	37) 3	38) 1	39) 4	40) 3
41) 3	42) 4	43) 2	44) 3	45)2					

EXERCISE - VI

CHARACTERISTICS OF PROGRESSIVE WAVE

1. The equation of a progressive wave is $y = 0.05\sin\left(200t - \frac{x}{2}\right)$ where x,y are in metres and t in seconds, then

a) velocity of wave is 100 ms^{-1}

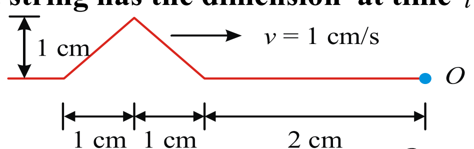
b) maximum velocity of particle in the wave is 10 ms^{-1}

c) wavelength of wave is $4\pi\ m$

1) only a and c are true 2) only b and c are true

3) only a and b are true 4) a,b,c are true

2. A wave pulse on a string has the dimension at time $t = 3s$ is



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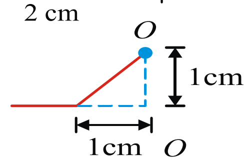
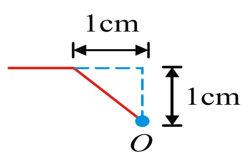
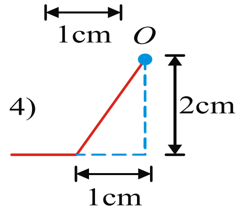
2) 

3) 

4) 

3. Two sound waves are represented by $y_1 = \frac{1}{2}\sin\omega t + \frac{\sqrt{3}}{2}\cos\omega t$ and $y_2 = \frac{\sqrt{3}}{2}\sin\omega t + \frac{1}{2}\cos\omega t$. The initial phase difference between the two waves is

1) 30° 2) 60° 3) 45° 4) 0°

4. A wave of angular frequency 30 rad/sec propagates so that a certain phase of oscillation moves along x-axis,y-axis,z-axis with speeds 1m/s,2m/sand 2m/s respectively. The propagation constant K is

1) $30\hat{i} + 15\hat{j} + 15\hat{k}$ 2) $10\hat{i} + 10\hat{j} + 10\hat{k}$ 3) $30\hat{i} + 30\hat{j} + 30\hat{k}$ 4) $6\hat{i} + 6\hat{j} + 6\hat{k}$

SPEED OF A TRAVELLING WAVE

5. A uniform rope of length 20m and mass 5kg is hanging vertically from a rigid support. A block of mass 4 kg is attached to the free end. The wave length of the transverse wave pulse at the lower end of the rope is 0.04 m. The wavelength of the same pulse as it reaches the top is

1) 0.06 m 2) 0.12 m 3) 1.5 m 4) 2.2 m

6. A uniform rope of mass 0.1 kg and length 2.45 m hangs from a ceiling (E - 2012)

i) The speed of transverse wave in the rope at a point 0.05 m distant from the lower end

ii) The time taken by a transverse wave to travel the full length of the rope are(g = 9.8 m /s^2)

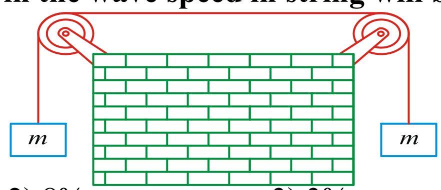
1) 0.7 m/s, 1 s 2) 0.7 m/s, 2 s 3) 0.7 m/s, 4 s 4) 0.7 m/s, 6 s

7. A travelling wave pulse is given by $y = \dfrac{10}{5+(x+2t)^2}$. The amplitude and velocity of the pulse propagating are

1) 2 units, -2 units 2) 2 units, 2 units

3) 10 units, 5 units 4) 10 units, 10 units

8. In the given arrangement, if hanging mass will be changed by 4%, then percentage change in the wave speed in string will be



1) 2% 2) 8% 3) 3% 4) 4%

PRINCIPLE OF SUPER POSITION, INTERFERENCE AND STATIONARY WAVES ON STRETCHED STRINGS.

9. A string of length *l* along x-axis is fixed at both ends and is vibrating in second harmonic. If at t = 0, y = 2.5mm for incident wave, the equation of standing wave is (T is tension and μ is linear density)

1) $(2.5mm)\sin\left(\frac{2\pi}{l}x\right)\cos\left(2\pi\sqrt{\left(\frac{T}{\mu l^2}\right)}t\right)$ 2) $(5mm)\sin\left(\frac{\pi}{l}x\right)cos 2\pi t$

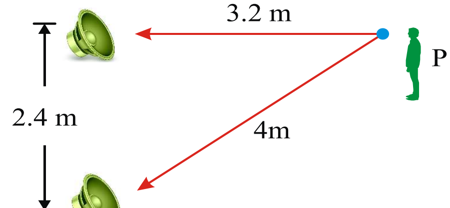
3) $(5mm)\sin\left(\frac{2\pi}{l}x\right)\cos\left(2\pi\sqrt{\left(\frac{T}{\mu l^2}\right)}t\right)$ 4) $(5mm)\cos\left(\frac{2\pi}{l}x\right)\cos\left(2\pi\sqrt{\left(\frac{T}{\mu l^2}\right)}t\right)$

10. A steel wire of length 1m, mass 0.1kg and uniform cross sectional area 10^{-6} m² is rigidly fixed at both ends. The temperature of the wire is lowered by 20°C. If the transverse waves are set up by plucking the string in the middle. Then the frequency of the fundamental mode of vibration is

(Y = 2 × 10^{11} N/m², $\alpha = 1.21\times10^{-5}/°C$)

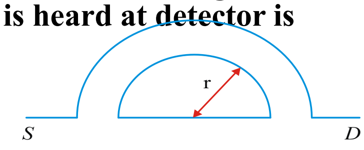
1) 21Hz 2) 42Hz 3) 11Hz 4) 22Hz

11. Two stereo speakers are separated by a distance of 2.4 m. A person stands at a distance of 3.2 m as shown directly in front of one of the speakers. The frequencies in audible range for which the listener will hear a minimum sound intensity are (Speed of the sound in air is 320 ms^{-1} and n is order of minimum)



1) $160(2n+1)$ 2) $320(2n+1)$ 3) $200(2n+1)$ 4) $100(2n+1)$

12. **A sound wave of wavelength 32cm enters the tube as shown in the figure. Then the smallest radius 'r' so that a maximum of sound is heard at detector is**



1) 7 cm 2) 14 cm
3) 21 cm 4) 28 cm

13. **A sonometer wire, with a suspended mass of M=1 kg, is in resonance with a given tuning fork. The apparatus is taken to the moon where the acceleration due to gravity is 1/6 that on earth. To obtain resonance on the moon, the value of M should be**

1) 1 kg 2) $\sqrt{6}$ kg 3) 6 kg 4) 36 kg

14. **A sonometer wire of length L is plucked at a distance L/8 from one end then it vibrates with a minimum frequency n. If the same wire plucked at a distance L/6 from another end the minimum frequency with which it vibrates is**

1) $\frac{\sqrt{3}}{2}n$ 2) $\frac{3}{2}n$ 3) $\frac{3n}{4}$ 4) $\frac{4n}{3}$

15. **A metal wire of linear mass density of 9.8 g/m is stretched with a tension of $10\ kgwt$ between two rigid supports 1m apart. The wire passes at its middle point between the poles of a permanent magnet and it vibrates in resonance when carrying an alternating current of frequency n. The frequency n of the alternating source is**

1) 50 Hz 2) 100 Hz 3) 200 Hz 4) 25 Hz

16. **A stretched wire of length 114 cm is divided into three segments whose frequencies are in the ratio 1 : 3 : 4, the lengths of the segments must be in the ratio (2010-ENG)**

1) 18 : 24 : 72 2) 24 : 72 : ;18 3) 24 : 18 : 72 4) 72 : 24 : 18

17. **If n_1, n_2 and n_3 are the fundamental frequencies of three segments into which a string is divided, then the original fundamental frequency n of the string with the same tension is given by**

1) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$ 2) $\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}} + \frac{1}{\sqrt{n_3}}$

3) $\sqrt{n} = \sqrt{n_1} + \sqrt{n_2} + \sqrt{n_3}$ 4) $n = n_1 + n_2 + n_3$

SOUND AND VELOCITY OF SOUND

18: **The speed of sound in oxygen (O_2) at a certain temperature is 460 ms^{-1}. The speed of sound in helium (He) at the same temperature will be (assume both gases to be ideal)**
[AIEEE 2008]

1)460 ms^{-1} 2)500 ms^{-1} 3)650 ms^{-} [1]4)1420 ms^{-1}

19. **A pressure of P causes a decrease in volume of water by a fraction 'Q'. The speed of sound in water is (in CGS)**

1) $\sqrt{\frac{P}{Q}}$ 2) $\sqrt{PQ}$ 3) $\frac{P}{Q}$ 4) PQ

20. **Velocity of hydrogen at NTP is V. The velocity of sound in a mixture of hydrogen and oxygen in the ratio of 4:1 at NTP is**

1) $\frac{1}{5}V$ 2) $\frac{1}{4}V$ 3) $\frac{1}{3}V$ 4) $\frac{1}{2}V$

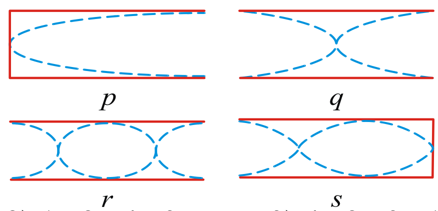
21. **A mixture of two diatomic gases exists in a closed cylinder. The volumes and velocities in the two gases are V_1, V_2 and c_1, c_2 respectively. Determine the velocities of the gases in the mixture.**

1) $C_1C_2\sqrt{\frac{V_1+V_2}{V_1c_2^2+V_2c_1^2}}$ 2) $C_1C_2\sqrt{\frac{V_1+V_2}{V_1c_1^2+V_2c_2^2}}$

3) $C_1C_2\sqrt{\frac{V_1+V_2}{V_1^2c_1+V_2c_2^2}}$ 4) $C_1C_2\sqrt{\frac{V_1+V_2}{V_1^2c_1+V_2^2c_2}}$

ORGAN PIPES

22. The vibrating of four air columns are represented in the figure. The ratio of frequencies $n_p : n_q : n_r : n_s$ is



1) 12 : 6 : 3 : 5 2) 1 : 2 : 4 : 3 3) 4 : 2 : 3 : 1 4) 6 : 2 : 3 : 4

23. An open pipe of length 24 cm is in resonance with a frequency 660 Hz in fundamental mode. The radius of pipe is (V = 330 ms^{-1})

1) 3 cm 2) 0.83 cm 3) 3.5 cm 4) 2cm

24. An open organ pipe has length *l*. The air in it vibrating in 3rd overtone with maximum amplitude A. The amplitude at a distance of $\frac{l}{16}$ from any open end is.

1) A 2) Zero 3) $\frac{A}{\sqrt{2}}$ 4) $\frac{\sqrt{3}A}{2}$

25. The frequency of a stretched uniform wire under tension is in resonance with the fundamental frequency of a closed tube. If the tension in the wire is increased by 8N, it is in resonance with first overtone of the closed tube. The initial tension in the wire is

1) 16 N 2) 8 N 3) 4 N 4) 1 N

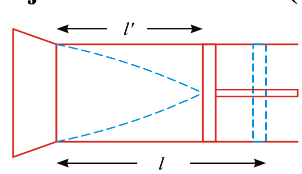
26. An open pipe resonates with frequency 100Hz and a closed pipe resonates with frequency 50Hz. If they are joined to form a longer tube then it will resonate with freqency of (neglect end corrections)

1) 25Hz 2) 50Hz 3) 75Hz 4) 100Hz

27. In a resonance column, first and second resonance are obtained at depths 22.7 cm and 70.2 cm, the third resonance will be obtained at a depth of

1)117.7 cm 2)92.9 cm 3)115.5 cm 4)113.5 cm

28. A 'pop' gun consists a tube 25cm long closed at one end by a cork and the other end by a tightly fitted piston as shown. The piston is pushed slowly in. When the pressure rises to one and half times the atmospheric pressure, the cork is violently blow out. The frequency of the'pop'caused by its ejection is (V = 340m/s)



1) 510Hz 2) 1020Hz

3) 205Hz 4) 740Hz

BEATS

29: A closed pipe and an open pipe of same length produce 2 beates, when they are set into vibration simultaneously in thier fundamental mode . If the length of the

open pipe is halved, and that of closed pipe is doubled, and if they are vibrating in the fundamental mode, then the number of beats produced is

1) 8 2) 4 3) 7 4) 2

30: A closed pipe is suddenly opened and changed to an open pipe of same length. The fundamental frequency of the resulting open pipe is less than that of 3rd hoarmonic of the earlier closed pipe by 55Hz. Then, the value of fundamental frequency of the closed pipe is

1) 165Hz 2) 100Hz 3) 55Hz 4) 220Hz

31. A fork gives 5 beats/s with a 40 cm long sonometer wire. If the length of the wire is shortened by 1 cm, the number of beats/s is still the same. The frequency of the fork is

1) 385 Hz 2) 320 Hz 3) 395 Hz 4) 400 Hz

32. Two tuning forks A and B are sounded together and 7 beats/s are heard. A is in resonance with a 32 cm air column closed at one end and B is in resonance when length of air column is increased by 1 cm. The frequencies of forks A and B are

1) 264 Hz, 256 Hz 2) 272 Hz, 264 Hz 3) 231 Hz, 224 Hz 4) 220 Hz, 512 Hz

33. An organ pipe opened from both ends produces 5 beats per second when vibrated with a source of frequency 200Hz. The second harmonic of the same pipe produces 10 beats per second with a source of frequency 420Hz. The fundamental frequency of organ pipe is

1) 195Hz 2) 205Hz 3) 190Hz 4) 210Hz

34. When a vibrating tuning fork is placed on a sound box of a sonometer, 8 beats per second are heard when the length of the sonometer wire is kept at 101 cm or 100 cm. Then the frequency of the tuning fork is (consider that the tension in the wire is kept constant) [E 2012]

1) 1616 Hz 2) 1608 Hz 3) 1632 Hz 4) 1600 Hz

35. Two parts of a sonometer wire divided by a movable bridge differ in length by 0.2 cm and produce one beat per second, when sounded together. The total length of wire is 1m, then the frequencies are

1) 250.5 and 249.5 Hz 2) 230.5 and 229.5 Hz
3) 220.5 and 219.5 Hz 4) 210.5 and 209.5 Hz

36. On vibrating an air column at 27°C and a tuning fork simultaneously, 5 beats per second are produced. The frequency of the fork is less than that of air column. No beats are heard at -3°C. The frequency of the fork is

1) 70 Hz 2) 147 Hz 3) 104 Hz 4) 92 Hz

37. The wavelength of two sound notes in air are $\frac{40}{195}m$ and $\frac{40}{193}m$. Each note produces 9 beats per second, separately with a third note of fixed frequency. The velocity of sound in air in m/s is (E-2011)

1) 360 2) 320 3) 300 4) 340

DOPPLER EFFECT

38. The velocity of a listener who is moving away from a stationary source of sound such that the listener notices 5% apparent decrease in frequency of sound is(Velocity of sound in air = 340 m/s)

1) 12.5 ms^{-1} 2) 17 ms^{-1} 3) 25 ms^{-1} 4) 34 ms^{-1}

39. Two trains are moving towards each other on parallel tracks at speeds of 144 kmph and 54 kmph. The first train sounds a whistle of freqency 600Hz. Freqency of the whistle as heard by a passenger in the second train is (V=340m/s)

1) 510Hz 2) 610Hz 3) 710Hz 4) 810Hz

40. A boy sitting on a swing which is moving to an angle of 30^0 from the vertical is blowing a whistle which is of frequency 1000 Hz. The whistle is 2 m from the

point of support of the swing. If a girl stands infront of the swing, the maximum and minimum frequencies she will hear are (velocity of sound = 330 m/s, g = 9.8 m/s^2)

1) 1000, 990 Hz 2) 1007, 1000 Hz 3) 1007,993 Hz 4) 1100, 900 Hz

41. **A source of sound produces waves of wave length 48cm. This source is moving towards north with speed V/4 where V is speed of sound. The apparant wavelength of the waves to an obsever standing south of the moving source will be**

1) 48 cm 2) 60 cm 3) 72 cm 4) 96 cm

42. **A siren of frequency n approaches a stationary observer and then receedes from the observer. If the velocity of source (V) << the velocity of sound (C), the apparent change in frequency is**

1) 2 n V/C 2) 2 n C/V 3) n/V 4) 2 VC/n

43. **s_1 and s_2 are two sound sources of frequencies 338 Hz and 342 Hz respectively placed at a large distance apart. The velocity with which an observer should move from s_2 to s_1 so that he may hear no beats will be..(velocity of sound in air = 340 m/s)**

1) 1 m/s 2) 2 m/s 3) 3 m/s 4) 4 m/s

44. **A vehicle moving on a straight road sounds a whistle of frequency 256Hz while nearing a hill with a velocity 10ms^{-1}. The number of beats per second observed by a person travelling in the vehicle is $\left(V = 330ms^{-1}\right)$.**

1) zero 2) 10 3) 14 4) 16

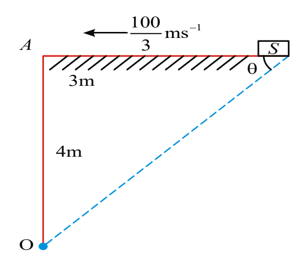
45. **If a vibrating tuning fork of frequency 255Hz is approaching with a velocity 4m/s perpendicular to a wall. The number of beats produced per sec is (speed of sound in air = 340m/s)**

1) 3 2) 4 3) 5 4) 6

46.Two sources A and B are sending notes of frequency 680Hz. A listener moves from A and B with a constant velocity u. If the speed of sound in air is 340 ms^{-1}, what must be the value of u so that he hears 10 beats per second? [E-2009]

1) 2.0 ms^{-1} 2) 2.5 ms^{-1} 3) 3.0 ms^{-1} 4) 3.5 ms^{-1}

47. **A source of sound is travelling at $\frac{100}{3}ms^{-1}$ along a road, towards a point A. When the source is 3m away from A, a person standing at a point O on a road perpendicular to the track hears a sound of frequency 'ν'. The distance of O from A at that time is 4m. If the original frequency is 640 Hz, then the value of ν is (given velocity of sound $= 340ms^{-1}$)**



1) 620 Hz 2) 680 Hz

3) 720 Hz 4) 840 Hz

EXERCISE - VI - KEY

1) 2	2) 1	3) 1	4) 1	5) 1	6) 1	7) 1	8)1	9) 3	10) 3
11) 3	12) 4	13) 3	14) 3	15)1	16) 4	17) 1	18) 4	19) 1	20) 4
21) 1	22) 2	23) 2	24) 3	25) 4	26) 1	27) 1	28) 1	29) 3	30) 3
31) 3	32) 3	33) 2	34) 2	35) 1	36) 4	37) 1	38) 2	39) 3	40) 3
41) 2	42) 1	43) 2	44) 1	45) 4	46) 2	47)2			

EXERCISE - VII

1. **The transverse displacement $y(x,t)$ of a wave on a string is given by $y(x,t)=e^{-(ax^2+bt^2+2\sqrt{ab}xt)}$. This represents a [AIEEE 2011]**

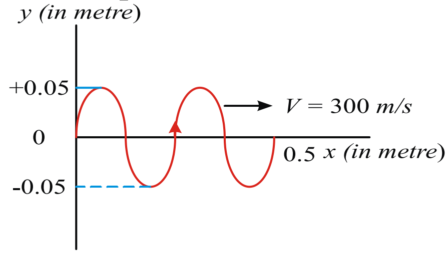
1) Wave moving in -ve x direction with speed $\sqrt{b/a}$

2) Wave moving in +ve x direction with speed $\sqrt{b/a}$

3) Standing wave of frequency $\sqrt{b}$

4) Standing wave of frequency $\frac{1}{\sqrt{b}}$

2. **A plane progressive wave is shown in the adjoining phase diagram. The wave equation of this wave, if its position is shown at t=0, is**



1) $y=0.05\sin 2\pi(300t-x)$ 2) $y=0.05\sin 2\pi(300t+x)$

3) $y=0.05\sin 8\pi(300t+x)$ 4) $y=0.05\sin 8\pi(300t-x)$

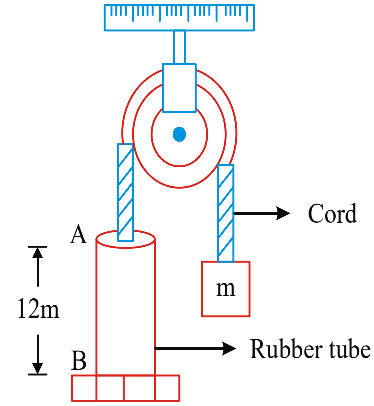
3. **A plane progressive wave of frequency 25 Hz, amplitude $2.5\times10^{-5}m$ and initial phase zero moves along the negative x-direction with a velocity of 300 ms^{-1}. A and B are two points 6m apart on the line of propagation of the wave. At any instant the phase difference between A and B is θ. The maximum difference the displacement of the particles at A and B is Δ, then**

1) $\theta=\pi$ 2) $\theta=0$ 3) $\Delta=0$ 4) $\Delta=5\times10^{-5}\ m$

4. **A wave pulse starts propagating in positive x- direction along a non-uniform wire of length 10 m with mass per unit length given $m=m_0+\alpha x$ and under a tension of 100 N. The time taken by the pulse to travel from the lighter end (x=0) to the heavier end is (given $m_0=10^{-2}kgm^{-1}$ and $\alpha=9\times10^{-3}kgm^{-2}$) (in sec)**

1) 4.66 2) 0.226 3)7.133 4) 5.24

5. **A long rubber tube having mass 0.9kg is fastened to a fixed support and the free end of the tube is attached to a chord which passes over a pulley and supports an object, with a mass of 5kg as shown in figure. If the tube is struck by a transverse blow at one end, the time required for the pulse to reach the other end is**



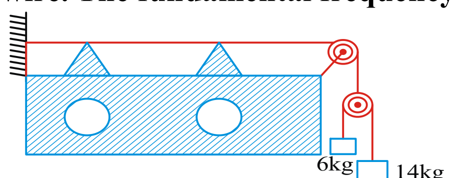
1) 5s 2) 0.48s 3) 4.8s 4) 3.2s

6. **A wave represented by $y=100\sin(ax+bt)$ is reflected from a dense plane at the origin. If 36% of energy is lost and rest of the energy is reflected then the equation of the reflected wave will be**

1) $y=-8.1\sin(ax-bt)$ 2) $y=8.1\sin(ax+bt)$

3) $y=-80\sin(ax-bt)$ 4) $y=-10\sin(ax-bt)$

7. **In a sonometer wire, the tension is maintained by suspending a 20kg mass from the free end of the wire. The fundamental frequency of vibration is 300 Hz.**



If the tension is provided by two masses of 6kg and 14kg suspended from a pulley as show in the figure the fundamental frequency will

1) stll remain 300 Hz 2) become larger

3) become smaller

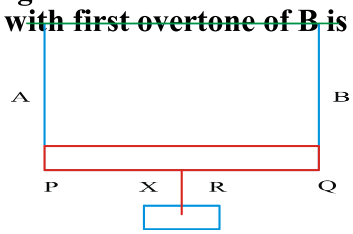
4) decrease in the present situation and increase if the suspended masses of 6kg and 14kg are interchanged.

8. **The length of the wire shown in figure between the pulley is 1.5m and its mass is 12 gm. Find the frequency of vibration with which the wire vibrates in two loops leaving the middle point of the wire between the pulleys at rest.**

1) 35 Hz 2) 40 Hz

3) 70 Hz 4) 80 Hz

9. **A rod PQ of length 'L' is hung from two identical wires A and B. A block of mass 'm' is hung at point R of the rod as shown in figure. The value of 'x' so that the fundamental mode in wire A is in resonance with first overtone of B is**



1) $\frac{4L}{5}$ 2) $\frac{L}{4}$

3) $\frac{L}{5}$ 4) $\frac{2L}{3}$

10. **Two wires are fixed on a sonometer. Their tensions are in the ratio 8:1, their lengths**

are in the ratio 36:35 , the diameters are in the ratio 4:1 and densities are in the ratio 1:2. Find the frequencies of the beats produced if the note of the higher pitch has a frequnecy of 360 /s.

1) 20 Hz 2) 10 Hz 3) 30 Hz 4) 40 Hz

11. **The vibrations of a string fixed at both ends are represented by** $y = 16 Sin\left(\frac{\pi x}{15}\right) Cos(96\pi t)$**. Where 'x' and 'y' are in cm and 't' in seconds. Then the phase difference between the points at x = 13 cm and x = 16 in radian is**

1) $\pi/5$ 2) π 3) 0 4) $2\pi/5$

12. **Two metallic strings A and B of different materials are connected in series forming a joint. The strings have similar cross-sectional area. The length of A is** $l_A = 0.3m$ **and that of B is** $l_B = 0.75m$**. One end of the combined string is tied with a support rigidly and the other end is loaded with a block of mass m passing over a frictionless pulley. Transverse waves are setup in the combined string using an external source of variable frequency. The total number of antinodes at this frequency with joint as node is (the densities of A and B are 6.3 × 10^3 kg m^{-3} and 2.8 × 10^3 kgm^{-3} respectively)**

1) 5 2) 8 3) 9 4) 6

13. **A source of sound emits waves isotropically in three dimensions. If the intensity at a distance r_0 from source is I_0, at what distance from the source is the intensity 0.100 I_0?**

1) 1.16 r_0 2) 2.16 r_0 3) 3.16 r_0 4) 4.16 r_0

14. **How long will it take sound waves to travel the distance *l* between the points A and B if the air temperature between them varies linearly from T_1 to T_2? The velocity of sound propagation in air is equal to $v = \alpha\sqrt{T}$, where α is constant.**

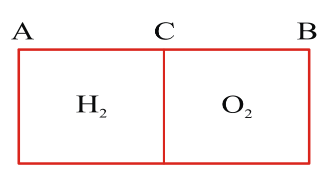
1) $t = \frac{2l}{\alpha\left[\sqrt{T_2} + \sqrt{T_1}\right]}$ 2) $t = \frac{4l}{\alpha\left[\sqrt{T_1} + \sqrt{T_2}\right]}$

3) $t = \frac{4l}{\alpha\left[\sqrt{T_1}\sqrt{T_2}\right]}$ 4) $t = \frac{2l}{\alpha\left[\sqrt{T_1 + T_2}\right]}$

15. **Air column of 20 cm length in a resonance tube resonates with a certain tuning fork when sounded at its upper open end. The lower end of the tube is closed and adjustable by changing the quantity of mercury filled inside the tube. The temperature of the air is 27°C. The change in length of the air column required, if the temperature falls to 7°C and the same tuning fork is again sounded at the upper open end is nearly**

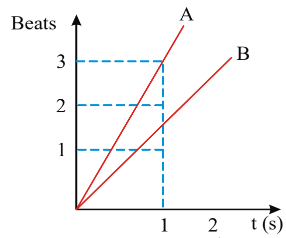
1) 1 mm 2) 7 mm 3) 5 mm 4) 13 mm

16. **AB is a cylinder of length 1m fitted with a thin flexible diaphragm C at middle and two other thin flexible diaphragms A and B at the ends as shown. The portions AC and BC contain hydrogen and oxygen gases respectively. The diaphragms A and B are set into vibrations of the same frequency. The minimum frequency of these vibrations for which diaphragm C is a node is (Under the conditions of the experiment the velocity of sound in hydrogen is 1100 m/s and oxygen 300 m/s)**



1) 1100 Hz 2) 3300 Hz 3) 1650 Hz 4) 1500 Hz

17. Two tuning forks P and Q are vibrated together. The number of beats produced are represented by the straight line OA in the following graph. After loading Q with wax again these are vibrated together and the beats produced are represented by the line OB. If the frequency of P is 341 Hz, the frequency of Q will be ___



1) 341 Hz 2) 338 Hz 3) 344 Hz 4) 330 Hz

18. A driver in a stationary car blows a horn which produces monochromatic sound waves of frequency 1000 Hz normally towards a reflecting wall. The wall approaches the car with a speed of 3.3 ms^{-1}. (velocity of sound v = 336m/s]

1) the frequency of sound reflected from wall and heard by the driver is 1000 Hz
2) the frequency of sound reflected from wall and heard by the driver is 980 Hz.
3) the percentage increase in frequency of sound after reflection from wall is 2%.
4) the percentage decrease in frequency of sound after reflection from wall is 2%.

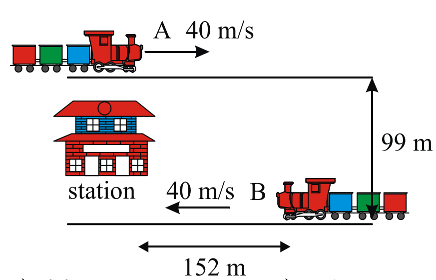
19. A sources of sonic oscillations with frequenccy n=1700Hz and a receiver are located on the same normal to a wall. Both the source and receiver are stationary, and the wall recedes from the source with velocity u=6.0 cm/s. Find the beat frequency registred by th receiver. The velocity of sound is equal to v=340 m/s.

1) 0.2 Hz 2) 0.3 Hz 3) 0.4 Hz 4) 0.6 Hz

20. A source of oscillations S is fixed to the riverbed of a river with stream velocity v. Two receivers R_1 and R_2 are fixed also to the riverbed. If the source generates frequency f_s, what frequencies are received by receivers R_1 and R_2.

1) f_s 2) 1.2 f_s 3) 1.4 f_s 4) 1.6 f_s

21. A train A crosses a station with a speed of 40 m/s and whistles a short pulse of natural frequency $n_0 = 596 Hz$. Another train B is approaching towards the same station with the same speed along a parallel track. Two tracks are d = 99m apart. When train A whistles, train B is 152m away from the station as shown in fig. If velocity of sound in air $v = 330 m/s$, calculate frequency of the pulse heard by driver of train B.



1) 724 Hz 2) 660 Hz 3) 742 Hz 4) 427 Hz

22. A wave travelling along the x-axis is described by the equation y(x, t) = 0.005 cos$(\alpha x - \beta t)$. If the wavelength and the time period of the wave are 0.08m and 2.0 s respectively, then α and β in appropriate units are [AIE- 2008]

1) $\alpha = 25.00\pi, \beta = \pi$ 2) $\alpha = \frac{0.08}{\pi}, \beta = \frac{2.0}{\pi}$

3) $\alpha = \frac{0.04}{\pi}, \beta = \frac{1.0}{\pi}$ 4) $\alpha = 12.50\pi, \beta = \frac{\pi}{2.0}$

23. A travelling wave represented by $y = A\sin(\omega t - kx)$ is superimposed on another wave represented by $y = A\sin(\omega t + kx)$. The resultant is [AIEEE 2011]

1) a standing wave having nodes at $x = \left(n + \frac{1}{2}\right)\frac{\lambda}{2}$, where n = 0,1,2

2) a wave travelling along + x direction

3) a wave travelling along – x direction

4) a standing wave having nodes at $x = \frac{n\lambda}{2}$ where n = 0,1,2

24. While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18 cm during winter. Repeating the same experiment during summer, she measures the column length to be x cm for the second resonance. Then [AIEEE 2008]

1) 18 > x 2) x > 54 3) 54 > x > 36 4) 36 > x > 18

25. A motor cycle starts from rest and accelerating along a straight path at 2ms^{-2}. At the starting point of the motor cycle, there is a stationary electric siren. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycle was at rest? (Speed of sound = 330 ms^{-1}) [AIE 2009]

1) 49 m 2) 98 m 3) 147 m 4) 196 m

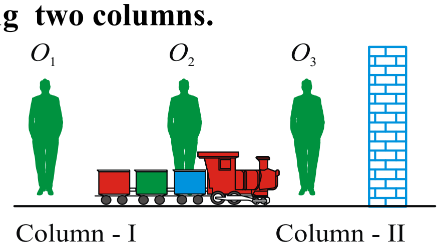
EXERCISE - VII - KEY

1) 1	2) 4	3) 1, 4	4) 2	5)2	6)3	7)3	8)3	9)3	10) 2
11) 2	12)2	13)3	14)1	5)2	16) 3	17) 3	18)3	19) 4	20) 1
21) 1	22) 1	23) 1	24) 2	25) 2					

EXERCISE - VIII

MATCHING TYPE QUESTIONS

1. A train T horns a sound of frequency f. It is moving towards a wall with speed $\frac{1}{4}$th the speed of sound. There are three observers O_1, O_2 and O_3 as shown. Match the following two columns.



Column - I	**Column - II**
a) Beat frequency Observed to O_1	p) $\frac{2}{3}$f

b) Beat frequency observed to O_2 — q) $\frac{8}{15}f$

c) Beat frequency observed to O_3 — r) f

d) If train moves in oppoisite direction with the same speed then beat frequency observed to O_3 — s) zero

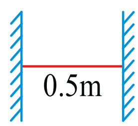
1) $a-q; b-s; c-r; d-p$ 2) $a-q; b-p; c-s; d-s$

3) $a-r; b-s; c-q; d-p$ 4) $a-s; b-p; c-r; d-p$

2. **In each of the four situations of Column-I a stretched string or an organ pipe is given along with required data. In case of strings the tension in string is** $T = 102.4N$ **and the mass per unit length of string is 1 g/m. Speed of sound in air is 320 m/s. Neglect and corrections. The frequencies of resonance are given in column II. Match each situation in column-I with the possible resonance frequencies given in column-II**

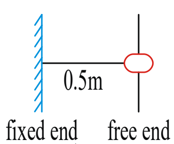
Column-I	**Column-II**
A) String fixed at both end	P) 320 Hz
B) String fixed at one end and free at other end	Q) 480 Hz
C) Open organ pipe	R) 640 Hz
D) Closed organ pipe	S) 800 Hz

A) String fixed at both end

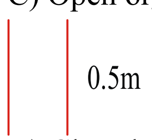


fixed fixed

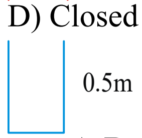
B) String fixed at one end and free at other end



C) Open organ pipe



D) Closed organ pipe

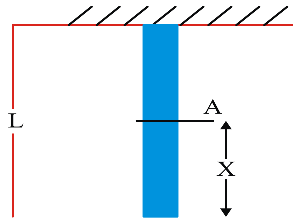


	A	B	C	D
1)	P,R	Q,S	P,R	Q,S
2)	P,S	Q,R	P,Q	Q,S
3)	Q,R	P,Q	Q,S	R,S
4)	P,R	Q,R	S,R	R,P

COMPREHENSION QUESTIONS

Paragraph - I

A heavy but uniform rope of length L is suspended from a ceiling



3. **Find the velocity of transverse wave travelling on the string as a funcition of the distance(x) from the lower end**

1) $L\sqrt{\frac{g}{x}}$ 2) $x\sqrt{\frac{g}{L}}$ 3) $\sqrt{gx}$ 4) $\sqrt{gx^2}$

4. **If the rope is given a sudden sideways jerk at the bottom, how long will it take for the pulse to reach the ceiling ?**

1) $\sqrt{\frac{2L}{g}}$ 2) $\sqrt{\frac{L}{2g}}$ 3) $\frac{1}{2}\sqrt{\frac{L}{g}}$ 4) $2\sqrt{\frac{L}{g}}$

5. **A particle is dropped from the ceiling at the same instant the bottom end is given the jerk. where will the particle meet the pulse measured from bottom ?**

1) $\frac{L}{2}$ 2) $\frac{L}{3}$ 3) $\frac{L}{6}$ 4) $\frac{L}{4}$

Paragraph - II

The vibrations of a string of length 600cm fixed at both ends are represented by the equation. $y = 4\sin\left[\frac{\pi x}{15}\right].\cos[90\pi.t]$ **where 'x' and 'y' are in cm. and 't' in seconds**

6. **What is the maximum displacement of a point x = 5 cm ?**

1) $\sqrt{3}$cm 2) $2\sqrt{3}$ cm 3) $\frac{\sqrt{3}}{2}$cm 4) $\frac{3\sqrt{3}}{2}$cm

7. **Where are the nodes located along the string?**

1) 15cm, 25cm 2) 20cm, 40cm 3) 15cm, 45cm 4) 10cm, 30cm

8. **What is the velocity of the particle at** $x = 7.5$ cm **at t = 0.25 s**

1) zero 2) 1/2 cm/s 3) 0.25 cm/s 4) 1 cm/s

Paragraph - III

Two sources $s_1 \& s_2$ **seperated by 2m, vibrate according to equation** $y_1 = 0.03\sin\pi t$ **and** $y_2 = 0.02\sin\pi t$ **where** y_1, y_2 **and t are in M.K.S units. They send out waves of velocity 1.5m/s. Calculate the amplitude of the resultant motion of the particle co-linear with** $s_1 \& s_2$ **and located at a point**

9. **To the right of** S_2

1) 0.0265m 2) 0.0365m 3) 0.0165m 4) 0.0465m

10. **To the left of** S_2

1) 0.0265m 2) 0.0365m 3) 0.0165m 4) 0.0465m

11. **In the middile of S_1 and S_2**

1) 0.25m 2) 0.05m 3) 1m 4) 2m

Paragraph - IV

A Source emits sound waves of frequency 1000 HZ .The source moves to the right with a speed of 32 m\s relative to ground , on the right a reflecting surface moves towards left with a speed of 64 m/s relative to the ground. The speed of sound in air is 332 m/s

12. **Find the wave length of sound in ahead of the source.**

1) 0.1 m 2) 0.2 m 3) 0.3 m 4) 0.4m

13. **Find the number of waves arriving per second which meets the refelcting surface**

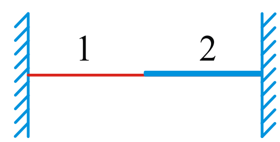
1) 1320 2) 1220 3) 1120 4) 1020

14. **Find the wavelength of reflected waves**

1) 0.1m 2) 0.2m 3) 0.3m 4) 0.4m

PassageV :

When a composite wire is made by joining two wires as shown in figure and possible frequencies of this wire is asked (both ends fixed) then the lowest frequency is that at which individual lowest frequencies of the two wires are equal.



In the figure given : $l_1 = l_2 = l,\ \mu_1 = \frac{\mu_2}{9} = \mu.$

15. **The lowest frequency such that the junction is a node is**

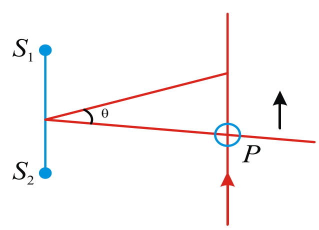
1) $\frac{1}{2l}\sqrt{\frac{T}{\mu}}$ 2) $\frac{1}{l}\sqrt{\frac{T}{\mu}}$ 3) $\frac{4}{l}\sqrt{\frac{T}{\mu}}$ 4) $\frac{2}{l}\sqrt{\frac{T}{\mu}}$

16. **The lowest frequency such that the junction is an antinode is**

1) $\frac{1}{4l}\sqrt{\frac{T}{\mu}}$ 2) $\frac{3}{4l}\sqrt{\frac{T}{\mu}}$ 3) $\frac{5}{4l}\sqrt{\frac{T}{\mu}}$ 4) $\frac{7}{4l}\sqrt{\frac{T}{\mu}}$

Passage VI:

Two speakers S_1 & S_2 driven by the same amplifiers are placed at y=1m and y=-1m. The speakers vibrate in phase at 600 Hz. A man stands at a point on x-axis at a very large distance form the origin and starts moving parallel to y-axis. The speed of sound in air is 330 m/s.



17. **The angle θ at which intensity of sound drop to a minimum for the first time**

1) 4^o 2) 20.5^o 3) 7.9^o 4) 35^o

18. **The angle θ at which he will hear maximum intensity for first time?**

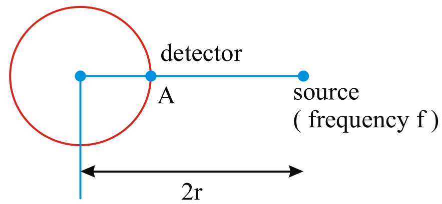
1) 2^o 2) 10^o 3) 16^o 4) 25^o

19. If he continous to walk along the same line how many more maxima can he hear

1) one 2) two 3) 5 4) 10

Passage VII:

A detector is moving in a circular path of radius r in anticlock wise direction with a constant angular velocity ω as shown in the figure. At time t=0, it starts from the location shown at A, assuming source at rest,



20. The frequency as received by the detector when it rotates by an angle $\frac{\pi}{2}$

1) $\left(\frac{V-r\omega}{V}\right)f$ 2) $\left(\frac{V-\frac{2}{\sqrt{5}}r\omega}{V}\right)f$ 3) $\left(\frac{V+r\omega}{V}\right)f$ 4) $\left(\frac{V+\frac{2}{\sqrt{5}}r\omega}{V}\right)f$

21. The time at which the detector will hear the maximum frequency for the 1st time

1) $\frac{\pi}{2\omega}$ 2) $\frac{3\pi}{2\omega}$ 3) $\frac{5\pi}{3\omega}$ 4) $\frac{2\pi}{3\omega}$

22. The time interval between minimum and maximum frequency as received by the detector

1) $\frac{\pi}{\omega}$ 2) $\frac{3\pi}{2\omega}$ 3) $\frac{4\pi}{3\omega}$ 4) $\frac{5\pi}{3\omega}$

EXERCISE - VIII - KEY

1)2	2)1	3)3	4)4	5)2	6)2	7)3	8)1	9)1	10)1
11)2	12)3	13)1	14)2	15)1	16)1	17)3	18)3	19)2	20)2
21)3	22) 3								

EXERCISE - I

1. **A cubical Gaussian surface encloses electric flux of 30 C per unit permittivity of a charge. The electric flux through each face of the cube per unit permittivity is**
1) 30 C 2) 15 C 3) 10 C 4) 5 C

2. **As one penetrates uniformly charged conducting sphere, what happens to the electric field strength**
1) decreases inversely as the square of the distance
2) decreases inversely as the distance
3) becomes zero
4) increases inversely as the square of distance

3. **Mark the correct option**
1) Gauss law is valid only for unsymmetrical charge distributions
2) Gauss law is valid only for charge placed in vacuum
3) The electric field calculated by Gauss law is the field due to the charges outside the Gaussian surface.
4) The flux of the electric field through a closed surface due to all the charges is equal to the flux due to the charges enclosed by the surface

4. **If the flux of the electric field through a closed surface is zero**
1) The electric field must be zero every where on the surface
2) The electric field must not be zero everywhere on the surface
3) The charge inside the surface must be zero
4) The charge in the vicinity of the surface must be zero

5. **An infinite plane sheet of a metal is charged to charge density $\sigma\ C/m^2$ in a medium of dielectric constant K. Intensity of electric field near the metallic surface will be**
1) $E=\frac{\sigma}{\varepsilon_o K}$ 2) $E=\frac{\sigma}{2\varepsilon_o}$ 3) $E=\frac{\sigma}{2\varepsilon_o K}$ 4) $E=\frac{K\sigma}{2\varepsilon_o}$

6. **The electric flux from a cube of edge l is ϕ. Its value if edge of cube is made $2l$ and charge enclosed is halved is**
1) $\phi/2$ 2) 2ϕ 3) 4ϕ 4) ϕ

7. **If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2, the electric charge inside the surface will be**
1) $(\phi_1+\phi_2)/\varepsilon_o$ 2) $(\phi_1-\phi_2)/\varepsilon_o$ 3) $(\phi_1+\phi_2)\varepsilon_o$ 4) $(\phi_2-\phi_1)\varepsilon_o$

8. **Electric flux at a point in an electric field is**
1) positive 2) negative 3) zero 4) positive or negtive

9. **Electric flux over a surface in an electric field may be**
1) positive 2) negative
3) zero 4) positive, negative, zero

10. **A charge Q is placed at the mouth of a conical flask. The flux of the electric field through the flask is**
1)zero 2) Q/ε_0 3) $\frac{Q}{2\varepsilon_0}$ 4) $<\frac{Q}{2\varepsilon_0}$

11. **A charge Q is placed at the mouth of a conical flask. At the centre of the circular**

crossection flux of the electric field through it is

1) zero 2) Q/ε_0 3) $\frac{Q}{2\varepsilon_0}$ 4) $< \frac{Q}{2\varepsilon_0}$

12. **Electric field intensity at a point due to an infinite sheet of charge having surface charge density σ is E. If sheet were conducting electric intensity would be**

1) E/2 2) E 3) 2 E 4) 4 E

13. **Two thin infinite parallel sheets (non conducting) have uniform surface densities of charge + σ and $-\sigma$. Electric field in the space between the two sheets is**

1) $\sigma/\in_0$ 2) $\sigma/2\in_0$ 3) $2\sigma/\in_0$ 4) zero

14. **In the above question, if the sheets were thick and conducting, value of E in the space between the two sheets would be**

1) $2\sigma/\in_0$ 2) $\sigma/\in_0$ 3) zero 4) $4\sigma/\in_0$

15. **In the above problem the value of E in the space outside the sheets is.**

1) $\sigma/\in_0$ 2) $\sigma/2\in_0$ 3) zero 4) $2\sigma/\in_0$

16. **The Gaussian surface for calculating the electric field due to a charge distribution is**

1) any closed surface around the charge distribution
2) any surface near the charge distribution
3) a spherical surface
4) a closed surface at a every point of which electric field has a normal component which is zero or a fixed value

17. **The electric flux over a sphere of radius 1m is ϕ. If radius of the sphere were doubled without changing the charge enclosed, electric flux would become**

1) 2ϕ 2) $\phi/2$ 3) $\phi/4$ 4) ϕ

18. **A charge q is placed at the centre of a cube. What is the electric flux associated with one of the faces of cube**

1) q/ε_0 2) ε_0/q 3) $6q/\varepsilon_0$ 4) $q/6\varepsilon_0$

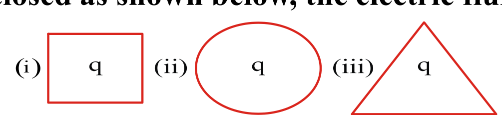
19. **A charge Q is placed at the corner of a cube. The electric flux through all the faces of the cube is**

1) Q/ε_0 2) $Q/6\varepsilon_0$ 3) $Q/8\varepsilon_0$ 4) $Q/3\varepsilon_0$

20. **A point charge +q is placed at mid point of a cube of side 'L'. The electric flux emerging from the cube is**

1) q/ε_0 2) $6qL^2/\varepsilon$ 3) $q/6L^2\varepsilon_0$ 4) zero

21. **A charge q is enclosed as shown below, the electric flux is**



1) maximum in (i) 2) maximum in (ii)
3) maximum in (iii) 4) equal in all

22. **An ellipsoidal cavity is carved with in a perfect conductor. A positive charge q is placed at the centre of the cavity. The points A and B are on the cavity surface**

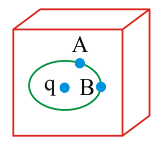
as shown in the figure then

a) Electric field near A in the cavity = Electric field near B in the cavity

b) Charge density at A = Charge density at B

c) Potential at A = Potential at B

d) Total electric flux through the surface of the cavity is q/e_0 .



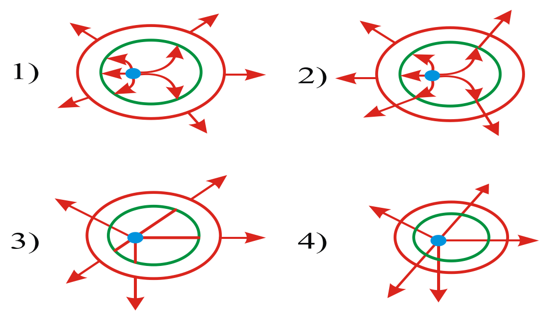
1) a,b,c,d are correct

2) a,b,c are correct

3) only a and b are correct

4) only c and d are correct

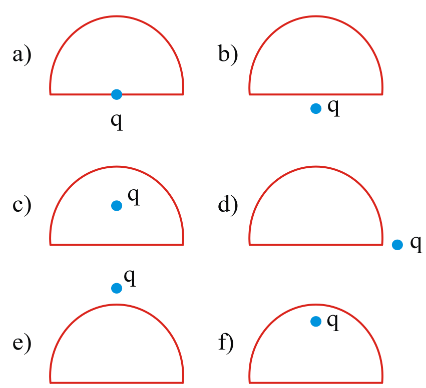
23. **A metallic shell has a point charge $'q'$ kept inside its cavity. Which one of the following diagrams correctly represents electric lines of forces**



24. **Two infinitely long thin styraight wires having uniform linear charge densities λ and 2λ are arranged parallel to each other at a distance r apart . The intesity of the electric field at a point midway between them is**

1) $\frac{2\lambda}{\pi\varepsilon_0 r}$ 2) $\frac{\lambda}{\pi\varepsilon_0 r}$ 3) $\frac{\lambda}{2\pi\varepsilon_0 r}$ 4) $\frac{3\lambda}{2\pi\varepsilon_0 r}$

25. **Find the total flux due to charge q associated with the given hemispherical surface**



1) $(a)\frac{q}{2\in_0},(b)0,(c)\frac{q}{\in_0},(d)0,(e)0(f)\frac{q}{\varepsilon_0}$ 2) $(a)0,(b)\frac{q}{2\in_0},(c)0,(d)\frac{q}{\in_0},(e)0(f)\frac{q}{\varepsilon_0}$

3) $(a)\frac{q}{2\in_0},(b)\frac{q}{\in_0},(c)0,(d)\frac{q}{\in_0},(e)0(f)\frac{q}{\varepsilon_0}$ 4) $(a)0,(b)\frac{q}{2\in_0},(c)0,(d)\frac{q}{\in_0},(e)\frac{q}{\in_0}(f)\frac{q}{\varepsilon_0}$

26. **A : A metallic sheild in the form of a hollow shell may be built to block an**

electric field.

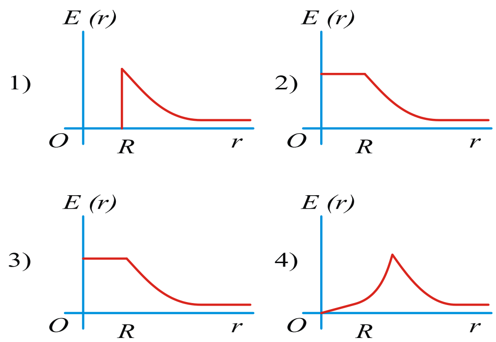
R : In a hollow spherical shield, the electric field inside it is zero at every point.

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.

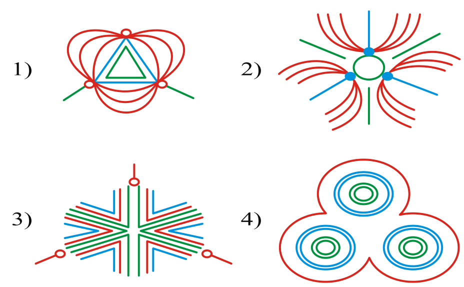
2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'.

3) 'A' is true and 'R' is false 4) 'A' is false and 'R' is true

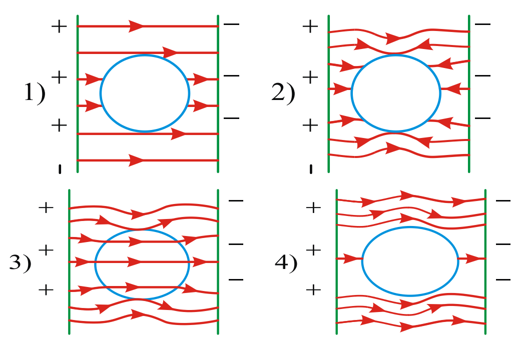
27. **A thin spherical shell of radius R has charge Q spread uniformly over its surface. Which of the following graphs most closely represents the electric field $E(r)$ produced by the shell in the range $0 \le r < \infty$, where r is the distance from the centre of the shell?**



28. **Three positive charges of equal value q are placed at vertices of an equilateral triangle. The resulting lines of force should be sketched as in (3)**



29. **An uncharged metal sphere is placed between two equal and oppositely Charged metal plates. The nature of line of force will be**



ASSERTION& REASON

1) Both (A) and (R) are true and (R) is the correct explanation of (A)

2) Both (A) and (R) are true and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false

4) (A) is false but (R) is true

30. **Assertion: A device used to measure $\vec{E}$ is located at some distance from a fixed**

point charge. In this situation, the device measures E_0 as the magnitude of electric field intensity. Now an uncharged conducting sphere with a very small hole is lowered by an insulating thread so that it surrounds the point charge. Now, the reading of the device becomes zero.

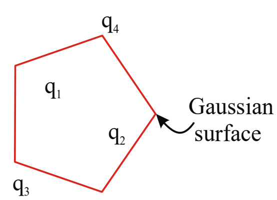
Reason: Electrostatic shielding is the phenomenon in which inside of hollow conductor is shielded for outside electric field

31. Assertion: E in outside vicinity of a conductor depends only on the local charge density σ

Reason: $\vec{E}$ in outside vicinity of a conductor is given by $\frac{\sigma}{\varepsilon_0}$

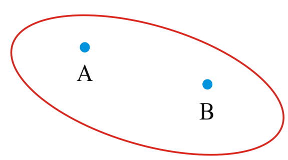
32. Assertion: Four point charges q_1, q_2, q_3 and q_4 are as shown in Fig. The flux over the shown Gaussian surface depends only on charges q_1 and q_2

Reason: Electric field at all points on Gaussian surface depends ony on charges q_1 and q_2



33. Assertion: A point charge q is placed near an arbitray shaped solid conductor as shown in figure. The potential difference between the points A and B within the conductor remain same irrespective of the magnitude of charge q.

Reason: The electric field inside a solid conductor is zero under electrostatic conditions.



34. Assertion: Two point charges +Q and -Q are fixed at point A(+a,0,0) and point B(-a,0,0) respectively. Then the magnitude of electric flux due to electric field of either point charge through infinite y-z plane (that is x=0 plane) is less than magnitude of net electric flux due to electric field of both charges through that plane (x = 0 plane).

Reason: The magnitude of net electric flux through a surface due to a system of point charges is equal to sum of magnitude of electric flux through that surface due to each of the point charge of the system.

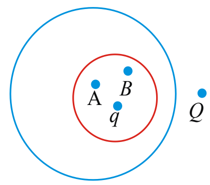
35. Assertion: In a region where uniform electric field exists, the net charge within volume of any size is zero.

Reason: The electric flux through any closed surface in region of uniform electric field is zero.

36. Assertion: A point charge q is placed at centre of spherical cavity inside a spherical conductor as shown. Another point charge Q is placed outside the conductor as shown in Fig. Now as the point charge Q is pushed away from conductor, the potential difference ($V_A - V_B$) between two points A and B within

the cavity of sphere remains constant

Reason: The electric field due to charges on outer surface of conductor and outside of the conductor is zero at all points inside the conductor.



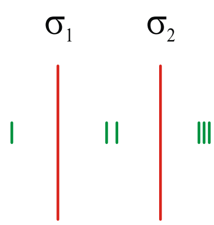
37. **Assertion: The electrostatic force on a charged particle located on a equipotential surface is zero**

Reason: **Componant of E along equipotential surface is zero.**

38. **Assertion: We cannot produce electric field in a neutral conductor.**

Reason: **Neutral conductor cannot produce electric field.**

39. **Two parallel metallic plates have surface charge densities σ_1 and σ_2 as shown in figure. Match the following:**



Column I **Column II**

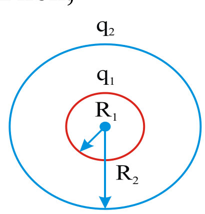
a) If $\sigma_1 + \sigma_2 = 0$ **(p) Electric field in region III is towards right**

b) If $\sigma_1 + \sigma_2 > 0$ **(q) Electric field in region I is zero**

c) If $\sigma_1 + \sigma_2 < 0$ **(r) Electric field in region I is towards right**

1) a-p, b-q, c-r 2) a-q, b-p, c-r 3) a-r b-q, c-r 4) a-p, b-r, c-r

40. **Two spherical shells are as shown in figure. Suppose r is the distance of a point from their common centre. Then,**



Column I	**Column II**
a) Electric field for	(p) is constant for $r < R_1$ q_2 and vary for q_1
b) Electric potential for	(q) is zero for $r < R_1$ q_2 and vary for q_1
c) Electron potential for	(r) is constant for both $R_1 < r < R_2$ q_1 and q_2
d) Electric field for	(s) is zero $R_1 < r < R_2$

1) a-r, b-s, c-p, d-q 2) a-s, b-r, c-p, d-q

3) a-s, b-s, c-p ,d-q 4) a-r, b-q, c-p ,d-q

EXERCISE-I - KEY

1) 4 2) 3 3) 4 4) 3 5) 1 6) 1 7) 4 8) 3 9) 4 10) 3 11) 3
12) 3 13) 1 14) 1 15) 3 16) 4 17) 4 18) 4 19) 3 20) 1 21) 4 22) 4
23) 1 24) 2 25) 1 26) 1 27) 1 28) 3 29)2 30) 4 31) 2 32) 3 33) 1
34) 1 35) 2 36) 1 37) 4 38) 2 39) 2 40) 3

EXERCISE -II

1. **A charged spherical conductor has a surface charge density of 0.7 C/m^2. When its charge is increased by 0.44C, the charge density changes by 0.14 C/m^2. The radius of the sphere is**
1) 5 cm 2) 1 0 m 3) 0.5 m 4) 5 m

2. **The electric field in a region of space is given by $\vec{E} = 5\hat{i} + 2\hat{j}\ NC^{-1}$. The electric flux due to this field through an area $2\,m^2$ lying in the YZ plane in S.I. units is**
1) 10 2) 20 3) $10\sqrt{2}$ 4) $2\sqrt{29}$

3. **Number of electric lines of force emerging from 1C of positive charge in vacuum is**
1) 8.85×10^{-12} 2) 9×10^{9} 3) $1/4\pi\times9\times10^{9}$ 4) 1.13×10^{11}

4. **A charge of 5 C is placed at the centre of a spherical gaussian surface of radius 5 cm. The electric flux through the surface is $\frac{1}{\varepsilon_0}$ times of**
1) 0.1 N-m^2/C 2) 0.5 N-m^2/C 3) 1 N-m^2/C 4) 5 N-m^2/C

5. **In a region where intensity of electric field is $5\ NC^{-1}$, 40 lines of electric force are crossing $10\ NC^{-1}$ will be**
1) 20 2) 80 3) 100 4) 200

6. **A half ring of radius R has a charge of λ per unit length. The potential at the centre of the half ring is ($k = \frac{1}{4\pi\varepsilon_o}$)**
1) $k\frac{\lambda}{R}$ 2) $k\frac{\lambda}{\pi R}$ 3) $k\frac{\pi\lambda}{R}$ 4) $k\pi\lambda$

7. **An electron is placed at the centre of a Conducting sphere of radius 0.2 metre having a charge 5×10^{-2} coulomb. The force on the electron is**
1) zero 2) $11\times10^{9}N$ 3) $22.5\times10^{9}N$ 4) $2.5\times10^{9}N$

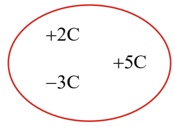
8. **Eightcharges,1 μC ,-7 μC ,-4 μC , 10 μC ,2 μC ,-5 μC ,-3 μC and 6 μC are situated at the eight corners of a cube of side 20 cm. A spheric al surface of radius 80 cm encloses this cube. The center of sphere coincides with center of the cube. Then the outgoing flux from the spherical surface(in units Vm) is**
1) $36\pi\times10^{3}$ 2) $684\pi\times10^{3}$ 3) zero 4) $72\pi\times10^{3}$

EXERCISE- II KEY

1) 3 2) 1 3) 4 4) 4 5) 2 6) 4 7) 1 8) 3

EXERCISE - III

1. **Caluclate the net flux emerging from given enclosed surface - $Nm^2\ C^{-1}$**



1) 4.5×10^{13} 2) 45×10^{12} 3) zero 4) 1.12×10^{12}

2. **A charge Q is situated at the centre of a cube. The electric flux through one of the faces of the cube is**

1) Q/ε_0 2) $Q/2\varepsilon_0$ 3) $Q/4\varepsilon_0$ 4) $Q/6\varepsilon_0$

3. **The magnitude of the electric field on the surface of a sphere of radius r having a uniform surface charge density σ is**

1) σ/ε_0 2) $\sigma/2\varepsilon_0$ 3) $\sigma/\varepsilon_0 r$ 4) $\sigma/2\varepsilon_0 r$

4. **If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2, the electric charge inside the surface will be**

1) $(\phi_2 - \phi_1)\,\varepsilon_0$ **2)** $(\phi_1 + \phi_2)/\varepsilon_0$ **3)** $(\phi_2 - \phi_1)/\varepsilon_0$ **4)** $(\phi_1 + \phi_2)\varepsilon_0$

5. **A charge q is placed at the centre of the open end of cylinderical vessel. Find the flux of the electric field through the surface of the vessel.**

1) $\frac{q}{2\epsilon_0}$ 2) $\frac{q}{\epsilon_0}$ 3) $\frac{q}{3\epsilon_0}$ 4) zero

LEVEL- III KEY

1) 1 2) 4 3) 1 4) 1 5) 1

EXERCISE - IV

1. **The inward and outward electric flux for a closed surface in units of N-m²/C are respectively 8×10^3 and 4×10^3. Then the total charge inside the surface in S.I units is (where ε_0 =permitivity constant)**

1) 4×10^3 2) -4×10^3 3) $-\frac{\pi R^2 - \pi R}{E}$ 4) $-4\times10^3\varepsilon_0$

2. **A cylinder of radius R and length L is placed in the uniform electric field E parallel to the cylinder axis. The total flux from the two flat surfaces of the cylinder is given by**

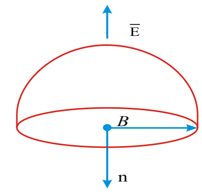
1) $2\pi R^2 E$ 2) $\frac{\pi R^2}{E}$ 3) $\frac{\pi R^2 - \pi R}{E}$ 4) zero

3. **A cube is arranged such that its length , breadth , height are along X,Y and Z directions . One of its corners is situated at the origin . Length of each side of the cube is 25cm . The components of electric field are $E_x = 400\sqrt{2}\,N/C$, $E_y = 0$ and $E_z = 0$ respectively. The flux coming out of the cube at one end will be**

1) $25\sqrt{2}Nm^2/C$ 2) $5\sqrt{2}Nm^2/C$ 3) $250\sqrt{2}Nm^2/C$ 4) $25Nm^2/C$

4. **If a hemispherical body is placed in a uniform electric field E then the flux**

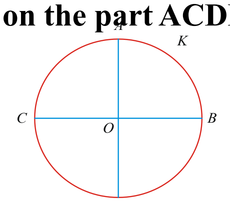
linked with the curved surface is



1) $2\pi R^2 E$ 2) $\pi R^2 E$

3) $4\pi R^2 E$ 4) $6\pi R^2 E$

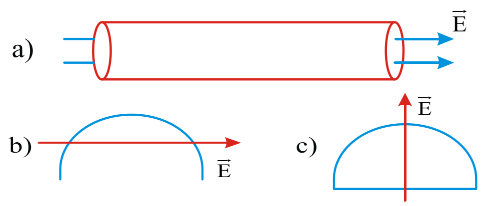
5. A thin conducting ring of radius R is given a charge +Q . The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part ACDB of the ring is



1)3 E along OK 2)3E along KO

3)E along OK 4) E along KO

6. In a unifrorm electric field find the total flux associated with the given surfaces (R is radius)



1) $a=0, b=0, c=0$

2) $a=0, b=\left(\pi R^2 E\right), c=0$

3) $a=2\pi RE, b=\left(\pi R^2 E\right), c=0$ 4) $a=\pi R^2 E, b=0, c=0$

7. Surface charge density of soap bubble of radius 'r' and surface tension T is σ. If P is excess pressure, the value of σ is

1) $\in_0\left[\frac{4T}{r}-P\right]^{\frac{3}{2}}$ 2) $\left[2\in_0\left(\frac{4T}{r}-P\right)\right]^{\frac{1}{2}}$

3) $\frac{4T}{r}$ 4) $\left[4\in_0\left(\frac{2T}{r}-P\right)\right]^{\frac{1}{2}}$

8. An infinitely long thin straight wire has uniform linear charge density of 1/3 coul.m^{-1}. Then the magnitude of the electric intensity at a point 18 cm away is

1) $0.33\times10^{11}\,NC^{-1}$ 2) $3\times10^{11}\,NC^{-1}$ 3) $0.66\times10^{11}\,NC^{-1}$ 4) $1.32\times10^{11}\,NC^{-1}$

9. Consider two concentric spherical surface S_1 with radius a and S_2 with radius 2a, both centred on the origin. There is a charge +q at the origin, and no other charges.Compare the flux ϕ_1 through S_1 with the flux ϕ_2 through S_2

1) $\phi_1=4\phi_2$ 2) $\phi_1=2\phi_2$ 3) $\phi_1=\phi_2$ 4) $\phi_1=\phi_2/2$

10. The electric field on two sides of a large charged plate is shown in fig. The charge density on the plate in S.I. units is given by (ε_o is the permittivity of

free space in S.I. units)

1) $2\varepsilon_o$ 2) $4\varepsilon_o$ 3) $10\varepsilon_o$ 4) zero

EXERCISE- IV KEY

1) 4 2) 4 3) 1 4) 2 5) 3 6) 1 7) 2 8) 1 9) 3 10) 2

EXERCISE - V

1. **The number of electric lines of force originating from a charge of 1C is**

   1) 1.129×10^{11} 2) zero 3) 1.129×10^{-11} 4) 1.129×10^{10}

2. **A cube of side l is placed in a uniform field E, where $E = E\hat{i}$. The net electric flux through the cube is**

   1) Zero 2) l^2E 3) $4l^2E$ 4) $6l^2E$

3. **A point charge +q is placed at the centre of a cube of side L. The electric flux emerging from the cube is**

   1) $\frac{q}{\varepsilon_0}$ 2) Zero 3) $\frac{6qL^2}{\varepsilon_0}$ 4) $\frac{q}{6L^2\varepsilon_0}$

4 **A long thin flat sheet has a uniform surface charge density σ. The magnitude of the electric field at a distance ' r ' from it is given by**

   1) σ/ε_0 2) $\sigma/2\varepsilon_0$ 3) $\sigma/\varepsilon_0 r$ 4) $\sigma/2\varepsilon_0 r$

5 **A charge of 8.85C is placed at the centre of a spherical Guassian surface of radius 5 cm. The electric flux through the surface is**

   1) 10^{12} V/m 2) 10^{-12} V/m
   3) 10^{8} V/m 4) 10^{10} V/m

6. **The inward and outward electric flux for a closed surface in units of $N\text{–}m^2/C$ are respectively 8×10^3 and 4×10^3. Then the total charge inside the surface in S.I. units is (where $\in_o$ = permitivity in free space)**

   1) 4×10^3 2) -4×10^3 **3)** $\frac{(-4\times10^3)}{\in_0}$ **4)** $-4\times10^3 \in_o$

7. **The total flux linked with unit negative charge put in air is**

   1) $\frac{1}{\varepsilon_0}$ out wards 2) $\frac{1}{\varepsilon_0}$ inwards 3) $\frac{1}{4\pi\varepsilon_0}$ outwards 4) $\frac{1}{4\pi\varepsilon_0}$ inwards

LEVEL- V KEY

1) 4 2) 4 3) 1 4) 2 5) 4 6) 4 7) 1

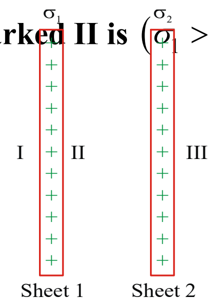
EXERCISE -VI

1. **A solid metallic sphere has a charge +3Q. Concentric with this sphere is a conducting spherical shell having charge +Q. The radius of the sphere is a and that of the spherical shell is b, (b>a). What is the electric field at a distance R (a<R<b) from the centre.**

   1) $\frac{Q}{2\pi\varepsilon_0 R}$ 2) $\frac{3Q}{2\pi\varepsilon_0 R}$ 3) $\frac{3Q}{4\pi\varepsilon_0 R^2}$ 4) $\frac{4Q}{2\pi\varepsilon_0 R^2}$

2. **Two parallel plane sheets 1 and 2 carry uniform charge densities σ_1 *and* σ_2 as**

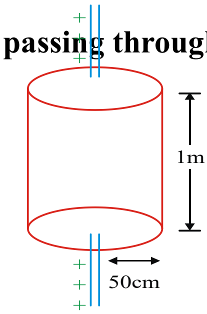
shown in fig. electric field in the region marked II is $(\sigma_1 > \sigma_2)$



1) $-\frac{(\sigma_1+\sigma_2)}{2\varepsilon_0}$ 2) $\frac{-(\sigma_1\sigma_2)}{2\varepsilon_0}$

3) $\frac{(\sigma_1+\sigma_2)}{2\varepsilon_0}$ 4) $\frac{(\sigma_1-\sigma_2)}{2\varepsilon_0}$

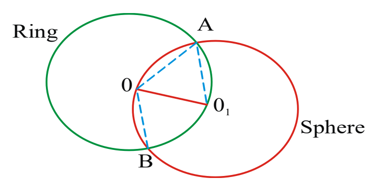
3. **Electric charge is uniformly distributed along a long straight wire of radius 1 mm. The charge per cm length of the wires is Q coulomb. Another cylindrical surface of radius 50 cm and length 1 m symmetrically encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is**



1) $\frac{Q}{\varepsilon_0}$ 2) $\frac{100Q}{\varepsilon_0}$

3) $\frac{10Q}{(\pi\varepsilon_0)}$ 4) $\frac{100Q}{(\pi\varepsilon_0)}$

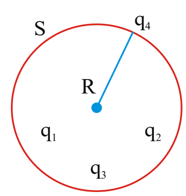
4. **A charge Q is distributed uniformly on a ring of radius r. A sphere of equal radius r is constructed with its centre at the periphery of the ring as shown in figure. Find the flux of the electric field through the surface of the sphere.**



1) $\frac{Q}{3\varepsilon_0}$ 2) $\frac{q}{\varepsilon_0}$

3) $\frac{q}{2\varepsilon_0}$ 4) zero

5. q_1, q_2, q_3 *and* q_4 **are point charges located at points as shown in the figure as S is a spherical Gaussian surface of radius R. Which of the following is true according to the Gauss's law**



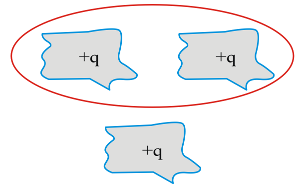
1) $\oint (\vec{E}_1+\vec{E}_2+\vec{E}_3)\cdot d\vec{A} = \frac{q_1+q_2+q_3}{2\varepsilon_0}$

2) $\oint (\vec{E}_1+\vec{E}_2+\vec{E}_3+\vec{E}_4)\cdot d\vec{A} = \frac{(q_1+q_2+q_3)}{\varepsilon_0}$

3) $\oint (\vec{E}_1+\vec{E}_2+\vec{E}_3+\vec{E}_4)\cdot d\vec{A} = \frac{(q_1+q_2+q_3+q_4)}{\varepsilon_0}$

4) None of the above

6. **Shown below is a distribution of charges. The flux of electric field due to these charges through the surface S is**



1) $3q/\varepsilon_0$ 2) $2q/\varepsilon_0$

3) q/ε_0 4) Zero

7. **A thin spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centre of the shell. The electrostatic potential at a point P at a distance R/2 from the centre of the shell is**

1) $\frac{2Q}{4\pi\varepsilon_0 R}$ 2) $\frac{2Q}{4\pi\varepsilon_0 R}-\frac{2q}{4\pi\varepsilon_0 R}$ 3) $\frac{2Q}{4\pi\varepsilon_0 R}+\frac{q}{4\pi\varepsilon_0 R}$ 4) $\frac{(q+Q)}{4\pi\varepsilon_0}\frac{2}{R}$

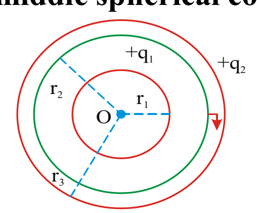
8. **A charge 'q' is distributed over two concentric hollow conducting spheres of radii a and b (b > a) such that their surface charge densites are equal. The potential at their common centre is**

1) Zero 2) $\frac{q}{4\pi\epsilon_0}\frac{(a+b)}{(a^2+b^2)^2}$ 3) $\frac{q}{4\pi\epsilon_0}\left[\frac{1}{a}+\frac{1}{b}\right]$ 4) $\frac{q}{4\pi\epsilon_0}\left[\frac{a+b}{(a^2+b^2)}\right]$

9. **Two concentric sphere of radii a_1 and a_2 carry charges q_1 and q_2 respectively. If the surface charge density (σ) is same for both spheres, the electric potential at the common centre will be**

1) $\frac{\sigma}{\epsilon_0}\frac{a_1}{a_2}$ 2) $\frac{\sigma}{\epsilon_0}\frac{a_2}{a_1}$ 3) $\frac{\sigma}{\epsilon_0}(a_1-a_2)$ 4) $\frac{\sigma}{\epsilon_0}(a_1+a_2)$

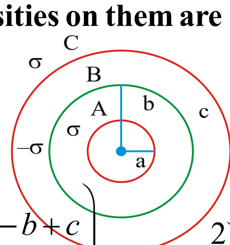
10. **Assume three concentric conducting spheres where charge q_1 and q_2 have been placed on inner and outer sphere where as middle sphere has been earthed. Find the charge on the outer surface of middle spherical conductor**



1) $-\frac{r_2}{r_3}q_2$ 2) $-q_1$

3) $-q_2$ 4) $\frac{r_2}{r_3}q_1$

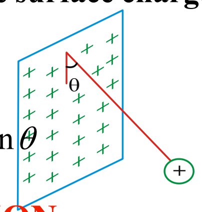
11. **Three concentric metallic spheres A, B and C have radii a,b and c (a < b < c) and surface charge densities on them are $\sigma, -\sigma$ and σ respectively. The values of V_A and V_B will be**



1) $\frac{\sigma}{\epsilon_0}(a-b+c), \frac{\sigma}{\epsilon_0}\left(\frac{a^2}{b}-b+c\right)$ 2) $(a-b+c), \frac{a^2}{c}$

3) $\frac{\epsilon_0}{\sigma}(a-b+c), \frac{\epsilon_0}{\sigma}\left(\frac{a^2}{b}-b+c\right)$ 4) $\frac{\sigma}{\epsilon_0}\left(\frac{a^2}{c}-\frac{b^2}{c}+c\right), \frac{\sigma}{\epsilon_0}(a-b+c)$

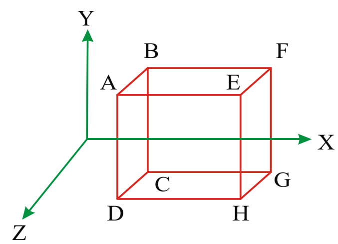
12. **A charged ball hangs from silk thread which makes an angle 'θ' with large charged conducting sheet 'P' as shown. The surface charge density (σ) of the sheet is proportional to**



1) $\cos\theta$ 2) $\cot\theta$ 3) $\sin\theta$ 4) $\tan\theta$

COMPREHENSION

The electric field in a region is given by $\overline{E}=(\alpha x)\bar{i}$. Here is α is a constant of proper dimensions.



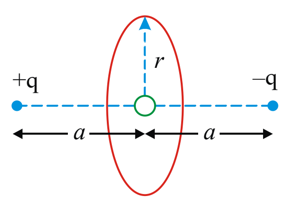
13. **Find the total flux passing through a cube bounded by surfaces**
$x=l, x=2l, y=0, y=l, z=0, z=l.$

1) αl^3 2) $2\alpha l^3$ 3) $3\alpha l^3$ 4) $4\alpha l^3$

14. **The charge contained inside the above cube is**

1) $2\alpha \in_0 l^3$ 2) $\alpha \in_0 l^3$ 3) $4\alpha \in_0 l^3$ 4) $3\alpha \in_0 l^3$

15. **Two point charges q *and* $-q$ are seperated by a distance 2a. Find the flux of the electric field vector acrossthe circle of radius r is shown.**



1) $\frac{q}{2\in_0}\left\{1-\frac{a}{\sqrt{a^2+r^2}}\right\}$ 2) $\frac{q}{\in_0}\left\{1-\frac{a}{\sqrt{a^2+r^2}}\right\}$

3) $\frac{2q}{\in_0}\left\{1-\frac{a}{\sqrt{a^2+r^2}}\right\}$ 4) Zero

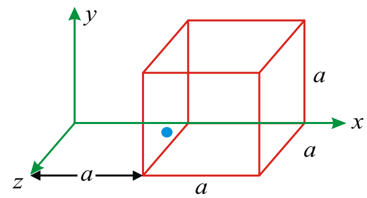
16. **A long string with a charge of λ per unit length passes through an imaginary cube of edge *a*. The maximum flux of the electric field through the cube will be**

1) $\lambda a/\in_0$ 2) $\sqrt{2}\lambda a/\in_0$ 3) $6\lambda a^2/\in_0$ 4) $\sqrt{3}\lambda a/\in_0$

17. **A rod with linear charge density λ is bent in the shape of circular ring. The electric potential at the centre of the circular ring is**

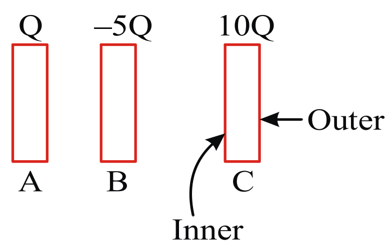
1) $\frac{\lambda}{4\varepsilon_0}$ 2) $\frac{\lambda}{2\varepsilon_0}$ 3) $\frac{\lambda}{\varepsilon_0}$ 4) $\frac{2\lambda}{\varepsilon_0}$

18. **The electric field components in the figure are $E_x = \alpha x^{1/2}, E_y = 0, E_z = 0$ where α = 800 N / m². If a = 0.1 m is the side of cube then the charge within the cube is**



1) $9.27\times10^{-12}C$ 2) $6\times10^{-12}C$ 3) $2.5\times10^{-12}C$ 4) Zero

19. **Three very large plates are given charges as shown in the figure. If the cross-sectional area of each plate is the same, the final charge distribution on plate C is**



a) +5Q on the inner surface , +5Q on the outer surface
b) +6Q on the inner surface, +4Q on the outer surface
c) +7Q on the inner surface, +3Q on the outer surface
d) +8Q on the inner surface, +2Q on the outer surface

20. **An electric dipole of dipole moment P is kept at a distance r from an infinite long charged wire of linear charge density λ as shown. The force acting on the dipole is**

1) $\frac{P\lambda}{2\pi\varepsilon_0 r^2}$ 2) $\frac{P\lambda}{\pi\varepsilon_0 r^2}$ 3) $\frac{2P\lambda}{\pi\varepsilon_0 r^2}$ 4) $\frac{P\lambda}{4\pi\varepsilon_0 r^2}$

21. **A point charge q is a distance r from the centre O of an uncharged spherical conducting layer, whose inner and outer radii equal to a and b respectively. The potential at the point** O if r < a is $\frac{q}{4\pi\epsilon_0}$ times

1) $\left(\frac{1}{r}-\frac{1}{a}+\frac{1}{b}\right)$ 2) $\left(\frac{1}{a}-\frac{1}{r}+\frac{1}{b}\right)$ 3) $\left(\frac{1}{b}-\frac{1}{c}-\frac{1}{r}\right)$ 4) $\left(\frac{1}{a}-\frac{1}{b}-\frac{1}{r}\right)$

22. **One-fourth of a sphere of radius R is removed as shown in fig. An electric field E exists parallel to x-y plane. Find the flux through the remaining curved part.**

1) $\pi R^2 E$ 2) $\sqrt{2}\pi R^2 E$ 3) $\pi R^2 E/\sqrt{2}$ 4) $2\pi R^2 E$

EXERCISE- VI - KEY

1) 3	2) 4	3) 2	4) 1	5) 2	6) 2	7) 3	8) 4	9) 4	10) 1	11) 1
12) 4	13) 1	14) 2	15) 4	16) 4	17) 2	18) 1	19)3	20) 1	21) 3	22) 3

EXERCISE - I

ELECTRIC CURRENT & DRIFT VELOCITY

1. **If the electron in a Hydrogen atom makes 6.25×10^{15} revolutions in one second, the current is**
   1) 1.12 mA 2) 1 mA 3) 1.25 mA 4) 1.5 mA

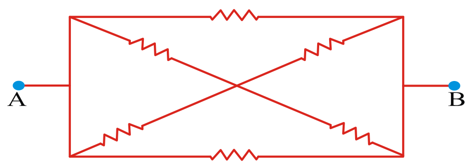
2. **The current through a wire connected to a condencer varies with time as**
   $i = (2t+1)A$
   The charge transport to the condenser from $t=0$ to $t=5s$ is
   1) 5C 2) 55C 3) 30C 4) 60C

3. **A copper wire of cross-sectional area 2.0 mm^2, resistivity = 1.7×10^{-8} Ωm, carries a current of 1 A. The electric field in the copper wire is**
   1) 8.5×10^{-5} V/m 2) 8.5×10^{-4} V/m 3) 8.5×10^{-3} V/m 4) 8.5×10^{-2} V/m

OHM'S LAW AND COMBINATION OF RESISTANCES

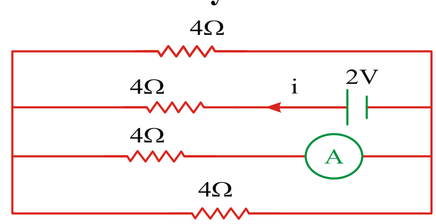
4. **Using three wires of resistances 1 ohm, 2ohm and 3 ohm, then no.of different values of resistances that possible are**
   1) 6 2) 4 3) 10 4) 8

5. **Six resistances of each 12 ohm are connected as shown in the fig. The effective resistance between the terminals A and B is**



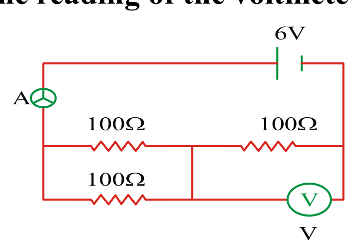
   1) 8Ω 2) 6Ω 3) 4Ω 4) 12Ω

6. **Current 'i' coming from the battery and ammeter reading are**



   1) $\frac{3}{8}A, \frac{1}{8}A$ 2) $\frac{1}{8}A, \frac{1}{8}A$ 3) $2A, \frac{2}{3}A$ 4) $2A, \frac{1}{8}A$

7. **In the circuit shown, the reading of the voltmeter and the ammeter are**



   1)4V, 0.2A 2) 2V, 0.4A 3)3V, 0.6A 4)4V, 0.04A

8. **The resistance of a wire of 100 cm length is 10 Ω. Now, it is cut into 10 equal**

parts and all of them are twisted to form a single bundle. Its resistance is

1) 1 Ω 2) 0.5 Ω 3) 5 Ω 4) 0.1 Ω

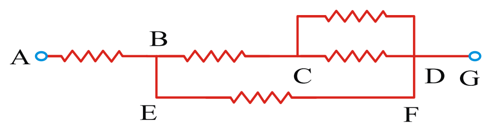
9. **A metallic wire of resistance 20 ohm stretched until its length is doubled. Its resistance is**

1) 20 Ω 2) 40 Ω 3) 80 Ω 4) 60 Ω

10. **A wire of resistance 20 Ω is bent in the form of a square. The resistance between the ends of diagonal is**

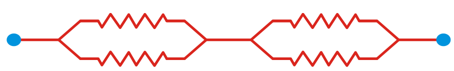
1) 10 Ω 2) 5 Ω 3) 20 Ω 4) 15 Ω

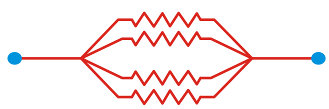
11. **Resistance of each 10 Ω are connected as shown in the fig. The effective resistance betweeen A and G is**

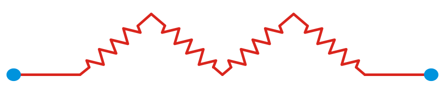


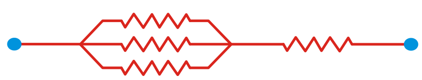
1) 16 Ω 2) 20 Ω 3) 12 Ω 4) 8 Ω

12. **Which arrangement of four identical resistances should be used to draw maximum energy from a cell of voltage V**

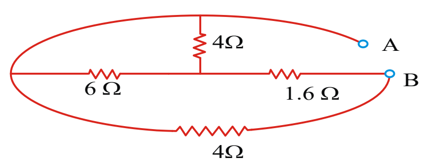
1) 

2) 

3) 

4) 

13. **If four resistances are connected as shown in the fig. between A and B the effective resistance is**

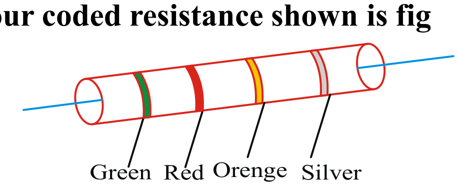


1) 4 Ω 2) 8 Ω 3) 2.4 Ω 4) 2 Ω

14. **A letter 'A' is constructed as a uniform wire of resistance 1 ohm/cm. The sides of the letter are 20 cm long and the cross piece in the middle is 10cm long while the vertex angle is 60^0. The resistance of the letter between the two ends of the legs is**

1) 40/3 Ω 2) 80/3 Ω 3) 40 Ω 4) 10 Ω

15. **Find the value of colour coded resistance shown is fig**



1) $520 \pm 10\%$ 2) $5200 \pm 1\%$ 3) $52000 \pm 10\%$ 4) $52000 \pm 1\%$

16. **The resistance of a wire is 2 Ω. If it is drawn** in such a way that it experiences a **longitudinal strain 200%. Its new resistance is**

1) 4Ω 2) 8Ω 3) 16Ω 4) 18Ω

17. 'n' conducting wires of same dimensions but having resistivities 1, 2, 3,...n are connected in series. The equivalent resistivity of the combination is

1) $\frac{n(n+1)}{2}$ 2) $\frac{n+1}{2}$ 3) $\frac{n+1}{2n}$ 4) $\frac{2n}{n+1}$

18. An Aluminium (α = 4 x $10^{-3}K^{-1}$) resistance R_1 and a carbon (α = -0.5 x $10^{-3}K^{-1}$) resistance R_2 are connected in series to have a resultant resistance of 36 Ω at all temperatures. The values of R_1 and R_2 in Ω respectively are :

1) 32, 4 2) 16, 20 3) 4, 32 4) 20, 16

19. The temperature coefficient of a wire is 0.00125°C^{-1}. At 300 K its resistance is one ohm. The resistance of the wire will be 2Ω at

1) 1154 K 2) 1100 K 3) 1400 K 4) 1127 K

20. The electrical resistance of a mercury column in a cylindrical container is 'R'. The mercury is poured into another cylindrical container with half the radius of cross-section. The resistance of the mercury column is

1) R 2) 2R 3) 16R 4) 5R

21. Four conductors of same resistance connected to form a square. If the resistance between diagonally opposite corners is 8 ohm, the resistance between any two adjacent corners is

1) 32 ohm 2) 8 ohm 3) 1/6 ohm 4) 6 ohm

22. The resistivity of a material is S ohm meter. The resistance between opposite faces of a solid cube of edge 10 cm is (in ohm)

1) S/2 2) S/10 3) 100S 4) 10S

23. Four wires made of same material have different lengths and radii, the wire having more resistance in the following case is

1) $\ell = 100cm, r = 1mm$ 2) $\ell = 50cm, r = 2mm$

3) $\ell = 100cm, r = \frac{1}{2}mm$ 4) $\ell = 50cm, r = \frac{1}{2}mm$

24. Two different wires have specific resistivities, lengths, area of cross-sections are in the raio 3:4, 2:9 and 8:27. Then the ratio of resistance of two wires is

1) $\frac{16}{9}$ 2) $\frac{9}{16}$ 3) $\frac{8}{27}$ 4) $\frac{27}{8}$

25. Two wires made of same material have their length are in the ratio 1:2 and their masses in the ratio 3 : 16. The ratio of resistance of two wires is

1) 3/4 2) 1:2 3) 2:1 4) 4:3

26. A wire of resistance 18 ohm is drawn until its radius reduce $\frac{1}{2}$ th of its original radius then resistance of the wire is

1) 188 Ω 2) 72Ω 3) 288 Ω 4) 388 Ω

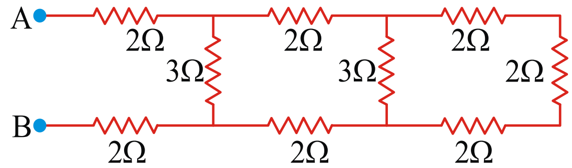
27. A piece of wire of resistance 4Ω is bent through 180^0 at its midpoint and the two halves are twisted together. Then the resistance is

1) 8 Ω 2) 1 Ω 3) 2 Ω 4) 5 Ω

28. If three wires of equal resistance are given then number of combinations they cany be made to give different resistance is

1) 4 2) 3 3) 5 4) 2

29. The effective resistance between A and B in the given circuit is



1) 20 Ω 2) 7 Ω 3) 3 Ω 4) 6 Ω

30. How many cells each marked $(6V-12A)$ should be connected in mixed grouping so that it may be marked $(24V-24A)$

1) 4 2) 8 3) 12 4) 6

31. The effective resistance in series combination of two equal resistance is 's'. When they are joined in parallel the total resistance is p. If s = np then the minimum possible value of 'n' is

1) 4 2) 1 3) 2 4) 3

ELECTRIC POWER & JOULES LEW

32. A 25 watt, 220 volt bulb and a 100 watt, 220 volt bulb are connected in series across 440 volt line

1) only 100 watt bulb will fuse 2) only 25 watt bulb will fuse
3) none of the bulb will fuse 4) both bulbs will fuse

33. There are 5 tube-lights each of 40W in a house. These are used on an average for 5 hours per day. In addition, there is an immersion heater of 1500W used on an average for 1 hour per day. The number of units of electricity are consumed ina month is

1) 25 units 2) 50 units 3) 75 units 4) 100 units

34. Three equal resistors connected in series across a source emf together dissipate 10 watt. If the same resistors are connected in parallel across the same emf the power dissipate will be

1) 10 watt 2) 30 watt 3) 10/3 watt 4) 90 watt

35. Time taken by a 836 W heater to heat one litre of water from $10^0 C\ to\ 40^0 C$ is

1) 50 s 2) 100 s 3) 150 s 4) 200 s

36. A lamp of 600W-240V is connected to 220V mains. Its resistance is

1) 96 Ω 2) 84 Ω 3) 90 Ω 4) 64 Ω

37. A 200W - 200V lamp is connected to 250V mains. It power consumption is

1) 300 W 2) 312.5W 3) 292 W 4) 250 W

38. If the current in a heater increases by 10% , the percentage change in the power consumption

1) 19% 2) 21% 3) 25% 4) 17%

39. The power of a heating coil is P. It is cut into two equal parts. The power of one of them across same mains is

1) 2P 2) 3P 3) P/2 4) 4P

40. In a house there are four bulbs each of 50W and 5 fans each of 60W. If they are used at the rate of 6 hours a day, the electrical energy consumed in a month of 30 days is

1) 64 KWH 2) 54 KWH 3) 72 KWH 4) 42 KWH

41. An electric kettle has two coils. When one coil is switched on it takes 15 minutes

and the other takes 30 minutes to boil certain mass of water. The ratio of times taken by them, when connected in series and in parallel to boil the same mass of water is

1) 9 :2 2) 2:9 3) 4:5 4) 5:4

42. **A resistance coil of $60\,\Omega$ is immersed in 42kg of water. A current of 7A is passed through it. The rise in temperature of water per minute is**

1) $4^0 C$ 2) $8^0 C$ 3) $1.3^0 C$ 4) $12^0 C$

43. **What is the required resistance of the heater coil of an immersion heater that will increase the temperature of 1.50 kg of water from $10^0 C$ to $50^0 C$ in 10 minutes while operating at $240V$?**

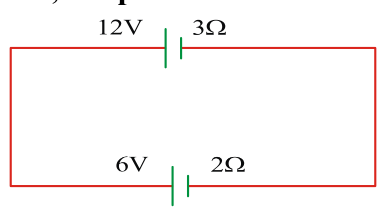
1) 25Ω 2) 12.5Ω 3) 250Ω 4) 125Ω

44. **A $5^0 C$ rise in the temperature is observed in a conductor by passing some current. When the current is doubled, then rise in temperature will be equal to**

1) $5^0 C$ 2) $10^0 C$ 3) $20^0 C$ 4) $40^0 C$

CELLS AND COMBINATION OF CELLS

45. **In the following diagram, the pd across 6V cell is**



1) 6V 2) 5.6V 3) 8.2V 4) 8.4V

46. **While connecting 6 cells in a battery in series, in a tape recorder, by mistake one cell is connected with reverse polarity. If the effective resistance of load is 24 ohm and internal resistance of each cell is one ohm and emf 1.5V, the current devlivered by the battery is**

1) 0.1A 2) 0.2A 3) 0.3A 4) 0.4A

47. **A 10m long wire of resistance 15 ohm is connected in series with a battery of emf 2V (no internal resistance) and a resistance of 5 ohm. The potential gradient along the wire is**

1) 0.15 Vm^{-1} 2) 0.45V m^{-1} 3) 1.5Vm^{-1} 4)4.5Vm^{-1}

48. **When a resistance of 2 ohm is placed across a battery the current is 1A and when the resistance across the terminals is 17 ohm, the current is 0.25A. the emf of the battery is**

1) 4.5 V 2) 5 V 3) 3 V 4) 6 V

49. **A battery has six cells in series. Each has an emf 1.5V and internal resistance 1 ohm. If an external load of 24 Ω is connected to it. The potential drop across the load is**

1) 7.2V 2) 0.3V 3) 6.8V 4) 0.4V

50. **12 cells of each emf 2V are connected in series among them, if 3 cells are connected wrongly. Then the effective emf. of the combination is**

1) 18 V 2) 12 V 3) 24 V 4) 6 V

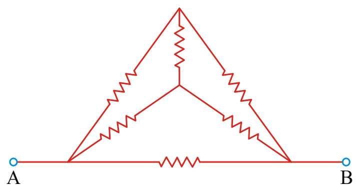
51. **When a battery connected across a resistor of $16\,\Omega$, the voltage across the resistor is 12V.When the same battery is connected across a resistor**

of 10Ω, voltage across it is 11V. The internal resistance of the battery in ohms is

1) 10/7 2) 20/7 3) 25/7 4) 30/7

KIRCHOFF'S LAWS, WHEATSTONE BRIDGE

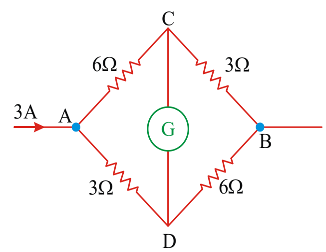
52. Six resistors of each 2 ohm are connected as shown in the figure. The resultant resistance between A and B is.



1) 4Ω 2) 2Ω

3) 1Ω 4) 10Ω

53. In the given circuit current through the galvanometer is



1) Zero

2) Flows from C to D

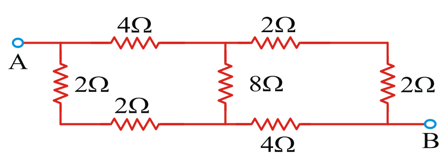
3) Flows from D to C

4) In sufficient information

54. The potential difference between A & B in the given branch of a circuit is

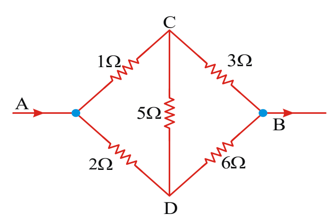
1) 6V 2) 12V 3) 9V 4) 0V

55. The resistance between A and B is



1) 8 Ω 2) 4Ω 3) 3.75Ω 4) 2Ω

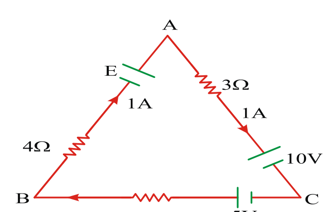
56. The resistance between A and B is



1) $\frac{288}{56}\Omega$ 2) 12Ω

3) $\frac{8}{3}\Omega$ 4) $\frac{9}{4}\Omega$

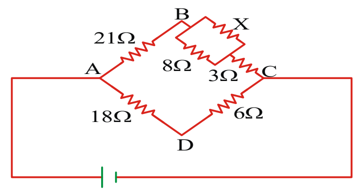
57. The value of E of the given circuit is



1) 10 V 2) 12 V

3) 14 V 4) 0 V

58. In the circuit shown in the figure, the value of Resistance X, when potential difference between the poins B and D is zero will be



1) 9 Ω 2) 8 Ω

3) 6 Ω 4) 4 Ω

METRE BRIDGE

59. **When an unknown resistance and a resistance of 4 Ω are connected in the left and right gaps of a Meterbridge, the balance point is obtained at 50cm. The shift in the balance point if a 4 Ω resistance is now connected in parallel to the resistance in the right gap is**

1) 66.7cm 2)16.7 cm 3) 34.6 cm 4) 14.6 cm

60. **In a meter bridge, the gaps are closed by resistances 2 and 3 ohms. The value of shunt to be added to 3 ohm resistor to shift the balancing point by 22.5 cm is**

1) 1 Ω 2) 2 Ω 3) 2.5 Ω 4) 5 Ω

61. **Two equal resistance are connected in the gaps of a metre bridge. If the resistance in the left gap is increased by 10%, the balancing point shift**

1) 10 % to right 2) 10% to left 3) 9.6% to right 4) 4.8% to right

POTENTIO METER

62. **A potentiometer having a wire of 4m length is connected to the terminals of a battery with a steady voltage. A leclanche cell has a null point at 1m. If the length of the potentiometer wire is increased by 1m, The position of the null point is**

1) 1.5m 2) 1.25m 3) 10.05m 4) 1.31m

63. **The emf of a battery A is balanced by a length of 80cm on a potentio meter wire. The emf of a standard cell 1v is balanced by 50cm. The emf of A is**

1) 2 V 2) 1.4 V 3) 1.5 V 4) 1.6 V

64. **When 6 identical cells of no internal resistance are connected in series in the seondary circuit of a potentio meter, the balancing length is 'l', balancing length becomes $l/3$ when some cells are connected wrongly, the number of cells conected wrognly are**

1) 1 2) 3 3) 2 4) 4

65. **In a potentiometer experiment, the balancing length with a cell is 560cm. When an external resistance of 10ohms is connected in parallel to the cell the balancing length changs by 60cm. The internal resistance of the cell in ohm is**

1) 3.6 2) 2.4 3) 1.2 4) 0.6

66. **The resistivity of a potentio meter wire is, if the are of cross section of the wire is 4cm^2. The current flowing in the circuit is 1A, the poetntial gradient is 7.5 v/m**

1) 3×10^{-3} Ω - m 2) 2×10^{-6} Ω - m 3) 4×10^{-6} Ω - m 4) 5×10^{-4} Ω - m

67. **A potentiometer wire of 10m legnth and 20 Ohm resistance is connected in series with a resistance R ohms and a battery of emf 2V, negligible internal resistance, Potential gradient on the wire is 0.16 millivolt / centimetre then R is ...ohms**

1) 50 Ω 2) 60 Ω 3) 230 Ω 4) 46 Ω

EXERCISE -I KEY

1) 2	2) 3	3) 3	4) 4	5) 3	6) 1	7) 4	8) 4	9)3	10) 2	11) 1
12) 2	13) 4	14) 2	15) 3	16) 4	17) 2	18) 3	19) 4	20) 3	21) 4	22) 4
23) 3	24) 2	25) 4	26) 3	27) 2	28) 1	29) 4	30) 1			

CURRENT ELECTRICITY

31) 1	32) 2	33) 3	34) 4	35) 3	36) 1	37) 2	38) 2	39) 1	40) 2	41) 1
42) 3	43) 4	44) 3	45) 4	46) 2	47) 1	48) 2	49) 1	50) 2	51) 2	52) 3
53) 3	54) 1	55) 2	56) 3	57) 4	58) 2	59) 2	60) 2			
61) 4	62) 2	63) 4	64) 3	65) 3	66) 1	67) 3				

EXERCISE - II

ELECTRIC CURRENT & DRIFT VELOCITY

1. The current passing through a conductor is 5 ampere. The charge that passes through that conductor in 5 minute is

1) 1200C 2) 300 C 3) 1000C 4)1500C

2. In a hydrogen atom, an electron is revolving with an angular frequency 6.28 rad/s around the nucleus. Then the equivalent electric current is ..... $\times 10^{-19}$ A

1) 0.16 2) 1.6 3) 0.016 4) 16

3. A current of 1.6 A is flowing in a conductor. The number of electrons flowing per second through the conductor is

1) 10^9 2) 10^{19} 3) 10^{16} 4) 10^{31}

4. If an electron revolves in the circular path of radius 0.5A^0 at a frequency of 5 x 10^{15} cycles/sec. The equivalent electric current is

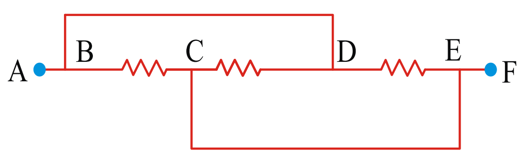
1) 0.4 mA 2) 0.8 mA 3) 1.2 mA 4) 1.6 mA

5. A current flows in a wire of circular cross section with the free electrons travelling with drift velocity $\vec{V}$. If an equal current flows in a wire of twice the radius, new drift velocity is

1) $\vec{V}$ 2) $\frac{\vec{V}}{2}$ 3) $\frac{\vec{V}}{4}$ 4) $2\vec{V}$

OHM'S LAW AND COMBINATION OF RESISTANCES

6. Three resistances each of 3Ω are connected as shown in fig. The resultant resistance between A and F is



1) 9Ω 2) 2Ω 3) 4Ω 4) 1Ω

7. Two wires made of same material have lengths in the ratio 1 : 2 and their volumes in the same ratio. The ratio of their resistances is

1) 4 : 1 2) 2 : 1 3) 1 : 2 4) 1 : 4

8. Two wires made of same material have their electrical resistances in the ratio 1 : 4. If their lengths are in the ratio 1 : 2, the ratio of their masses is

1) 1: 1 2) 1 : 8 3) 8 : 1 4) 2 : 1

9. There are five equal resistors.
The minimum resistance possible by their combination is 2 ohm. The maximum possible resistance we can make with them is

1) 25 ohm 2) 50 ohm 3) 100 ohm 4) 150 ohm

10. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii of the wires are in the

ratio 4/3 and 2/3, then the ratio of the currents passing through the wires will be

1) 3 2) 1/3 3) 8/9 4) 2

11. **A current of 1 A is passed through two resistances 1 Ω and 2 Ω connected in parallel. The current flowing through 2 Ω resistor will be**

1) 1/3 A 2) 1 A 3) 2/3 A 4) 3 A

12. **The colour coded resistance of corbon resistance is (Initial three bands are red and fourth band is silver)**

1) $222\Omega \pm 10\%$ 2) $2200\Omega \pm 10\%$ 3) $333\Omega \pm 5\%$ 4) $33000\Omega \pm 10\%$

13. **The resistance of a wire is 10 ohm. The resistance of a wire whose length is twice and the radius is half, if it is made of same material is**

1) 20 Ω 2) 5 Ω 3) 80 Ω 4) 40 Ω

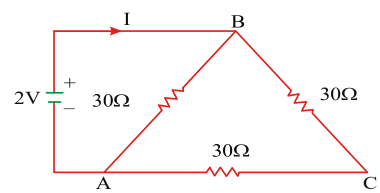
14. **The resultant resistance of two resistors when connected in series is 48 ohm. The ratio of their resistances is 3 : 1. The value of each resistance is**

1) 20 Ω, 28 Ω 2) 32 Ω, 16 Ω 3) 36 Ω, 12 Ω 4) 24 Ω, 24 Ω

15. **The resistance of a bulb filament is 100Ω at a temperature of $100^0 C$. If its temperature coefficient of resistance be 0.005 per ^0C, its resistance will become 200Ω at temperature of**

1) $300^0 C$ 2) $400^0 C$ 3) $500^0 C$ 4) $200^0 C$

16. **The current 'i' in the circuit given aside is**



1) 0.1 A 2) 0.2A

3) 1.0A 4) 2.0 A

17. **The combined resistance of two conductors in series is 1 Ω. If the conductance of one conductor is 1.1 siemen, the conductance of the other conductor in siemen is**

1) 10 2) 11 3) 1 4) 1.1

18. **Four conductors of resistnace 16Ω each are connected to form a square. The equivalent resistance across two adjacent corners is (in ohm)**

1) 6 2) 18 3) 12 4) 16

19. **When two resistances are connected in parallel then the equivalent resistance is $6/5\Omega$. When one of the resistance is removed then the effective resistance is 2Ω. The resistance of the wire removed will be**

1) 3 ohm 2) 2 ohm 3) $\frac{3}{5} ohm$ 4) $\frac{6}{5} ohm$

20. **A material 'B' has twice the specific resistance of 'A'. A circular wire made of 'B' has twice the diameter of a wire made of 'A'. Then for the two wires to have the same resistace, the ratio l_B/l_A of their respective lengths must**

1) 1 2) 1/2 3) 1/4 4) 2/1

21. **If a wire of resistance 'R' is melted and recasted in to half of its length, then the new resistance of the wire will be**

1) R/4 2) R/2 3) R 4) 2R

22. **When a wire is drawn until its radius decreases by 3%. Then percentage of increase in resistance is**

1) 10% 2) 9% 3) 6% 4) 12%

23. **When three wires of unequal resistances are given the number of combinations they can be made to give different resistances is**

1) 6 2) 4 3) 2 4) 8

24. **The resistance of a coi is 4.2Ω at 100^{0}C and the temperature coefficient of resistance of its material is 0.004/^{0}C. Its resistance at 0^{0}C is**

1) 6.5 Ω 2) 5 Ω 3) 3 Ω 4) 2.5 Ω

25. **You are given several identical resistors each of value 10Ω and each capable of carrying a maximum current of 1A. It is required to make a suitable combination of these to resistances to produce a resistance of 5Ω which can carry a current of 4A. The minimum number of resistors required for this job is**

1) 4 2) 8 3) 10 4) 20

26. **A wire of resistance 50Ω is cut into six equal parts and they ae bundled together side by side to form a thicker wire. The resistance of the bundle is**

1) $\frac{18}{25}\Omega$ 2) $\frac{9}{12.5}\Omega$ 3) $\frac{25}{9}\Omega$ 4) $\frac{25}{18}\Omega$

27. **Three conductors of resistance 12Ω each are connected to form an equilateral triangle. The resistance between any two vertices is**

1) 4 Ω 2) 2Ω 3) 6 Ω 4) 8Ω

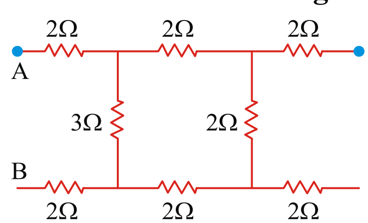
28. **When three equal resistance are connected in parallel, the effective resistance is $1/3\Omega$. If all are connected in series, the effective resistance is**

1) 9 Ω 2) 3 Ω 3) 6 Ω 4) 12 Ω

29. **A technician has only two resistance coils. By using them in series or in paralle he is able to obtain the resistance 3,4,12 and 16 ohms. The resistance of two coils are**

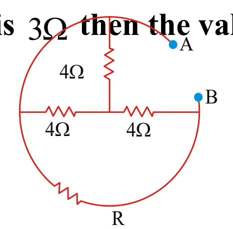
1) 6, 10 2) 4, 12 3) 7, 9 4) 4, 16

30. **The effective resistance between A&B in the given circuit is**



1) 7Ω 2) 2Ω 3) 6 Ω 4) 5Ω

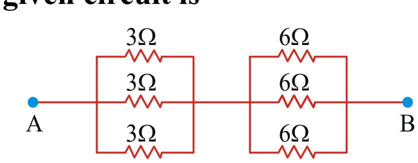
31. **The effective resistance between A and B is 3Ω then the value of R is**



1) 2 Ω 2) 4Ω

3) 6Ω 4) 8Ω

32. **The effective resistance between A and B in the given circuit is**



1) 2Ω 2) 4Ω

3) 3 Ω 4) 6Ω

ELECTRIC POWER & JOULES LAW

33. **An electric bulb is rated 220 volt and 100 watt. Power consumed by it when operated on 110 volt is**
1) 50 watt 2) 75 watt 3) 90 watt 4)25 watt

34. **A heater coil is cut in to two parts of equal length and only one of them is used in the heater. The ratio of the heat produced by this half-coil to that by the original coil is**
1) 2 : 1 2) 1 : 2 3) 1 : 4 4) 4 : 1

35. **If the electric current in a lamp decreases by 5% then the power output decreases by**
1) 20% 2) 10% 3) 5% 4) 2.5%

36. **Two electric bulbs whose resistances are in the ratio of 1 : 2 are connected in parallel to a constant voltage source. The powers dissipated in them have the ratio**
1) 1 : 2 2) 1 : 1 3) 2 : 1 4) 1 : 4

37. **A bulb rated 60 W -120V is connected to 80V mains. What is the current through the bulb**
1) $\frac{1}{3}A$ 2) $\frac{2}{3}A$ 3) $\frac{5}{3}A$ 4) $\frac{3}{5}A$

38. **An electric bulb has the following specifications 100 watt, 220 volt. The resistance of bulb**
1) 384 Ω 2) 484 Ω 3) 344 Ω 4) 584 Ω

39. **A 200W and 100W bulbs, both meant for operation at 220V, are connected in series to 220V. The power consumption by the combination is**
1) 46 W 2) 66 W 3) 56 W 4) 75 W

40. **Five bulbs, each rated at 40 W-220 V are used for 5 hours daily on 20V line. How may units of electric energy is consumed in a month of 30 days?**
1) 20 units 2) 25 units 3) 15 units 4) 30 units

41. **An electric Kettle has two heating coils. When one of them is switched on water in it boils in 6 minutes and when other is switched on water boils in 4 minutes. In what time will the water boil if both coil are switched on simultaneously**
1) 1.6 min 2) 2.8 min 3) 2.4 min 4) 3 min

42. **A 10 V storage battery of negligible internal resistance is connected across a 50Ω resistor. How much heat energy is produced in the resistor in 1 hour**
1) 7200J 2) 6200J 3) 5200J 4) 4200J

CELLS AND COMBINATION OF CELLS

43. **A cell of emf 6V is being charged by 1A current. If the internal resistance of the cell is 1 ohm, the potential difference across the terminals of the cell is**
1) 5V 2) 7V 3) 6V 4) 8V

44. **When two identical cells are connected either in series or in parallel across 2 ohm resistor they send the same current through it. The internal resistance of each cell is**
1) 2 ohm 2) 1.2 ohm 3) 12 ohm 4) 21 ohm

45. **The emf of a Daniel cell is 1.08V. When the terminals of the cells are connected to a resistance of $3\,\Omega$, the potential difference across the terminlas is found to be 0.6V. Then the internal resistance of the cell is**
1) 1.8 Ω 2) 2.4 Ω 3) 3.24 Ω 4) 0.2 Ω

46. **Four cells each of emf 2V and internal resistance 1 ohm are connected in parallel with an external resistance of 6 ohm. The current in the external resistance is**

1) 0.32 A 2) 0.16 A 3) 0.2 A 4) 0.6 A

47. **A student is asked to connected four cells of emf of 1 V and internal resistance 0.5 ohm in series with an external resistance of 1 ohm. But one cell is wrongly connected by him with its terminal reversed, the current in the circuit is**

1) $\frac{1}{3}A$ 2) $\frac{2}{3}A$ 3) $\frac{3}{4}A$ 4) $\frac{4}{3}A$

48. **Two cells of emf 1.25V, 0.75V and each of internal resistance 1Ω are connected in parallel. The effective emf will be**

1) 1 V 2) 1.25 V 3) 2 V 4) 0.5 V

49. **The emf of a cell is 2V. When the terminals of the cell is connected to a resistance 4Ω. The potential difference across the terminals, if internal resistance of cell is 1Ω is**

1) $\frac{3}{5}V$ **2)** $\frac{8}{5}V$ **3)** $\frac{6}{5}V$ **4)** $\frac{5}{8}V$

50. **If the external resistance is equal to internal resistance of a cell of emf E. The current across the circuit is**

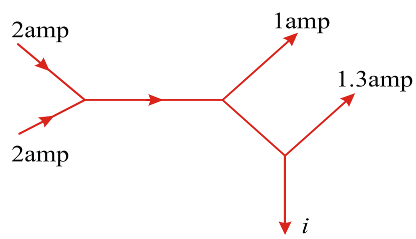
1) $\frac{E}{r}$ **2)** $\frac{r}{E}$ **3)** $\frac{r}{2E}$ **4)** $\frac{E}{2r}$

51. **Two cells each of emf 10V and each 1Ω internal resistance are used to send a current through a wire of 2Ω resistance. The cells are arranged in parallel. Then the current through the circuit**

1) 2A 2) 4A 3) 3A 4) 5A

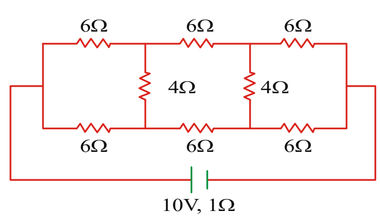
KIRCHOFF'S LAWS, WHEATSTONE BRIDGE

52. **The figure below shows current in a part of electric circuit. The current i is**



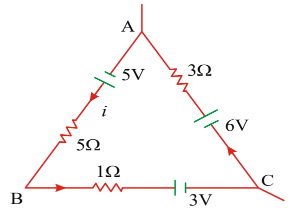
1) 1.7*amp* 2) 3.7 *amp* 3) 1.3 *amp* 4) 1 *amp*

53. **Current in the main circuit shown is**



1) 1.5 A 2) 2 A 3) 0.6 A 4) 1 A

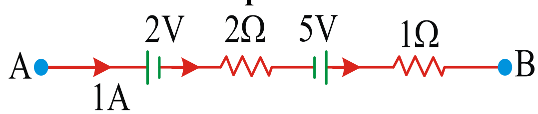
54.. Find 'i' for the given loop.



1) $\frac{6}{5}A$ 2) $\frac{8}{9}A$

3) $\frac{1}{2}A$ 4) 1A

55. The potential difference between points A and B is

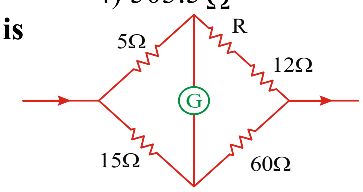


1) 0 V 2) 10 V 3) 4 V 4) 5 V

56. In wheat stone bridge, P and Q are approximately equal. When R is 500Ω, the bridge is balanced. On interchanging P and Q, the values of R is 505Ω for balanching . The value of 'S' is

1) 500.5 Ω 2) 501.5 Ω 3) 502.5 Ω 4) 503.5 Ω

57. To balance the bridge in the circuit, the values of R is



1) 8 Ω 2) 4 Ω

3) 20 Ω 4) 12 Ω

METRE BRIDGE

58. The point in a Metre bridge is at 35.6 cm. If the resistances in the gaps are interchanged,the new balance point is

1) 64.4 cm 2) 56 cm 3) 41.2 cm 4) 56.7 cm

59. In a metre bridge expt, when the resistances in the gaps are interchanged the balance point is increases by 10cm. The ratio of the resistances is

1) $\frac{15}{5}$ 2) $\frac{12}{8}$ 3) $\frac{11}{9}$ 4) $\frac{10}{9}$

60. When an unknown resistance and a resistance 6Ω are connected in the left and right gaps of a meter bridge, the balance point is obtained at 50cm. If 3Ω resistance is connected in parallel to resistance in right gap, the balance point is

1) decrease by 25 cm 2) increase by 25 cm

3) decrease by 16.7 cm 4) increase by 16.7 cm

61. When un known resistance and a resistance of 5Ω are used in left and right gaps of meter bridge the balance point is 50cm. The balanceing point if 5Ω resistance is now connected in seriece to the resistor in right gap

1) 20 cm 2) 33.3 cm 3) 60 cm 4) 60 cm

62. In a meter bridge experiement two unkonwn resistances X and y are connected to left and right gaps of a meter bridge and the balancing point is obtained at 20cm from right (X>Y) the new position of the null point from left if one decides balance a resistance of 4X against Y.

1) 114 cm 2) 80 cm 3) 53.3 cm 4) 70 cm

POTENTIO METER

63. In a potentiometer the balance length with standard cadmium cell is 509 cm. The emf of a cell which when connected in the place of the standard cell gave a

balance length of 750 cm is (emf of standard cell is 1.018V)

1) 1.5V 2) 0.5V 3) 1.08V 4) 1.2V

64. **Two cells of emf's E_1 and E_2 when placed in series produce null deflection at a distance of 204 cm in a potentio meter. When one cell is reversed they produce null deflection at 36 cm if E_1 1.4v then E_2=**

1) 0.98 V 2) 2.47 V 3) 0.098 V 4) 98.8 V

65. **When 6 identical cells of no internal resistance are connected in series in the second arycircuit of a poetntio meter, the balancing length is *l*. If two of them are wrongly connected the balancing length becomes**

1) $\frac{l}{4}$ 2) $\frac{l}{3}$ 3) l 4) $\frac{2l}{3}$

66. **In an experiment to determine the internal resistance of a cell with potentiometer, the balancing length is 165cm. When a resistance of 5 ohm is joined in parallel with the cell the balancing length is 150cm. The internal resistance of cell is**

1) 2.2Ω 2) 1.1 Ω 3) 3.3Ω 4) 0.5 Ω

67. The resistivity of a potentio meter wire is 40 x 10^{-8} $\Omega - m$ **and its area of cross section is 8 x 10^{-6} m^2. If 0.2A current is flowing through the wire, the potential gradient will be**

1) 10^{-2} V/m 2) 10^{-1} V/m 3) 3.2×10^{-2} V/m 4) 1 V/m

68. **The emf of a cell is Ev, and its its internal resistance is 1Ω. A resistance of 4Ω is joined to battery in parallel. This is connected in secondary circuit of poetntio meter. The balancing length is 160cm. If 1V cell balances for 100cm of potentio meter wire, the emf of cell E is**

1) 1 V 2) 3 V 3) 2 V 4) 4 V

EXERCISE -II KEY

1) 4	2) 2	3) 2	4) 2	5) 3	6) 4	7) 4	8) 1	9) 2	10) 2	11) 1
12) 2	13) 3	14) 3	15) 2	16) 1	17) 2	18) 3	19) 1	20) 4	21) 1	22) 4
23) 4	24) 3	25) 2	26) 4	27) 4	28) 2	29) 2	30) 3	31) 3	32) 3	33) 4
34) 1	35) 2	36) 3	37) 1	38) 2	39) 2	40) 4	41) 3	42) 1	43) 2	44) 1
45)2	46) 1	47) 2	48) 1	49) 2	50) 4	51) 2	52) 1	53) 4	54) 2	55) 1
56) 3	57) 1	58) 1	59) 3	60) 2	61) 2	62) 3	63) 1	64) 1	65) 2	66) 4
67) 1	68) 3									

EXERCISE - III

ELECTRIC CURRENT AND DRIFT VELOCITY

1. **The electron of hydrogen atom is considered to be revolving around the proton in circular orbit of radius $\frac{\hbar^2}{me^2}$ with velocity $\frac{e^2}{\hbar}$, where $\hbar = \frac{h}{2\pi}$. The current I is**

1) $\frac{4\pi^2 me^2}{h^2}$ 2) $\frac{4\pi^2 me^2}{h^3}$ 3) $\frac{4\pi^2 m^2 e^2}{h^3}$ 4) $\frac{4\pi^2 me^5}{h^3}$

2. **In a straight conductor of uniform cross-section charge q is flowing for time t. Let s be the specific charge of an electron. The momentum of all the free electrons per unit length of the conductor, due to their drift velocity only is**

1) $\frac{q}{ts}$ 2) $\left(\frac{q}{ts}\right)^2$ 3) $\sqrt{\frac{q}{ts}}$ 4) qts

3. **Potential difference of 100 V is applied to the ends of a copper wire one metre long. Find the ratio of average drift velocity and thermal velocity of electrons at $27^o C$. (Consider there is one conduction electron per atom. The density of copper is 9.0×10^3; Atomic mass of copper is 63.5 g. $N_A = 6.0\times10^{23}$ per gram-mole, conductivity of copper is $5.81\times10^7\,\Omega^{-1}$. K $= 1.38\times10^{-23}\,JK^{-1}$)**

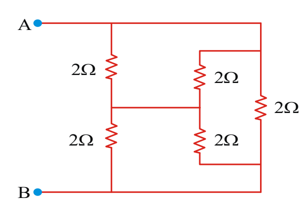
1) 3.67×10^{-6} 2) 4.3×10^{-6} 3) 6×10^{-5} 4) 5.6×10^{-6}

OHM'S LAW AND COMBINATION OF RESISTANCES

4. **The sides of rectangular block are 2cm, 3cm and 4cm. The ratio of the maximum to minimum resistance between its parallel faces is**

1) 3 2) 4 3) 2 4) 1

5. **Find the equivalent resistance across AB:**



1) 1Ω 2) 2Ω

3) 3Ω 4) 4Ω

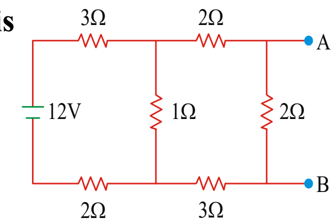
6. **Two wires of the same material have length 6cm and 10cm and radii 0.5 mm and 1.5 mm respectively. They are connected in series across a battery of 16V. The p.d. across the shorter wire is**

1) 5V 2) 13.5 V 3) 27 V 4) 10 V

7. **Three ammeters P,Q and R with internal resistances r, 1.5r ,3r respectively . Q and R parallel and this combination is in series with P , The whole combination concted between X and Y . When the battery connected between X and Y , the ratio of the readings of P,Q and R is**

1) 2:1:1 2) 3:2:1 3) 3:1:2 4) 1:1:1

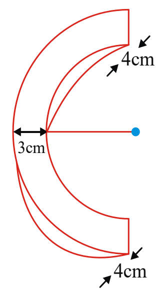
8. **The potential difference between the points A and B is**



1) 1.50 V 2) 2.50 V

3) 1.00 V 4) 0.50 V

9. **The resistance of a semicircle shown in fig. between its two end faces is (Given that radial thickness = 3 cm, axial thickness = 4 cm, inner radius = 6 cm and resistivity =** $4\times10^{-6}\Omega cm$**)**



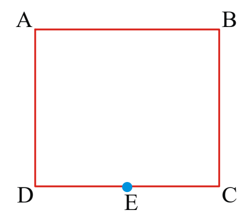
1) $24.15\times10^{-6}\Omega$

2) $7.85\times10^{-7}\Omega$

3) $7.85\times10^{-6}\Omega$

4) $7.85\times10^{-5}\Omega$

10. **ABCD is a square where each side is a uniform wire of resistance** 1Ω**. A point E lies on CD such that if a uniform wire of resistance** 1Ω **is connected across AE and constant potential difference is applied across A and C, then B and E are equipotential .**



1) $\frac{CE}{ED}=1$ 2) $\frac{CE}{ED}=\frac{1}{\sqrt{2}}$

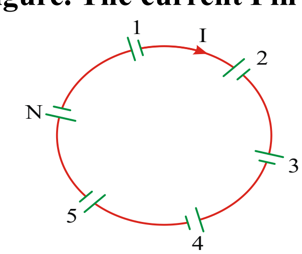
3) $\frac{CE}{ED}=\frac{1}{2}$ 4) $\frac{CE}{ED}=\sqrt{2}$

11. **A heating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds to a steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is** $27.0^{o}C$**? Temperature coefficient of resistance of nichrome averaged over the temperature range involved is** $1.70\times10^{-4}C^{-1}$**?**

1) $680^{0}C$ 2) $867^{0}C$ 3) $920^{0}C$ 4) $750^{0}C$

CELLS, KIRCHOFF'S LAW 'S , WHEAT STONE BRIDGE

12. **A group of N cells where e.m.f. varies directly with the internal resistance as per the equation** $E_N = 1.5\ r_N$ **are connected as shown in the figure. The current I in the circuit is:**



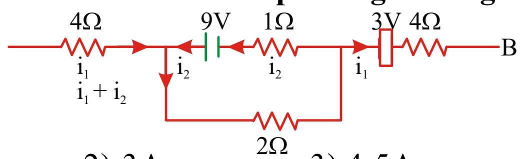
1) 0.51 A 2) 5.1 A

3) 0.15 A 4) 1.5 A

13. **Cell A has emf 2*E* and internal resistance 4*r*. Cell B has emf *E* and internal resistance *r*. The negative of A is connected to the positive of B and a load resistance of *R* is connected across the battery formed. If the terminal potential difference across A is zero, then *R* is equal to**

1) $3r$ 2) $2r$ 3) r 4) $5r$

14. For the circuit shown in the figure, potential difference between points A and B is 16V. Find the current passing through 2Ω

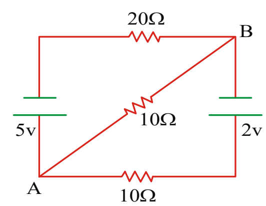


1) 3.5A 2) 3A 3) 4.5A 4) 5.5A

15. The minimum number of cells in mixed grouping required to produce a maximum current of 1.5 A through an external resistance of 30Ω, given the emf of each cell is 1.5 V and internal resistance is 1Ω is

1) 30 2) 120 3) 40 4) 60

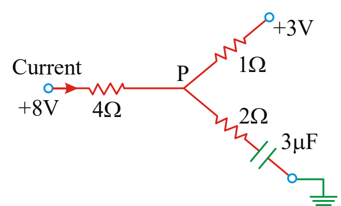
16. The p.d between the terminals A & B is



1) 2V 2) 3V

3) 3.6 V 4) 1.8 V

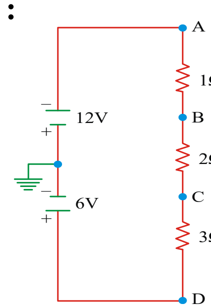
17. The energy stored in the capcitor is



1) $12\mu J$ 2) $24\mu J$

3) $36\mu J$ 4) $48\mu J$

18. In the circuit shown in figure, the potentials of B,C and D are :



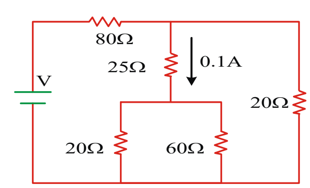
1) $V_B = 6V; V_C = 9V; V_D = 11V$

2) $V_B = 11V; V_C = 9V; V_D = 6V$

3) $V_B = 9V; V_C = 11V; V_D = 6V$

4) $V_B = 9V; V_C = 6V; V_D = 11V$

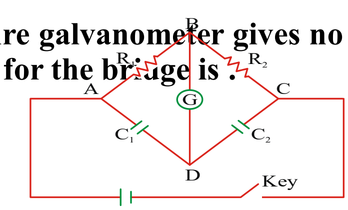
19. A current of 0.10 A flows through the 25Ω resistor represented in the diagram to the right. The current through the 80Ω resistor is:



1) 0.10 A 2) 0.20 A

3) 0.30 A 4) 0.40 A

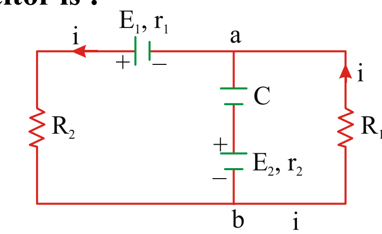
20. In Wheat stone's bridge shown in the adjoining figure galvanometer gives no deflection on pressing the key, the balance condition for the bridge is :



1) $\frac{R_1}{R_2}=\frac{C_1}{C_2}$ 2) $\frac{R_1}{R_2}=\frac{C_2}{C_1}$

3) $\frac{R_1}{R_1+R_2}=\frac{C_1}{C_1-C_2}$ 4) $\frac{R_1}{R_1-R_2}=\frac{C_1}{C_1+C_2}$

21. In the steady state, the energy stored in the capacitor is :

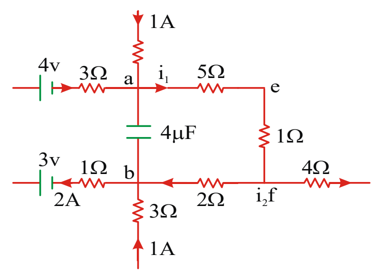


1) $\frac{1}{2}C(E_1+E_2)^2$

2) $\frac{1}{2}C(E_1-E_2)^2$

3) $\frac{1}{2}C\left(\frac{E_1R_1+E_1R_2}{r_1+r_2+R_1+R_2}\right)^2$ 4) $\frac{1}{2}C\left(E_2+\frac{E_1R_1}{r_1+R_1+R_2}\right)^2$

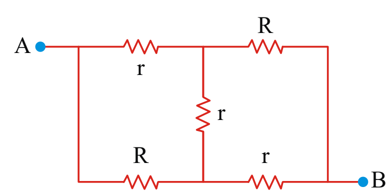
22. A part of circuit in steady state along with the currents flowing in the branches, the value of resistances is shown in figure. Calculate the energy stored in the capacitor.



1) $8\times10^{-1}J$ 2) $8\times10^{-2}J$

3) $8\times10^{-3}J$ 4) $8\times10^{-4}J$

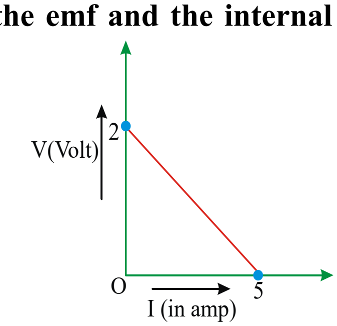
23. Equivalent resistance across A and B in the given circuit if r = 10 Ω, R = 20 Ω is



1) 7 Ω 2) 14 Ω

3) 35 Ω 4) 20/3 Ω

24. For a cell, the graph between the p.d.(V) across the terminals of the cell and the current I drawn from the cell is shown in the fig. the emf and the internal resistance of the cell is E and r repectively.



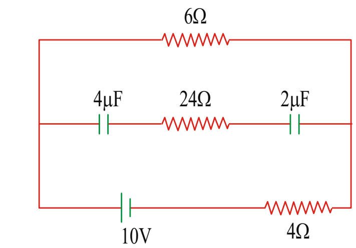
1) E = 2V, r = 0.5Ω

2) E = 2V, r = 0.4Ω

3) E > 2V, r = 0.5Ω

4) E > 2V, r = 0.4Ω

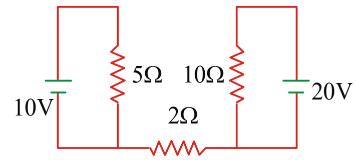
25. The charge developed on 4 μ F condenser is



1) 18 μ C   2) 4 μ C

3) 8 μ C   4) Zero

26. Find out the value of current through 2Ω resistance for the given circuit.



1) 0   2) 1.6 A

3) 2.4 A   4)3A

ELECTRIC POWER, JOULE'S LAW

27. Same mass of copper is drawn into 2 wires of 1mm thick and 3mm thick. Two wires are connected in series and current is passed. Heat produced in the wires is the ratio of

1) 3 : 1   2) 9 : 1   3) 81 : 1   4) 1 : 81

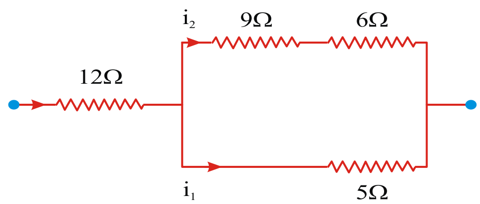
28. Masses of three are in the ratio 1:3:5. Their lengths are in the ratio 5:3:1. When they are connected in series to an external source, the amounts of heats produced in them are in the ratio

1) 125 : 15 : 1   2) 1 : 15 : 125   3) 5 : 3 : 1   4) 1 : 3 : 5

29. A heater coil rated at 1000W is connected to a 110V mains. How much time will take to melt 625 gm of ice at 0^0C. (for ice L = 80 cal/gm)

1) 100s   2) 150s   3) 200s   4) 210s

30. In the following circuit, 5Ω resistor develops 45 J/s due to current flowing through it. The power developed across 12Ω resistor is



1) 16 W   2) 192 W   3) 36 W   4) 64 W

31. Two wires 'A' and 'B' of the same material have their lengths in the ratio 1 : 2 and radii in the ratio 2 : 1. The two wires are connected in parallel across a battery. The ratio of the heat produced in 'A' to the heat produced in 'B' for the same time is

1) 1 : 2   2) 2 : 1   3) 1 : 8   4) 8 : 1

32. An electric motor operating on 50 volt D.C. supply draws a current of 10 amp. If the efficiency of motor is 40%, then the resistance of the winding of the motor is

1) 1.5Ω 2) 3Ω 3) 4.5Ω 4) 6Ω

33. The resistance of a 240 V – 200 W electric bulb when hot is 10 times the resistance when cold. The resistance at room temperature and the temperature coefficient of the filament are (given working temperature of the filament is $2000\,°C$)

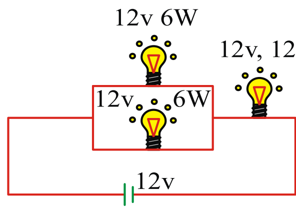
1) $28.8\Omega, 4.5\times10^{-3}/°C$ 2) $14.4\Omega, 4.5\times10^{-3}/°C$

3) $28.8\Omega, 3.5\times10^{-3}/°C$ 4) $14.4\Omega, 3.5\times10^{-3}/°C$

34. A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raisied by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross-section but the length 2L The temperature of the wire is raised by the same amount ΔT in the same time t. The value of N is :

1) 3 2) 2 3) 6 4) 4

35. Three bulbs with their power and working voltage are connected as shown in the circuit diagram to a 12 V battery. The total power consumed by the bulbs is (ignore the internal resistance of the battery shown)



1) 24 W 2) 12 W 3) 6 W 4) 15 W

36. A cell of emf 12 V and internal resistance $6\,\Omega$ is connected in parallel with another cell of emf 6 V and internal resistance $3\,\Omega$, such that the positive of the first cell joins the positive of the second cell and similarly the negative of first cell joins the negative of
the second cell. A bulb of filament resistance
$14\,\Omega$ is connected across the combination. The power delivered to be bulb is

1) 4.0 W 2) 3.5 W 3) 8.5 W 4) 2.5 W

37. A cell develops the same power across two resistances $R_1 \& R_2$ separately. The internal resistance of the cell is

1) $\sqrt{R_1R_2}$ 2) $\sqrt{2R_1R_2}$ 3) R_1+R_2 4) R_1-R_2

METRE BRIDGE

38. A metallic conductor at $10^{\circ}C$ connected in the left gap of meter bridge gives balancing length 40 cm. When the conductor is at $60^{\circ}C$, the balancing point shifts by---cm, (temperature coefficeint of resistance of the material of the wire is $(1/220)/^{0}C$)

1) 4.8 2) 10 3) 15 4) 7

39. When a conducting wire is connected in the right gap and known resistance in the left gap, the balancing length is 60cm. The balancing length becoms 42.4 cm when the wire is stretched so that its length increases by

1) 10% 2) 20% 3) 25% 4) 42.7%

40. '*n*' identical resistors are taken. '*n*/2' resistors are connected in series and the remaining are connected in parallel. The series connected group is kept in the

left gap
of a meter bridge and the parallel connected group in the right gap. The distance of the balance point from the left end of the wire is

1) $\frac{100n^2}{n^2+4}$ 2) $\frac{100n^2}{n^2+1}$ 3) $\frac{400}{n^2+4}$ 4) $\frac{400}{n^2+1}$

41. **In a metere bridge, the balance length from left end (standard resistance of 1Ω is in the right gap) is found to be 20 cm, the length of resistance wire in left gap is $\frac{1}{2}m$ and radius is 2mm its specific resistance is**

1) $\pi \times 10^{-6} ohm-m$ 2) $2\pi \times 10^{-6} ohm-m$

3) $\frac{\pi}{2} \times 10^{-6} ohm-m$ 4) $3\pi \times 10^{-6} ohm-m$

POTENTIO METER

42. **In an experiment with potentiometer to mea- sure the internal resistance of a cell, when the cell is shunted by 5Ω, the null point is obtained at 2m. When cell is shunted by 20Ω the null point is obtained at 3m. The internal resistance of cell is**

1) 2Ω 2) 4Ω 3) 6Ω 4) 8Ω

43. **A potentiometer wire of length 100cm has a resistance 5Ω. It is connected in series with a resistance and a cell of emf 2v and of negligible internal resistance. A source of emf 5mv balanced by 10 cm length of potentiometer wire. The value of external reistance is _____**

1) 540Ω 2) 195Ω 3) 190Ω 4) 990Ω

44. **1Ω resistance is in series with an Ammeter which is balanced by 75 cm of potentiometer wire. A standard cell of 1.02V is balanced by 50 cm. The Ammeter shows a reading of 1.5A. The error in the Ammeter reading is**

1) 0.002A 2) 0.03A 3) 1.01A 4) no error

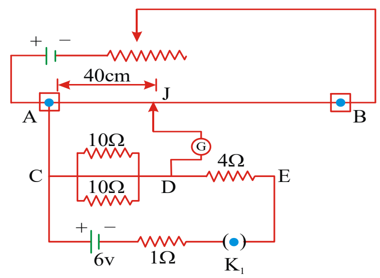
45. **An ideal battery of emf 2V and a series resistance R are connected in the primary circuit of a potentio meter of length 1m and resistance 5Ω. The value of R to give a potential difference of 5mV across the 10cm of potentiometer wire is**

1) 180Ω 2) 190Ω 3) 195Ω 4) 200Ω

46. **In an experiment for calibration of voltmeter, a standard cell of emf 1.5V is balanced at 300cm length of potentiometer wire. The P.D.across a resistance in the circuit is balanced at 1.25m. If a voltmeter is connected across the same resistance, it reads 0.65V. The error in the volt meter is**

1) 0.05V 2) 0.025V 3) 0.5V 4) 0.25V

47. **In the circuit shown in fig., the potential difference between the points C and D is balanced against 40 cm length of poten-tiometer wire of total length 100 cm. In order to balance the potential difference between the points D and E. The jockey to be pressed on potentiometer wire at a distance of**



1) 16 cm 2) 32 cm 3) 56 cm 4) 80 cm

EXERCISE -III KEY

1) 4	2) 1	3) 1	4) 2	5) 1	6) 2	7) 2	8) 4	9) 3	10) 4	11) 2
12) 2	13) 4	14) 3	15)2	16) 2	17) 2	18) 4	19) 2	20)3	21) 3	22) 2
23) 4	24) 2	25) 2	26) 3	27) 1	28) 3	29)1	30) 4	31) 2	32)4	33) 2
34)1	35) 3	36) 3	37)2	38) 1	39) 1	40) 4	41) 1	42) 2	43)2	44) 2
45) 2	46) 3	47) 2								

EXERCISE - IV

Instructions for Assertion & Reason Type questions:

1) Both (A) and (R) are true and (R) is the correct explanation of A.

2) Both (A) and (R) are true but (R) is not the correct explanation of A.

3) (A) is true but (R) is false

4) (A) is false but (R) is true

1. **Assertion : Terminal voltage of a cell is greater than emf of cell, during charging of the cell.**

Reason : The emf of a cell is always greater than its terminal voltage.

2. **Assertion : In metrebridge experiment, a high resistance is connected in series with the galvanometer.**

Reason : As resistance increases, current through the circuit increases

3. **Assertion (A) : In a metrebridge ; copper wire is connected in the left gap and silicon is connected in the right gap, when the temp of both wires increase, balancing point shifts to right.**

Reason (R) : Temperature coeficient of copper is -Ve and that of silicon is +Ve.

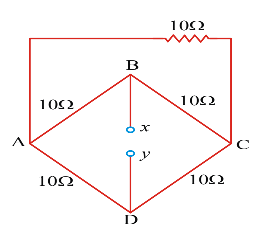
4. **Assertion (A) : If a current flows through a wire of non-uniform cross-section, potential difference per unit length of the wire in the direction of current is same at different points.**

Reason (R) : V = iR and current in the wire is same throughout.

5. **Assertion (A) : Voltmeter is much better than a potentiometer for measuring emf of cell.**

Reason (R) : A potentiometer draws no current while measuring emf of a cell.

6. **Assertion (A):The equivalent resistance between the points X and Y in the figure, is** 10Ω .



Reason (R) : According to wheatstone bridge points A and C have the same potential.

7. **Assertion : The drift velocity of electrons in a metallic wire will decrease, if the temperature of the wire is increased.**
Reason : On increasing temperature, conductivity of metallic wire decreases.

8. **Assertion (A) :The electric bulb glows immediately when switch is on.**
Reason (R) : The drift velocity of electrons in a metallic wire is very high.

9. **Assertion (A) : If the length of the conductor is doubled, the drift velocity will become half of the original value (keeping potential difference unchanged)**
Reason (R) : At constant potential difference, drift velocity is inversely proportional to the length of the conductor.

10. **Assertion (A): If the current of a lamp decreases by 20%, the percentage decrease in the illumination of the lamp is 40%**
Reason (R) : Illumination of the lamp is directly proportional to square of the current through lamp.

11. **Assertion (A) : However long a fuse wire may be, the safe current that can be allowed is the same.**
Reason (R): The safe current that can be allowed to pass through a fuse wire depends on the radius of the wire.

12. **Assertion (A) : The resistance of an ideal voltmeter should be infinite.**
Reason (R) : The potential difference measured by a voltmeter across a resistor is always less than the actual potential difference across the resistor.

13. **Assertion (A) : Current is passed through a metallic wire, heating it red. When cold water is poured on half of its portion, then rest of the half portion becomes more hot.**
Reason (R) : Resistance decreases due to decrease in temperature and then current through wire increases.

MATCHING TYPE QUESTIONS

14. **Match list - I with List - II**

List - I	List- II
a) Ohm's law	e) conservation of charge
b) Joule's La w	f) conservation of energy
c) Kirchhoff's I Law	g) $v = Ri$
d) Kirchhoff's II Law	h) $H = i^2Rt$

1) a - h, b - g, c - e, d - f 2) a - g, b - h, c - e, d - f
3) a - h, b - f, c - e, d - g 4) a - e, b - f, c - g, d - h

15. **Match list - I with List - II**

List - I	List - II
a) Potentimeter	e) For measuring current
b) Metrebridge	f)For measuring internal resistance
c) Ammeter	g)For measuring specific resistance of wire
d) Voltmeter	h) For measuring potential difference

1) a-f, b-g, c-e, d-h 2) a-g, b-e, c-f, d-h 3) a-h, b-e, c-f, d-g 4) a-h, b-f, c-e, d-g

16. Match list - I with List - II

List - I	**List - II**
a) Thermistor	**e) High** $+ve'\alpha'$
b) Carbon	**f)** α **almost zero**
c) Nichrome	**g) either positive or negative** $'\alpha'$
d) Constantan, and manganin	**h) Negative** $'\alpha'$

1) a-g, b-h, c-e, d-f 2) a-h, b-g, c-e, d-f 3) a-e, b-f, c-g, d-h 4) a-e, b-g, c-h, d-f

17. Match list - I with List - II

List - I	**List - II**
a) Resistivity	**e) Volt**
b) Conductivity	**f) Siemen**
c) emf	**g) ohm - metre**
d) conductance	**h)** $mho - metre^{-1}$

1) a-e, b-f, c-g, d-h 2) a-f, b-e, c-g, d-h 3) a-g, b-h, c-e, d-f 4) a-h, b-g, c-e, d-f

18. Three wires of same material are connected in parallel to a source of emf. The length ratio of the wires is 1 : 2 : 3 and the ratio of their area of cross section is 2 : 4 : 1.

Table – 1	**Table - 2**
(a) Resistance ratio	**(p) 6 : 6 : 1**
(b) Current ratio	**(q) 1 : 6 : 6**
(c) Power ratio	**(r) 1 : 1 : 6**
	(s) None

1) a-r,b-q,c-p 2) a-p,b-q,c-r 3) a - r; b - p, c - p 4) a-q,b-p,c-r

19. In the figure shown, each resistance is R.

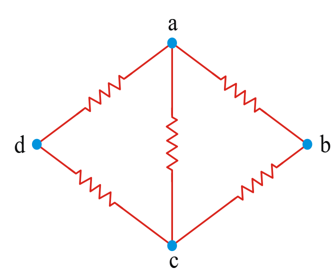


Table – 1	**Table - 2**
(a) Resistance between a and b	**(p)** $\frac{R}{2}$
(b) Resistance between a and c	**(q)** $\frac{5}{8}R$
(c) Resistance between b and d	**(r) R**
	(s) None

1) a-q,b-p,c-r 2) a - r; b - p; c - p 3) a-p,b-q,c-s 4) a-s,b-r,c-p

20. Six batteries of increasing emf and increasing internal resistance are as shown in figure.

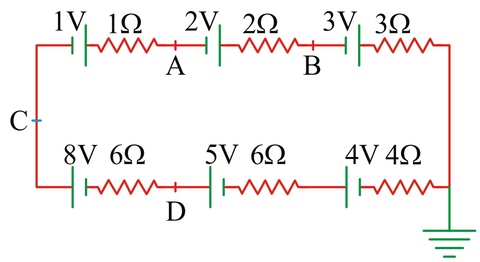


Table – 1	**Table - 2**
(a) Potential of point A	**(p) Zero**
(b) Potential of point B	**(q) 2 V**
(c) Potential of point C	**(r) 4 V**
(d) Potential of point D	**(s) 6 V**
	(t) none

1) a - p; b - p; c - p,d-p 2) a-p,b-s,c-q
3) a-q,b-q,c-s 4) a-r,b-r,c-p

21. In the potentiometer arrangement shown in figure, null point is obtained at length l.

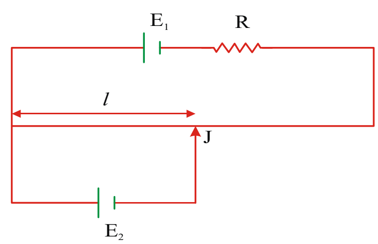


Table – 1	**Table - 2**
(a) If E_1 is increased	**(p) l should increase**
(b) If R is increased	**(q) l should decrease**
(c) If E_2 is increased	**(r) l should remain the same to again get the null point**

1) a-q,b-q,c-p 2) a-r,b-r,c-q 3) a-p,b-p,c-r 4) a - q; b - p; c - p

22. In the circuit shown in figure, if a resistance R is connected in parallel with R_2

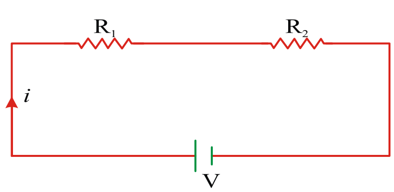


Table – 1	**Table - 2**
(a) Main current i	**(p) will increase**
(b) Power across R_1	**(q) will decrease**
(c) Power across R_2	**(r) will remain same**

1) a-p,b-p,c-p 2) a-q,b-q,c-q 3) a - p, b - p, c - q 4) a-r,b-r,c-r

CURRENT ELECTRICITY

23. **In the circuit shown,**

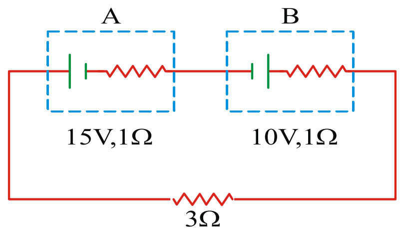


Table – 1	**Table - 2**
(a) Potential difference across battery A	**(p) A**
(b) Potential difference across battery B	**(q) B**
(c) Power is supplied by battery	**(r) 14 V**
(d) Power is consumed by battery	**(s) 9 V**
	(t) 11V

1) a-p; b-p;c-q;d-r 2) a-q;b-q;c-r;d-s 3) a-r, b-t, c-p, d-q 4) a-r;b-r;c-s;d-t

24. **Current is flowing through a wire of non-uniform cross section. Cross section of wire A is less than the cross section of wire at B.**

Table – 1	**Table - 2**
(a) current at A	**(p) is zero**
(b) drift velocity of electrons at A	**(q) is more than at B**
(c) electric field in the wire at A	**(r) is less than at B**
(d) current density at A	**(s) is equal to that at B**

1) a-p;b-q;c-q;d-p 2) a-s, b-q, c-q, d-q 3) a-q;b-r;c-p;d-q 4) a-r;b-s;c-r;c-s

25. **In the circuit shown in figure,**

$R_1 = R_2 = R_3 = R$.

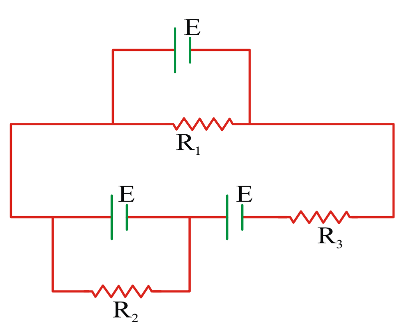


Table – 1	**Table - 2**
(a) current through R_1	**(p) E/R**
(b) current through R_2	**(q) 2E/R**
(c) current through R_3	**(r) E/2R**
	(s) Zero

1) a-p, b-p, c-p 2) a-p;b-q;c-s 3) a-q;b-r;c-r 4) a-r;b-s;c-p

26. **Matrix Matching**

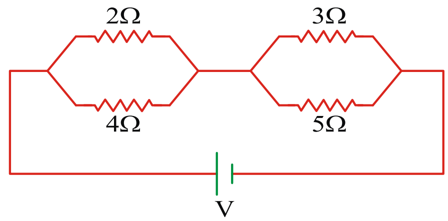


Table – 1	**Table - 2**
(a) Minimum current will flow through	**(p)** 2Ω
(b) Maximum current will flow through	**(q)** 4Ω
(c) Maximum power will be generated across	**(r)** 3Ω
(d) Minimum power will be generated across	**(s)** 5Ω

1) a-p;b-p;c-q;d-r
2) a-r;b-r;c-p;d-s
3) a - q, b - p, c - r, d - q
4) a-s;b-s;c-r;d-q

27. **Statement (A) : Thermistor can have only negative temperature coefficeints of resistances.**

Statement (B) : Thermistors with negative temperature coefficients of resistance are used as resistance thermometers, to measure low temperatures of the order of 10 K.

1) both A and B are true
2) both A and B are false
3) A is true and B is false
4) A is false, but B is true

28. **Statement (A) : Resistivity of insulators is about 10^{22} times the resistivity of metallic conductors.**

Statment (B) : Metals like silver, copper and aluminium have very high values of resistivity.

1) A and B are true
2) A and B are false
3) A is true, B is false
4) A is false, B is true

29. **Statement (A) : Series combination of cells is preferred when external resistance is large compared to internal resistance of cell.**

Statement (B) : Parallel combination of cells is preferred when external resistance is small compared to the internal resistance of each cell.

1) A and B are true
2) A and B are false
3) A is true, B is false
4) A is false, B is true

30. **Statement (A) : The difference between a new torch light cell and an old one is due to increase in internal resistance.**

Statement(B) : At 0 kelvin specific resistance of prefect insulator is infinity.

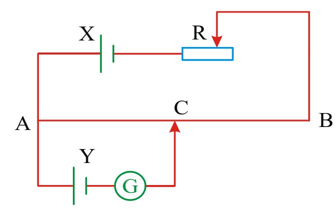
1) Both A and B are true
2) A is true, B is false
3) A is false, B is true
4) Both A and B are false

31. **Statement-1: The temperature dependence of resistance is usually given as $R = R_0(1+\alpha\Delta t)$. The resistance of a wire changes from $100\,\Omega$ to $150\,\Omega$ when its temperature is increased from 27°C to 227°C. This implies that** $\alpha = 2.5\times10^{-3}\,/^0 C$

Statement 2 : - $R = R_0(1+\alpha\Delta t)$ **is valid only when the change in the temperature** ΔT **is small and** $\Delta R = (R - R_0) << R_0$

1) Statement -1 is true, statement -2 is true, Statement-2 is the correct explanation of statement -1.
2) Statement -1 is true, statement -2 is true,statement -2 is not the correct explanation of statement -1
3) Statement - 1 is false, Statement - 2 is true
4) Statement - 1 is true, Statement - 2 is false

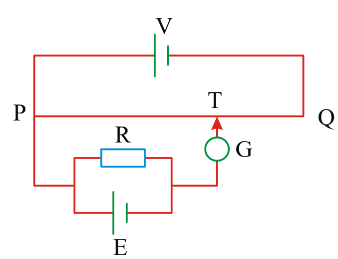
32. In the above circuit, *C* denotes the balance position on the potentiometer wire *AB*. Which of the following procedures can shift *C* towards the end *B*?



a) replacing the driving cell *X* by one with a smaller EMF
b) adding a resistance in series with the galvanometer *G*
c) increasing the resistance of the rheostat *R*

1) a, b and c 2) a and b only 3) b and c only 4) a and (c) only

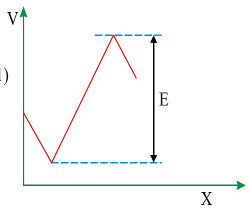
33. The potentiometer circuit shown is used to find the internal resistance of the cell *E*. At balance, the galvanometer pointer does not deflect, and NO current flows through

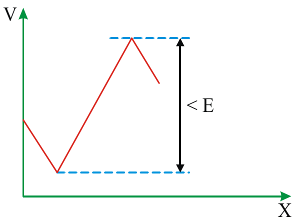


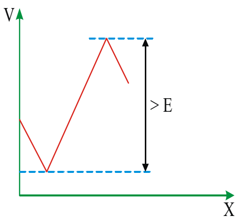
A) the potentiometer wire PQ
B) the resistor R
C) the galvanometer G

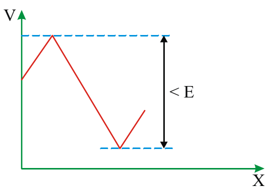
1) A, B and C 2) A and B only 3) B and C only 4) C only

34. The two ends of a uniform conductor are joined to a cell of emf E and some internal resistance. Starting from the mid point P of the conductor, we move in the direction of
current and return to P. The potential V at every point on the path is plotted against the distance covered (x). One of the following best represent the resulting curve?

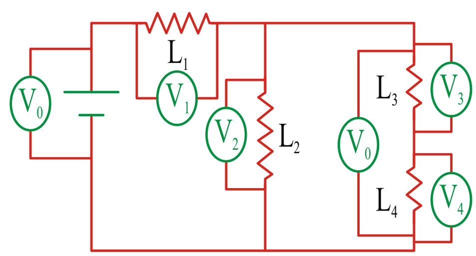
1) 

2) 

3) 

4) 

35. **In the circuit shown L1, L2, L3, and L4 are** identical light bulbs. There are six **voltmeters connected to the circuit as shown. Assume that the voltmeters are ideal. If L3 were to** burn out, opening the circuit, which **voltmeter(s) would read zero volts?**



1) none would read zero
2) only V3
3) only V4
4) only V3, V4, and V5

EXERCISE-IV KEY

1) 3	2) 3	3) 3	4) 4	5) 4	6) 1	7) 2	8) 3	9) 1	10) 4	11) 1
12) 2	13) 1	14) 2	15) 1	16) 1	17) 3	18) 3	19) 1	20) 1	21) 4	22) 3
23) 3	24) 2	25) 1	26) 3	27) 4	28) 3	29) 1	30) 1	31) 3	32) 4	33) 4
34) 2	35) 3									

EXERCISE - I

MAGNETIC MOMENT AND RESULTANT MAGNETIC MOMENT

1. The geometric length of a bar magnet is 24 cm. The length of the magnet is

1) 24cm 2) 28.8cm 3) 20cm 4) 30cm

2. The magnetic moment of a bar magnet is 3.6×10^{-3} A.m^2. Its pole strength is 120 milli amp. m. Its magnetic length is

1) 3cm 2) 0.3cm 3) 33.33cm 4) 3×10^{-2} cm

3. Two magnets have their lengths in the ratio 2 : 3 and their pole strengths in the ratio 3 : 4. The ratio of their magnetic moment is

1) 2 :1 2) 4 :1 3) 1 : 2 4) 1 : 4

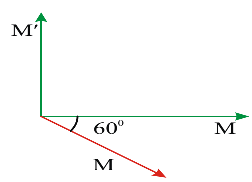
4. The length of a magnet is 16 cm. Its pole strength is 250 milli. amp. m. When it is cut into four equal pieces parallel to its axis, the magnetic length, pole strength and moments of each piece are: (respectively)

1) 4 cm; 62. 5 milli Am; 250 milli amp. cm^2
2) 8 cm ; 500 milli Am; 400 milli amp. cm^2
3) 16 cm; 250 milli Am; 4000 milli amp. cm^2
4) 16 cm; 62.5 milli Am; 0.01 A.m^2

5. A bar magnet of magnetic moment M_1 is axially cut into two equal parts. If these two pieces are arranged perpendicular to each other, the resultant magnetic moment is M_2. Then the value of $\frac{M_1}{M_2}$ is(2007M)

1) $\frac{1}{2\sqrt{2}}$ 2) 1 3) $\frac{1}{\sqrt{2}}$ 4) $\sqrt{2}$

6. The resultant magnetic moment for the following arrangement (non coplanar vectors)



1) M 2) 2M 3) 3M 4) 4M

7. Two magnets of moments 4Am^2 and 3Am^2 are joined to form a cross (+), then the magnetic moment of the combination is

1) 4Am^2 2) 1Am^2 3) 7Am^2 4) 5Am^2

8. A magnet of magnetic moment M and length 2l is bent at its mid-point such that the angle of bending is 60^0. The new magnetic moment is.

1) M 2) $\frac{M}{2}$ 3) 2M 4) $\frac{M}{\sqrt{2}}$

9. A bar magnet of magnetic moment M is bent in '⊔' shape such that all the parts are of equal lengths. Then new magnetic moment is

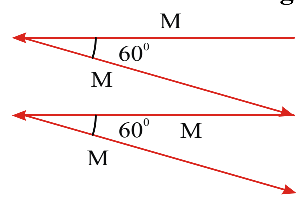
1) M/3 2) 2M 3) $\sqrt{3}M$ 4) $3\sqrt{3}M$

10. A thin bar magnet of length 'ℓ' and magnetic moment 'M' is bent at the mid point so that the two parts are at right angles. The new magnetic length and magnetic

moment are respectively

1) $\sqrt{2}\ell, \sqrt{2}M$ 2) $\frac{\ell}{\sqrt{2}}, \frac{M}{\sqrt{2}}$ 3) $\sqrt{2}\ell, \frac{M}{\sqrt{2}}$ 4) $\frac{\ell}{\sqrt{2}}, \sqrt{2}M$

11. The resultant magnetic moment for the following arrangement is



1) M 2) 2M 3) 3M 4) 4M

12. Three magnets of same length but moments M,2M and 3M are arranged in the form of an equilateral triangle with opposite poles nearer, the resultant magnetic moment of the arrangement is

1) 6M 2) zero 3) $\sqrt{3}M$ 4) $\frac{\sqrt{3}}{2}M$

13. A bar magnet of moment M is cut into two identical pieces along the length. One piece is bent in the form of a semi circle. If two pieces are perpendicular to each other, then resultant magnetic moment is

1) $\left(\frac{M}{\pi}\right)^2 + \left(\frac{M}{2}\right)^2$ 2) $\sqrt{\left(\frac{M}{\pi}\right)^2 + \left(\frac{M}{2}\right)^2}$ 3) $\sqrt{\left(\frac{M}{\pi}\right)^2 - \left(\frac{M}{2}\right)^2}$ 4) $\frac{M}{\pi} + \frac{M}{2}$

MAGNETIC FIELD

14. A magnetic pole of pole strength 9.2 A m. is placed in a field of induction 50×10^{-6} tesla. The force experienced by the pole is

1) 46N 2) 46×10^{-4}N 3) 4.6×10^{-4}N 4) 460N

15. The magnetic induction at distance of 0.1 m from a strong magnetic pole of strength 1200 Am is

1) 12×10^{-3} T 2) 12×10^{-4} T 3) 1.2×10^{-3} T 4) 24×10^{-3} T

16. If area vector $\overline{A} = 3\overline{i} + 2\overline{j} + 5\overline{k}\ m^2$ flux density vector $\overline{B} = 5\overline{i} + 10\overline{j} + 6\overline{k}\,(web/m^2)$. The magnetic flux linked with the coil is

1) 31Wb 2) 9000Wb 3) 65Wb 4) 100Wb

17. P and Q are two unlike magnetic poles. Induction due to 'P' at the location of 'Q' is B, and induction due to 'Q' at the location of P is B/2. The ratio of pole strengths of P and Q is

1) 1 : 1 2) 1 : 2 3) 2 : 1 4) $1:\sqrt{2}$

18. Two north poles each of pole strength m and a south pole of pole strength m are placed at the three corners of an equilateral triangle of side a. The intensity of magnetic induction field strength at the centre of the triangle is

1) $\frac{\mu_0}{4\pi}\frac{m}{a^2}$ 2) $\frac{\mu_0}{4\pi}\frac{6m}{a^2}$ 3) $\frac{\mu_0}{4\pi}\frac{9m}{a^2}$ 4) $\frac{\mu_0}{4\pi}\frac{m}{2a^2}$

19. The pole strength of a horse shoe magnet is 90 Am and distance between the poles is 6 cm. The magnetic induction at mid point of the line joining the poles is,

1) $10^{-2}\,\boldsymbol{T}$ 2) Zero 3) $2\times10^{-2}\,\boldsymbol{T}$ 4) $10^{-4}\,\boldsymbol{T}$

20. The force acting on each pole of a magnet when placed in a uniform magnetic field of 7 A/m is 4.2×10^{-4} N. If the distance between the poles is 10 cm, the moment of the magnet is

1) $\frac{15}{\pi}$ 2) $\frac{\pi}{15}$ Am^2 3) 7.5 x 10^{-12} Am^2 4) 6x10^{-6} Am^2

21. An iron specimen has relative permeability of 600 when placed in uniform magnetic field of intensity 110 amp /m. Then the magnetic flux density inside is....... tesla.

1) 18.29 x 10^{-3} 2) 8.29 x 10^{-2} 3) 66 x 10^3 4) 7.536 x 10^{-4}

COUPLE ACTING ON THE BAR MAGNET

22. A magnetic needle of pole strength 'm' is pivoted at its centre. Its N-pole is pulled eastward by a string. Then the horizontal force required to produce a deflection of θ from magnetic meridian (B_H horizontal componet of earths magnetic field)

1) $mB\cos\theta$ 2) $mB\sin\theta$ 3) $2mB\tan\theta$ 4) $mB\cot\theta$

23. Two identical bar magnets are joined to form a cross. If this combination is suspended freely in a uniform field the angles made by the magnets with field direction are respectively

1) 60°, 30° 2) 37°, 53° 3) 45°, 45° 4) 20°, 70°

24. A bar magnet of length 16 cm has a pole strength of 500 milli amp.m. The angle at which it should be placed to the direction of external magnetic field of induction 2.5 gauss so that it may experience a torque of $\sqrt{3}$ x10^{-5} Nm is

1) π 2) $\pi/2$ 3) $\pi/3$ 4) $\pi/6$

25. A bar magnet is at right angles to a uniform magnetic field. The couple acting on the magnet is to be one fourth by rotating it from the position. The angle of rotation is

1) $Sin^{-1}(0.25)$ 2) $90^0 - Sin^{-1}(0.25)$ 3) $Cos^{-1}(0.25)$ 4) $90^0 - Cos^{-1}(0.25)$

26. A bar magnet of moment $\overline{M} = \hat{i} + \hat{j}$ is placed in a magnetic field induction $\vec{B} = 3\hat{i} + 4\hat{j} + 4\hat{k}$. The torque acting on the magnet is

1) $4\hat{i} - 4\hat{j} + \hat{k}$ 2) $\hat{i} + \hat{k}$ 3) $\hat{i} - \hat{j}$ 4) $\hat{i} + \hat{j} + \hat{k}$

27. A bar magnet of magnetic moment 1.5 J/T is aligned with the direction of a uniform magnetic field of 0.22 T. The work done in turning the magnet so as to align its magnetic moment opposite to the field and the torque acting on it in this position are respectively.

1) 0.33J, 0.33N-m 2) 0.66J, 06.66N-m 3) 0.33J, 0 4) 0.66J, 0

28. The work done in turning a magnet of magnetic moment M by an angle of 90^0 from the meridian is n times the corresponding work done to turn it through an angle of 60^0, where n is given by

1) $\frac{1}{2}$ 2) 2 3) $\frac{1}{4}$ 4) 1

29. A bar magnet of moment $4Am^2$ is placed in a nonuniform magnetic field. If the field strength at poles are 0.2 T and 0.22 T then the maximum couple acting on it is

1) 0.04Nm 2) 0.84Nm 3) 0.4 Nm 4) 0.44Nm

30. A magnet of length 10 cm and pole strength 4x10^{-4} Am is placed in a magnetic field of induction 2x10^{-5} weber m^{-2}, such that the axis of the magnet makes an angle 30^0 with the lines of induction. The moment of the couple acting on the magnet is

1) 4x10^{-10} Nm 2) 8x10^{-10} Nm 3) 4x10^{-6} Nm 4) $\sqrt{3}$ x10^{-11} Nm

31. **A bar magnet of magnetic moment $2Am^2$ is free to rotate about a vertical axis passing through its center. The magnet is released from rest from east - west position. Then the KE of the magnet as it takes N-S position is $\left(B_H = 25\mu T\right)$**

1) $25\mu J$ 2) $50\mu J$ 3) $100\mu J$ 4) $12.5\mu J$

32. **A bar magnet of length 10cm and pole strength 2 Am makes an angle 60^0 with a uniform magnetic field of induction 50T. The couple acting on it is**

1) $5\sqrt{3}$Nm 2) $\sqrt{3}$Nm 3) $10\sqrt{3}$Nm 4) $20\sqrt{3}$Nm

FIELD OF A BAR MAGNET

33. **The magnetic induction field strength due to a short bar magnet at a distance 0.20 m on the equatorial line is 20×10^{-6} tesla. The magnetic moment of the bar magnet is**

1) 3.2Am^2 2) 6.4Am^2 3) 1.6Am^2 4) 16Am^2

34. **The magnetic induction field strength at a distance 0.3 m on the axial line of a short bar magnet of moment 3.6 Am^2 is**

1) 4.5×10^{-4} T 2) 9×10^{-4} T 3) 9×10^{-5} T 4) 2.6×10^{-5} T

35. **A magnet of length 10 cm and magnetic moment 1Am^2 is placed along the side of an equilateral triangle of the side AB of length 10 cm. The magnetic induction at third vertex C is**

1) 10^{-9} T 2) 10^{-7} T 3) 10^{-5} T 4) 10^{-4}T

36. **The length of a magnet of moment 5Am^2 is 14 cm. The magnetic induction at a point, equidistant from both the poles is 3.2×10^{-5} Wb/m^2. The distance of the point from either pole is**

1) 25 cm 2) 10 cm 3) 15 cm 4) 5 cm

37. **A pole of pole strength 80 Am is placed at a point at a distance 20cm on the equatorial line from the centre of a short magnet of magnetic moment 20Am^2. The force experienced by it is**

1) 8 x 10^{-2} N 2) 2 x 10^{-2} N 3) 16 x 10^{-2} N 4) 64 x 10^{-2} N

38. **A short bar magnet produces magnetic fields of equal induction at two points one on the axial line and the other on the equatorial line. The ratio of their distances is**

1) 2:1 2) $2^{1/2}$:1 3) $2^{1/3}$:1 4) $2^{1/4}$:1

SUPERPOSITION OF MAGNETIC FIELDS

39. **Two short bar magnets with magnetic moments 8Am^2 and 27Am^2 are placed 35cm apart along their common axial line with their like poles facing each other. The neutral point is**

1) midway between them 2) 21 cm from weaker magnet
3) 14 cm from weaker magnet 4) 27 cm from weaker magnet

40. **A short magnetic needle is pivoted in a uniform magnetic field of induction 1T. Now, simultaneoulsy another magnetic field of induction $\sqrt{3}T$ is applied at right angles to the first field; the needle deflects through an angle θ where its value is (EAM 2010)**

1) 30^0 2) 45^0 3) 90^0 4) 60^0

41. **Two magnetic poles of pole strengths 324 milli amp.m. and 400 milli amp m are kept at a distance of 10 cm in air. The null point will be at a distance of ...... cm, on the line joining the two poles, from the weak pole if they are like poles.**

1) 4.73 2) 5 3) 6.2 4) 5.27

TIME PERIOD OF SUSPENDED MAGNET IN THE UNIFORM MAGNETIC FIELD

42. **With a standard rectangular bar magnet, the time period in the uniform magnetic field is 4 sec. The bar magnet is cut parallel to its length into 4 equal pieces. The time period in the uniform magnetic field when the piece is used (in sec) (bar magnet breadth is small)**

1) 16 2) 8 3) 4 4) 2

43. **A bar magnet of moment of inertia $1\times10^{-2}kgm^2$ vibrates in a magnetic field of induction 0.36×10^{-4} tesla. The time period of vibration is 10 s. Then the magnetic moment of the bar magnet is (Am^2)**

1) 120 2) 111 3) 140 4) 160

44. **Two bar magnets are placed together suspended in the uniform magnetic field vibrates with a time period 3 second. If one magnet is reversed, the combination takes 4s for one vibration. The ratio of their magnetic moments is**

1) 3 : 1 2) 5 : 18 3) 18 : 5 4) 25 : 7

45. **A bar magnet of length 'l' breadth 'b' mass 'm' suspended horizontally in the earths magnetic field, oscillates with period T. If 'l', m, b are doubled with pole strength remaining the same, the new period will be**

1) 8T 2) 4T 3) T/2 4) 2T

46. **The time period of a suspended magnet is T_0. Its magnet is replaced by another magnet whose moment of inertia is 3 times and magnetic moment is 1/3 of that of the initial magnet. The time period now will be**

1) $3T_o$ 2) T_o 3) $\frac{T_o}{\sqrt{3}}$ 4) $\frac{T_o}{3}$

47. **A magnetic needle is kept in a uniform magnetic field of induction 0.5 x 10^{-4} tesla. It makes 30 oscillations per minute. If it is kept in a field of induction 2 x 10^{-4} tesla. Then its frequency is**

1) 1 oscillation/s 2) 60 oscillations/s
3) 15 oscillations/min 4) 15 oscillations/s

48. **A magnet is suspended horizontally in the earth's field. The period of oscillation in the place is T. If a piece of wood of the same moment of inertia as the magnet is attached to it, the new period of oscillation would be**

1) $\frac{T}{\sqrt{2}}$ 2) T/2 3) T/3 4) $\sqrt{2}T$

49. **A magnet freely suspended makes 30 vibrations per minute at one place and 20 vibrations per minute at another place. If the value of B_H at first place is 0.27 tesla. The value of B_H at other place is**

1) 0.12 T 2) 2.1 T 3) 5.4 T 4) 0.61 T

TYPES OF MAGNETIC MATERIALS

50. **A magnet has a dimensions of 25 cm x 10 cm x 5 cm and pole strength of 200 milli ampm The intensity of magnetisation due to it is**

1) 6.25A/m 2) 62.5A/m 3) 40A/m 4) 4A/m

51. **The mass of iron rod is 110g, its magnetic moment is 20 Am^2. The density of iron is $8g/cm^3$. The intensity of magnetization is nearly**

1) $2x10^5$ Am^{-1} 2) $2.26x10^6$ Am^{-1} 3) $1.6x10^6$ Am^{-1} 4) 1.4×10^6 Am^{-1}

52. **Relative permeability of iron is 5500, then its magnetic susceptibility will be:**

1) 5500×10^7 2) 5500×10^{-7} 3) 5501 4) 5499

53. **A specimen of iron is uniformly magnetised by a magnetising field of $500Am^{-1}$. If the magnetic induction in the specimen is 0.2 Wbm^{-2}. The susceptibility nearly is**

1) 317.5 2) 418.5 3) 217.5 4) 175

54. **The magnetic susceptibility of a rod is 499. The absolute permeability of vacuum is $4\pi\times10^{-7}H/m$. The absolute permeability of the material of the rod is**

1) $\pi\times10^{-4}H/m$ 2) $2\pi\times10^{-4}H/m$ 3) $3\pi\times10^{-4}H/m$ 4) $4\pi\times10^{-4}H/m$

EXERCISE- I KEY

1) 3	2) 1	3) 3	4) 4	5) 4	6) 2	7) 4	8) 2	9) 1	10)2	11) 2
12) 3	13) 2	14) 3	15)1	16) 3	17) 3	18) 2	19) 3	20) 1	21) 2	22) 3
23) 3	24) 3	25) 2	26) 1	27) 4	28) 2	29) 2	30) 1	31) 2	32) 1	33) 3
34) 4	35) 4	36) 1	37) 2	38) 3	39) 3	40) 4	41) 1	42) 3	43) 2	44) 4
45) 4	46) 1	47) 1	48) 4	49) 1	50) 3	51) 2	52) 4	53) 1	54) 2	

EXERCISE - II

Magnetic Moment and Resultant Magnetic Moment

1. **If a bar magnet of pole strength 'm' and magnetic moment 'M' is cut equally 4 times parallel to its axis and 3 times perpendicular to its axis then the pole strength and magnetic moment of each piece are respectively**

1) $\frac{m}{20},\frac{M}{20}$ 2) $\frac{m}{4},\frac{M}{20}$ 3) $\frac{m}{5},\frac{M}{20}$ 4) $\frac{m}{5},\frac{M}{4}$

2. **Three identical bar magnets each of magnetic moment M are arranged in the form of an equilateral triangle such that at two vertices like poles are in contact. The resultant magnetic moment will be**

1) Zero 2) 2M 3) $\sqrt{2}$ M 4) $M\sqrt{3}$

3. **If two identical bar magnets, each of length 'l', pole strength 'm' and magnetic moment 'M' are placed perpendicular to each other with their unlike poles in contact, the magnetic moment of the combination is**

1) $\frac{M}{\sqrt{2}}$ 2) $lm(\sqrt{2})$ 3) $2lm(\sqrt{2})$ 4) $2M$

4. **A magnetised wire of magnetic moment 'M' and length 'l' is bent in the form of a semicircle of radius 'r'. The new magnetic moment is**

1) $\frac{M}{\pi}$ 2) $\frac{2Mr}{l}$ 3) $\frac{M}{2\pi}$ 4) $\frac{M}{4\pi}$

5. **A long thin magnet of moment M is bent into a semi circle. The decrease in the Magnetic moment is**

1) $2M/\pi$ 2) $\pi M/2$ 3) $M(\pi-2)/\pi$ 4) $M(2-\pi)/2$

6. **A magnet of magnetic moment M is in the form of a quadrant of a circle. If it is**

straightened, its new magnetic moment will be

1) $\frac{M\pi}{\sqrt{2}}$ 2) $\frac{M}{\sqrt{2}}$ 3) $\frac{\sqrt{2}M}{\pi}$ 4) $\frac{M\pi}{2\sqrt{2}}$

7. **A bar magnet of moment 'M' is bent into a shape'**  **'. If the length of the each part is same, its new magnetic moment will be**

1) $\frac{M}{\sqrt{3}}$ 2) $\frac{M}{\sqrt{5}}$ 3) $\frac{M}{\sqrt{2}}$ 4) $\frac{2}{3}M$

8. **Four magnets of magnetic moments M, 2M, 3M and 4M are arranged in the form of a square such that unlike poles are in contact. Then the resultant magnetic moment is**

1) $2\sqrt{2}M$ 2) $\sqrt{2}M$ 3) 10M 4) 2M

COUPLE ACTING ON THE BAR MAGNET

9. **A torque of 2×10^{-4} Nm is required to hold a magnet at right angle to the magnetic meridian. The torque required to hold it at 30^0 to the magnetic meridian in N-m is**

1) 0.5×10^{-4} 2) 1×10^{-4} 3) 4×10^{-4} 4) 8×10^{-4}

10. **A bar magnet of 5 cm long having a pole strength of 20 A.m. is deflected through 30^0 from the magnetic meridian. If $H = \frac{320}{4\pi}$ A/m, the deflecting couple is**

1) 1.6×10^{-4} Nm 2) 3.2×10^{-5} Nm 3) 1.6×10^{-5} Nm 4) 1.6×10^{-2} Nm

11. **A short bar magnet placed with its axis at 30^0 with a uniform external magnetic field of 0.16 T experience a torque of magnitude 0.032 N m. If the bar magnet is free to rotate, its potential energies when it is in stable and unstable equilibrium are respectively**

1) -0.064J, +0.064J 2) -0.032J, +0.032J 3) +0.064J, -0.128J 4) 0.032J, -0.032J

12. **When a bar magnet is placed at 90^0 to uniform magnetic field, it is acted upon by a couple which is maximum. For the couple to be half of the maximum value, it is to be inclined to the magnetic field at an angle is**

1) 30^0 2) 45^0 3) 60^0 4) 90^0

13. **A magnet of moment $4Am^2$ is kept suspended in a magnetic field of induction $5\times10^{-5}T$. The workdone in rotating it through 180^0 is**

1) 4×10^{-4} J 2) 5×10^{-4} J 3) 2×10^{-4} J 4) 10^{-4} J

14. **The work done in rotating the magnet from the direction of uniform field to the opposite direction to the field is W. The work done in rotating the magnet from the field direction to half the maximum couple position is**

1) 2 W 2) $\frac{\sqrt{3}W}{2}$ 3) $\frac{W}{4}\left(2-\sqrt{3}\right)$ 4) $\frac{W}{2}\left(1-\sqrt{3}\right)$

15. **The work done in rotating a magnet of pole strength 1 A-m and length 1 cm through an angle of 60^0 from the magnetic meridian is (H=30 A/m)**

1) 9.42×10^{-8} J 2) 3.14×10^{-8} J 3) 18.84×10^{-8} J 4) 10×10^{-8} J

16. **The work done in turning a magnet normal to field direction from the direction of the field is 40×10^{-6} J. The kinetic energy attained by it when it reaches the field direction when released is**

1) Zero 2) 30×10^{-6}J 3) 10×10^{-6} J 4) 40×10^{-6} J

17. **A magnet is parallel to a uniform magnetic field. The work done in rotating the magnetic through 60^0 is $8x10^{-5}$ J. The work done in rotating through another 30^0 is**

1) 4 $x10^{-5}$J 2) 6 $x10^{-5}$J 3) 8 x 10^{-5}J 4) 2 x 10^{-5}J

FIELD OF A BAR MAGENT

18. **The magnetic induction field strength at a distance 0.2 m on the axial line of a short bar magnet of moment $3.6Am^2$ is**

1) $4.5\times10^{-4}T$ 2) $9\times10^{-4}T$ 3) $9\times10^{-5}T$ 4) $4.5\times10^{-5}T$

19. **A short bar magnet produces magnetic fields of equal induction at two points on the axial line and the other on the equatorial line. Then the ratio of the distance is**

1) $1:2^{1/3}$ 2) $1/2$ 3) $2^{1/3}:2$ 4) $2^{1/3}:1$

SUPERPOSITION OF MAGNETIC FIELDS

20. **A short bar magnet of magnetic moment 1.2Am^2 is placed in the magnetic meridian with its south pole pointing the north. If a neutral point is found at a distance of 20 cm from the centre of the magnet, the value of the horizontal component of the earth's magnetic field is**

1) 3×10^{-5}T 2) 3×10^{-4}T 3) 3×10^{3}T 4) 3×10^{-2}T

21. **A very long magnet of pole strength 4 Am is placed vertically with its one pole on the table.The distance from the pole, the neutral point will be formed is** $\left(B_H=4\times10^{-5}T\right)$

1) 0.5 m 2) 0.1 m 3) 0.15 m 4) 6.66 m

TIME PERIOD OF SUSPENDED MAGNET IN THE UNIFORM MAGNETIC FIELD

22. **A bar magnet of magnetic moment M and moment of inertial I is freely suspended such that the magnetic axis is in the direction of magnetic meridian. If the magnet is displaced by a very small angle (θ), the angular acceleration is (Magnetic induction of earth's horizontal field = B_H)**

1) $\frac{MB_H\theta}{I}$ 2) $\frac{IB_H\theta}{M}$ 3) $\frac{M\theta}{IB_H}$ 4) $\frac{I\theta}{MB_H}$

23. **If the moments of inertia of two bar magnets are same, and if their magnetic moments are in the ratio 4 : 9 and if their frequencies of oscillations are same, the ratio of the induction field strengths in which they are vibrating is**

1) 2 : 3 2) 3 : 2 3) 4 : 9 4) 9 : 4

24. **If the strength of the magnetic field is increased by 21% the frequency of a magnetic needle oscillating in that field.**

1) Increased by 10% 2) Decreases by 10%
3) Increases by 11% 4) Decreased by 21%

25. **A bar magnet has a magnetic moment equal to 5 x 10^{-5} weber x metre. It is suspended in a magnetic field which has a magnetic induction (B) equal to $8\pi\times10^{-4}$ tesla. The magnet vibrates with a period of vibration equal to 15**

seconds. The moment of inertia of the magnet is:

1) 9×10^{-13} kg m^2 2) 11.25 x 10^{-13} kg m^2

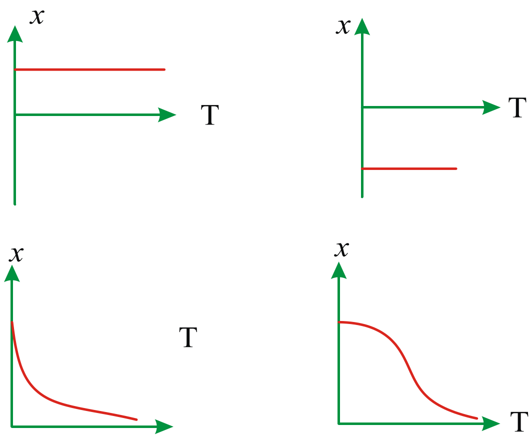
3) 5.62 x 10^{-13} kg m^2 4) 0.57 x 10^{-13} kg m^2

26. Two bar magnets are suspended and allowed to vibrate. They make 20 oscillations /minute when their similar poles are on the same side and they make 15 oscillations per minute with their opposite poles lie on the same side. The ratio of their moments

1) 9:5   2) 25:7   3) 16:9   4) 5:4

TYPES OF MAGNETIC MATERIALS

27. The variation of magnetic susceptibility (χ) with temperature for a diamagnetic substance is best represented by



28. The magnetic induction and the intensity of magnetic field inside an iron core of an electromagnet are 1 Wbm^{-2} and $150\,Am^{-1}$ respectively. The relative permeability of iron is : $(\mu_0 = 4\pi \times 10^{-7}\,Henry/m)$

1) $\frac{10^6}{4\pi}$ 2) $\frac{10^6}{6\pi}$ 3) $\frac{10^5}{4\pi}$ 4) $\frac{10^5}{6\pi}$

29. The mass of an iron rod is 80 gm and its magnetic moment is 10 Am^2. If the density of iron is $8gm/c.c.$ Then the value of intensity of magnetisation will be

1) $10^6\,A/m$ 2) $10^4\,A/m$ 3) $10^2\,A/m$ 4) $10\,A/m$

30. A rod of cross sectional area $10cm^2$ is placed with its length parallel to a magnetic field of intensity 1000 A/M the flux through the rod is 10^4webers. Then the permeability of material of rod is

1) $10^4\,wb/Am$ 2) $10^3\,wb/Am$ 3) $10^2\,wb/Am$ 4) $10\,wb/Am$

31. A bar magnet of magnetic moment $10\,Am^2$ has a cross sectional area of $2.5 \times 10^{-4}\,m^2$ .If the intensity of magnetisation of the magnet is $10^6\,A/m$, then the length of magnet is

1) 0.4m   2) 0.04cm   3) 0.04m   4) 40 cm

EXERCISE- II - KEY

1) 3	2) 2	3) 2	4) 2	5)3	6) 4	7) 2	8) 1	9) 2	10)3	11) 1
12) 1	13) 1	14) 3	15)3	16) 4	17) 3	18)3	19) 4	20) 1	21) 2	22) 1
23) 4	24) 1	25) 1	26) 2	27)2	28) 4	29) 1	30) 1	31) 3		

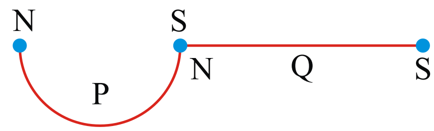
EXERCISE - III

MAGNETIC MOMENT AND RESULTANT MAGNETIC MOMENT

1. **A magnetised wire is bent into an arc of a circle subtending an angle 60^0 at its centre. Then its magnetic moment is X. If the same wire is bent into an arc of a circle subtending an angle 90^0 at its centre then its magnetic moment will be**

1) $\frac{x\sqrt{2}}{3}$ 2) $\frac{x}{3}$ 3) $\frac{(2\sqrt{2})x}{3}$ 4) $\frac{3x}{2\sqrt{2}}$

2. **A magnet of length 2L and moment 'M' is axially cut into two equal halves 'P' and 'Q'. The piece 'P' is bent in the form of semi circle and 'Q' is attached to it as shown. Its moment is**



1) $\frac{M}{\pi}$ 2) $\frac{M}{2\pi}$ 3) $\frac{M(2+\pi)}{2\pi}$ 4) $\frac{M\pi}{(2+\pi)}$

3. **A bar magnet of magnetic moment 'M' is bent in the form of an arc which makes angle 60^0. The percentage change in the magnetic moment is**

1) 9% Increase 2) 9% Decrease 3) 4.5% Decrease 4) 4.5% Increase

MAGNETIC FIELD

4. **At two corners A and B of an equilateral triangle ABC, a south and north pole each of strength 30Am are placed. If the side of the triangle is 1m. The magnetic induction at C is**

1) 3×10^{-6} T 2) 4×10^{-6} T 3) 8×10^{-6} T 4) 2×10^{-6} T

5. **A bar Magnet of Magnetic Moment 3.0 amp.m^2 is placed in a uniform Magnetic induction field 2×10^{-5} T. If each pole of the magnet experience a force of 6×10^{-4} N, the length of the magnet is**

1) 0.5 m 2) 0.3 m 3) 0.2 m 4) 0.1 m

6. **The magnetic induction at a distance 'd' from the magnetic pole of unknown strength 'm' is B. If an identical pole is now placed at a distance of 2d from the first pole, the force between the two poles is**

1) mB 2) $\frac{mB}{2}$ 3) $\frac{mB}{4}$ 4) 2mB

7. **Two identical north poles each of strength m are kept at vertices A and B of an equilateral triangle ABC of side a. The mutual force of repulsion between them has a magnitude of F. The magnitude of magnetic induction at C is**

1) F/m 2) $F/\sqrt{3}m$ 3) F/3m 4) $\sqrt{3}F/m$

COUPLE ACTING ON THE BAR MAGNET

8. Two magnets of magnetic moments M and $\sqrt{3}M$ are joined to form a cross +. The combination is suspended freely in a uniform magnetic field. In the equilibrium position, the angle between the magnetic moment $\sqrt{3}$ M and the field is

1) 30° 2) 45° 3) 60° 4) 90°

9. The rate of change of torque 'τ' with deflection θ is maximum for a magnet suspended freely in a uniform magnetic field of induction B when θ is equal to

1) 0° 2) 45° 3) 60° 4) 90°

10. The couple acting on a bar magnet of pole strength 2 Am when kept in a magnetic field of intensity 10 A/m, such that axis of the magnet makes an angle 30^0 with the direction of the field is $80\times10^{-7}\,Nm$. The distance between the poles of the magnet is

1) $\frac{2}{\pi}$m 2) $\frac{\pi}{2}$m 3) 63.36m 4) $\frac{1}{2\pi}$m

11. A bar magnet with poles 25cm apart and pole strength 14.4 Am rests with its center on a frictionless pivot. If it is held in equilibrium at 60^0 to a uniform magnetic field on induction 0.25 T by applying a force F at right angles to its axis 10cm from the pivot, the value of F in newton is (nearly)

1) 3.9N 2) 7.8N 3) 15.6N 4) 31.2N

12. A bar magnet of magnetic moment M_1 is suspended by a wire in a magnetic field. The top of the wire is twisted through 180^0, then the magnet is rotated through 45^0. Under similar conditions another magnet of magnetic moment M_2 is rotated through 30^0, the ratio M_1:M_2 is

1) $9:10\sqrt{2}$ 2) $1:\sqrt{2}$ 3) $1:1$ 4) 1:3

13. Two magnets of moments M_1 and M_2 are rigidly fixed together at their centres so that their axes are inclined to each other. This system is suspended in a magnetic field of induction 'B' so that M_1 makes an angles θ_1 and M_2 makes an angles θ_2 with the field direction and unlike poles on either side of the field direction. The resultant torque on the rigid system is

1) $B(M_1\sin\theta_1 + M_2\sin\theta_2)$ 2) $B(M_1\cos\theta_1 + M_2\cos\theta_2)$

3) $B(M_1\sin\theta_2 + M_2\sin\theta_1)$ 4) $B(M_1\cos\theta_2 + M_2\cos\theta_1)$

14. A short magnet placed with its axis making an angle with a uniform external magnetic field of induction B experiences a torque (τ). If the magnet is free to rotate, which orientation would correspond to its stable and unstable equilibrium.

1) $\theta=0^0$, $\theta=90^0$ 2) $\theta=0^0$, $\theta=180^0$

3) $\theta=45^0$, $\theta=135^0$ 4) $\theta=0^0$, $\theta=270^0$

FIELD OF A BAR MAGNET

15. Two short magnets each of moment 10 A-m^2 are placed in end - on position so that their centres are 0.1m apart. The force between them is

1) 0.4N 2) 0.5N 3) 0.6N 4) 0.8N

16. The ratio of magnetic fields on the axial line of a long magnet at distances of 10cm and 20cm is 12.5:1. The length of the magnet is

1) 5cm 2) 10cm 3) 10m 4)15 m

17. Two short magnets AB and CD in the X-Y plane and are parallel to X-axis and the co-ordinates of their centres respectively are (0,2) and (2,0). Line joining the North - South poles of CD is opposite to that of AB and lies along the positive X-axis. The resultant field induction due to AB and CD at a point P(2,2) is 100×10^{-7}T. When the poles of the magnet CD are reversed, the resultant field induction is 50×10^{-7}T. The values of magnetic moments of AB and CD are (in Am^2)

1) 300:200 2) 400:600 3) 200:100 4) 300:100

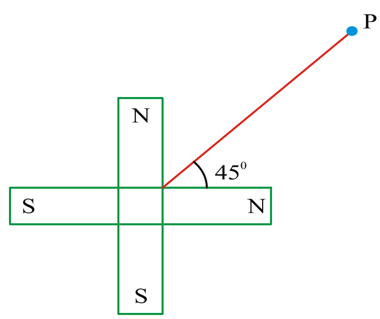
18. Two identical bar Magnets each having Magnetic Moment of 'M' are kept at a distance of 2d with their axes perpendicular to each other in a horizontal plane. The Magnetic induction at midway between them is

1) $\frac{\mu_o}{4\pi}.(\sqrt{2})\frac{M}{d^3}$ 2) $\frac{\mu_o}{4\pi}.(\sqrt{3})\frac{M}{d^3}$ 3) $\frac{\mu_o}{4\pi}.\frac{M}{d^3}$ 4) $\frac{\mu_o}{4\pi}.(\sqrt{5})\frac{M}{d^3}$

19. Magnetic induction at a point on the axial line of a short bar magnet is B towards east. If the magnet is turned through 90^0 in clock wise direction, then magnetic induction at the same point is (Neglect earth's magnetic field)

1) B/4 towards east 2) B/2 towards west
3) B/2 towards north 4) B/2 towards south

20. Two short bar magnets of equal dipole moments 'M' each are fastened perpendicular at their centers as shown in figure. The magnitude of the magnetic field at 'P' at a distance d from their common center as shown in figure is



1) $\frac{\mu_0}{4\pi}\frac{M}{d^3}$ 2) $\frac{\mu_0}{4\pi}\frac{2\sqrt{2}M}{d^3}$ 3) $\frac{\mu_0}{4\pi}\frac{2M}{d^3}$ 4) $\frac{\mu_0}{2\pi}\frac{M}{d^3}$

SUPERPOSITION OF MAGNETIC FIELDS

21. A magnetic dipole is under the influence of two magnetic fields having an angle of 120^0 between them. One of the fields has a magnitude $1.2\times10^{-2}T$. If the dipole comes to stable equilibrium at an angle of 30^0 with this field, then magnitude of the other field is

1) 8.484×10^{-2} T 2) 0.6×10^{-2} T 3) 4.242×10^{-3}T 4) 4.242×10^{-5}T

22. A short bar magnet is placed with its south pole facing geographic south and the distance between the null points is found to be 16 cm. When the magnet is turned pole to pole at the same place then the distance between the null points will be

1) will be same , along the axial line

2) will be same , along the equatorial line
3) will be $16 \times 2^{1/3}$, on the axial line
4) will be $16 \times 2^{1/3}$, on the equatorial line

23. A bar magnet is placed with its North pole pointing North. Neutral point is at a distance 'd' from the center of magnet. The net magnetic induction at the same distance on the axial line of the magnet is

1) $2B_H$ 2) $3B_H$ 3) B_H 4) $7B_H$

24. A bar magnet is placed with its North pole pointing North. Neutral point is at 12 cm. Another magnet is now placed on the first magnet, then the neutral point is found to be at 8 cm. The ratio of their magnetic moments is

1) 3:2 2) 27:19 3) 9:4 4) 9:5

TIME PERIOD OF SUSPENDED MAGNET IN THE UNIFORM MAGNETIC FIELD

25. The period of a thin magnet in a magnetic field is 2s. It is cut into four equal parts by cutting it along length and breadth. The period of each of them in the same field is

1) 1 s 2) 2 s 3) 3 s 4) 4 s

26. A bar magnet suspended in magnetic meridian executes oscillations with a time period of 2 sec in the earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be:

1) 1s 2) 2s 3) 3s 4) 4s

27. Two bar magnets are bound together side by side and suspended. They swing in 12s when their like poles are together and in 16s when their unlike poles are together, the magnetic moments of these magnets are in the ratio

1)27:5 2)25:7 3)7:25 4)24:7

28. A short bar magnet is oscillating in a magnetic field and its time period is 2 seconds . If another piece of brass of double moment of inertia be placed over that magnet the time period of that combination in that field is

1) $2\sqrt{3}$ S 2) $2\sqrt{2}$ S 3) 2 S 4) $1/\sqrt{2}$ S

29. When two identical bar magnets placed one above the other, such that they are mutually perpendicular and bisect each other. The time period of oscillation in a horizontal magnetic field is 4 seconds. If one of the magnets is removed the time period of the other in the same field ($2^{1/4}$=1.189)

1)1.34sec 2) 2.34sec 3) 3.36sec 4) 4.34sec

30. A bar magnet suspended freely in uniform magnetic field is vibrating with a time period of 3 seconds.If the initial field strength is 2T, then the final field strength, for which time period becomes 4 seconds is

1) 1.125Tesla 2) 0.625Tesla 3) 3.55 Tesla 4) 0.75 Tesla

31. A short bar magnet of magnetic moment $2Am^2$ and moment of inertia $6x10^2kgm^2$ is freely suspended such that the magnetic axial line is in the direction of magnetic meridian. If the magnet is displaced by a very small angle (3^0), the angular acceleration is — $x10^{-6}rad/sec^2$ (Magnetic induction of earth's horizontal field = $4x\ 10^{-4}T$).

1) $\pi/20$ 2) $\pi/45$ 3) $\pi/60$ 4) $\pi/75$

32. **The period of oscillation of a magnet at a place is 4 seconds. When it is remagnetised, so that the pole strength becomes 1/9th of initial value, the period of oscillation in seconds is**

1) 3 2) 12 3) 5 4) 4

33. **The magnetic needle of a vibration magnetometer makes 12 oscillations per minute in the horizontal component of earth's magnetic field.When an external short bar magnet is placed at some distance along the axis of the needle in the same line it makes 15 oscillations per minute.If the poles of the bar magnet are inter changed , the number of oscillations it takes per minute is**

1) $\sqrt{61}$ 2) $\sqrt{63}$ 3) $\sqrt{65}$ 4) $\sqrt{67}$

34. **The magnetic needle of a V.M.M completes 10 oscillations in 92seconds. When a small magnet is placed in the magnetic meridian 10cm due north of needle with north pole towards south completes 15 oscillations in 69seconds. The magnetic moment of magnet $\left(B_H = 0.3G\right)$ is**

1) $4.5Am^2$ 2) $0.45Am^2$ 3) 0.75 Am^2 4) $0.225Am^2$

35. **A magnetic needle has a frequency of 20 oscillations per minute in the earth's horizontal field. when the field of a magnet supports the earths horizontal field, the frequency increases to 30 oscillations per minute. The ratio of the field of the magnet to that of the earth is**

1)4:7 2)7:4 3)5:4 4)4:5

TYPES OF MAGNETIC MATERIALS

36. **A thin iron rod is cut into 10 equal parts parallel to its length. The intensity of magnetisation of each piece will be....**

1) $\frac{1}{10}$th of initial value 2) 10 times initial value

3) does not change 4) become half

37. **The dipole moment of each molecule of paramagnetic gas is $1.5\times10^{-23}\ Am^2$ .The temperature of gas is 27^0C and the number of molecules per unit volume in it is $2\times10^{26}\ m^{-3}$. The maximum possible intensity of magnetisation in the gas will be (in A/m) is**

1) 3×10^3 2) 4×10^{-3} 3) 5×10^5 4) 6×10^{-4}

38. **A paramagnetic sample shows a net magnetisation of 8 A/m when placed in an external magnetic field of 0.6T at a temperature of 4K.When the same sample is placed in an external magnetic field of 0.2T at a temperature of 16K , the mangnetisation will be:**

1) $\frac{32}{3}A/m$ 2) $\frac{2}{3}A/m$ 3) $6A/m$ 4) $2.4A/m$

TERRESTRIAL MAGNETISM

39. **The angle of the dip at a place is 40.6^0 and the vertical component of the earths**

magnetic field B_V = 6 x 10^{-5}T. The total intensity of the earth's magnetic field at this place is $\left(\sin 40.6^0 = 0.65\right)$

1) 7 x 10^{-5}T 2) 6 x 10^{-5}T 3) 5 x 10^{-5}T 4) 9.2 x 10^{-5}T.

40. The correct value of dip angle at a place is 45^0. If the dip circle is rotated by 45^0 out of the meridian, then the tangent of the angle of apparent dip at the place is

1) 1 2) 1/2 3) $1/\sqrt{2}$ 4) $\sqrt{2}$

41. A compass needle oscillates 20 times per minute at a place where dip is 45^0 and 30 times per minute where dip is 30^0. The total magnetic field of earth at second to first places is

1) 1.51 2) 1.83 3) 1.63 4) 1.23

42. The real angle of dip, if a magnet is suspended at an angle of 30^0 to the magnetic meridian and the dip needle makes an angle of 45^0 with horizontal is

1) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ 2) $\tan^{-1}\left(\sqrt{3}\right)$ 3) $\tan^{-1}\left(\sqrt{\frac{3}{2}}\right)$ 4) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$

43. At a place the value of B_H and B_V are $0.4\times10^{-4}T$ and $0.3\times10^{-4}T$ respectively. The resultant earth's magnetic field is

1) $0.5\times10^{-4}T$ 2) $10^{-4}T$ 3) $2\times10^{-4}T$ 4) $5\times10^{-4}T$

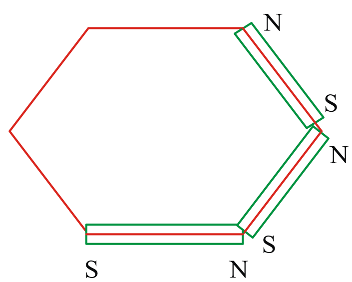
EXERCISE- III KEY

1) 3	2) 3	3) 2	4) 1	5) 4	6) 3	7) 4	8) 1	9) 1	10) 1	11) 2
12) 1	13) 1	14) 2	15) 3	16) 2	17) 1	18) 4	19) 3	20) 2	21) 2	22) 3
23) 2	24) 2	25) 1	26) 4	27) 2	28) 1	29) 3	30) 1	31) 2	32) 2	33) 2
34) 3	35) 3	36) 3	37) 1	38) 2	39) 4	40) 4	41) 2	42) 4	43) 1	

EXERCISE - IV

MAGNETIC MOMENT AND RESULTANT MAGNETIC MOMENT

1. Three identical thin bar magnets each of moment M are placed along three adjacent sides of a regular hexagon as shown in figure. The resultant magnetic moment of the system is



1) M 2) $M\sqrt{3}$ 3) $M\sqrt{2}$ 4) $2M$

2. **The magnetic moment of a bar magnet is 0.256 amp.m^2. Its pole strength is 400 milli amp. m. It is cut into two equal pieces and these two pieces are arranged at right angles to each other with their unlike poles in contact (or like poles in contact). The resultant magnetic moment of the system is**

1) $\sqrt{2}\times 256\times 10^{-3}$ Am^2 2) 250 x 10^{-3}Am^2 3) $\frac{256}{\sqrt{2}}\times 10^{-3}$ Am^2 4) $\frac{128}{\sqrt{2}}\times 10^{-3}$ Am^2

COUPLE ACTING ON THE BAR MAGNET

3. **A bar magnet is suspended in a uniform magnetic field in a position such that it experiences maximum torque. The angle through which it must be rotated from this position such that it experiences half of the maximum troque is**

1) 60° 2) 30° 3) 45° 4) 37°

4. **If the maximum couple acting on a magnet in a field of induction 0.2 tesla is 10 Nm, what is its magnetic moment ?**

1) 50 Am^2 2) 2 Am^2 3) 5 Am^2 4) 20 Am^2

5. **A bar magnet of length 10 cm experiences a torque of 0.141 N-m in a uniform magnetic field of induction 0.4 wb/m^2, when it is suspended making an angle 45^0 with the field, the pole strength of the magnet is**

1) 5 A-m 2) 2.5 A-m 3) 10 A-m 4) 15 Am

6. **A bar magnet of pole strength 2 A-m is kept in a magnetic field of induction $4\times 10^{-5} wbm^{-2}$ such that the axis of the magnet makes an angle 30^0 with the direction of the field. The couple acting on the magnet is found 80×10^{-7} N-m. Then the distance between the poles of the magnet is**

1) 20 m 2) 2m 3) 3cm 4) 20 cm

7. **A magnet of magnetic moment 20$\hat{k}$ Am^2 is placed along the z - axis in a magnetic field $\vec{B} = (0.4\hat{j}+0.5\hat{k})$ T. The torque acting on the magnet is**

1) 8$\hat{i}$ N-m 2) 6$\hat{j}$ N-m 3) – 8$\hat{i}$ N-m 4) – 6$\hat{j}$ N-m

8. **The torque required to keep a magnet of length 10cm at 45^0 to a uniform magnetic field is $\sqrt{2}\times 10^{-5}$ Nm. The magnetic force on each pole is**

1) 0.2mN 2) 20 μN 3) 0.02N 4) 2N

9. **A bar magnet of moment 40 A-m^2 is free to rotate about a vertical axis passing through its centre. The magnet is released from rest from east west direction. The kinetic energy of the magnet as it takes north-south direction is (B_H = $30\mu T$)**

1) 0.6 mJ 2) 1.2 mJ 3) 2.4 mJ 4) 0.3 mJ

10. **A bar magnet of magnetic moment M is divided into 'n' equal parts cutting parallel to length. Then one part is suspended in a uniform magnetic field of strength 2T and held making an angle 60^0 with the direction of the field. When the magnet is released the K.E of the magnet in the equilibrium position is**

1) $\frac{M}{n}$J 2) Mn J 3) $\frac{M}{n^2}$J 4) Mn^2 J

FIELD OF A BAR MAGNET

11. **A short bar magnet of magnetic moment $12.8\times 10^{-3} Am^2$ is arranged in the magnetic meridian with its south pole pointing geographic north. If $B_H = 0.4$**

gauss, the distance between the null points is

1) 4cm 2) 8cm 3) 12cm 4) 16cm

12. **The magnetic field strength at a point a distance 'd' from the centre on the axial line of a very short bar magnet of magnetic moment 'M' is'B'.Then magnetic induction at a diatance 2d from the centre on the equatorial line of a magnetic moment 8M will be**

1) 4B 2) B/2 3) B/4 4) 2B

13. **Two north poles each of pole strength 8Am are placed at corners A and C of a square ABCD. The pole that should be placed at B to make D as null point is**

1) North pole of pole strength $8\sqrt{2}Am$ 2) North pole of pole strength $16\sqrt{2}Am$

3) North pole of pole strength $8\sqrt{2}Am$ 4) North pole of pole strength $16\sqrt{2}Am$

14. **Two short bar magnets of magnetic moments $0.125\,Am^2$. and $0.512\,Am^2$ are placed with their like poles facing each other . If the distance between the centres of the magnet is 0.26m. The distance of neutral point from the weaker magnet is**

1) 0.13 m 2) 0.2 m 3) 0.26 m 4) 0.1 m

TIME PERIOD OF OSCILLATION

15. **A bar magnet of moment of inertia I is vibrated in a magnetic field of induction $0.4\times10^{-4}T$. The time period of vibration is 12 sec. The magnetic moment of the magnet is $120Am^2$. The moment of inertia of the magnet is (in kgm^2) approximately**

1) 1728×10^{-2} 2) 172.8×10^{-4} 3) $2.1\pi^2$ 4) 1.5×10^{-2}

16. **A bar magnet has moment of inertia $49x10^{-2}kgm^2$ vibrates in a magnetic field of induction $0.5x10^{-4}$ Tesla. The time period of vibration is 8.8sec . The magnetic moment of the bar magnet is (2007E)**

1) $350Am^2$ 2) $490Am^2$ 3) $490Am^2$ 4) 500Am^2

17. **A thin rod 30 cm long is uniformly magnetised and its period of oscillation is 4 s. It is broken into three equal parts normal to its length. The period of oscillation of each part is**

1) 12 s 2) 6 s 3) 1.33 s 4) 2.66 s

18. **The moment of inertia as well as the frequencies of two magnets are in the ratio 3:4 the ratio of their magnetic moments is**

1) 27 : 64 2) 64 : 27 3) 9 : 16 4) 16 : 9

19. **A magnet freely suspended in a vibration magnetometer makes 40 oscillations per minute at a place A and 20 oscillations per min at a place B. If the horizontal component of earth's magnetic field at A is $36\times10^{-6}T$, then its value at 'B' is**

1) $36\times10^{-6}T$ 2) $9\times10^{-6}T$ 3) $144\times10^{-6}T$ 4) $288\times10^{-6}T$

20. **A magnetic needle pivoted through its centre of mass and is free to rotate in a plane containing uniform magnetic field 200 x 10^{-4}T. When it is displaced slightly from the equilibrium it makes 2 oscillations per second. If the moment of inertia of the needle about the axis of oscillation is 0.75 x 10^{-5} kg m^2, the magnetic moment of the needle is**

1) 0.06 J/T 2) 0.03 J/T 3) 0.12 J/T 4) 0.6 J/T

PROPERTIES OF MAGNETIC MATERIALS

21. **The magnetic susceptibility of a medium is 0.825.Its relative permeability is**

1)1.825 2)825 3)285 4)1825

22. **A magnetic field strength (H) $3x10^3\ A/m$ produces a magnetic field of Induction (B)of 12π telsa in an iron rod.The relative permeability of iron is**

1) 10^5 2) 10^4 3) 10^3 4) 10^2

23. **The magnetic moment of magnet of mass 75 gm is $9\times 10^{-7}\ Am^2$. If the density of the material of magnet is $7.5\times 10^3 \frac{kg}{m^3}$ then intensity of magnetisation will be**

1) $0.9\ A/m$ 2) $0.09\ A/m$ 3) $9\ A/m$ 4) $90\ A/m$

24. **A magnetising field of 5000 A/m produces a magnetic flux of 5×10^{-5} weber in an iron rod. If the area of cross section of the rod is 0.5 cm^2, then the permeability of the rod will be**

1) 1×10^{-3} 2) 2×10^{-4} 3) 3×10^{-5} 4) 4×10^{-6}

25. **A short bar magnet of magnetic moment 20Am^2 has a cross sectional area of $1.5\times 10^{-4} m^2$. If the intensity of magnetisation of the magnet is 10^{5}A/m. The length of magnet is**

1) 0.33m 2) 0.13cm 3) 1.33m 4) 1.33cm

EXERCISE- IV - KEY

1) 4	2) 3	3) 1	4) 1	5) 1	6) 4	7) 3	8) 1	9) 2	10) 1	11) 2
12)2	13) 4	14) 4	15) 2	16) 4	17) 3	18) 1	19) 2	20) 1	21) 1	22) 2
23) 2	24) 2	25) 3								

EXERCISE - V

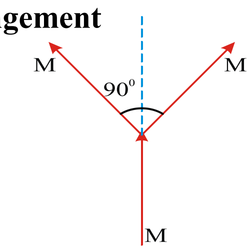
MAGNETIC MOMENT

1. **A cylindrical rod magnet has a length of 5.0 cm and a diameter of 1.0 cm . It has a unifrom magnetisation of $5.3\times 10^3 A/m$ What is its magnetic dipole moment ?**

1) $20.8 JT^{-1}$ 2) $10.8 JT^{-1}$

3) $5.8 JT^{-1}$ 4) $30.8 JT^{-1}$

2. **Find the resultant magnetic moment for the following arrangement**



1) $\sqrt{2}M$ 2) $\left(\sqrt{2}+1\right)M$

3) $\left(\sqrt{2}-1\right)M$ 4) M

COUPLE ACTING ON THE BAR MAGNET

3. A bar magnet with poles 25.0 cm apart and of pole strength 14.4 Am rests with its centre on a friction less point. It is held in equilibrium at 60^0 to a uniform

magnetic field of induction 0.25 T by applying a force F at right angle to the axis, 12 cm from its pivot. The magnitude of the force is

1) $15\sqrt{3}$N 2) $75\sqrt{3}$N 3) $3.75\sqrt{3}$N 4) $25\sqrt{3}\,N$

4. **A magnet is suspended in the magnetic meridian with an untwisted wire. The upper end of the wire is rotated through 180^0 to deflect the magnet by 30^0 from magnetic meridian. Now this magnet is replaced by another magnet. Now the upper end of the wire is rotated through 270^0 to deflect the magnet 30^0 from the magnetic meridian. The ratio of the magnetic moments of the two magnets is**

1) 3 : 4 2) 1 : 2 3) 4 : 7 4) 5 : 8

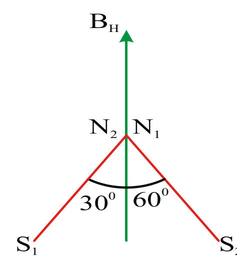
5. **A magnet is suspended in a uniform magnetic field by a thin wire. On twisting the wire through half revolution, the magnet twists through 30^0 from the original position. How much should we rotate the wire in order to twist the magnet through 45^0 from its original position**

1) 257^0 2) 252^0 3) 275^0 4) 127^0

6. **A magnetic dipole is under the influence of two magnetic fields. The angle between the field directions is 60^0 and one of the fields has a magnitude of $1.2\text{x}10^{-2}$T. If the dipole comes to stable equilibrium at angle of 15^0 with this field, then the magnitude of the other field ($\sin15^0 = 0.2588$)**

1) $1.39\text{x}10^{-3}$T 2) $2.39\text{x}10^{-3}$T 3) $3.39\text{x}10^{-3}$T 4) $4.39\text{x}10^{-3}$T

7. **Two small magnets X and Y of dipole moments M_1 and M_2 are fixed perpendicular to each other with their north poles in contact. This arrangement is placed on a floating body so as to move freeely in earth's magnetic field as shown in figure then the ratio of magnetic moment is**

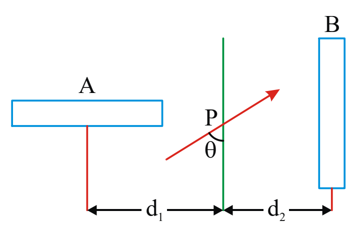


1) $1:\sqrt{3}$ 2) $2:\sqrt{3}$

3) $\sqrt{3}:2$ 4) $\sqrt{3}:1$

FIELD OF A BAR MAGNET

8. **Two magnets A and B are identical and these are arranged as shown in the figure. Their length is negligible in comparision with the seperation between them. A magnetic needle is placed between the magnets at point P which gets deflected through an angle θ under the influence of magnets. The ratio of distances d_1 and d_2 will be**



1. $(2\cot\theta)^{1/3}$ 2. $(2\tan\theta)^{-1/3}$

3. $(2\cot\theta)^{-1/3}$ 4. $(2\tan\theta)^{1/3}$

TIME PERIOD OF SUSPENDED MAGNET IN THE UNIFORM MAGNETIC FIELD

9. **When a bar magnet is placed at some distance along the axis of the magnetic needle of an oscillation magnetometer located in earth's magnetic field, the needle makes 14 oscillations per minute. If the bar magnet is turned so that its poles exchange their positions, the needle makes 20 oscillations per minute. If the magnet is completely removed, the frequency of the needle is nearly (assume $B>B_H$ at needle)**

1) 20 oscillations/minute 2) 15 oscillations/minute
3) 5 oscillations/minute 4) 10 oscillations/minute

10. **A vibration magnetometer consists of two identical bar magnets placed one over the other such that they are mutually perpendicular and bisect each other. The time period of oscillations of combination in a horizontal magnetic field is 4s. If one of the magnets is removed, then the period of oscillations of the other in the same field is**

1) $2^{1/4}$ sec 2) $2^{5/4}$ sec 3) $2^{7/4}$ sec 4) $2^{3/4}$ sec

11. **A magnet is suspended in such a way that it oscillates in the horizontal plane. If it makes 20 oscillations per minute at a place where dip angle is 30^0 and 15 oscillations per minute at a place where dip angle is 60^0. The ratio of total earth's magnetic field at the two places is**

1) $3\sqrt{3}:8$ 2) $16:9\sqrt{3}$ 3) $4:9$ 4) $2\sqrt{3}:9$

12. **A thin rectangular magnet suspended freely has a period of oscillation equal to T. Now it is broken into two equal haves (each having half of the original length) and one piece is made to oscillate freely in the same field. If its period of oscillation is T' then $\frac{T'}{T}$ is**

1) $\frac{1}{4}$ 2) $\frac{1}{2\sqrt{2}}$ 3) $\frac{1}{2}$ 4) 2

13. **A compass needle makes 10 oscillations per minute in the earths horizontal field.A bar magnet deflects the needle by 60^0 from the magnetic meridian. The frequency of oscillation in the deflected position in oscillations per minute is (field due to magnet is perpendicular to B_H)**

1) $5\sqrt{2}$ 2) $20\sqrt{2}$ 3) $10\sqrt{2}$ 4) 10

14. **Two bar magnets are placed in vibration magnetometer and allowed to vibrate. They make 20 oscillations per minute when their similar poles are on the same side, while they make 15 osillations per minute when their opposite poles lie on the same side. The ratio of their magnetic moments is**
(Eamcet (M) 2008, E(2009)

1) 7 : 25 2) 25 : 7 3) 25 : 16 4) 16 : 25

15. **With a standard rectangular bar magnet the time period of a vibration magnetometer is 4 seconds. The bar magnet is cut parallel to its length into four equal pieces. The time period of vibration magnetometer when one piece is used (in seconds) (bar magent breadth is small.) is (E-2008)**

1) 16 2) 8 3) 4 4) 2

TYPES OF MAGNETIC MATERIALS

16. The relation between μ and H for a specimen of iron is $\mu = \left[\frac{0.4}{H} + 12\times10^{-4}\right]$ henry/metre. The value of H which produces flux density of 1 tesla will be

1) $250 A/m$ 2) $500 A/m$ 3) $750 A/m$ 4) $10^3 A/m$

17. The mass of a specimen of a ferromagnetic material is 0.6kg. and its density is $7.8\times10^3 kg/m^3$. If the area of hysteresis loop of alternating magnetising field of frequency 50Hz is 0.722 MKS units then the hysteresis loss per second will be

1) $277.7\times10^{-5} Joule$ 2) $277.7\times10^{-6} Joule$

3) $277.7\times10^{-4} Joule$ 4) $277.7\times10^{-3} Joule$

18. 300 turns of a thin wire are uniformly wound on a permanent magnet shaped as a cylinder of length 15cm. When a current 3A is passed through the wire, the field outside the magnet disappears. Then the coercive force of the material is

1) $2\ kNm^{-1}$ 2) $4\ kNm^{-1}$ 3) $5\ kNm^{-1}$ 4) $6\ kNm^{-1}$

19. At a temperature of $30^0 C$, the susceptibility of ferromagnetic material is found to be 'χ'. Its susceptibility at $333^0 C$ is

1) χ 2) $\frac{\chi}{2}$ 3) 2χ 4) 11.1χ

20. What will be the energy loss per hour in the iron core of a transformet if the area of its hysteresis loop is equivalent to $2500 erg/cm^3$. The frequency of alternating current is 50 Hz. The mass of core is 10 Kg and the density of iron is $7.5 gm/cm^3$.

1) $2\times10^2 Joule$ 2) $4\times10^3 Joule$ 3) $6\times10^4 Joule$ 4) $8\times10^5 Joule$

21. Find the percentage increase in the mag netic field B when the space within the current carrying toroid is filled with aluminium. The susceptibility of aluminium is

1) 3.1×10^{-3} 2) 1.1×10^{-3} 3) 2.1×10^{-3} 4) 2.1×10^{-5}

TYPES OF MAGNETIC MATERIALS

22. A rod of ferromegnetic material with dimensions 10cm x 0.5cm x 2cm is placed in a magnetising field of intensity 2×10^5A/m. The magnetic moment produced due it is 6 $amp-m^2$. The value of magnetic induction will be-----10^{-2}T.

1)100.48 2)200.28 3)50.24 4)300.48

23. A magnetic material of volume $30 cm^3$ is placed in a magnetic field of intensity 5 oersted.The magnetic moment produced due it is 6 $amp-m^2$.The value of magnetic induction will be.

1)0.2517 Tesla 2)0.025 Tesla 3)0.0025 Tesla 4)25 Tesla

24. The total magnetic flux in a material, which produces a pole of strength m_p when a magnetic material of cross- sectional area A is placed in a magnetic field of strength H, will be

1) $\mu_0(AH + m_p)$ 2) $\mu_0 AH$ 3) $\mu_0 m_p$ 4) $\mu_0(m_p AH + A)$

25. Relative permittivity and permeability of a material are e_r and m_r, respectively.

Which of the following values of these quantities are allowed for a diamagnetic material ?

(AIE 2008)

1) $e_r = 0.5, m_r = 1.5$ 2) $e_r = 1.5, m_r = 0.5$

3) $e_r = 0.5, m_r = 0.5$ 4) $e_r = 1.5, m_r = 1.5$

TERRESTRIAL MAGNETISM

26. The angle of dip at a place is δ. If the dip is measured in a plane making an angle θ with the magnetic meridian, the apparent angle of dip δ_1 will be

1) $\tan^{-1}(\tan\delta)$ 2) $\tan^{-1}(\tan\delta\cos\theta)$

3) $\tan^{-1}(\tan\delta\sec\theta)$ 4) 0

27. If δ_1 and δ_2 be the angles of dip observed in two vertical planes at right angles to each other and δ is the true value of dip then

1) $\tan^2\delta = \tan^2\delta_1 + \tan^2\delta_2$ 2) $\cot^2\delta = \cot^2\delta_1 + \cot^2\delta_2$

3) $\tan^2\delta = \dfrac{\tan^2\delta_1 + \tan^2\delta_2}{\tan^2\delta_1 \tan^2\delta_2}$ 4) $\cot^2\delta = 1 + \cot^2\delta_1\cos^2\delta_2$

28. A magnet makes 10 oscillations per minute at a place where the angle of dip is 45^0 and the total intensity is 0.4 gauss. The number of oscillations made per sec by the same magnet at another place where the angle of dip is 60^0 and the total intensity 0.5 gauss is approximately.

1) $6Hz$ 2) $\dfrac{1}{1.06\times6}Hz$ 3) $6\times1.06\,Hz$ 4) $\frac{1}{6}Hz$

29. The horizontal component of earth's magnetic field at place is $0.36x10^{-4}\,weber/m^2$. If the angle of dip at that place is 60° then the value of

vertical component of earth'smagnetic field will be (in wb/m^2)

1) $6x10^{-5}T$ 2) $6\sqrt{2}x10^{-5}T$ 3) $3.6\sqrt{3}\times10^{-5}T$ 4) $\sqrt{2}x10^{-5}T$

30. An iron rod is subjected to cycles of magnetisation at the rate of 50Hz. Given the density of the rod is 8×10^3 kg / m^3 and specific heat is 0.11×10^{-3} cal / kg^{0}C. The rise in temperature per minute, if the area enclosed by the B – H loop corresponds to energy of 10^{-2} J is (Assume there is no radiation losses)

1) 78^0C 2) 88^0C 3) 8.1^0C 4) none of these

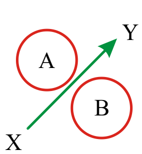
EXERCISE- V - KEY

1) 1 2) 2 3) 3 4) 4 5) 1 6) 4 7) 4 8) 1 9) 4 10) 3 11) 2
12) 3 13) 3 14) 3 15) 3 16) 2 17) 1 18) 1 19) 2 20) 3 21) 3 22) 1
23) 1 24) 1 25) 3 26) 3 27) 2 28) 2 29) 3 30) 3

EXERCISE - I

FARADAY'S EXPERIMENT, INDUCED E.M.F & LENZ'S' LAW

1. **When ever the flux linked with a coil changes, then**
   1) current is always induced
   2) an emf and a current are always induced
   3) an emf is induced but a current is never induced
   4) an emf is always induced and a current is induced, when the coil is a closed one
2. **Whenever the magnet flux linked with a coil changes, then there is an induced emf in the circuit. This emf lasts**
   1) For a short time 2) For a long time 3) For ever
   4) So long as the change in the flux takes place
3. **A magnet is moved towards the coil (i) quickly (ii) slowly then the induced emf is**
   1) Larger in case (i) 2) Smaller in case (i)
   3) Equal in both
   4) Larger or smaller depending upon the radius of the coil
4. **The laws of electromagnetic induction have been used in the construction of a**
   1) galvanometer 2) voltmeter 3) electric motor 4) electric generator
5. **When a rate of change of current in a circuit is unity, the induced emf is equal to**
   1) Total flux linked with the coil 2) induced charge
   3) Number of turns in the circle 4) Coefficient of self induction
6. **A bar magnet is dropped along the axis of copper ring held horizontally. The acceleration of fall is**
   1) Equal to 'g' at the place 2) Less than 'g' 3) More than 'g'
   4) Depends upon diameter of the ring and length of the magnet
13. **An annular circular brass disk of inner radius 'r' and outer radius 'R' is rotating about an axis passing through its center and perpendicular to its plane with a uniform angular velocity 'ω' in a uniform magnetic filed of induction 'B' normal to the plane of the disk. The induced emf between the inner and outer edge of the annular disk is**
   1) $\frac{B\omega(r^2+R^2)}{2}$ 2) $\frac{B\omega(R^2-r^2)}{2}$ 3) $\frac{B\omega(r-R)}{2}$ 4) $\frac{B\omega(r+R)}{2}$
14. **Consider the situation shown in the figure. If the current I in the long straight conducting wire XY is increased at a steady rate then the induced e.m.f.'s in loops A and B will be**



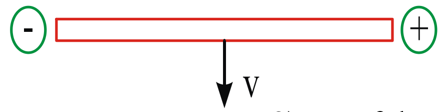
   1) clockwise in A, anti clockwise in
   2) anti clockwise in A, clockwise in B
   3) clockwise in both A and B
   4) anti clockwise in both A and B

FLEMING'S RIGHT HAND RULE

15. **The direction of the induced e.m.f. is determined by**
   1) Fleming's left hand rule
   2) Fleming's right hand rule
   3) Maxwell's right hand screw rule

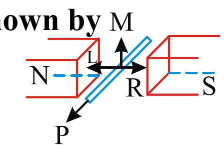
4) Ampere's rule of swimming

16. **A wire moves with a velocity "v" through a magnetic field and experiences an induced charge separation as shown. Then the direction of the magnetic field is**



1) in to the page
2) out of the page
3) towards the bottom of the page
4) towards the top of the page

17. **An electric potential difference will be induced between the ends of the conductor shown in the figure, if the conductor moves in the direction shown by**



1) P
2) R
3) L
4) M

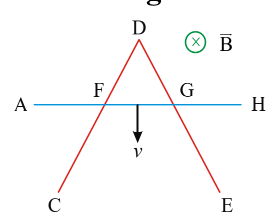
18. **A horizontal straight conductor when placed along south-north direction falls under gravity; there is**

1) an induced current form south-to-north direction
2) an induced current from north-to-south direction
3) no induced emf along the length of the conductor
4) an induced emf along the length of the conductor

19. **Two circular, similar, coaxial loops carry equal currents in the same direction. If the loops are brought nearer, what will happen?**

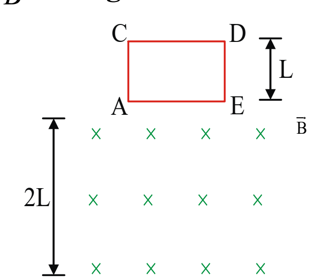
1) Current will increase in each loop
2) Current will decrease in each loop
3) Current will remain same in each loop
4) Current will increase in one and decrease in the other

20. **A long conducting wire AH is moved over a conducting triangular wire CDE with a constant velocity v in a uniform magnetic field $\vec{B}$ directed into the plane of the paper. Resistance per unit length of each wire is ρ. Then**



1) a constant clockwise induced current will flow in the closed loop
2) an increasing anticlockwise induced current will flow in the closed loop
3) a decreasing anticlockwise induced current will flow in the closed loop
4) a constant anticlockwise induced current will flow in the closed loop

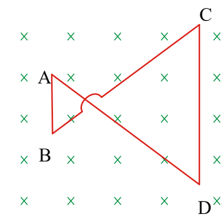
21. **A square coil *ACDE* with its plane vertical is released from rest in a horizontal uniform megnetic field $\vec{B}$ of length 2 L. The acceleration of the coil is**



1) less than 'g' for all the time till the loop crosses the magnetic field completely

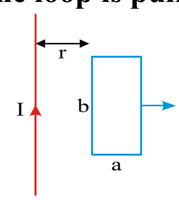
2) less than 'g' when it enters the field and greater than 'g' when it comes out of the field
3) 'g' all the time
4) less than 'g' when it enters and comes out of the field but equal to 'g' when it is within the field

22. **A conducting wire frame is placed in a magnetic field which is directed into the plane of the paper. The magnetic field is increasing at a constant rate. The directions of induced currents in wires *AB* and *CD* are**



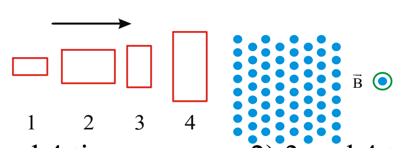
1) *B* to *A* and *D* to *C*
2) *A* to *B* and *C* to *D*
3) *A* to *B* and *D* to *C*
4) *B* to *A* and *C* to *D*

23. **A rectangular loop of wire with dimensions shown in figure is coplanar with a long wire carrying current 'I'. The distance between the wire and the left side of the loop is r. The loop is pulled to the right as indicated. What are the directions of the induced current in the loop and the magnetic forces on the left and the right sides of the loop when the loop is pulled?**



Induced Current	Force on Left side	Force on Right side
a.Cunterclockwise	To the left	To the left
b. Counterclokwise	To the right	To the left
c. Clokwise	To the right	To the left
d. Clockwise	To the left	To the right

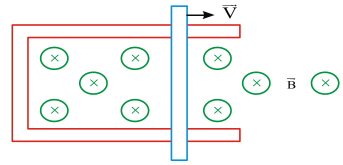
24. **The four wire loops shown figure have vertical edge lengths of either $L, 2L$ or $3L$. They will move with the same speed into a region of uniform magnetic field $\vec{B}$ directed out of the page. Rank them according to the maximum magnitude of the induced emf greatest to least.**



1) 1 and 2 tie, then 3 and 4 tie
2) 3 and 4 tie, then 1 and 2 tie
3) 4,2,3,1
4) 4 then, 2 and 3 tie and then 1

25. **A rod lies across frictionless rails in a uniform magnetic field $\vec{B}$ as shown in figure. The rod moves to the right with speed V. In order to make the induced**

emf in the circuit to be zero, the magnitude of the magnetic field should



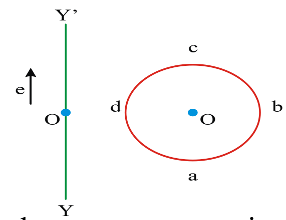
1) not change

2) increase linearly with time

3) decrease linearly with time

4) decrease nonlinearly with time

26. **An electron moves on a straight line path YY' as shown in figure. A coil is kept on the right such that YY' is the plane of the coil. At the instant when the electron gets closest to the coil (neglect self-induction of the coil)**



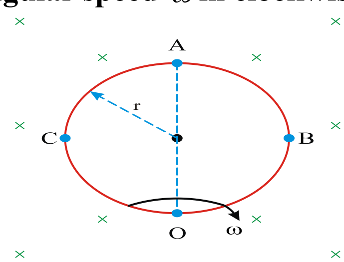
1) The current in the coil flows clockwise

2) The current in the coil flows anticlockwise

3) The current in the coil is zero

4) The current in the coil does not change the direction as the electron crosses point O

27. **In figure, there is a conducting ring having resistance R placed in the plane of paper in a uniform magnetic field B_0. If the ring is rotating in the plane of paper about an axis passing through point O and perpendicular to the plane of paper with constant angular speed ω in clockwise direction, then**



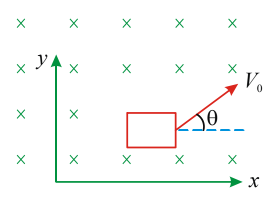
1) point O will be at higher potential than A

2) the potential of point B and C will be different

3) the current in the ring will be zero

4) the current in the ring will be $2B_0\omega r^2 / R$

28. **In the space shown a non-uniform magnetic field $\vec{B} = B_0(1+x)(-\hat{k})$ tesla is present. A closed loop of small resistance, placed in the xy plane is given velocity V_0. The force due to magnetic field on the loop is**



1) zero

2) Along $+x$ direction

3) along $-x$ direction

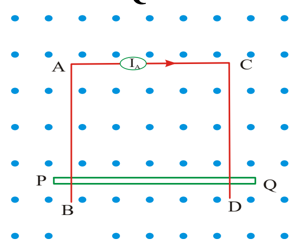
4) along $+y$ direction

29. **Two identical cycle wheels (geometrically) have different number of spokes connected from centre to rim. One is having 20 spokes and the other having only 10 (the rim and the spokes are resistanceless). One resistance of value R is**

connected between centre and rim. The current in R will be

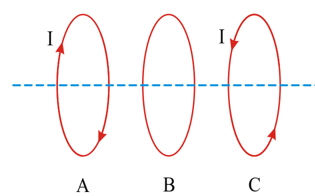
1) double in the first wheel than in the second wheel
2) four times in the first wheel than in the second wheel
3) will be double in the second wheel than that of the first wheel
4) will be equal in both these wheels

30. **AB and CD are fixed conducting smooth rails placed in a vertical palne and joined by a constant current source at its upper end. PQ is a conducting rod which is free to slide on the rails. A horizontal uniform magnetic field exists in space as shown in figure. If the rod PQ is released from rest then,**



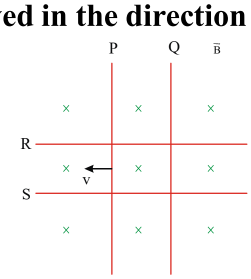
1) the rod PQ will move downward with constant acceleration
2) the rod PQ will move upward with constant acceleration
3) the rod will remain at rest 4) any of the above

31. **Three identical coils A, B and C carrying currents are placed coaxially with their planes parallel to one another. A and C carry current as shown in figure B is kept fixed while A and C both are moved towards B with the same speed. Initially, B is equally seperated from A and C. The direction of the induced current in the coil B is**



1) same as that in coil A
2) same as that in coil B
3) zero
4) none of these

32. **Two identical conductors P and Q are placed on two frictionless rails R and S in a uniform magnetic field directed into the plane. If P is moved in the direction shown in figure with a constant speed, then rod Q**



1)will be attracted towards P
2)will be repelled away from P
3) will remain stationary
4) may be repelled away orattracted towards P

SELF INDUCTION AND MUTUAL INDUCTION

33. **An inductance stores energy in the**

1) electric filed   2) magnetic field
3) resistance of the coil   4) electric and magnetic fields

34. **If 'N'is the number of turns in a coil, the value of self inductance varies as**

1) N^0 2) N   3) N^2 4) N^{-2}

35. **A series combination of L and R is connected to a battery of emf E having negligible internal resistance. The final value of current depends upon**

1) L and R only 2) E and L only
3) E and R only 4) L, R and E only

36. Two coils of inductances L_1, and L_2 are linked such that their mutual inductance is M

1) L_1+L_2 2) $\frac{1}{2}(L_1+L_2)$ 3) $(L_1 \pm L_2)$ 4) $\sqrt{L_1 L_2}$

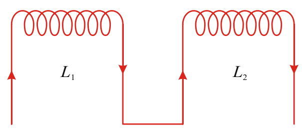
37. The coefficient of self inductance and the coefficient of mutual inductance have

1) same units but different dimensions
2) different units but same dimensions
3) different units and different dimensions
4) same units and same dimensions

38. The mutual inductance between a pair of coils each of 'N' turns is 'M'. If a current is 'I' in the first coil is bought to zero in a time t, then the average emf induced in the second coil is

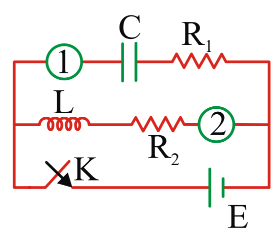
1) MI/t 2) Mt/I 3) Mt/IN 4) It/MN

39. A circuit contains two inductors of self-inductance L_1 and L_2 in series. If M is the mutual inductance then the effective inductance of the circuit shown will be



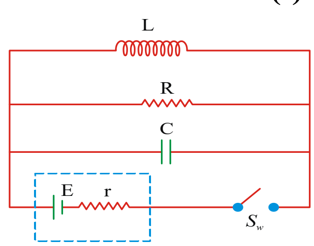
1) L_1+L_2 2) L_1+L_2-2M
3) L_1+L_2+M 4) L_1+L_2+2M

40. In the circuit of figure, (1) and (2) are ammeters. Just after key K is pressed to complete the circuit, the reading is



1) maximum in both (1) and (2)
2) zero in both (1) and (2)
3) zero in (1), minimum in (2)
4) maximum in (1), zero in (2)

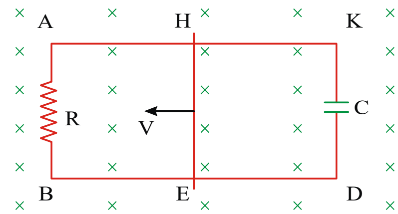
41. A pure inductor L, a capacitor C and a resistance R are connected across a battery of emf E and internal resistance r as shown in the figure. Switch S_W is closed at $t=0$, select the correct alternative(s).



1) current through resistance R is zero all the time
2) current through resistance R is zero at $t=0$ and $t \to \infty$
3) maximum charge stored in the capacitor is CE
4) maximum enrgy stored in the inductor is equal to the maximum energy stored in the capacitor

42. In the circuit shown in figure, a conducting wire HE is moved with a constant speed v towards left. The complete circuit is placed in a uniform magnetic field

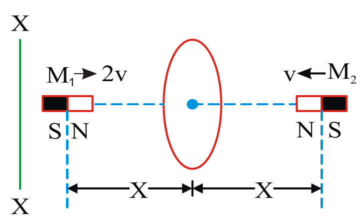
$\vec{B}$ perpendicular to the plane of the circuit inwards. The current in $HKDE$ is



1) clockwise
2) anticlockwise
3) alternating
4) zero

43. **In which of the following cases the emf is induced due to time varying magnetic field (induced field emf)?**
Case I A magnet is moving along the axis of a conducting coil
Case II A loop having varying area (due to moving jumper) is placed in a magnetic field
Case III The resistance of the coil is changing, which is connected to an ideal battery. Case IV A current carrying wire is approaching a conducting ring.
1) I, II and III only 2) I, III and IV only
3) I, II and IV only 4) All the four

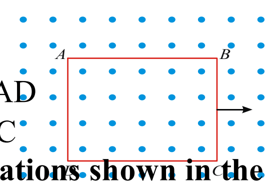
44. **A closed conducting ring is placed in between two bar magnets as shown in the figure. The pole strength of M_1 is double that of M_2. When the two bar magnets are at same distance from the centre of the ring, the bar magnet M_1 has given a velocity $2v$ while M_2 is given velocity v in the direction as shown in the figure.**



The direction of induced current in the ring as seen from XX from this moment to the moment till bar magnets collide is
1) always clockwise 2) always anticlockwise
3) first clockwise, and then anticlockwise
4) first anti-clockwise, and then clockwise

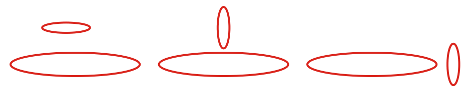
45. **Two identical ciruclar loops of metal wire are lying on a table without touching each other. Loop A carries a current which increases with time. In response, the loop B**
1) remains stationary
2) is attracted by the loop A
3) is repelled by the loop A
4) rotates about its CM, with CM fixed

46. **A metallic square loop $ABCD$ is moving in its own plane with velocity v in a uniform magnetic field perpendicular to its plane as shown in the figure. Electric field is induced.**



1) in AD, but not in BC
2) in BC, but not in AD
3) neither in AD nor in BC
4) in both AD and BC

47. **Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inducatnce will be**



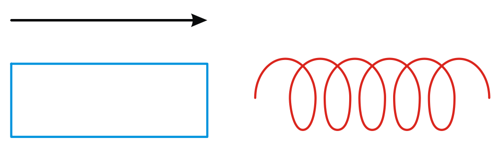
(A) (B) (C)

1) maximum in situation (A) 2)maximum in situation (B)
3) maximum in situation (C) 4) the same in all situations

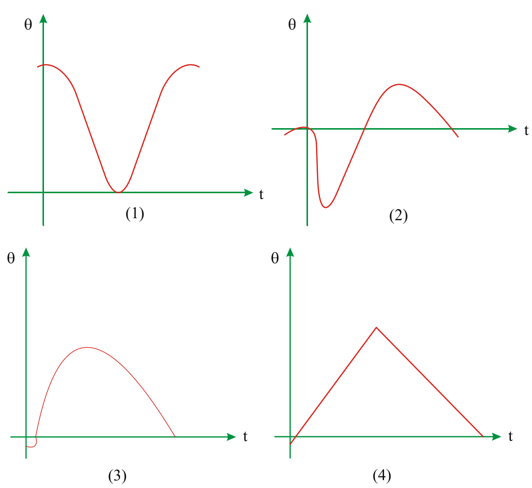
48. As shown in the figure, P and Q are two coaxil conducting loops separated by some distance. When the switch S is closed, a clockwise current I_p flows in P (as seen by E) and an induced current I_{Q_1} flows in Q. The switch remains closed for a long time. When S is opened, a current I_{Q_2} flows in Q. Then the direction I_{Q_1} and I_{Q_2} (as seen by E) are

1) respectively clockwise and anticlockwise
2) both clockwise 3) both anticlockwise
4) respectively anticlockwise and clockwise

49. The variation of induced emf (e) with time (t) in a coil if



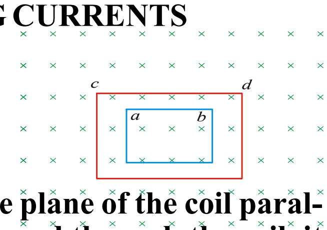
a short bar magnet is moved along axis of the coil shown with a constant velocity is best represented as



50. An infinitely long cylinder is kept parallel to an uniform magnetic field B directed along positive z-axis. The direction of induced current as seen from the z-axis will be

1) clockwise of the +ve z-axis 2) anticlockwise of the +ve z-axis
3) zero 4) along the magnetic field

51. The figure shows certain wire segments joined together to form a coplanar loop. The loop is placed in a perpendicular magnetic field in the direction going into the plane of the figure. The magnitude of the field increases with time. I_1 and I_2 are the currents in the segments ab and cd. Then,



1) $I_1 > I_2$ 2) $I_1 < I_2$
3) I_1 is in the direction ba and I_2 is in the direction cd
4) I_1 is in the direction ab and I_2 is in the direction dc

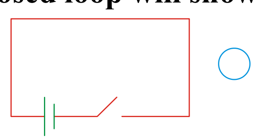
52. A coil is suspended in a uniform magnetic field with the plane of the coil parallel to the magnetic lines of force. When a current is passed through the coil, it starts oscillating; it is very difficult to stop. But if an aluminium plate is placed near to the coil, it stops. This is due to
1) development of air current when the plate is placed
2) induction of electrical charge on the plate
3) shileding of magnetic lines of force as aluminium is a paramagnetic material
4) electromagnetic induction in the aluminium plate giving rise to electromagnetic damping

53. Which of the following units denotes the dimensions $\left[ML^2/Q^2\right]$, where Q denotes the electric charge?
1) Wb/m^2 2) henry (H) 3) H/m^2 4) weber (Wb)

54. A rod of length l rotates with a small but uniform angular velocity ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the centre of the rod and an end is
1) zero 2) $1/8\ \omega Bl^2$ 3) $1/2\ \omega Bl^2$ 4) $B\omega l^2$

55. A rod of length l rotates with a uniform angular velocity ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the two ends of the rod is
1) zero 2) $1/2\,Bl\omega^2$ 3) $Bl\omega^2$ 4) $2Bl\omega^2$

56. Consider the situation shown in figure . If the switch is closed and after some time it is opened again, the closed loop will show



1) an anticlockwise current-pulse
2) a clockwise current-pulse
3) an anticlockwise current-pulse and then a clockwise current-pulse
4) a clockwise current-pulse and then an anticlockwise current-pulse

57. A bar magnet is released from rest along the axis of a very long, vertical copper tube. After some time the magnet
1) will stop in the tube
2) will move with almost contant speed
3) will move with an acceleration g 4) will oscillate

ASSERTION & REASON

1) Both A and R are true and R is the correct explanation of A
2) Both A and R are true and R is not the correct explanation of A
3) A is true but R is false
4) A is false but R is true.

58. Assertion : Magnetic flux is a vector qunatity
Reason: Value of magnetic flux can be positive, negative or zero

59. Assertion : Lenz'a law violates the principle of conservation of energy

Reason: Induced emf always oppose the change in magnetic flux responsible for its production

60. **Assertion:** When number of turns in a coil is doubled, coefficient of self-inductance of the coil becomes 4 times.
Reason: This is because $L \propto N^2$

61. **Assertion :** The induced emf and current will be same in two identical loops of copper and aluminium, when rotated with same speed in the same magnetic field.
Reason: Mutual induction does not depend on the orientation of the coils

62. **Assertion :** When two coils are wound on each other, the mutual induction between the coils is maximum.
Reason: Mutual induction does not depend on the orientation of the coils.

63. **Assertion (A):** Only a change in magnetic flux will maintain an induced current in a closed coil.
Reason (R): The presence of large magnetic flux through a coil maintains a current in the coil if the coil is continuous.

64. **Magnetic flux in a circular coil of resistance 10Ω changes with time as shown in figure. Symbol $\otimes$ indicates a direction perpendicular to paper inwards. Match the following:**

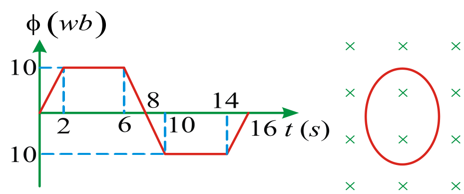


Table - 1
1) At 1s is induced current is
2) At 5s induced current is
3) At 9s induced current is
4) At 15s induced current is

Table-2
p) clockwise
q) anticlockwise
r) zero
s) 2A
t) None

1) a-q; b-r; c-p; d-q
2) a-p; b-r; c-q; d-p
3) a-r; b-p; c-q; d-q
4) a-p; b-r; c-s; d-q

65. **Three coils are placed infront of each other as shown. Currents in 1 and 2 are in same direction, while that in 3 is in opposite direction. Match the following table.**

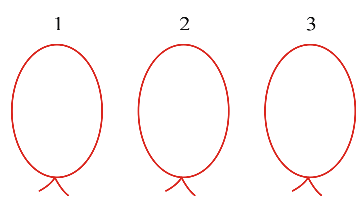


Table - 1	**Table - 2**
a) When current is increased	**p) Current in 1 will increase**
b) When current in 2 is increased	**q) Current in 2 will increase**
c) When current in 3 is increased	**r) Current in 3 will increase**
	s) None

1) a-r; b-r; c-p,q
2) a-p; b-p; c-q
3) a-q; b-q; c-r
4) a-r; b-q; c-p

EXERCISE- I - KEY

1) 4	2) 4	3) 1	4) 4	5) 4	6) 2	7) 3	8) 3	9) 2	10) 2	11) 1
12) 3	13) 2	14) 1	15) 2	16) 1	17) 4	18) 3	19) 2	20) 4	21) 4	22) 1
23) 4	24) 4	25) 4	26) 3	27) 3	28) 3	29) 4	30) 4	31) 3	32) 1	33) 2
34) 3	35) 3	36) 4	37) 4	38) 1	39) 4	40) 4	41) 2	42) 4	43) 2	44) 2
45) 3	46) 4	47) 1	48) 4	49) 2	50) 3	51) 4	52) 4	53) 2	54) 2	55)1
56) 4	57) 2	58) 4	59) 4	60) 1	61) 3	62) 3	63) 3	64) 1	65) 1	

EXERCISE - I

INSTANTANEOUS, PEAK,R.M.S & AVERAGE VALUES OF A.C AND A.V

1. The r.m.s. value of an a.c. of 50 Hz is 10 A. The time taken by the alternating current in reaching from zero to maximum value and the peak value of current will be

1) 2×10^{-2} sec and 14.14 A 2) 1×10^{-2} sec and 7.07 A
3) 5×10^{-3} sec and 7.07 A 4) 5×10^{-3} sec and 14.14 A

2. An inductor has a resistance R and inductance L. It is connected to an A.C. source of e.m.f E_V and angular frequency ω, then the current I_v in the circuit is

1) $\frac{E_V}{\omega L}$ 2) $\frac{E_V}{R}$ 3) $\frac{E_V}{\sqrt{R^2+\omega^2L^2}}$ 4) $\sqrt{\left(\frac{E_V}{R}\right)^2+\left(\frac{E_V}{\omega L}\right)^2}$

3. The peak voltage of 220 Volt AC mains (in Volt) is

1) 155.6 2) 220.0 3) 311 4) 440.0

4. The peak value of A.C. is $2\sqrt{2}A$. It's apparent value will be

1) 1A 2) 2A 3) 4A 4) zero

5. Alternating current in circuit is given by $I = I_0 \sin 2\pi nt$. Then the time taken by the current to rise from zero to r.m.s. value is equal to

1) 1/2n 2) 1/n 3) 1/4n 4) 1/8n

6. Using an A.C. voltmeter the potential difference in the electrical line in a house is read to be 234 volt. If the line frequency is known to be 50 cycles/second, the equation for the line voltage is

1) $V = 165\ \sin(100\pi\ t)$ 2) $V = 331\ \sin(100\pi\ t)$
3) $V = 220\ \sin(100\pi\ t)$ 4) $V = 440\ \sin(100\pi\ t)$

7. A mixer of 100Ω resistance is connected to an A.C. source of 200V and 50 cycles/sec. The value of average potential difference across the mixer will be

1) 308V 2) 264V 3) 220V 4) zero

A.C ACROSS PURE RESISTOR, INDUCTOR & CAPACITOR

8. The equation of an alternating voltage is E=220 $\sin(\omega t+\pi/6)$ and the equation of the current in the circuit is I=10 $\sin(\omega t-\pi/6)$. Then the impedance of the circuit is

1) 10 ohm 2) 22 ohm 3) 11 ohm 4) 17 ohm

9. A steady P.D. of 10V produces heat at a rate 'x' in resistor. The peak value of A.C. voltage which will produce heat at rate of x/2 in same resistor is

1) 5 V 2) $5\sqrt{2}$ V 3) 10 V 4) $10\sqrt{2}$ V

10. An alternating voltage of $E = 200\sqrt{2}\sin(100t)V$ is connected to a condenser of 1 μF through an A.C. ammeter. The reading of the ammeter will be

1) 10 mA 2) 40 mA 3) 80 mA 4) 20 mA

11. The inductance of a coil is 0.70 henry. An A.C. source of 120 volt is connected in

parallel with it. If the frequency of A.C. is 60Hz, then the current which is flowing in inductance will be

1) 4.55 A 2) 0.355 A 3) 0.455 A 4) 3.55 A

TRANSFORMER

12. **A transformer steps up an A.C. voltage from 230 V to 2300 V. If the number of turns in the secondary coil is 1000, the number of turns in the primary coil will be**

1) 100 2) 10,000 3) 500 4) 1000

13. **The transformer ratio of a transformer is 5. If the primary voltage of the transformer is 400 V, 50 Hz, the secondary voltage will be**

1) 2000 V, 250 Hz 2) 80 V, 50 Hz 3) 80 V, 10 Hz 4) 2000 V, 50 Hz

14. **A step-up transformer works on 220V and gives 2 A to an external resistor. The turn ratio between the primary and secondary coils is 2:25. Assuming 100% efficiency, find the secondary voltage, primary current and power delivered respectively**

1) 2750 V, 25 A, 5500 W 2) 2750 V, 20 A, 5000 W
3) 2570 V, 25 A, 550 W 4) 2750 V, 20 A, 55 W

A.C ACROSS L-R, L-C & L-C-R SERIES CIRCUITS

15. **A coil of self - inductance $\left(\frac{1}{\pi}\right)$ H is connected in series with a 300 Ω resistance. A voltage of 200V at frequency 200Hz is applied to this combination. The phase difference between the voltage and the current will be**

1) $\tan^{-1}\left(\frac{4}{3}\right)$ 2) $\tan^{-1}\left(\frac{3}{4}\right)$ 3) $\tan^{-1}\left(\frac{1}{4}\right)$ 4) $\tan^{-1}\left(\frac{5}{4}\right)$

16. **A condenser of $10\mu F$ and an inductor of 1H are connected in series with an A.C. source of frequency 50Hz. The impedance of the combination will be (take $\pi^2 = 10$)**

1) zero 2) Infinity 3) 44.7 Ω 4) 5.67 Ω

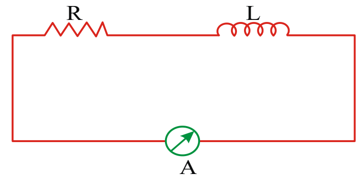
17. **A 100 km telegraph wire has capacity of 0.02 $\mu F / km$, if it carries an alternating current of frequency 5 kHZ. The value of an inductance required to be connected in series so that the impedence is minimum.**

1) 50.7mH 2) 5.07mH 3) 0.507mH 4) 507mH

18. **In an *LCR* series circuit the rms voltages across *R, L* and *C* are found to be 10 V, 10 V and 20 V respectively. The rms voltage across the entire combination is**

1) 30 V 2) 1 V 3) $20V$ 4) $10\sqrt{2}\,V$

19. **In the circuit shown, a 30V d.c. source gives a current 2.0 A as recorded in the ammeter A and 30V a.c. source of frequency 100Hz gives a current 1.2A. The inductive reactance is**



1) 10 ohm 2) 20 ohm 3) $5\sqrt{34}$ ohm 4) 40 ohm

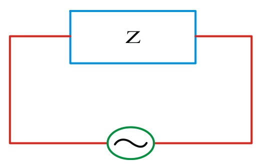
20. A choke coil has negligible resistance. The alternating potential drop across it is 220 volt and the current is 5mA. The power consumed is

1) $220\times\frac{5}{1000}$W 2) $\frac{220}{5}$W 3) zero 4) 2.20 x 5W

21. In an A.C. circuit, the instantaneous values of e.m.f. and current are E = 200 sin 314t volt and $I = \sin(314t + \pi/3)$ ampere then the average power consumed in watts is

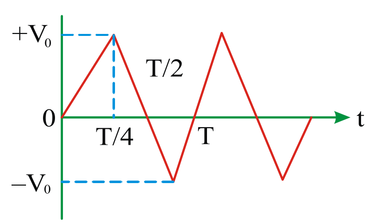
1) 200 2) 100 3) 0 4) 50

22. In a black box of unkown elements (L, C or R or any other combination) an AC voltage $E = E_0 \sin(\omega t + \phi)$ is applied and current in the circuit was found to be $i = i_0 \sin(\omega t + \phi + \pi/4)$. Then the unknown elements in the box may be



1) only capacitor 2) both inductor and resistor
3) either capacitor, resistor and inductor or only capacitor and resistor
4) only resistor

23. The voltage time (V - t) graph for triangular wave having peak value V_0 is as shown in figure.



The rms value of V in time interval from $t = 0$ to $\frac{T}{4}$ is

1) $\frac{V_0}{\sqrt{3}}$ 2) $\frac{V_0}{2}$ 3) $\frac{V_0}{\sqrt{2}}$ 4) $2V_o$

EXERCISE-I - KEY

1) 4 2) 3 3) 3 4) 2 5) 4 6) 2 7) 4 8) 2 9) 3 10) 4 11) 3
12) 1 13) 4 14) 1 15) 1 16) 1 17) 3 18) 4 19) 2 20) 3 21) 4 22) 3
23) 1

EXERCISE - II

INSTANTANEOUS, PEAK,R.M.S & AVERAGE VALUES OF A.C AND A.V

1. For a given AC source the average emf during the positive half cycle

1) depends on E_0
2) depends on shape of wave
3) both 1 and 2
4) depends only on peak value of E_0

2. An alternating emf given by $V = V_0 \, Sin\,\omega t$ has peak value 10 volt and frequency 50 Hz. The instantaneous emf at $t = \frac{1}{600} s$ is

1) 10 V
2) $5\sqrt{3}V$
3) 5 V
4) 1V

3. The equation of A.C. of frequency 75Hz, if it's RMS value is 20A is

1) $I = 20 Sin(150\pi t)$
2) $I = 20\sqrt{2}\, Sin(150\pi t)$
3) $I = \frac{20}{\sqrt{2}} Sin(150\pi t)$
4) $I = 20\sqrt{2}\, Sin(75\pi t)$

4. The voltage of an A.C. source varies with time according to the equation $V = 50 \sin 100\pi\, t \cos 100\pi\, t$, where 't' is in sec and 'V' is in volt. Then

1) The peak voltage of the source is 100 V
2) The peak voltage of the source is $100/\sqrt{2}V$
3) The peak voltage of the source is 25 V
4) The frequency of the source is 50 Hz

5. The form factor for a sinusoidal A.C. is

1) $2\sqrt{2} : \pi$
2) $\pi : 2\sqrt{2}$
3) $\sqrt{2} : 1$
4) $1 : \sqrt{2}$

6. At resonance the peak value of current in L-C-R series circuit is

1) E_0/R
2) $\frac{E_0}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$
3) $\frac{E_0}{\sqrt{2}\sqrt{R^2 + \left(\omega^2 L - \frac{1}{\omega^2 C^2}\right)^2}}$
4) $\frac{E_0}{\sqrt{2}R}$

7. In an AC circuit, the rms value of the current, I_{rms} is related to the peak current I_0 as

1) $I_{rms} = \frac{1}{\pi} I_0$
2) $I_{rms} = \frac{1}{\sqrt{2}} I_0$
3) $I_{rms} = \sqrt{2} I_0$
4) $I_{rms} = \pi I_0$

8. A voltmeter connected in an A.C circuit reads 220V. It represents,

1) peak voltage
2) RMS voltage
3) Average voltage
4) Mean square voltage

9. If the instantaneous current in a circuit is given by $I = 2\cos(\omega t + \phi)$ A, the rms

value of the current is

1) $2A$ 2) $\sqrt{2}A$ 3) $2\sqrt{2}A$ 4) zero

10. **The time taken by an AC of 50 Hz in reaching from zero to its maximum value will be**

1) 0.5 s 2) 0.005 s 3) 0.05 s 4) 5s

11. **A generator produces a voltage that is given by V=240 sin 120t V, where t is in second. The frequency and r.m.s. voltage are respectively**

1) 60Hz and 240V 2) 19Hz and 120V
3) 19Hz and 170V 4) 754Hz and 170V

A.C ACROSS PURE RESISTOR, INDUCTOR & CAPACITOR

12. **A 220 V, 50 Hz AC supply is connected across a resistor of 50 $k\Omega$. The current at time t second, assuming that it is zero at $t=0$, is**

1) $4.4\sin(314t)mA$ 2) $6.2\sin(314t)mA$
3) $4.4\sin(157t)mA$ 4) $6.2\sin(157t)mA$

13. **A resistance of 20Ω is connected to a source of alternating current rated 110 V, 50 Hz. Then the time taken by the current to change from its maximum value to the r.m.s. value is**

1) 2.5×10^{-3} sec 2) 2.5×10^{-2} sec 3) 5×10^{-3} sec 4) 25×10^{-3} sec

14. **A condenser of capacity 1pF is connected to an A.C source of 220V and 50Hz frequency. The current flowing in the circuit will be**

1) 6.9 x 10^{-8}A 2) 6.9A 3) 6.9 x 10^{-6}A 4) zero

15. **In a circuit, the frequency is $f=\frac{1000}{2\pi}$ Hz and the inductance is 2 henry, then the reactance will be**

1) 200Ω 2) $200\mu\Omega$ 3) 2000Ω 4) $2000\mu\Omega$

TRANSFORMER

16. **The transformer ratio of a transformer is 10:1. The current in the primary circuit if the secondary current required is 100 A assuming the transformer be ideal, is**

1) 500 A 2) 200 A 3) 1000 A 4) 2000 A

17. **The transformer ratio of a transformer is 10:1. If the primary voltage is 440V, secondary emf is**

1) 44 V 2) 440V 3) 4400 V 4) 44000 V

A.C ACROSS L-R, L-C & L-C-R SERIES CIRCUITS

18. **The frequency at which the inductive reactance of 2H inductance will be equal to the capacitive reactance of $2\mu F$ capacitance (nearly)**

1) 80Hz 2) 40 Hz 3) 60Hz 4) 20Hz

19. **In a series LCR circuit $R=10\Omega$ and the impedance $Z=20\Omega$. Then the phase difference between the current and the voltage is**

1) 60^o 2) 30^o 3) 45^o 4) 90^o

20. **In an L-C-R series circuit,**
$R=\sqrt{5}\Omega,\ X_L=9\Omega,\ X_C=7\Omega$**. If applied voltage in the circuit is 50V then impedance of the circuit in ohm will be**

1) 2 2) 3 3) $2\sqrt{5}$ 4) $3\sqrt{5}$

21. **In an AC circuit the potential differences across an inductance and resistance joined in series are respectively 16 V and 20 V. The total potential difference across the circuit is**

1) 20 V 2) 25.6 V 3) 31.9 V 4) 53.5 V

22. **Current in an ac circuit is given by** $i=3\sin\omega t+4\cos\omega t$ **then**

1) rms value of current is 5 A
2) mean value of this current in one half period will be $6/\pi$
3) if voltage applied is $V=V_m\sin\omega t$ then the circuit must be containing resistance and capacitance
4) if voltage applied is $V=V_m\sin\omega t$, the circuit may contain resistance and inductance

23. **A fully charged capacitor C with initial charge** q_0 **is connected to a coil of self inductance** L **at** $t=0$**. The time at which the energy is stored equally between the electric and the magnetic fields is**

1) $\frac{\pi}{4}\sqrt{LC}$ 2) $2\pi\sqrt{LC}$ 3) $\sqrt{LC}$ 4) $\pi\sqrt{LC}$

EXERCISE-II - KEY

1) 3 2) 3 3) 2 4) 3 5) 2 6) 1 7) 2 8) 2 9) 2 10) 2 11) 3
12) 2 13) 1 14) 1 15) 3 16) 3 17) 3 18) 1 19) 1 20) 2 21) 2 22) 3
23) 1

EXERCISE - III

INSTANTANEOUS, PEAK,R.M.S & AVERAGE VALUES OF A.C AND A.V

1. **The average current of a sinusoidally varrying alternating current of peak value 5A with initial phase zero, between the instants t = T/8 to t = T/4 is (Where 'T' is time period)**

1) $\frac{10}{\pi}\sqrt{2}A$ 2) $\frac{5}{\pi}\sqrt{2}A$ 3) $\frac{20\sqrt{2}}{\pi}A$ 4) $\frac{10}{\pi}A$

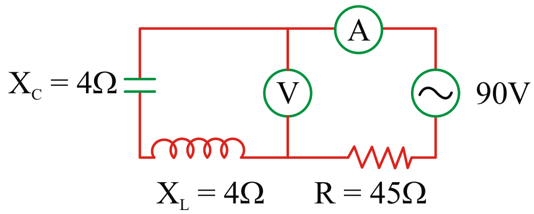
A.C ACROSS L-R, L-C & L-C-R SERIES CIRCUITS

2. **A** 100Ω **resistance is connected in series with a 4H inductor. The voltage across the resistor is** $V_R=2\sin(1000t)V$**. The voltage across the inductor is**

1) $80\sin\left(1000t+\frac{\pi}{2}\right)$ 2) $40\sin\left(1000t+\frac{\pi}{2}\right)$

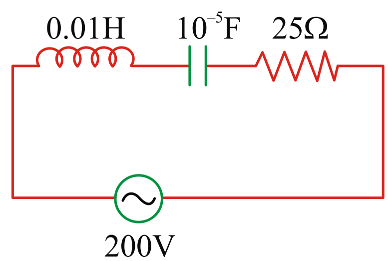
3) $80\sin\left(1000t-\frac{\pi}{2}\right)$ 4) $40\sin\left(1000t-\frac{\pi}{2}\right)$

3. **The reading of voltmeter and ammeter in the following figure will respectively be**



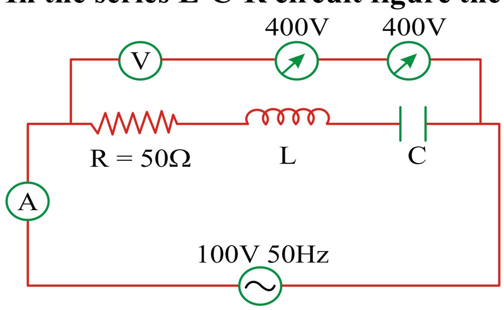
1) 0 and 2A 2) 2A and 0V 3) 2V and 2A 4) 0V and 0A

4. **In the following circuit, the values of current flowing in the circuit at f = 0 and f = ∞ will respectively be**



1) 8A and 0A 2) 0A and 0A 3) 8A and 8A 4) 0A and 8A

5. **In the series L-C-R circuit figure the voltmeter and ammeter readings are**



1) V=100 volt, I=2A 2) V=100 volt, I = 5 A
3) V=1000 volt, I=2A 4) V=300 volt, I = 1 A

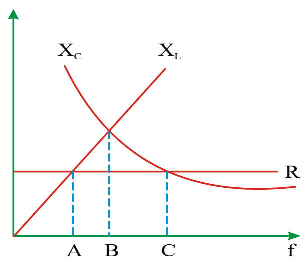
6. **The potential difference between the ends of a resistance R is V_R, between the ends of capacitor is $V_C = 2V_R$ and between the ends of inductance is $V_L = 3V_R$. Then the alternating potential of the source in terms of V_R will be**

1) $\sqrt{2}V_R$ 2) V_R 3) $\frac{V_R}{\sqrt{2}}$ 4) $5V_R$

7. **A 220V, 50Hz a.c. generator is connected to an inductor and a 50Ω resistance in series. The current in the circuit is 1.0A. The P.D. across inductor is**

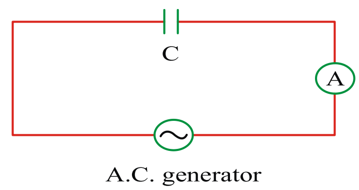
1) 102.2V 2) 186.4V 3) 213.6V 4) 302V

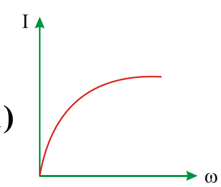
8. **The figure shows variation of R, X_L and X_C with frequenc *f* in a series L, C, R circiut. Then for what frequency point, the circuit is inductive**

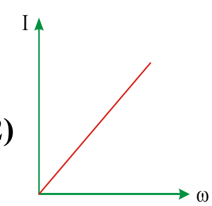


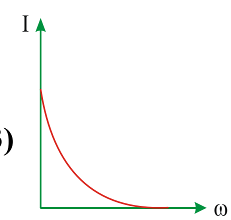
1) A 2) B 3) C 4) All points

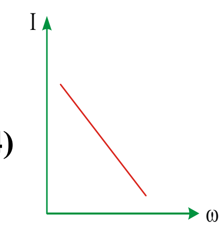
9. A constant voltage at different frequencies is applied across a capacitance C as shown in the figure. Which of the following graphs correctly depicts the variation of current with frequency



1) 

2) 

3) 

4) 

10. In a series $L-C-R$ circuit $R=200\Omega$ and the voltage and the frequency of the main supply is 220 V and 50Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30^0. On taking out the inductor from the circuit the current leads the voltage by 30^0. The power dissipated in the $L-C-R$ circuit is

1) 305 W 2) 210 W 3) zero 4) 242 W

11. In a series resonant LCR circuit, the voltage across R is 100V and $R=1k\Omega$ with $C=2\mu F$. The resonant frequency ω is 200 rad/s. At resonance the voltage across L is

1) $2.5\times10^{-2}V$ 2) 40 V 3) 250 V 4) $4\times10^{-3}V$

EXERCISE-III - KEY

1) 1 2) 1 3) 1 4) 2 5) 1 6) 1 7) 3 8) 3 9) 2 10) 1 11) 2

EXERCISE - IV

INSTANTANEOUS, PEAK,R.M.S & AVERAGE VALUES OF A.C AND A.V

1. An alternating current 'i' is given by $i = i_0 \sin 2\pi(t/T + 1/4)$. Then the average current in the first one quarter time period is

   1) $\frac{2i_0}{\pi}$ 2) $\frac{I_0}{\pi}$ 3) $\frac{I_0}{2\pi}$ 4) $\frac{3I_0}{\pi}$

A.C ACROSS L-R, L-C & L-C-R SERIES CIRCUITS

2. In an LR circuit, R = 10 Ω and L = 2H. If an alternating voltage of 120V and 60Hz is connected in this circuit, then the value of current flowing in it will be _______ A (nearly)

   1) 0.32 2) 0.16 3) 0.48 4) 0.8

3. The equation of an alternating current is $I = 50\sqrt{2}\ \sin 400\pi t$ A, then the frequency and the root mean square value of the current are respectively.

   1) 200Hz, 50 A 2) 400Hz, $50\sqrt{2}$A

   3) 200Hz, $50\sqrt{2}$A 4) 500Hz, 200A

4. A circuit operating at $\frac{360}{2\pi} Hz$ contains a $1\mu F$ capacitor and a 20Ω resistor. The inductor must be added in series to make the phase angle for the circuit zero is

   1) 7.7 H 2) 10 H 3) 3.5 H 4) 15 H

5. A resistor R and capacitor C are connected in series across an AC source of rms voltage 5 V. If the rms voltage across C is 3 V then that across R is

   1) 1V 2) 2 V 3) 3 V 4) 4 V

6. An *LCR* series circuit containing a resistance of 120Ω has angular resonance frequency $4\times10^5\ rad\ S^{-1}$. At resonance the voltage across resistance and inductance are 60V and 40V respectively. Then the values of L and C are respectively.

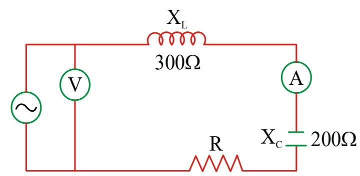
   1) $0.2\,mH, 1/32\,\mu F$ 2) $0.4\,mH, 1/16\,\mu F$

   3) $0.2\,mH, 1/16\,\mu F$ 4) $0.4\,mH, 1/32\,\mu F$

7. The natural frequency of an LC - circuit is 1,25,000 cycles per second. Then the capacitor C is replaced by another capacitor with a dielectric medium of dielectric contant k. In this case, the frequency decreases by 25 kHz. The value of k is

   1) 3.0 2) 2.1 3) 1.56 4) 1.7

8. In the given figure, the instantaneous value of alternating e.m.f. is e = 14.14 sin ωt . The reading of voltmeter in volt will be



1) 141.4 2) 10 3) 200.0 4) 70.7

9. **A coil of inductance 0.1H is connected to 50V, 100Hz generator and current is found to be 0.5A. The potential difference across resistance of the coil is**
1) 15V 2) 20V 3) 25V 4) 39V

10. **The voltage of A.C. source varies with time according equation. V = 120 sin $100\pi t$ cos 100 πt. Then the frequency of source is**
1) 50Hz 2) 100Hz 3) 150Hz 4) 200Hz

11. **The current in a coil of self inductance 5 henry is increasing according to i = $2\sin^2 t$. The amount of energy spent during the period when current changes from 0 to 2 amperes is**
1) 10J 2) 5J 3) 100J 4) 2J

12. **In an AC circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The power consumption in the circuit is given by**
1) $P = \frac{E_0 I_0}{\sqrt{2}}$ 2) P= zero 3) $P = \frac{E_0 I_0}{2}$ 4) $P = \sqrt{2} E_0 I_0$

TRANSFORMER

13. **The efficiency of a transformer is 98%. The primary voltage and current are 200 V and 6A. If the secondary voltage is 100 V, the secondary current is**
1) 11.76 A 2) 12.25 A 3) 3.06 A 4) 2.94 A

EXERCISE-IV - KEY

1) 1 2) 2 3) 1 4) 1 5) 4 6) 1 7) 3 8) 2 9) 4 10) 2 11) 4
12) 4 13) 3

EXERCISE - V

1. **An AC voltage source of variable angular frequency ω and fixed amplitude V_0 is connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When ω is increased**
1) The bulb glows dimmer 2) The bulb glows brignther
3) Total impedance of the circuit is unchanged
4) Total impedance of the circuit increases

40. **In an A.C circuit the instantaneous values of current and voltage are $I = 120 \sin \omega t$ ampere and $E = 300 \sin(\omega t + \pi/3)$ volt respectively. What will be the inductive reactance of series LCR circuit if the resistance and capacitive reactance are 2 ohm and 1 ohm respectively?**
1) 4.5 ohms 2) 2 ohms 3) 2.5 ohms 4) 3 ohms

3. **A pure resistive circuit element *'x'* when connected to an A.C. supply of peak voltage 100 V gives a peak current of 4 A which is in phase with the voltage. A second circuit element *'y'* when connected to the same AC supply also gives the same value of peak current but the current lags behind by 90^0. If the series combination of 'x' and 'y' is connected to the same supply. R.M.S. value of current is**

1) $\frac{5}{\sqrt{2}}A$ 2) 2A 3) 1/2 A 4) $\frac{\sqrt{2}}{5}A$

4. **An ideal inductor takes a current of 10 A when connected to a 125 V, 50 Hz AC supply. A pure resistor across the same source takes 12.5 A. if the two are connected in series across a $100\sqrt{2}V$, 40 Hz supply, the current through the circuit will be**

1) 10 A 2) 12.5 A 3) 20 A 4) 25 A

5. **A circuit containing resistance R_1, Inductance L_1 and capacitance C_1 connected in series resonates at the same frequency 'n' as a second combination of R_2, L_2 and C_2. If the two are connected in series. Then the circuit will resonates at**

1) n 2) 2n 3) $\sqrt{\frac{L_2C_2}{L_1C_1}}$ 4) $\sqrt{\frac{L_1C_1}{L_2C_2}}$

6. **An AC source of variable frequency is applied across a series L-C-R circuit. At a frequency double the resonance frequency. The impedance is $\sqrt{10}$ times the minimum impedance. The inductive reactance is**

1) R 2) 2R 3) 3R 4) 4R

7. **A 20V, 750 HZ source is connected to a series combination of R = 100Ω, C = $10\,\mu$F and L = 0.1803 H. Calculate the time in which resistance will get heated by 10^oC. (If thermal capacity of the material = 2 J / ^oC)**

1) 328 sec 2) 348 sec 3) 3.48 sec 4) 4.32 sec

8. **An AC source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to $\omega/3$ (but maintaining the same voltage), the current in the circuit is found to be halved. The ratio of reactance to resistance at the original frequency ω is**

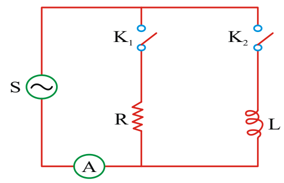
1) $\sqrt{\frac{3}{5}}$ 2) $\sqrt{\frac{5}{3}}$ 3) $\frac{3}{5}$ 4) $\frac{5}{3}$

9. **An LCR circuit has L = 10 mH, R = 3Ω, and C = 1 μF connected in series to a source of $15\cos\omega t$ volt. The current amplitude at a frequency that is 10% lower than the resonant frequency is**

1) 0.5 A 2) 0.7 A 3) 0.9 A 4) 1.1 A

10. **In the given circuit, *R* is a pure resistor, *L* is a pure inductor, S is a 100V, 50 Hz AC source, and A is an AC ammeter. With either K_1 or K_2 alone closed, the ammeter reading is *I*. If the source is changed to 100 V, 100 Hz, the ammeter**

reading with K_1 alone closed and with K_2 alone closed will be respectively.



1) $I, I/2$ 2) $I, 2I$ 3) $2I, I$ 4) $2I, I/2$

11. **A capacitor has a resistance of $1200\ M\Omega$ and capacitance of $22\ \mu F$. When connected to an a.c. supply of frequency 80 hertz, then the alternating voltage supply required to drive a current of 10 virtual ampere is**

1) $904\sqrt{2}$V 2) 904V 3) $904/\sqrt{2}$V 4) 452V

12. **A 120V, 60Hz a.c. power is connected 800Ω non-inductive resistance and unknown capcitance in series. The voltage drop across the resistance is found to be 102V, then voltage drop across capacitor is**

1) 8V 2) 102V 3) 63V 4) 55V

13. **A 100 V a.c source of frequency 50 Hz is connected to a LCR circuit with L = 8.1 millihenry, $C = 12.5\mu F$ and $R = 10ohm$, all connected in series. What is the potential difference across the resistance?**

1) 100 V 2) 200 V 3) 300 V 4) 450 V

14. **A coil has an inductance of 0.7H and is joined in series with a resistance of 220Ω. When an alternating e.m.f. of 220V at 50 c.p.s. is applied to it, then the wattless component of the current in the circuit is**

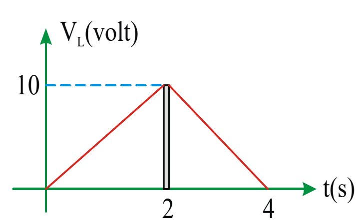
1) 5 ampere 2) 0.5 ampere 3) 0.7 ampere 4) 7 ampere

15. **Two alternating voltage generators produce emfs of the same amplitude E_0 but with a phase difference of $\frac{\pi}{3}$. The resultant e.m.f.is**

1) $E_0 \sin\left(\omega t + \frac{\pi}{3}\right)$ 2) $E_0 \sin\left(\omega t + \frac{\pi}{6}\right)$

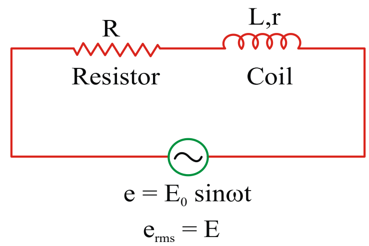
3) $\sqrt{3}E_0 \sin\left(\omega t + \frac{\pi}{6}\right)$ 4) $\sqrt{3}E_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

16. **The potential difference across a 2H inductor as a function of time is shown in figure. At time t = 0, current is zero.**
Current t = 2 second is



1) 1A 2) 3A 3) 4A 4) 5A

17. **For the circuit shown in the figure the rms value of voltages across R and coil are E_1 and E_2, respectively.**



The power (thermal) developed across the coil is

1) $\frac{E-E_1^2}{2R}$ 2) $\frac{E-E_1^2-E_2^2}{2R}$ 3) $\frac{E^2}{2R}$ 4) $\frac{(E-E_1)^2}{2R}$

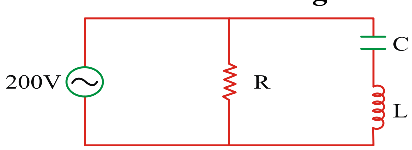
18. **A bulb is rated at 100 V, 100 W, it can be treated as a resistor. Find out the inductance of an inductor (called choke coil) that should be connected in series with the bulb to operate the bulb at its rated power with the help of an ac source of 200 V and 50 Hz**

1) $\frac{\pi}{\sqrt{3}}H$ 2) 100 H 3) $\frac{\sqrt{2}}{\pi}H$ 4) $\frac{\sqrt{3}}{\pi}H$

19. **An ac source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to $\omega/3$ (but maintaining the same voltage), the current in the circcuit is found to be halved. Then the ratio of reactance to resistance at the original frequency ω is**

1) $\sqrt{3/5}$ 2) $\sqrt{5/3}$ 3) $\sqrt{2/3}$ 4) $\sqrt{3/2}$

20. **In the circuit diagram shown, $X_C = 100\,\Omega, X_L = 200\,\Omega \,\&\, R = 100\,\Omega$. The effective current through the source is**



1) 2 A 2) $2\sqrt{2}A$ 3) 0.5 A 4) $\sqrt{0.4}\,A$

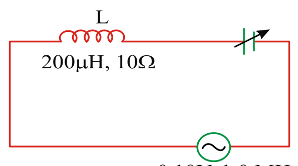
EXERCISE-V - KEY

1) 2 2) 1 3) 2 4) 1 5) 1 6) 4 7) 2 8) 1 9) 2 10) 1 11) 2
12) 3 13) 1 14) 2 15) 3 16) 4 17) 2 18) 4 19) 1 20) 2

EXERCISE-VI

1. **At resonance, V_L and V_C are both very much greater than the applied potential, V itself. The quality factor for an LCR circuit in resonance is given by $Q=\frac{X_L}{R}$.**

In practice, $Q=200$ has been achieved.



(a) **At resonance, the capacitor has been adjusted for**

1 $200\times10^{-6}\mu F$ 2. $0.00013\mu F$ 3. $0.0013\mu F$ 4. $0.0013F$

(b) **At resonance, the potential difference across the inductance is**

1) 1.3 V 2) 13 V 3) 0.3 V 4) none of these

(c) **The potential across the capacitance at resonance is**

1) 13 V 2) > 13 V 3) < 13 V 4) none of these

(d) **The Q factor is**

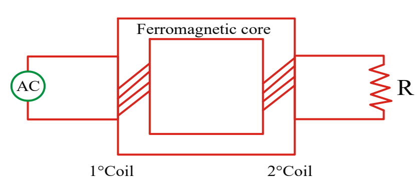
1. $\frac{V_L}{V_C}$ 2. $\frac{V_C}{V_L}$ 3. $\frac{V_C}{V}$ 4. $\frac{V_L}{V}$

(e) **choose the right statement.**

1. V_L+V_C can be greater than $V_{applied}$ 2. $V_L+V_C=V_{applied}$

3. $V_L+V_C<V_{applied}$ 4. none of these

2. **A physics lab is designed to study the transfer of electrical energy from one circuit to another by means of a magnetic field using simple transformers. Each transformer has two coils of wire electrically insulated from each other but wound around a common core of ferromagnetic material. The two wires are close together but do not touch each other.**



The primary coil is connected to a source of alternating (AC) current. The secondary coil is connected to a resistor such as a light bulb. The AC source produces an oscillating voltage and current in the primary coil that produces an oscillating magnetic field in the core material. This in turn induces an oscillating voltage and AC current in the secondary coil.
Student collected the following data comparing the number of turns per coil (N), the voltage (V) and the current (I) in the coils of three transformers

	Primary Coil			Secondary coil		
	N_1	V_1	I_1	N_2	V_2	I_2
Transformer 1	100	10V	10 A	20	20 V	5 A
Transformer 2	100	10V	10 A	50	5 V	20 A
Transformer 3	200	10V	10 A	100	5 V	20 A

a) **The primary coil of a transformer has 100 turns and is connected to a 120V AC source. How many turns are in the secondary coil if there is a 2400 V across it**

1) 5 2) 50 3) 200 4) 2000

b) **A transformer with 40 turns in its primary coil is connected to a 120 V AC source. If 20 W of power is supplied to the primary coil, the power developed in the secondary coil is**

1) 10 W 2) 20 W 3) 80 W 4) 160 W

c) **One of the following is a correct expression for R, the resistance of the load connected to the secondary coil (pick the correct one)**

1) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{2^0}}{N_{1^0}}\right)$ 2) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{1^0}}{N_{2^0}}\right)^2$ 3) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{1^0}}{N_{2^0}}\right)$ 4) $\left(\frac{V_{1^0}}{I_{1^0}}\right)\left(\frac{N_{1^0}}{N_{2^0}}\right)^2$

d). **A 12 V battery is used to supply 2.0 mA of current to the 300 turns in the primary coil of a given transformer. What is the current in the secondary coil if $N_2 = 150$ turns**

1) zero 2) 1.0 mA 3) 2.0 mA 4) 4.0 mA

EXERCISE-VI - KEY

1) a) 2 b) 2 c) 1 d) 3,4 e) 4 2) a) 4 b) 2 c) 1 d) 4

EXERCISE -I

1. **If $\vec{E}$ and $\vec{B}$ are the electric and magnetic field vectors of electromagnetic waves then the direction of propagation of electromagnetic waves is along the direction of -**

1. $\vec{E}$ 2. $\vec{B}$ 3. $\vec{E}\times\vec{B}$ 4. $\vec{B}\times\vec{E}$

2. **The electromagnetic waves do not transport-**

1. energy 2. charge 3. momentum 4. information

3. **A capacitor is connected in an electric circuit. When key is pressed, the current in the circuit is-**

1. zero 2. maximum
3. any transient value 4. depends on capacitor used

4. **Displacement current is continuous-**

1. when electric field is changing in the circuit
2. when magnetic field is changing in the circuit
3. in both types of fields.
4. through wire and resistance only

5. **The conduction current is the same as displacement current when the source is**

1. A.C. only 2. D.C. only
3. both A.C and D.C. 4. neither for A.C. nor for D.C.

6. **The Maxwells four equations are written as**

(i) $\oint \vec{E}.\overrightarrow{dS} = \dfrac{q_0}{\varepsilon_0}$ **(ii)** $\oint \vec{B}.\overrightarrow{dS} = 0$

(iii) $\oint \vec{E}.\overrightarrow{dl} = \dfrac{d}{dt}\oint \vec{B}.\overrightarrow{dS}$ **(iv)** $\oint \vec{B}.\overrightarrow{dl} = \mu_0\varepsilon_0 \dfrac{d}{dt}\oint \vec{E}.\overrightarrow{dS}$

The equations which have sources of $\vec{E}$ and $\vec{B}$ are

1. (i), (ii), (iii) 2. (i), (ii) 3. (i) and (iii) only 4. (i) and (iv) only

7. **Out of the above four equations, the equations which do not contain source field are -**

1. (i) and (ii) 2. (ii) only 3. all of four 4. (iii) only

8. **Out of the four Maxwell's equations above, which one shows non-existence of monopoles?**

1. (i) and (iv) 2. (ii) only 3. (iii) only 4. none of these

9. **Which of the above Maxwell's equations shows that elelctric field lines do not form closed loops?**

1. (i) only 2. (ii) only 3. (iii) only 4. (iv) only

10. **In an electromagnetic wave the average energy density is associated with -**

1. electric field only 2. magnetic field only
3. equally with electric and magnetic fields.
4. average energy density is zero.

11. The displacement current flows in the dielectric of a capacitor when the potential difference across its plates-

1. becomes zero
2. has assumed a constant value
3. is increasing with time
4. decreasing with time

12. Select wrong statement from the following-Electromagnetic waves

1. are transverse
2. travel with same speed in all media
3. travel with the speed of light
4. are produced by accelerating charge.

13. The waves related to telecommuni-cation are-

1. infra red
2. visible light
3. microwaves
4. ultraviolet rays

14. **The magnitudes of Poynting vector and electric field vector are respectively S and E, then**

1. $S = E^2\sqrt{\frac{\varepsilon_0}{\mu_0}}$
2. $S = E^2\sqrt{\varepsilon_0\mu_0}$
3. $S = E^2\sqrt{\frac{\mu_0}{\varepsilon_0}}$
4. $S^2 = \frac{E^2}{\mu_0}$

15. The nature of electromagnetic wave is-

1. longitudinal
2. longitudinal stationary
3. transverse
4. transverse stationary

16. The frequencies of x-rays**,** γ-rays **and ultraviolet rays are respectively a,b and c. Then:**

1. $a < b, b < c$
2. $a > b, b > c$
3. $a > b, b < c$
4. $a < b, b > c$

17. Electromagnetic radiation of frequency 3×10^5 MHz **can be produced by which of the following wave**

1. Radiowave
2. X-rays
3. Ultraviolet
4. Microwave

18. Maxwell's equations describe the fundamental laws of

1. electricity only
2. magnetism only
3. mechanics only
4. both 1 and 2

19. Which of the following statements is not correct?

1. photographic plates are sensitive to infrared rays
2. photographic plates are sensitive to ultraviolet rays
3. Infra-red rays are invisible but can cast shadows like visible light
4. infrared photons have more energy than photons of visible light

20. Radio waves and visible light in vacuum have

1. same velocity but different wavelength
2. continuous emission spectrum
3. band absorption spectrum
4. line emission spectrum

21. Energy stored in electromagnetic oscillations is in the form of

1. electrical energy
2. magnetic energy
3. both 1 and 2
4. neither of the above

22. Whcih wave is not electromagnetic in nature?

1. micro
2. radio
3. X-ray
4. audio

23. Total energy of EM waves in free space is given by

1. $\frac{E^2}{2\varepsilon_0}+\frac{B^2}{2\mu_0}$
2. $\frac{\varepsilon_0 E^2}{2}+\frac{\mu_0 B^2}{2}$
3. $\frac{E^2+B^2}{C}$
4. $\frac{\varepsilon_0 E^2}{2}+\frac{B^2}{2\mu_0}$

24. Which of the following waves have the maximum wavelength?

1. Ultraviolet rays
2. I.R. rays
3. UV rays
4. radio waves

25. Electromagnetic waves are transverse in nature is evident by

1. polarization 2. interference 3. reflection 4. diffraction

26. Which of the following are not electromagnetic waves?

1. cosmic rays 2. gamma rays 3. $\beta - rays$ 4. X-rays

27. Let $\vec{E}, \vec{B}$ and $\vec{C}$ represent the electric field, magnetic field and velocity of an electromagnetic wave respectively. Their directions, at any instant point along the unit vectors given below in order. Which of the following cannot be true?

1) $\hat{k}, \hat{i}, \hat{j}$ 2) $\hat{k}, \hat{j}, -\hat{i}$ 3) $\hat{i}, \hat{j}, \hat{k}$ 4) $-\hat{j}, -\hat{k}, -\hat{i}$

28. A lamp radiates power P_0 uniformly in all directions, the amplitude of electric field strength E_0 at a distance r from it is

1) $E_0 = \frac{P_0}{2\pi\varepsilon_0 cr^2}$ 2) $E_0 = \sqrt{\frac{P_0}{2\pi\varepsilon_0 cr^2}}$ 3) $E_0 = \sqrt{\frac{P_0}{4\pi\varepsilon_0 cr^2}}$ 4) $E_0 = \sqrt{\frac{P_0}{8\pi\varepsilon_0 cr}}$

29. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface

1) E/C 2) 2E/C 3) EC 4) E/C^2

30. An electromagnetic wave passing through vacuum is described by the equation;

$E = E_0 \sin(kx - \omega t)$ and $B = B_0 \sin(kx - \omega t)$; **then**

1) $E_0 = B_0$ 2) $E_0\omega = B_0 k$ 3) $E_0 B_0 = \omega k$ 4) $E_0 k = B_0 \omega$

31. The frequency of visible light is of the order of

1. 10^{15}Hz 2. 10^{10}Hz 3. 10^{6}Hz 4. 10^{4}Hz

32. Which of the following wavelength falls in X-ray region?

1. $1 A^0$ 2. $10 A^0$ 3. $10^{-2} A^0$ 4. $10^{-3} A^0$

33. An electro magnetic wave is vaccume has the electric and magnetic field $\vec{E}$ and $\vec{B}$ which are always perpendicular to each other. The direction of polarisation is given by $\vec{X}$ and that of wave propagation by $\vec{K}$ then (AIE:2012)

1) $\vec{X} \parallel \vec{B}$ and $\vec{K} \parallel \vec{B} \times \vec{E}$ 2) $\vec{X} \parallel \vec{E}$ and $\vec{K} \parallel \vec{E} \times \vec{B}$

3) $\vec{X} \parallel \vec{E}$ and $\vec{K} \parallel \vec{E} \times \vec{B}$ 4) $\vec{X} \parallel \vec{E}$ and $\vec{K} \parallel \vec{B} \times \vec{E}$

Note : Directions q.no. 34 to 46

1. Both Assertion and reason are true and the reason is correct explanation of the Assertion.

2. Both Assertion and reason are true, but reason is not correct explanation of Assertion.

3. Assertion is true, reason is false

4. Assertion is false, reason is true

34. Assertion: Displacement current arises on account of change in electric flux.

Reason: $I_d = \in_0 \dfrac{d\phi_E}{dt}$

35. **Assertion (A): In an e.m. wave, magnitude of magnetic field vector $\vec{B}$ is much smaller than the magnitude of vector $\vec{E}$**

Reason(R): This is because in an e.m. wave E/B $= c = 3\times10^8\ m/s.$

36. **Assertion(A): Microwaves have more energy than the radio waves**

Reason(R): $E = h\upsilon = \dfrac{hc}{\lambda}$

37. **Assertion: Displacement current decreases with the increase in frequency of a.c. supplied to a capacitor**

Reason: Reactance due to capacitance is directly proportional to the frequency of a.c.

38. **Assertion: The electrostatic field lines cannot form a closed path.**

Reason: $\oint \vec{E}.\vec{dl} = 0$

39. **Assertion: The magnetic flux through a closed surface is zero**

Reason: Gauss's law applies in the case of electric flux only

40. **Assertion: A changing electric-field produces a magnetic field.**

Reason:A changing magnetic field produces an electric field.

41. **Statement I: Sound waves are not electromagnetic waves.**

Statemenet II: Sound waves require a material medium for propagation.

42. **Statement I: Electromagnetic waves are transverse in nature.**

Statement II: The electric and magnetic fields of an e.m. wave are perpendicular to each other and also perpendicular to the direction of wave propagation.

43. **Statement I: Electromagnetic waves exert pressure, called radiation pressure.**

Statement II: This is because they carry energy.

44. **Statment I: in an electric circuit a capacitor of reactance 100 Ω is connected across a 220 V source. The displacement current is 2.2 A.**

Statement II: The data is insufficient.

45. **Statement I: An e.m. radiation of energy 14.4 keV belongs to X-ray region.**

Statement II: $E = hv = hc/\lambda$

46. **Statement I : The velcoity of all electromagnetic waves in vacuum is different.**

Statement II: The different electromagnetic waves are of different frequency

47. **Column I**

(A) Aveage energy density of electric field in electromagnetic wave

(B) Average energy density of magnetic field in electromagnetic wave

(C) Total average energy density of electromagnetic wave

(D) Intensity of electromagnetic wave

Column II

(P) $\frac{1}{2}\in_0 E_0^2 c$ (Q) $\frac{1}{2}\in_0 E_0^2$ (R) $\frac{1}{4}\in_0 E_0^2$ (S) $\frac{1}{4}\in_0 \frac{B_0^2}{\mu_0}$

1. A-P, B-Q, C-R, D-S
2. A-Q, B-R, C-S, D-P
3. A-R, B-S, C-Q, D-P
4. A-Q, B-R, C-S, D-P

48. **Column I**

(A) Radiowaves (B) Infrared radiations

(C)Ultraviolet ray (D)Gamma rays

Column II

(P) Vibrations of atoms and molecules

(Q) Arc lamp

(R) Nuclear origin

(S) Oscillating circuit

1. A-P, B-Q, C-R, D-S
2. A-Q, B-R, C-S, D-P
3. A-R, B-S, C-P, D-Q
4. A-S, B-P, C-Q, D-R

EXERCISE-I - KEY

1) 3	2) 2	3) 2	4) 1	5) 2	6) 4	7) 2	8) 2	9) 1	10) 3	11) 3
12) 2	13) 3	14) 1	15) 3	16) 4	17) 4	18) 4	19) 4	20) 1	21) 3	22) 4
23) 4	24) 4	25) 1	26) 3	27) 4	28) 2	29) 2	30) 4	31) 1	32) 1	33) 2
34) 1	35) 1	36) 2	37) 3	38) 1	39) 3	40) 2	41) 1	42) 1	43) 2	44) 3
45) 2	46) 4	47) 3	48) 4							

EXERCISE - II

DISPLACEMENT CURRENT

1. **A Parallel plate condenser of capacity 100 pF is connected to 230 V of AC supply of 300rad/sec frequency. The rms value of displacement current.**

1) $6.9\mu A$ 2) $2.3\mu A$ 3) $9.2\mu A$ 4) $4.6\mu A$

2. **A parallel plate capacitor of plate separation 2mm is connected in an electric circuit having source voltage 400V. If the plate area is $60\,cm^2$, then the value of displacement current for 10^{-6} sec. will be**

1) $1.062\,amp$ 2) 1.062×10^{-2} amp

3) $1.062\times10^{-3}\,amp$ 4) $1.062\times10^{-4}\,amp$

MAGNETIC FIELD PRODUCED BETWEEN PLATES OF PARALLEL PLATE CAPACITOR

3. **The magnetic field between the plates of a capacitor when $r > R$ is given by -**

1. $\frac{\mu_0 I_D r}{2\pi R^2}$ 2. $\frac{\mu_0 I_D}{2\pi R}$ 3. $\frac{\mu_0 I_D}{2\pi r}$ 4. zero

4. **A condenser is charged using a constant current. The ratio of the magnetic fields at a distance of $\frac{R}{2}$ and R from the axis is (R is the radius of plate)**

1) $1:1$ 2) $2:1$ 3) $1:2$ 4) $1:4$

5. **The magnetic field between the plates of radius 12 cm separated by distance of 4mm of a parallel plate capacitor of capacitance 100 pF. along the axis of plates having conduction current of 0.15 A is**

1) zero 2) 1.5 T 3) 15 T 4) 0.15 T

WAVE EQUATION

6. **The wave function (in S.I unit) for an electromagnetic wave is given as -**

$\psi(x,t) = 10^3 \sin\pi\left(3\times10^6 x - 9\times10^{14} t\right)$

The speed of the wave is

1. 9×10^{14} m/s 2. 3×10^8 m/s 3. 3×10^6 m/s 4. 3×10^7 m/s

7. **The velocity of all radiowaves in free space is 3×10^8 m/s, the frequency of a wave of wavelength 150 m is**

1. 45 MHz 2. 2 MHz 3. 2 KHz 4. 20 KHz

8. **The relative permeability of glass is 3/8 and the dielectric constant of glass is 8. The refractive index of glass is**

1) 1.5 2) 1.1414 3) 1.732 4) 1.6

9. **An electromagnetic wave of frequency 3 MHz passes from Vacuum into a dielectric medium with permittiviy $\in = 4.0$ Then (AIE : 2004)**

1) Wave length doubled and frequency remains unchanged
2) wave length is doubled and frequency becomes half
3) wave length is halved and frequency remains unchanged
4) wave length and frequency both remain unchanged

RELATION BETWEEN B & E

10. **In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of 2×10^{10} Hz and amplitude 48 V/m. The amplitude of oscillating magnetic field will be**

1. $\frac{1}{16}\times10^{-8}$ Wb/m^2 2. 16×10^{-8} Wb/m^2 3. 12×10^{-7} Wb/m^2 4. $\frac{1}{12}\times10^{-7}$ Wb/m^2

11. **In a plane electromagnetic wave, the electric field oscillates sinnusoidally at a**

frequency of 2×10^{10}Hz and amplitude 48V/m., the wavelength of the wave will be -

1. 1.5 m 2. 66.6 m 3. 1.5 cm 4. 66.6 cm

12. **In an apparatus the electric field was found to oscillate with an amplitude of $18Vm^{-1}$. The rms of the oscillating magnetic field is**

1) $6\times10^{-8}T$ 2) $4.23\times10^{-8}T$ 3) $9\times10^{-8}T$ 4) $7.0\times10^{-8}T$

13. **The amplitude of the sinusoidally oscillating electric field of a plane wave is 60v/m. Then the amplitude of the magnetic field is**

1) $12\times10^{7}T$ 2) $6\times10^{7}T$ 3) $6\times10^{-7}T$ 4) $2\times10^{-7}T$

MOMENTUM AND FORCE

14. **Light with energy flux of $18w/cm^2$ falls on a non reflecting surface of area $20cm^2$ at normal incidence the momentum delivered in 30 minutes is**

1) $1.2\times10^{-6}kgms^{-1}$ 2) $2.16\times10^{-3}kgms^{-1}$

3) $1.18\times10^{-3}kgms^{-1}$ 4) $3.2\times10^{-3}kgms^{-1}$

15. **Light with energy flux of $24wm^{-2}$ is incident on a well polished disc of radius 3.5cm for one hour. The momentum transferred to the disc is**

1) $1.1\mu\ kg\ ms^{-1}$ 2) $2.2\mu\ kg\ ms^{-1}$ 3) $3.3\mu\ kg\ ms^{-1}$ 4) $4.4\mu\ kg\ ms^{-1}$

ENERGY DENSITY

16. **The maximum electric field of a plane electromagnetic wave is 88 V/m. The average energy density is**

1) $3.4\times10^{-8}Jm^{-3}$ 2) $13.7\times10^{-8}Jm^{-3}$ 3) $6.8\times10^{-8}Jm^{-3}$ 4) $1.7\times10^{-8}Jm^{-3}$

17. **The rms value of the electric field of a plane electromagnetic wave is 314V/m. The average energy density of electric field and the average energy density are**

1) $4.3\times10^{-7}Jm^{-3};2.15\times10^{-7}Jm^{-3}$ 2) $4.3\times10^{-7}Jm^{-3};8.6\times10^{-7}Jm^{-3}$

3) $2.15\times10^{-7}Jm^{-3};4.3\times10^{-7}Jm^{-3}$ 4) $8.6\times10^{-7}Jm^{-3};4.3\times10^{-7}Jm^{-3}$

INTENSITY

18. **If a source of power 4 kW produces 10^{20} photons/second, the radiation belong to a part of the spectrum called [AIE 2010]**

1. X - rays 2. Ultraviolet rays 3. Microwaves 4. γ rays

19. **The intensity of electromagnetic wave at a distance of 1 Km from a source of power 12.56 kw. is**

1) $10^{-3}Wm^{-2}$ 2) $4\times10^{-3}Wm^{-2}$

3) $12.56\times10^{-3}Wm^{-2}$ 4) $1.256\times10^{-3}Wm^{-2}$

20. **The sun delivers $10^{3}W/m^2$ of electromagnetic flux incident on a roof of dimensions $8m\times20m$, will be**

1) $6.4\times10^3 W$ 2) $3.4\times10^4 W$ 3) $1.6\times10^5 W$ 4) $3.2\times10^5 W$

EXERCISE-II - KEY

1) 1 2) 2 3) 3 4) 3 5) 1 6) 2 7) 2 8) 3 9) 3 10) 2 11) 3
12) 2 13) 4 14) 2 15) 2 16) 3 17) 2 18) 1 19) 1 20) 3

EXERCISE - III

DISPLACEMENT CURRENT

1. The voltage between the plates of a parallel plate condenser of capacity $2.0\ \mu F$ **is charging at a rate of** $10 Vs^{-1}$**. The displacement current**

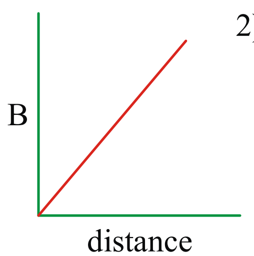
1) $2\,mA$ 2) $2\,\mu A$ 3) $20\,\mu A$ 4) $2A$

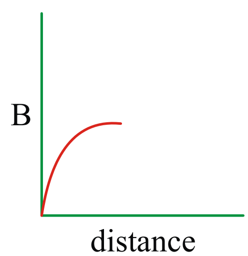
2. A parallel plate condenser of capacity $10\mu F$ **is charged with a constant charging current of 0.16A. The displacement current is**

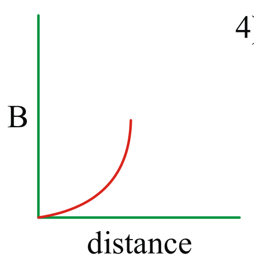
1) $0.16\mu A$ 2) $0.16A$ 3) $0.96A$ 4) $9.6A$

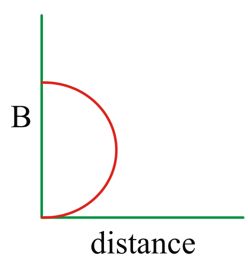
MAGNETIC FIELD PRODUCED BETWEEN PLATES OF PARALLEL PLATE CAPACITOR

3. The graph representing the variation of induced magnetic field in the gap of the condenser plates during its charging with the distance from the axis of the gap is

1)


2)


3)


4)


4. The electrical field in the gap of a condenser charges as $10^{12} Vm^{-1}s^{-1}$**. If the radius of each plate of the condenser is 3cm, the magnetic field at the edge of plate in the gap is**

1) $1.67\,mT$ 2) $0.167\,\mu T$ 3) $0.5\,\mu T$ 4) $5\,\mu T$

WAVE EQUATION

5. **An LC circuit contains inductance $L = 1\mu H$ and capacitance $C = 0.01\mu H$. The wavelength of electromagnetic wave generated is nearly**

1. 0.5 m 2. 5 m 3. 188 m 4. 30 m

6. **The wave length of the Green light of mercury is 550nm. If the refractive index of the glass is 1.5, the time period of the electrical vector in glass nearly $\left(C_0 = 3\times10^8 mS^{-1}\right)$**

1) $1.8\times10^{-9} S$ 2) $3.6\times10^{-15} S$ 3) $9\times10^{-15} S$ 4) $2.75\times10^{-15} S$

7. **The all India Radio, station at Vijayawada transmits its signals at 840 K C/s. The length of the radio wave is**

1) 35.7m 2) 357m 3) 35.7 km 4) 3.57 m

RELATION BETWEEN B & E

8. **A point source of electromagnetic radiation has an average power output of 800W, The maximum value of electric field at a distance 3.5 m from the source will be 62.6 V/m, the maximum value of magnetic field will be -**

1. 2.09×10^{-5}T 2. 2.09×10^{-6}T 3. 2.09×10^{-7}T 4. 2.09×10^{-8}T

9. **A plane E.M. wave of frequency 40 MHz travels along X-axis. At same point at same instant, the electric field E has maximum value of 750 N/C in Y-direction. The magnitude and direction of magnetic field is**

1) $2.5\mu T$ along X-axis 2) $2.5\mu T$ along Y-axis

3) $2.5\mu T$ aloing Z-axis 4) $5\mu T$ along Z-axis

10. **A plane electromagnetic wave of frequency 25 MHz travels in free space along the x-direction. At a particular point in space and time $\overline{E} = 6.3\hat{j}$. The magnetic field $\overline{B}$ at this point is**

1) $4.2\times10^{-8}\hat{k}T$ 2) $2.1\times10^{-8}\hat{k}T$ 3) $18.9\times10^{8}\hat{k}T$ 4) $2.1\times10^{8}\hat{k}T$

MOMENTUM AND FORCE

11. **Light with energy flux $36 w/cm^2$ is incident on a well polished metal square plate of side 2cm. The force experienced by it is**

1) $0.96\mu N$ 2) $0.24\mu N$ 3) $0.12\mu N$ 4) $0.36\mu N$

ENERGY DENSITY

12. **The rms value of the electric field of the light coming from the sun is 720 N/C. The average total energy density of the electromagnetic wave is**

1) $3.3\times10^{-3} J/m^3$ 2) $4.58\times10^{-6} J/m^3$

3) $6.37\times10^{-9} J/m^3$ 4) $81.35\times10^{-12} J/m^3$

13. **In an electromagnetic wave, the amplitude of electric field is 1V/m. The frequency of wave is $5\times10^{14} Hz$. The wave is propagating along z-axis. The average energy**

density of electric field, in $Joule/m^3$, will be

1) 1.1×10^{-11} 2) 2.2×10^{-12} 3) 3.3×10^{-13} 4) 4.4×10^{-14}

INTENSITY

14. **About 5% of the power of a 100 W light bulb is converted to visible radiation. The average intensity of visible raditaion at a distance of 1 m from the bulb:**

1. $0.4\mathrm{W/m^2}$ 2. $0.5\mathrm{W/m^2}$ 3. $0.6\mathrm{W/m^2}$ 4. $0.8\mathrm{W/m^2}$

15. **The sun radiates electromagnetic energy at the rate of $3.9\times10^{26}W$. Its radius is $6.96\times10^{8}m$. The intensity of sun light at the solar surface will be (in W/m^2)**

1) 1.4×10^{4} 2) 2.8×10^{5} 3) 64×10^{6} 4) 5.6×10^{7}

16. **The intensity of TV broad cast station of $E=800\,Sin\left(10^9 t-k\,x\right)$ V/M is...... and the wave length in meter is ......**

1) $850\,wm^{-2};0.6\pi$ 2) $425\,wm^{-2};0.6\pi$ 3) $850\,wm^{-2};0.3\pi$ 4) $425\,wm^{-2};0.3\pi$

EXERCISE-III - KEY

1) 3 2) 2 3) 1 4) 2 5) 3 6) 4 7) 2 8) 3 9) 3 10) 2 11) 1
12) 2 13) 2 14) 1 15) 3 16) 1

EXERCISE - IV

DISPLACEMENT CURRENT

1. **A parallel plate condenser consists of two circular plates each of radius 2cm separated by a distance of 0.1mm. A time varying potential difference of $5\times10^{13}v/s$ is applied across the plates of the condenser. The displacement current is**

1) $5.50A$ 2) $5.56\times10^{2}A$ 3) $5.56\times10^{3}A$ 4) $2.28\times10^{4}A$

2. **A parallel plate condenser has conducting plates of radius 12cm separated by a distance of 5mm. It is charged with a constant charging current of 0.16 A, the rate at which the potential difference between the plate change is**

1) $1\times10^{9}\,Vs^{-1}$ 2) $2\times10^{10}\,Vs^{-1}$ 3) $3\times10^{12}\,Vs^{-1}$ 4) $2\times10^{9}\,Vs^{-1}$

MAGNETIC FIELD PRODUCED BETWEEN PLATES OF PARALLEL PLATE CAPACITOR

3. **A condenser has two conducting plates of radius 10cm separated by a distance of 5mm. It is charged with a constant current of 0.15A. The magnetic field at a point 2cm from the axis in the gap is**

1) $1.5\times10^{-6}T$ 2) $3\times10^{-8}T$ 3) $6\times10^{-8}T$ 4) $3\times10^{-6}T$

4. **An AC rms voltage of 2V having a frequency of 50 KHz is applied to a condenser of capacity of $10\mu F$. The maximum value of the magnetic field between the plates of the condenser if the radius of plate is 10cm is**

1) $0.4\,p\,\mu$ 2) $4\pi\,\mu T$ 3) $2\,\mu T$ 4) $40\pi\,\mu T$

WAVE EQUATION

5. **The wave emitted by any atom or molecule must have some finitetotal length which is known as the coherence length. For sodium light, this length is 2.4cm. The number of oscillations in this length will be Given** $\lambda = 5900 A^0$

1) $4.068\times10^5\ Hz$ 2) $4.068\times10^4\ Hz$ 3) $4.068\times10^6\ Hz$ 4) $4.068\times10^8\ Hz$

6. **A wave is propagating in a medium of dielectric constant 2 and relative permeability 50. The wave impedance is**

1) 5Ω 2) 376.6Ω 3) 3776Ω 4) 1883Ω

RELATION BETWEEN B & E

7. **The magnetic field in travelling EM wave has a peak value of 20nT. The peak value of electric field strength is (AIE : 2013)**

1) 6 V/m 2) 9 V/m 3) 12 V/m 4) 3 V/m

MOMENTUM AND FORCE

8. **A plane electromagnetic wave of wave intensity** 6W/m^2 **stikes a small mirror of area** $40\ \text{cm}^2$**, held prependicular to the approaching wave. The momentum transfered by the wave to the mirror each second will be**

1. 6.4×10^{-7}kg-m/s 2. 4.8×10^{-8}kg-m/s 3. 3.2×10^{-9}kg-m/s 4. 1.6×10^{-10}kg-m/s

9. **In the above question the radiation force on the mirror will be**

1. 6.4×10^{-7}N 2. 4.8×10^{-8}N 3. 3.2×10^{-9}N 4. 1.6×10^{-10}N

ENERGY DENSITY

10. **A point source of electromagnetic radiation has an average power output of 800W. The maximum value of electric field at a distance 3.5 m from the source will be 62.6 V/m, the energy density at a distance 3.5 m from the source will be - (in joule/m^3)**

1. 1.73×10^{-5} 2. 1.73×10^{-6} 3. 1.73×10^{-7} 4. 1.73×10^{-8}

11. **An electromagnetic radiation has an energy 14.4 KeV. To which region of electromagnetic spectrum does it belong?**

1. Infra red region 2. Visible region 3. X-rays region 4. γ- ray region

INTENSITY

12. **A laser beam can be focussed on an area equal to the square of its wavelength. A He-Ne laser radiates energy at the rate of 1mW and its wavelength is 600 nm. The intensity of focussed beam will be**

1) $3.2\times10^9 W/m^2$ 2) $2.8\times10^{13} W/m^2$ 3) $2.7\times10^9 W/m^2$ 4) $3.2\times10^{13} W/m^2$

13 **The intensity of solar radiation at the earths surface is** $1KW\,m^{-2}$**. The power entering the pupil of an eye of diameter 0.5 cm is**

1. 39.2 mw 2) 19.6 mw 3) 9.8 mw 4) 4.9 mw

EXERCISE-IV - KEY

1) 3 2) 4 3) 3 4) 3 5) 2 6) 4 7) 1 8) 4 9) 4 10) 4 11) 4
12) 3 13) 2

EXERCISE - V

DISPLACEMENT CURRENT

1. The area of each plate of a parallel plated condenser is $144\,cm^2$. The electrical field in the gap between the plates changes at the rate of $10^{12}\,V\,m^{-1}\,s^{-1}$. The displacement current is

1) $\frac{4}{\pi}A$ 2) $\frac{0.4}{\pi}A$ 3) $\frac{40}{\pi}A$ 4) $\frac{1}{10\pi}A$

2. A condenser having circular plates having radius 2cm and separated by a distance of 3mm. It is charged with a current of 0.1 A. The rate at which the potential difference between the plates change is

1) $9\times10^{10}V/S$ 2) $1.8\times10^{10}V/S$ 3) $2.7\times10^{6}V/S$ 4) $2.7\times10^{10}V/S$

3. An AC source having a frequency of 50 Hz and voltage supply of 300v is applied directly to the condenser of capacity $100\mu F$. The peak and rms values of displacement current are

1) $9.42\,A;\frac{9.42}{\sqrt{2}}A$ 2) $\frac{9.42}{\sqrt{2}}A;9.42\sqrt{2}A$

3) $9.42\sqrt{2}A;9.42A$ 4) $9.42A;9.42A$

MAGNETIC FIELD PRODUCED BETWEEN PLATES OF PARALLEL PLATE CAPACITOR

4. The capacity of a parallel plate condenser is 50 pF. A magnetic field of $4\times10^{-7}T$ is produced at a distance of 10cm from the axis of the gap. The charging current is

1) 0.1A 2) 0.2 A 3) 0.3 A 4) 0.15 A

5. The diameter of the condenser plate is 4cm. It is charged by an external current of 0.2A. The maximum magnetic field induced in the gap

1) $2\mu T$ 2) $4\mu T$ 3) $6\mu T$ 4) $8\mu T$

6. A condenser of capacity 50 p F is connected to an AC supply of 220 V 50 Hz. The rms value of magnetic field at a distance of 5cm from the axis is

1) $22\pi\,x10^{-14}T$ 2) $22\pi\,x10^{-12}T$ 3) $44\pi\,x10^{-13}T$ 4) $\frac{11}{5}\pi\,x10^{-12}T$

WAVE EQUATION

7. The velocity of an electromagnetic wave in a medium is $2\times10^{8}\,mS^{-1}$. If the relative

permeability is 1 the relative permittivity of the medium is $\left(C_0 = 3\times10^8 mS^{-1}\right)$

1) 2.25 2) 1.5 3) 4/9 4) 2/3

RELATION BETWEEN B & E

8. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of $2\times10^{10} Hz$ **and amplitude 48 V/m. The amplitude of oscillating magnetic field will be**

1) $\frac{1}{16}\times10^{-8} Wb/m^2$ 2) $16\times10^{-8} Wb/m^2$

3) $12\times10^{-7} Wb/m^2$ 4) $\frac{1}{12}\times10^{-7} Wb/m^2$

9. In an apparatus, the electric field was found to oscillate with amplitude of 18 V/m. The amplitude of the oscillating magnetic field will be

1) $4\times10^{-6} T$ 2) $6\times10^{-8} T$ 3) $9\times10^{-9} T$ 4) $11\times10^{-11} T$

MOMENTUM AND FORCE

10. Light with energy flux $36 Wm^{-2}$ **is incident on a circular part of radius 1.4 m of a perfectly black body. The force experienced by the body and the momentum delivered in 10 minutes are**

1) $2.2\mu N; 7.2\mu\, kgms^{-1}$ 2) $3.5\mu N; 7.4\mu\, kgms^{-1}$

3) $0.74\mu N; 444\mu\, kgms^{-1}$ 4) $7.4\mu N; 2.2\mu\, kgms^{-1}$

11. Light with energy flux $18\, wcm^{-2}$ **is incident on a mirror of size** $2cm\times2cm$ **normally. The force experienced by it and momentumdelivered in one minute are**

1) $0.48\,\mu N; 28.8\,\mu\, kgms^{-1}$ 2) $48\,\mu N; 2.88\,\mu\, kgms^{-1}$

3) $28.8\,\mu N; 4.8\,\mu\, kgms^{-1}$ 4) $0.24\,\mu N; 28.8\,\mu\, kgms^{-1}$

12. Electromagnetic radiation with energy flux $50 W\, cm^{-2}$ **is incident on a totally absorbing surface normally for 1 hour. If the surface has an area of** $0.05 m^2$**, then the average force due to the radiation pressure, on it is;**

1) $8.3\times10^{-7} N$ 2) $8.3\times10^{-5} N$ 3) $1.2\times10^{-7} N$ 4) $1.2\times10^{-5} N$

ENERGY DENSITY

13. In an electromagnetic wave in vacuum. The electrical and magnetic fields are $40\pi\, V/m$ **and** $0.4\times10^{-7} T$**. The Poynting vector**

1) $4.4 Wm^{-1}$ 2) $0.44 Wm^{-1}$ 3) $5.65 Wm^{-1}$ 4) $4.0 Wm^{-1}$

INTENSITY

14. The amplitude of magnetic field at a region carried by an electromagnetic wave

is $0.1\mu T$ **. The intensity of wave is**

1) $4\mu Wm^{-2}$ 2) $1.2Wm^{-2}$ 3) $4Wm^{-2}$ 4) $1.2\mu Wm^{-2}$

EXERCISE-V - KEY

1) 2 2) 4 3) 3 4) 2 5) 1 6) 2 7) 18) 2 9) 2 10) 3 11) 1
12) 2 13) 4 14) 2

EXERCISE - VI

1. A parallel plate capacitor of plate seperation 2 mm is connected in an electric circuit having source voltage 400V. If the plate area is $60\,cm^2$**, then the value of displacement current for** 10^{-6} sec. **will be-**

1. 1.062 amp. 2. 1.062×10^{-2} amp 3. 1.062×10^{-3} amp 4. 1.062×10^{-4} amp

2. A long straight wire of resistance R, radius 'a' and length 'l' carries a constant current 'I'. The poynting vector for the wire will be-

1. $\frac{IR}{2\pi al}$ 2. $\frac{IR^2}{al}$ 3. $\frac{I^2R}{al}$ 4. $\frac{I^2R}{2\pi al}$

3. To establish an instantaneous displacement current of 2A in the space between two parallel plates of $1\,\mu F$ **capacitor, the potential difference across the capacitor plates will have to be changed at the rate of**

1) $4\times10^4 V/s$ 2) $4\times10^6 V/s$ 3) $2\times10^4 V/s$ 4) $2\times10^6 V/s$

4. The sun delivers $10^3 W/m^2$ **of electromagnetic flux to the earth's surface. The total power that is incident on a roof of dimensions** $8m \times 20m$, **will be -**

1. 6.4×10^3 W 2. 3.4×10^4 W 3. 1.6×10^5 W 4. none of these

5. The sun delivers $10^3 W/m^2$ **of electromagnetic flux to the earth's surface. The total power that is incident on a roof of dimensions** $8m \times 20m$ **is** 1.6×10^5 W**, the radiation force on the roof will be -**

1. 3.33×10^{-5} N 2. 5.33×10^{-4} N 3. 7.33×10^{-3} N 4. 9.33×10^{-2} N

6. An electric field of 300V/m is confined to a circular area 10 cm in diameter. If the field is increasing at the rate of 20V/m-s, **the magnitude of magnetic field at a point 15cm from the centre of the circle will be-**

1. 1.85×10^{-15}T 2. 1.85×10^{-16}T 3. 1.85×10^{-17}T 4. 1.85×10^{-18}T

7. A lamp emits monochromatic green light uniformly in all directions. The lamp is 3% efficient in converting electrical power to electromagnetic waves and consumes 100W of power. The amplitude of the electric field associated with the electromagnetic radiation at a distance of 10m from tha lamp will be -

1. 1.34 V/m 2. 2.68 V/m 3. 5.36V/m 4.9.37 V/m

8. A flood light is covered with a filter that transmits red light. The electric field of the emerging beam is represented by a sinusoidal plane wave

$E_x = 36\sin\left(1.20\times10^7 z\text{-}3.6\times10^{15} t\right)$ V/m

The average intensity of the sun will be-

1. $0.86 W/m^2$ 2. $1.72 W/m^2$ 3. $3.44 W/m^2$ 4. $6.88 W/m^2$

9. **A plane electromagnetic wave of frequency 40 MHz travels in free space in the X-direction. At some point and at some instant, the electric field $\vec{E}$ has its maximum value of 750 N/C in Y-direction.The wavelength of the wave is-**

1. 3.5 m 2. 5.5 m 3. 7.5 m 4. 9.5 m

10. **A plane electromagnetic wave propagating in the x-direction has a wavelength of 60 mm. The electric field is in the y-direction and its maximum magnitude is $33 Vm^{-1}$. The equation for the electric field as function of x and t is**

1. $11\sin\pi\left(t - x/c\right)$ 2. $33\sin\pi\times10^{10}\left(t - x/c\right)$

3. $33\sin\pi\left(t - x/c\right)$ 4. $11\sin\pi\times10^{10}\left(t - x/c\right)$

EXERCISE-VI - KEY

1) 2 2) 4 3) 4 4) 3 5) 2 6) 4 7)1 8) 2 9) 3 10) 2

EXERCISE – I

1. For a concave mirror, whenever the distance of object is less than the focal length, the image is virtual. That is called virtual image, because :
(A) the image is formed behind the mirror
(B) the image is not inverted
(C) the image cannot be obtained on a screen
(D) the image can be located by virtue of parallax.
2. A real, inverted and equal in size image is formed by :
(A) a concave mirror (B) a convex mirror
(C) plane mirror (D) none of these
3. In case of concave mirror, the minimum distance between a real object and its real image is :
(A) f (B) 2f (C) 4f (D) zero
4. For a spherical mirror, the paraxial ray is the ray which :
(A) coincides with the principal axis (B) is near the principal axis
(C) is far away from the principal axis (D) is normal to the principal axis
5. A virtual image larger than a real object can be produced by :
(A) convex mirror (B) concave mirror (C) plane mirror (D) concave lens
6. In looking mirror or a window pane you find that your face appears larger than normal. The mirror or glass pane is :
(A) plane (B) concave (C) convex (D) none of these
7. Looking into a mirror one finds his image long and thn, the mirror is :
(A) concave (B) convex (C) cylindrical (D) parabolic
8. A real image is formed by a convex mirror, when the object is placed at :
(A) infinity (B) between centre of curvature and focus
(C) between focus and pole (D) none of the above
9. Mark the wrong statement about a virtual image :
(A) a virtual image can be photographed
(B) a virtual image can be seen
(C) a virtual image can be photographed by exposing a film at the location of the image
(D) a virtual image may be diminished or enlarged in size in comparison to an object
10. Check the only wrong statement out of the following :
(A) a convex mirror can give a virtual image
(B) a concave mirror can give a virtual image
(C) a concave mirror can give a diminished virtual image
(D) a concave mirror can give a real image
11. Which one of the following can produce a parallel beam of light from a point source of light ?
(A) Concave mirror (B) Convex mirror (C) Plane mirror (D) Concave lens
12. A convex mirror is used to form an image of a real object. Point out the wrong statement :
(A) the image lies between the pole and focus
(B) image is diminished in size

(C) image is erect (D) image is real

13. An inverted image of a real object can be seen in a convex mirror :
(A) under no circumstances
(B) when object is very far from the mirror
(C) when object is at a distance equal to the radius of the mirror
(D) when object is at a distance equal to the focal length of the mirror

14. A virtual object placed between the pole and the principal focus of a convex mirror produces the image which is :
(A) real, magnified and upright (B) virtual, diminished and inverted
(C) virtual, diminished and upright (D) real, diminished and inverted

15. A convex mirror has a focal length f. A real object placed at a distance f in front of it from the pole, produces an image at :
(A) infinity (B) f (C) f/2 (D) 2f

16. A concave mirror is used to form an image of the sun on a white screen. If the lower half of the mirror were covered with an opaque card, the effect on the image on the screen would be :
(A) to make the image less brighter than before
(B) to make the lower half of the image disappear
(C) to prevent the image from being focussed
(D) none of the above

17. Which of the following is used to obtain a wide angle rear view from the driver's seat in a car ?
(A) Plane mirror (B) Concave mirror (C) Convex mirror (D) Convex lens

18. Which of the following is used as the objective of a reflecting telescope ?
(A) Plane mirror (B) Concave mirror (C) Convex mirror (D) All of these

19. Which of the following are used in a kaleidoscope ?
(A) Plane mirrors (B) Concave mirrors (C) Convex mirrors (D) All of these

20. In a concave mirror an object is placed at a distance x_1 from the focus and the image is formed at a distance x_2 from the focus. Then the focal length of the mirror is :
(A) x_1x_2 (B) $\sqrt{x_1x_2}$ (C) $(x_1+x_2)/2$ (D) $\sqrt{x_1/x_2}$

21. A concave mirror of focal length f produces an image n times the size of the object. If the image is real, then the distance of the object from the mirror is :
(A) (n –1) f (B) [(n –1)/n] f (C) [(n + 1)/n] f (D) (n + 1) f

22. A convex mirror of focal length f produces an image (1/n)th of the size of the object. The distance of the object from the mirror is :
(A) nf (B) f/n (C) (n +1)f (D) (n – 1) f

23. A short linear object of length L lies on the axis of a spherical mirror of focal length f at a distance u from the mirror. Its image has an axial length L' equal to :
(A) $L\left[\frac{f}{(u-f)}\right]^{1/2}$ (B) $L\left[\frac{(u+f)}{f}\right]^{1/2}$ (C) $L\left[\frac{(u-f)}{f}\right]^{2}$ (D) $L\left[\frac{f}{(u+f)}\right]^{2}$

24. A thin convergent glass lens (μ_g = 1.5) has a power of + 5.0 D. When this lens is immersed in a liquid of refractive index μ_1 it acts as a divergent lens of focal length 100 cm. The value of μ_1 must be :
(A) 4/3 (B) 5/3 (C) 5/4 (D) 6/5

25. A convergent lens of focal length 20 cm and made of a material with refractive index 1.1 is immersed in water. The lens will behave as a :
(A) converging lens of focal length 20 cm
(B) converging lens of focal length less than 20 cm
(C) converging lens of focal length more than 20 cm
(D) divergent lens

26. Parallel rays of light are focussed by a thin convex lens. A thin concave of same focal length is then joined to the convex lens and the result is that :
(A) the focal point shifts away from the lens by a small distance
(B) the focal point shifts towards the lens by a small distance
(C) the focal point does not shift at all
(D) the focal point shift to infinity

27. A glass concave lens is placed in a liquid in which it behaves like a convergent lens. If the refractive indices of glass and liquid with respect to air are ${}^a\mu_g$ and ${}^a\mu_l$ respectively, then :
(A) ${}^a\mu_g = 5\,{}^a\mu_l$ (B) ${}^a\mu_g > {}^a\mu_l$ (C) ${}^a\mu_g < {}^a\mu_l$ (D) ${}^a\mu_g = 2\,{}^a\mu_l$

28. A double convex air bubble in water will behave as :
(A) convergent lens (B) divergent lens (C) plane glass slab (D) concave mirror

29. In case of a curved mirror if the distance of object (u) and image (v) are measured from the pole and a graph is plotted between (1/u) and (1/v), the graph is a :
(A) straight line passing through the origin
(B) straight line making an intercept with both u and v axes
(C) parabola (D) hyperbola

30. In case of a curved mirror if the object and image distances are measured from the focus and a graph is plotted between them, the graph will be a :
(A) straight line passing through the origin
(B) straight line not passing through the origin
(C) parabola (D) hyperbola

31. The sun (diameter = D) subtends an angle of θ radians at the pole of a concave mirror of focal length f. The diameter of the image of the sun formed by the mirror is :
(A) $f\,\theta$ (B) $2f\,\theta$ (C) $f^2\,\theta/D$ (D) D/θ

32. The focal length of a spherical mirror is :
(A) maximum for red light (B) maximum for blue light
(C) maximum for white light (D) same for all lights

33. If a spherical mirror is immersed in a liquid, its focal length will :
(A) increase (B) decrease
(C) remain unchanged (D) depend on the nature of liquid

34. A convex lens of focal length f will form a magnified real image of an object if the object is placed.
(A) between F and 2F (B) anywhere beyond F
(C) anywhere beyond 2F (D) between lens and F

35. The image produced by a concave lens is :
(A) always real (B) always virtual (C) always inverted (D) always enlarged

36. To obtain magnified virtual image of an object by a convex lens of focal length f, the distance between the object and the lens should be :
(A) > 4 f (B) between 2f and 4f
(C) < f (D) > 6 f

RAY OPTICS

37. The minimum distance between an object and its real image formed by a convex lens is :

(A) 2f (B) 4f (C) f (D) 0

38. An object is placed at a distance (f/2) from a convex lens. The image will be :

(A) at one of the foci, virtual and double in size

(B) at (3/2) f, real and inverted

(C) at 2f, virtual and erect (D) at f, real and inverted

39. A thin lens has focal length f and its aperture has diameter d. If forms an image of intensity I. Now, the central part of the aperture up to diameter (d/2) is blocked by an opaque paper. The focal length and image intensity will change to :

(A) (f/2) and (I/2) (B) f and (I/4) (C) (3f/4) and (I/2) (D) f and (3I/4)

40. A double convex thin lens made out of glass (μ=1.5) has both radii of curvature of 20 cm. Incident light rays parallel to the axis of the lens will converge at a distance of L cm such that :

(A) L = 10 (B) L = 20 (C) L = 40 (D) L = (20/3)

41. What is the power of a diverging lens of focal length 40 cm ?

(A) + 2.5 D (B) – 2.5 D (C) – 3.5 D (D) + 4.0 D

42. Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If the speed of light in the material of the lens is 2×10^8 m/s, the focal length of the lens is :

(A) 15 cm (B) 20 cm (C) 30 cm (D) 10 cm

43. Out of the following :

(1) pole (2) focus (3) radius of curvature and

(4) principal axis for a spherical mirror, the quantities that do not depend on whether the rays are paraxial or not, are :

(A) all (1), (2), (3) and (4) (B) only (1), (2) and (3)

(C) only (1), (3) and (4) (D) only (1) and (4)

44. Let the lateral magnification produced by a spherical mirror be m. Then for the same position of object and mirror the longitudinal magnification will be :

(A) m (B) $\sqrt{m}$ (C) m^2 (D) I/m

45. A luminous point is moving at speed v_0 towards a spherical mirror, along its axis. Then the speed at which the image of this point object is moving is given by (with R = radius of curvature and u = object distance)

(A) $v_i = -v_0$ (B) $v_i = -v_0\left(\frac{R}{2u-R}\right)$

(C) $v_i = -v_0\left(\frac{2u-R}{R}\right)$ (D) $v_i = -v_0\left(\frac{R}{2u-R}\right)^2$

46. For a concave mirror of focal length 20 cm, if the object is at a distance of 30 cm from the pole, then the nature of the image and magnification will be :

(A) real and – 2 (B) virtual and –2 (C) real and +2 (D) virtual and +2

47. To obtain a parallel reflected beam from a torch, the reflector of the torch should be

(A) plane mirror (B) spherical mirror (C) parabolic mirror (D) all of these

48. A square object of area 100 sq. cm is placed perpendicular to the principal axis of a concave mirror. If the lateral magnification of the mirror, for the above object position, is 0.4, then the area of the image will be :

(A) 16 sq. cm (B) 40 sq. cm (C) 100 sq. cm (D) 250 sq. cm

49. How will an image produced by a lens change, if half the lens is wrapped in black paper ?
(A) There will be no effect
(B) The size of the image will be reduced to one half
(C) The image will disappear
(D) The brightness of the image will be reduced

50. A magnifying glass is to be used at the fixed object distance of 2 cm. If it is to produce an erect image magnified 5 times, its focal length should be :
(A) 2.5 cm (B) – 2.5 cm (C) 5.0 cm (D) none of thes

51. A person standing in front of a mirror finds his image larger than himself. This implies that the mirror is
(A) concave (B) convex (C) plane (D) any of these

52. A person standing at some distance from a mirror finds his image erect, virtual and of the same size. Then the mirror is possibly :
(A) plane mirror (B) concave mirror
(C) plane or concave mirror (D) plane or concave or convex mirror

53. Two thin convex lenses of focal lengths 20 cm and 5 cm, respectively, are placed at a distance d. If a parallel beam incident on the first lens emerges as a parallel beam from the second lens, then the value of d is :
(A) 5 cm (B) 15 cm (C) 20 cm (D) 25 cm

54. A man standing in front of a concave spherical mirror of radius of curvature 120 cm sees an erect image of his face four times its natural size. Then the distance of the man from the mirror is :
(A) 180 cm (B) 300 cm (C) 240 cm (D) 45 cm

55. The nature of image of a candle flame located 40 cm from a concave spherical mirror is real, inverted and magnified four times. Then the radius of curvature of the mirror is :
(A) 32 cm (B) 64 cm (C) 48 cm (D) 80 cm

56. Concave mirrors are used :
(A) as reflectors in lamps
(B) as objectives in reflecting type of astronomical telescope
(C) in opthalmoscope
(D) in all of the above

57. The image of an object formed by a device is always virtual and small. The device may be :
(A) convex lens (B) concave mirror (C) a glass plate (D) concave lens

58. A double convex lens made of glass of refractive index 1.6 has radius of curvature 15 cm each. The focal length of this lens when immersed in a fluid of refractive index 1.63 is :
(A) – 407.5 cm (B) + 407. 5 cm (C) 125 cm (D) 25 cm

59. The focal length of a convex lens is f. An object is placed at a distance x from its first focal point. The ratio of the size of the real image to that of the object is :
(A) f/x^2 (B) x^2/f (C) f/x (D) x/f

60. A ray of light falls on the surface of a spherical paper weight making an angle α with the normal and is refracted in the medium at an angle β. The angle of deviation of the emergent ray from the direction of the incident ray is :
(A) $(\alpha - \beta)$ (B) $2(\alpha - \beta)$ (C) $(\alpha - \beta)/2$ (D) $(\beta - \alpha)$

RAY OPTICS

61. Given ${}^a\mu_g$ = 3/2 and ${}^a\mu_w$ = 4/3. There is an equiconvex lens with radius of each surface equal to 20 cm. There is air in the object space and water in the image space. The focal length of lens is :

(A) 80 cm (B) 40 cm (C) 20 cm (D) 10 cm

62. Focal length of a lens for red colour is :

(A) same as that for violet (B) greater than that for violet

(C) lesser than that of violet (D) none of thes

63. A double convex lens is made of glass which has its refractive index 1.55 for violet rays and 1.50 for red rays. If the focal length for violet rays is 20 cm, the focal length for red rays will be :

(A) 9 cm (B) 18 cm (C) 20 cm (D) 22 cm

64. Even in absolutely clear water, a diver cannot see very clearly :

(A) because rays of light get diffused

(B) because velocity of light is reduced in water

(C) because a ray of light passing through the water makes it turbid

(D) because focal length of the eye lens in water gets changed and image is no longer focussed sharply on the retina

65. The focal point of an equiconvex lens whose refractive index is 1.5, is 10 cm in air. Its focal point inside a liquid of refractive index 1.25 is :

(A) 20 cm (B) 25 cm (C) 30 cm (D) 50 cm

66. A lamp is placed 6.0 m from a wall. On putting a lens between the lamp and the wall at a distance of 1.2 m from the lamp, a real image of the lamp is formed on the wall. The magnification of the image is:

(A) 3 (B) 4 (C) 5 (D) 6

67. A diminished image of an object is to be obtained on a screen 1.0 m from it. This can be achieved by appropriately placing : **[IIT 1998]**

(A) a convex mirror of suitable focal length

(B) a convex mirror of suitable focal length

(C) a concave lens of suitable focal length

(D) a convex lens of suitable focal length less than 0.25 m.

68. A lens is placed between a source of light and a wall. It forms images of areas A_1 and A_2 on the wall for its two different positions. The area of the source was

(A) $(A_1/A_2)/2$ (B) $[(1/A_1) + (1/A_2)]^{-1}$

(C) $\sqrt{(A_1A_2)}$ (D) $[(\sqrt{A_1}+\sqrt{A_2})/2]^2$

69. A concave and a convex lens have the same focal length of 20 cm and are put into contact to form a lens combination. The combination is used to view an object of 5 cm length kept at 20 cm from the lens combination. As compared to the object, the image will be :

(A) magnified and inverted (B) reduced and erect

(C) of the same size as the object and would be erect

(D) of the same size as the object but would be inverted

70. A real image is formed by a convex lens. If we put it in contact with a concave lens and the combination again forms a real image, which of the following is true for the new image from the combination ?

(A) Shifts towards the lens system (B) Shift away from the lens system

(C) Remains at the original position (D) No image is formed

71. A concave mirror of focal length f in air is used in a medium of refractive index 2.

What will be the focal length of the mirror in the medium ?
(A) 4f (B) 2f (C) f/2 (D) None of these

72. A mirror always forms a virtual image of same size as the object. What is the focal length of the mirror?
(A) 1 cm (B) 1 m
(C) More than 1 m but not infinity (D) Infinity

73. The plane surface of a plano-convex lens of focal length f is silvered. It will behave as:
(A) plane mirror (B) convex mirror of focal length 2f
(C) convex mirror of focal length f/2 (D) none of the above

74. A concave lens of focal length 20 cm placed in contact with a plane mirror acts as a
(A) convex mirror of focal length 10 cm (B) concave mirror of focal length 40 cm
(C) concave mirror of focal length 60 cm (D) concave mirror of focal length 10 cm

75. A concave mirror of focal length f (in air) is immersed in water ($\mu = 4/3$). The focal length of mirror in water will be :
(A) f (B) (4/3) f (C) (3/4) f (D) (7/3) f

76. A symmetrical double convex lens is cut in two equal parts by a plane containing the principal axis. If the power of the original lens was 4D, the power of a divided lens will be :
(A) 2D (B) 3D (C) 4D (D) 5D

77. A convex lens of power P is immersed in water. How will its power change ?
(A) Increases (B) Decreases
(C) Remains unchanged
(D) Increases for red colour and decreases for blue colour

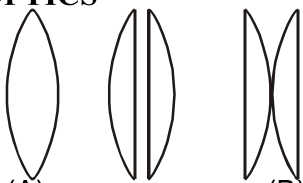
78. A convex mirror gives an image three times as large as the object placed at a distance of 20 cm from it. For the image to be real, the focal length should be :
(A) 10 cm (B) 15 cm (C) 20 cm (D) 30 cm

79. A lens of power + 3.5 D is placed in contact with a lens of power –2.5 D. The combination will behave like :
(A) a convergent lens of focal length 100 cm
(B) a divergent lens of focal length 100 cm
(C) a convergent lens of focal length 200 cm
(D) a divergent lens of focal length 200 cm

80. The distance between an object and the screen is 100 cm. A lens produces an image on the screen when placed at either of the positions 40 cm apart. The power of the lens is :
(A) $\simeq$ 3D (B) $\simeq$ 5 D (C) $\simeq$ 7 D (D) $\simeq$ 9 D

81. The plane face of a plano-convex lens of focal length 20 cm is silvered. What type of mirror will it become and of what focal length f ?
(A) Convex, f = 20 cm (B) Concave, f = 20 cm
(C) Convex, f = 10 cm (D) Concave, f = 10 cm

82. A convex lens of focal length 20 cm is cut into two equal parts so as to obtain two plano-convex lens as shown in figure. The two parts are then put in contacts as shown in figure. What is the focal length of the combination ?

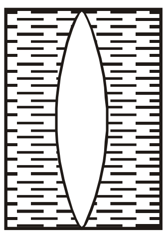


(A) zero (B) 5 cm (C) 10 cm (D) 20 cm

83. The plane faces of two identical plano-convex lenses, each having focal length of 40 cm, are placed against each other to form a usual convex lens. The distance from this lens at which an object must be placed to obtain a real, inverted image with magnification one is :

(A) 80 cm (B) 40 cm (C) 20 cm (D) 160 cm

84. As shown in figure, a convergent lens is placed inside a cell filled with liquid. The lens has focal length + 20 cm when in air, and its material has refractive index 1.50. If the liquid has refractive index 1.60, the focal length of the system is :



(A) + 80 cm (B) – 80 cm (C) – 24 cm (D) – 100 cm

85. A double convex thin lens made out of glass (refractive index μ = 1.5) has both radii of curvature of magnitude 20 cm. Incident light parallel to the axis of the lens will converge at a distance d cm such that :

(A) d = 10 (B) d = 20/3 (C) d = 40 (D) d = 20

86. A beam of parallel rays is brought to a focus by a plano-convex lens. If a thin concave lens of the same focal length is joined to the first lens, then :

(A) focus shifts to infinity (B) focus remains undisturbed
(C) focal point shifts towards the lens (D) focal point shifts away from the lens

87. In the displacement method, a convex lens is placed in between an object and a screen. If the magnifications in the two positions are m_1 and m_2 and the displacement of the lens between the two positions is x, then the focal length of the lens is :

(A) $\frac{x}{(m_1+m_2)}$ (B) $\frac{x}{(m_1-m_2)}$ (C) $\frac{x}{(m_1+m_2)^2}$ (D) $\frac{x}{(m_1-m_2)^2}$

88. The plane face of a plano-convex lens is silvered. If μ be the refractive index and R, the radius of curvature of curved surface, then the system will behave like a concave mirror of radius of curvature:

(A) μR (B) R/(μ – 1) (C) R^2/μ (D) [(μ+1)/(μ–1)] R

89. A convex lens of focal length f is placed somewhere in between an object and a screen. The distance between the object and the screen is x. If the numerical value of the magnification produced by the lens is m, the focal length of the lens is :

(A) $\frac{mx}{(m+1)^2}$ (B) $\frac{mx}{(m-1)^2}$ (C) $\frac{(m+1)^2}{m}x$ (D) $\frac{(m-1)^2}{m}x$

90. The distance between object and the screen is D. Real images of an object are

formed on the screen for two position of a lens separated by a distance d. The ratio between the sizes of two images will be:

(A) D/d (B) D^2/d^2 (C) $(D-d)^2/(D+d)^2$ (D) $\sqrt{(D/d)}$

91. A thin lens has focal length f, and its aperture has diameter d. It forms an image of intensity I. Now, the central part of the aperture up to diameter d/2 is blocked by an opaque paper. The focal length and image intensity will change to

(A) f/2 and I/2 (B) f and I/4 (C) 3f/4 and I/2 (D) f and 3I/4

92. A concave mirror and a convex lens are of the same focal length in air. When they are immersed in water:

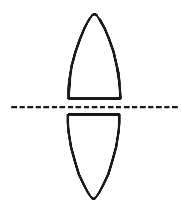
(A) the concave mirror will have its focal length increased

(B) the convex lens will have its focal length increased

(C) they will have equal focal length, different from those in air

(D) they will have equal focal lengths, same as those in the air

93. A point object is placed beyond the focus of a convex lens cut into two halves, each of which are separated by a small distance. Then the number of images formed will be :



(A) zero (B) one (C) two (D) four

94. A thin plano-convex lens acts like a concave mirror of focal length 0.2 m, when silvered on its plane surface. The refractive index of the material of lens is 1.5. The radius of curvature of the convex surface of the lens will be :

(A) 0.1 m (B) 0.2 m (C) 0.4 m (D) 0.8

95. A convex lens of focal length 0.15 m is made of a material of refractive index 3/2. When it is placed in a liquid, its focal length is increased by 0.225 m. The refractive index of the liquid is:

(A) $\frac{7}{4}$ (B) $\frac{5}{4}$ (C) $\frac{9}{4}$ (D) $\frac{3}{2}$

96. A luminous object is placed at a distance of 30 cm from a convex lens of focal length 20 cm. On the other side of the lens, at what distance from the lens must a convex mirror of radius of curvature 10 cm be placed in order to have an upright image of the object coincident with it ?

(A) 30 cm (B) 60 cm (C) 50 cm (D) 12 cm

97. A convex lens of focal length f produces an image 1/n times that of the size of the object. The distance of the object from the lens is :

(A) $\frac{f}{n}$ (B) nf (C) (n – 1) f (D) (n + 1) f

98. A convex mirror gives an image three times as large as the object placed at a distance of 20 cm from it. For the image to be real, the focal length should be :

(A) 15 cm (B) 10 cm (C) 30 cm (D) 20 cm

99. A point object is placed at a distance of 30 cm from a convex mirror of focal length

30 cm. The image will from at :

(A) infinity (B) focus (C) pole (D) 15 cm behind the mirror

100. The equivalent focal length of the two lenses in contact is 80 cm. If the focal length of one of the lens is 20 cm, find the power of the second lens :

(A) 1.66 D (B) 3.75 D (C) – 3.75 D (D) – 1.66 D

101. The power of the lens a short-sighted person uses is – 2 dioptre. Find the maximum distance of an object, which he can see without spectacles :

(A) 25 cm (B) 50 cm (C) 100 cm (D) 10 cm

102. The focal length of an equiconvex lens in air is equal to either of its radii of curvature. The refractive index of the material of the lens is :

(A) 4/3 (B) 2.5 (C) 0.8 (D) 1.5

103. A satisfactory photographic print is obtained when the exposure time is 10 sec at a distance of 2 m from a 60 Cd lamp. The time of exposure required for the same quality print at a distance of 4 m from a 120 Cd lamp is :

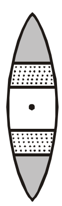
(A) 5 sec (B) 10 sec (C) 15 sec (D) 20 sec

104. A convex lens forms an image of an object on a screen 30 cm from the lens. When the lens is moved 90 cm towards the object the image is again formed on the screen. Then the focal length of the lens is:

(A) 13 cm approximately (B) 23 cm approximately

(C) 33 cm approximately (D) 40 cm approximately

105. A convex lens is made up of three different materials as shown in the figure. For a point object placed on its axis, the number of images formed are :



(A) 1 (B) 3 (C) 4 (D) 5

106. Two identical glass (μ_g = 3/2) equiconvex lenses of focal length f are kept in contact. The space between the two lenses is filled with water (μ_w = 4/3). The focal length of the combination is :

(A) f (B) $\frac{f}{2}$ (C) $\frac{4f}{3}$ (D) $\frac{3f}{4}$

107. An object is kept at a distance of 16 cm from a thin lens and the image formed is real. If the object is kept at a distance of 6 cm from the same lens the image formed is virtual. If the size of the images formed are equal, the focal length of the lens will be :

(A) 15 cm (B) 17 cm (C) 21 cm (D) 11 cm

108. A concave lens forms the image of an object such that the distance between the object and image is 10 cm and the magnification produced is 1/4. The focal length of the lens will be:

(A) 8.6 cm (B) 6.2 cm (C) 10 cm (D) 4.4 cm

109. The magnification of an object placed in front of a convex lens of focal length 20 cm is + 2. To obtain a magnification of –2, the object has to be moved a distance equal to :

(A) 10 cm (B) 20 cm (C) 30 cm (D) 40 cm

110. For a real object, which of the following can produce a real image ?

(A) Plane mirror (B) Concave lens (C) Convex mirror (D) Concave mirror

111. The maximum magnification that can be obtained with a convex lens of focal length 2.5 cm(the least distance of distinct vision is 25 cm) :

(A) 10 (B) 0.1 (C) 62.5 (D) 11

112. Two lenses of power 6D and – 2D are combined to form a single lens. The focal length of this lens will be :

(A) $\frac{3}{2}$m (B) $\frac{1}{4}$m (C) 4 m (D) $\frac{1}{8}$m

113. An object of length 6 cm is placed on the principle axis of a concave mirror of focal length f at a distance of 4f. The length of the image will be :

(A) 2 cm (B) 12 cm (C) 4 cm (D) 1.2 cm

114. An object is placed 20 cms apart from a convex lens of 10 cms focal length. The distance of its image from the lens is :

(A) 10 cm (B) 30 cm (C) 15 cm (D) 20 cm

115. An object 2.5 cm high is placed at a distance of 10 cm from a concave mirror of radius of curvature 30 cm. The size of the image is :

(A) 9.2 mm (B) 10.5 mm (C) 5.6 mm (D) 7.5 mm

116. For a convex lens the distance of the object is taken on x-axis and the distance of the image is taken on y-axis, the nature of the graph so obtained is :

(A) hyperbola (B) parabola (C) circle (D) straight line

117. Two thin lenses, one of focal length + 60 cm and the other of focal length – 20 cm are put in contact. The combined focal length is :

(A) – 30 cm (B) + 30 cm (C) – 15 cm (D) + 15 cm

118. A candle placed 25 cm from a lens, forms an image on a screen placed 75 cm on the other end of the lens. The focal length and type of the lens should be :

(A) + 18.75 cm and convex lens (B) – 18.75 cm and concave lens
(C) + 20.25 cm and convex lens (D) – 20.25 cm and concave lens

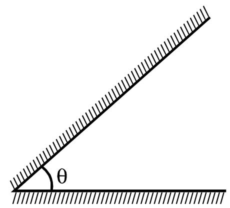
EXERCISE – I(KEY)

1. C	2. A	3. D	4. B	5. B	6. B	7. C	8. D	9. C	10. C	11. A
12. D	13. A	14. A	15. C	16. A	17. B	18. C	19. A	20. B	21. C	22. D
23. C	24. B	25. D	26. D	27. C	28. B	29. B	30. D	31. A	32. D	33. C
34. A	35. B	36. C	37. B	38. A	39. D	40. B	41. B	42. C	43. C	44. C
45. D	46. A	47. C	48. A	49. D	50. A	51. A	52. A	53. D	54. D	55. B
56. D	57. A	58. A	59. B	60. C	61. B	62. B	63. D	64. D	65. B	66. D
67. D	68. C	69. C	70. B	71. D	72. D	73. C	74. D	75. A	76. C	77. D
78. B	79. A	80. B	81. D	82. D	83. B	84. D	85. D	86. A	87. B	88. B
89. A	90. C	91. D	92. B	93. C	94. B	95. B	96. C	97. D	98. A	99. A
100.C	101.B	102.D	103.D	104.D	105.B	106.D	107.D	108.D	109.B	110.D
111.A	112.B	113.A	114.D	115.D	116.B	117.A	118.A			

EXERCISE – II

1. Two plane mirrors are inclined to each other at an angle 60^0. If a ray of light incident on the first mirror is parallel to the second mirror, it is reflected from the second mirror
(A) Perpendicular to the first mirror (B) Parallel to the first mirror
(C) Parallel to the second mirror (D) Perpendicular to the second mirror

2. Two mirrors are inclined at an angle θ as shown in the figure. Light ray is incident parallel to one of the mirrors. The ray will start retracing its path after third reflection if :



(A) $\theta = 45°$ (B) $\theta = 30°$ (C) $\theta = 60°$ (D) all three

3. Two plane mirrors are parallel to each other and spaced 20 cm apart. An object is kept in between them at 15 cm from A. Out of the following at which point(s) image(s) is/are not formed in mirror A (distance measured from mirror A):
(A) 15 cm (B) 25 cm (C) 45 cm (D) 55 cm

4. A point object is kept in front of a plane mirror. The plane mirror is doing SHM of amplitude 2 cm. The plane mirror moves along the x-axis and x- axis is normal to the mirror. The amplitude of the mirror is such that the object is always infront of the mirror. The amplitude of SHM of the image is
(A) zero (B) 2 cm (C) 4 cm (D) 1 cm

5. A person's eye level is 1.5 m. He stands in front of a 0.3m long plane mirror which is 0.8 m above the ground. The length of the image he sees of himself is:
(A) 1.5m (B) 1.0m (C) 0.8m (D) 0.6m

6. A person is standing in a room of width 200 cm. A plane mirror of vertical length 10 cm is fixed on a wall in front of the person. The person looks into the mirror from distance 50 cm. How much width (height) of the wall behind him will he be able to see:
(A) 30 cm (B) 40 cm (C) 50 cm (D) none of these

7. An unnumbered wall clock shows time 04: 25: 37, where 1st term represents hours, 2nd represents minutes & the last term represents seconds. What time will its image in a plane mirror show.
(A) 08: 35: 23 (B) 07: 35: 23 (C) 07: 34: 23 (D) none of these

8. A plane mirror is moving with velocity $4\hat{i} + 5\hat{j} + 8\hat{k}$. A point object in front of the mirror moves with a velocity $3\hat{i} + 4\hat{j} + 5\hat{k}$. Here $\hat{k}$ is along the normal to the plane mirror and facing towards the object. The velocity of the image is:
(A) $-3\hat{i} - 4\hat{j} + 5\hat{k}$ (B) $3\hat{i} + 4\hat{j} + 11\hat{k}$ (C) $-3\hat{i} - 4\hat{j} + 11\hat{k}$ (D) $7\hat{i} + 9\hat{j} + 11\hat{k}$

9. Images of an object placed between two plane mirrors whose reflecting surfaces make an angle of 90^0 with one another lie on a :
(A) straight line (B) zig-zag curve (C) circle (D) ellipse

10. A concave mirror of radius of curvature 20 cm forms image of the sun. The diameter of the sun subtends an angle 1° on the earth. Then the diameter of the image is (in cm):

(A) 2 $\pi/9$ (B) $\pi/9$ (C) 20 (D) $\pi/18$

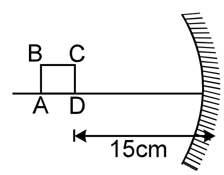
11. A candle is kept at a distance equal to double the focal length from the pole of a convex mirror. Its magnification will be:
(A) – 1/3 (B) 1/3 (C) 2/3 (D) – 2/3

12. An object is kept perpendicular to the principal axis of a convex mirror of radius of curvature 20 cm. If the distance of the object from the mirror is 20 cm then its magnification will be:
(A) + 1/3 (B) – 1/3 (C) – 1 (D) none of these

13. An object of height 1 cm is kept perpendicular to the principal axis of a convex mirror of radius of curvature 20 cm. If the distance of the object from the mirror is 20 cm then the distance between tips of the image and the object will be:
(A) $\sqrt{\frac{6404}{9}}$ (B) $\sqrt{\frac{6414}{9}}$ (C) $\frac{40}{3}$ (D) none of these

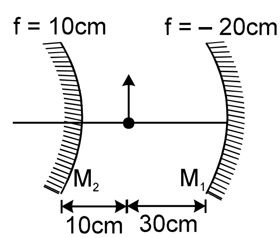
14. An object is kept between a plane mirror and a concave mirror facing each other. The distance between the mirrors is 22.5 cm. The radius of curvature of the concave mirror is 20 cm. What should be the distance of the object from the concave mirror so that after two successive reflections the final image is formed on the object itself: [Consider first reflection from concave mirror]
(A) 5 cm (B) 15 cm (C) 10 cm (D) 7.5 cm

15. A square ABCD of side 1mm is kept at distance 15 cm infront of the concave mirror as shown in the figure. The focal length of the mirror is 10 cm. The length of the perimeter of its image will be :



(A) 8 mm (B) 2 mm (C) 12 mm (D) 6 mm

16. In the figure shown find the total magnification after two successive reflections first on M_1 & then on M_2



(A) + 1 (B) – 2 (C) + 2 (D) – 1

17. A luminous point object is moving along the principal axis of a concave mirror of focal length 12 cm towards it. When its distance from the mirror is 20 cm its velocity is 4 cm/s. The velocity of the image in cm/s at that instant is
(A) 6, towards the mirror (B) 6, away from the mirror
(C) 9, away from the mirror (D) 9, towards the mirror.

18. A particle is moving towards a fixed spherical mirror. The image:
(A) must move away from the mirror
(B) must move towards the mirror
(C) may move towards the mirror

(D) will move towards the mirror, only if the mirror is convex.

19. A point object on the principal axis at a distance 15 cm in front of a concave mirror of radius of curvature 20 cm has velocity 2 mm/s perpendicular to the principal axis. The velocity of image at that instant will be:
(A) 2 mm/s (B) 4 mm/s (C) 8 mm/s (D) none of these

20. A point object at 15 cm from a concave mirror of radius of curvature 20 cm is made to oscillate along the principal axis with amplitude 2 mm. The amplitude of its image will be
(A) 2 mm (B) 4 mm (C) 8 mm (D) none of these

21 The distance of an object from the focus of a convex mirror of radius of curvature ' a ' is ' b '. Then the distance of the image from the focus is:
(A) $b^2 / 4a$ (B) a / b^2 (C) $a^2 / 4b$ (D) none of these

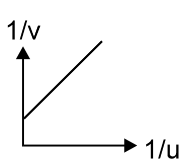
22. A concave mirror cannot form:
(A) virtual image of virtual object (B) virtual image of a real object
(C) real image of a real object (D) real image of a virtual object

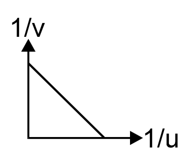
23. The largest distance of the image of a real object from a convex mirror of focal length 20 cm can be:
(A) 20 cm (B) infinite
(C) 10 cm (D) depends on the position of the object

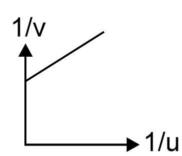
24. Which of the following can form erect, virtual, diminished image?
(A) plane mirror (B) concave mirror (C) convex mirror (D) none of these

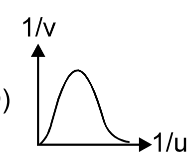
25. I is the image of a point object O formed by spherical mirror, then which of the following statement is incorrect :
(A) If O and I are on same side of the principal axis, then they have to be on opposite sides of the mirror.
(B) If O and I are on opposite sides of the principal axis, then they have to be on same side of the mirror.
(C) If O and I are on opposite side of the principal axis, then they can be on opposite side of the mirror as well.
(D) If O is on principal axis then I has to lie on principal axis only.

26. An object is placed at a distance *u* from a concave mirror and its real image is received on a screen placed at a distance of *v* from the mirror. If *f* is the focal length of the mirror, then the graph between 1/*v* versus 1/*u* is

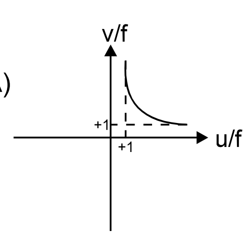
(A) 

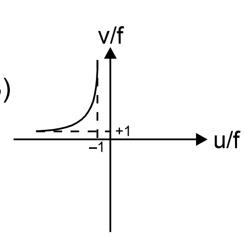
(B) 

(C) 

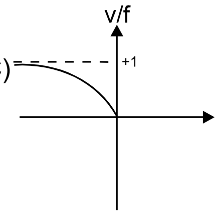
(D) 

27. A real inverted image in a concave mirror is represented by (u, v, f are coordinates)

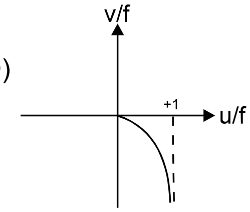
(A) 

(B) 

(C)



(D)



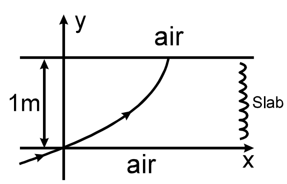
28. When a wave is refracted:
(A) its path must change
(B) its amplitude must change
(C) its velocity must change
(D) its frequency must change

29. The wavelength of light in vacuum is 6000 ^{0}A and in a medium it is 4000 ^{0}A. The refractive index of the medium is:
(A) 2.4
(B) 1.5
(C) 1.2
(D) 0.67

30. A ray of light passes from vacuum into a medium of refractive index n. If the angle of incidence is twice the angle of refraction, then the angle of incidence is:
(A) $\cos^{-1}(n/2)$
(B) $\sin^{-1}(n/2)$
(C) $2\cos^{-1}(n/2)$
(D) $2\sin^{-1}(n/2)$

31. A ray of light is incident on a parallel slab of thickness *t* and refractive index *n*. If the angle of incidence θ is small, than the displacement in the incident and emergent ray will be:
(A) $\frac{t\theta(n-1)}{n}$
(B) $\frac{t\theta}{n}$
(C) $\frac{t\theta n}{n-1}$
(D) none

32. A ray of light travelling in air is incident at grazing angle on a slab with variable refractive index, $n(y) = [k y^{3/2} + 1]^{1/2}$ where $k = 1\ m^{-3/2}$ and follows path as shown. What is the total deviation produced by slab when the ray comes out.

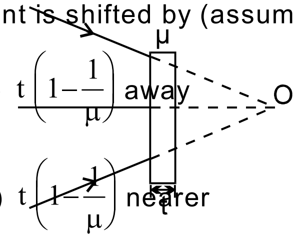


(A) 60°
(B) 53°
(C) $\sin^{-1}(4/9)$
(D) no deviation at all

33. A ray incident at a point at an angle of incidence of 60^0 enters a glass sphere of $\mu = \sqrt{3}$ and it is reflected and refracted at the farther surface of the sphere. The angle between reflected and refracted rays at this surface is
(A) 50^0
(B) 90^0
(C) 60^0
(D) 40^0

34. How much water should be filled in a container of 21 cm in height, so that it appears half filled (of total height of the container) when viewed from the top of the container ?
(Assume near normal incidence and μ_w=4/3)
(A) 8.0 cm
(B) 10.5 cm
(C) 12.0 cm
(D) 14.0 cm

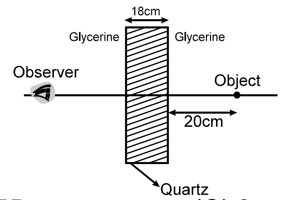
35. A beam of light is converging towards a point. A plane parallel plate of glass of thickness t, refractive index μ is introduced in the path of the beam. The convergent point is shifted by (assume near normal incidence):



(A) $t\left(1-\frac{1}{\mu}\right)$ away
(B) $t\left(1+\frac{1}{\mu}\right)$ away
(C) $t\left(1-\frac{1}{\mu}\right)$ nearer
(D) $t\left(1+\frac{1}{\mu}\right)$ nearer

36. Given that, velocity of light in quartz = 1.5×10^8 m/s and velocity of light in glycerine

= (9/4) × 10^8 m/s. Now a slab made of quartz is placed in glycerine as shown. The shift of the object produced by slab is



(A) 6 cm (B) 3.55 cm (C) 9 cm (D) 2 cm

37. An object is seen through a glass slab of thickness 36 cm and refractive index 3/2. The observer, object and the slab are dipped in water (n = 4/3). The shift produced in the position of the object is:
(A) 12 cm (B) 4 cm
(C) cannot be calculated (D) 9/2 cm

38. The critical angle of light going from medium A to medium B is θ. The speed of light in medium A is v. The speed of light in medium B is:
(A) $\frac{v}{\sin\theta}$ (B) v sin θ (C) v cot θ (D) v tan θ

39. A ray of monochromatic light is incident on one refracting face of a prism of angle 75^0. It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is
(A) 30^0 (B) 45^0 (C) 60^0 (D) 0^0

40. A prism having refractive index $\sqrt{2}$ and refracting angle 30º, has one of the refracting surfaces polished. A beam of light incident on the other refracting surface will retrace its path if the angle of incidence is:
(A) 0º (B) 30º (C) 45º (D) 60º

41. A ray of light is incident at angle *i* on a surface of a prism of small angle A & emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, the angle of incidence *i* is nearly equal to:
(A) A/μ (B) A/(2 μ) (C) μ A (D) μ A/2

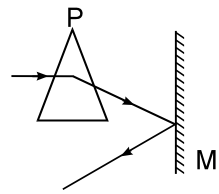
42. A beam of monochromatic light is incident at i = 50^0 on one face of an equilateral prism, the angle of emergence is 40^0, then the angle of minimum deviation is:
(A) 30^0 (B) < 30^0 (C) ≤ 30^0 (D) ≥ 30^0

43. A prism of refractive index $\sqrt{2}$ has refracting angle 60º. In order that a ray suffers minimum deviation it should be incident at an angle :
(A) 45^0 (B) 90^0 (C) 30^0 (D) none

44. For a glass prism (μ= $\sqrt{2}$) the angle of minimum deviation is equal to the refracting angle of the prism. The angle of the prism is:
(A) 80^0 (B) 45^0 (C) 60^0 (D) 90^0

45. The maximum refractive index of a material of a prism of apex angle 90^0 for which light will be transmitted is:
(A) $\sqrt{3}$ (B) 1.5 (C) $\sqrt{2}$ (D) None of these

46. A prism having an apex angle of 4^0 and refractive index of 1.50 is located in front of a vertical plane mirror as shown. A horizontal ray of light is incident on the prism. The total angle through which the ray is deviated is

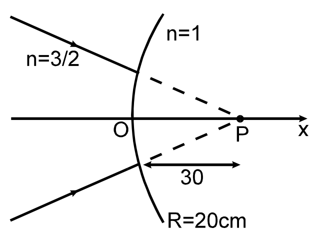


(A) 4^0 clockwise (B) 178^0 clockwise (C) 2^0 clockwise (D) 8^0 clockwise

47. There is a small black dot at the centre C of a solid glass sphere of refractive index μ. When seen from outside, the dot will appear to be located:
(A) away from C for all values of μ
(B) at C for all values of μ
(C) at C for μ = 1.5, but away from C for $\mu \neq 1.5$
(D) at C only for $\sqrt{2} \leq \mu \leq 1.5$.

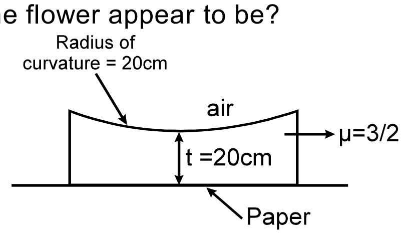
48. A fish is near the centre of a spherical water filled fish bowl . A child stands in air at a distance 2 R (R is radius of curvature of the sphere) from the centre of the bowl . At what distance from the centre would the child's nose appear to the fish situated at the centre (R.I. of water = 4/3)
(A) 4R (B) 2R (C) 3R (D) R

49. The image for the converging beam after refraction through the curved surface is formed at:



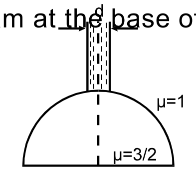
(A) x = 40 cm (B) x = $\frac{40}{3}$ cm (C) x = $-\frac{40}{3}$ cm (D) x = $\frac{180}{7}$ cm

50. A planoconcave lens is placed on a paper on which a flower is drawn. How far above its actual position does the flower appear to be?



(A) 10 cm (B) 15 cm (C) 50 cm (D) none of these

51. A beam of diameter ‘d‘ is incident on a glass hemisphere as shown. If the radius of curvature of the hemisphere is very large in comparison to d, then the diameter of the beam at the base of the hemisphere will be:



(A) $\frac{3}{4}$ d (B) d (C) $\frac{d}{3}$ (D) $\frac{2}{3}$ d

RAY OPTICS

52. The power (in diopters) of an equi convex lens with radii of curvature of 10 cm & refractive index 1.6 is:

(A) + 12 (B) – 12 (C) + 1.2 (D) – 1.2

53. A convexo - concave diverging lens is made of glass of refractive index 1.5 and focal length 24 cm. Radius of curvature for one surface is double that of the other. Then radii of curvature for the two surfaces are (in cm):

(A) 6, 12 (B) 12, 24 (C) 3, 6 (D) 18, 36

54. Two symmetric double convex lenses A and B have same focal length, but the radii of curvature differ so that $R_A = 0.9\ R_B$. If $n_A = 1.63$, find n_B.

(A) 1.7 (B) 1.6 (C) 1.5 (D) 4/3

55. When a lens of power P (in air) made of material of refractive index μ is immersed in liquid of refractive index μ_0. Then the power of lens is:

(A) $\frac{\mu - 1}{\mu - \mu_0}$ P (B) $\frac{\mu - \mu_0}{\mu - 1}$ P (C) $\frac{\mu - \mu_0}{\mu - 1} \cdot \frac{P}{\mu_0}$ (D) none of these

56. A lens behaves as a converging lens in air and a diverging lens in water. The refractive index of the material is (refractive index of water = 1.33)

(A) equal to unity (B) equal to 1.33
(C) between unity and 1.33 (D) greater than 1.33

57. The diameter of the sun subtends an angle of 0.5^0 at the surface of the earth. A converging lens of focal length 100 cm is used to provide an image of the sun on to a screen. The diameter in mm of the image formed is about

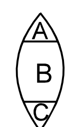
(A) 1 (B) 3 (C) 5 (D) 9

58. A thin lens of focal length f and its aperture diameter d, forms a real image of intensity I. Now the central part of the aperture upto diameter (d/2) is blocked by an opaque paper. The focal length and image intensity would change to

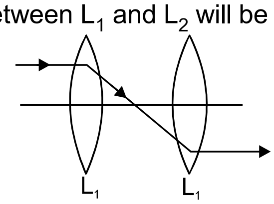
(A) f/2, I/2 (B) f, I/4 (C) 3f/4, I/2 (D) f, 3I/4

59. A thin symmetrical double convex lens of power P is cut into three parts, as shown in the figure. Power of A is:

(A) 2 P (B) $\frac{P}{2}$ (C) $\frac{P}{3}$ (D) P

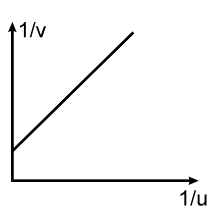


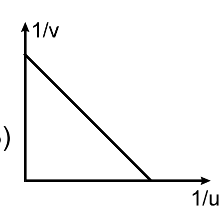
60. In the figure given below, there are two convex lens L_1 and L_2 having focal length of f_1 and f_2 respectively. The distance between L_1 and L_2 will be

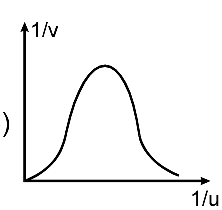


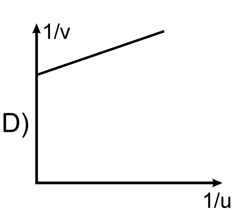
(A) f_1 (B) f_2 (C) $f_1 + f_2$ (D) $f_1 - f_2$

61. An object is placed at a distance *u* from a **converging lens** and its real image is received on a screen placed at a distance of *v* from the lens. If *f* is the focal length of the lens, then the graph between 1/*v* versus 1/*u* is:

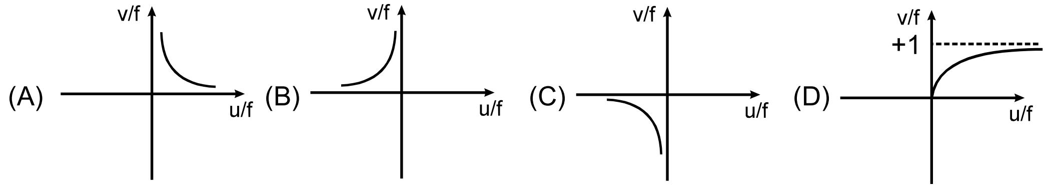
(A) 

(B) 

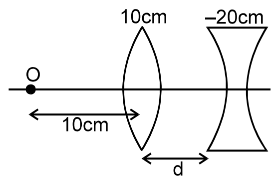
(C) 

(D) 

62. A virtual erect image by a **diverging lens** is represented by (u, v, f are coordinates)



63. What should be the value of distance d so that final image is formed on the object itself. (focal lengths of the lenses are written on the lenses).



(A) 10 cm (B) 20 cm (C) 5 cm (D) none of these

64. A thin linear object of size 1 mm is kept along the principal axis of a convex lens of focal length 10 cm. The object is at 15 cm from the lens. The length of the image is:
(A) 1 mm (B) 4 mm (C) 2 mm (D) 8 mm

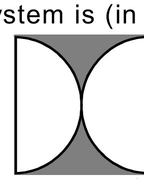
65. A biconvex lens is used to project a slide on screen. The slide is 2 cm high and 10 cm from the lens. The image is 18 cm high. What is the focal length of the lens?
(A) 9 cm (B) 18 cm (C) 4.5 cm (D) 20 cm

66. The minimum distance between a real object and its real image formed by a thin convex lens of focal length f is
(A) 4f (B) 2f (C) f (D) f/2

67. A plano-convex lens, when silvered at its plane surface is equivalent to a concave mirror of focal length 28 cm. When its curved surface is silvered and the plane surface not silvered, it is equivalent to a concave mirror of focal length 10 cm, then the refractive index of the material of the lens is:
(A) 9/14 (B) 14/9 (C) 17/9 (D) none

68. In the above question the radius of curvature of the curved surface of plano-convex lens is :
(A) $\frac{280}{9}$ cm (B) $\frac{180}{7}$ cm (C) $\frac{39}{3}$ cm (D) $\frac{280}{11}$ cm

69. Two plano-convex lenses each of focal length 10 cm & refractive index $\frac{3}{2}$ are placed as shown. In the space left, water $\left(\text{R.I.}=\frac{4}{3}\right)$ is filled. The whole arrangement is in air. The optical power of the system is (in diopters):



(A) 6.67 (B) - 6.67 (C) 33.3 (D) 20

70. The focal length of a plano-concave lens is – 10 cm, then its focal length when its plane surface is polished is:

(A) 20 cm (B) – 5 cm (C) 5 cm (D) none of these

71. A convex lens of focal length 25 cm and a concave lens of focal length 20 cm are mounted coaxially separated by a distance d cm. If the power of the combination is zero, *d* is equal to
(A) 45 (B) 30 (C) 15 (D) 5

72. The dispersion of light in a medium implies that :
(A) lights of different wavelengths travel with different speeds in the medium
(B) lights of different frequencies travel with different speeds in the medium
(C) the refractive index of medium is different for different wavelengths
(D) all of the above.

73. Critical angle of light passing from glass to air is minimum for
(A) red (B) green (C) yellow (D) violet

74. A plane glass slab is placed over various coloured letters. The letter which appears to be raised the least is:
(A) violet (B) yellow (C) red (D) green

75. A medium has $n_v = 1.56$, $n_r = 1.44$. Then its dispersive power is:
(A) 3/50 (B) 6/25 (C) 0.03 (D) none of these

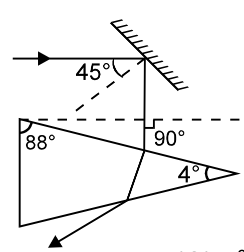
76. All the listed things below are made of flint glass. Which one of these have greatest dispersive power (ω).
(A) prism (B) glass slab (C) biconvex lens (D) all have same ω

77. A thin prism P_1 with angle 4^0 made of glass of refractive index 1.54 is combined with another thin prism P_2 made of glass of refractive index 1.72 to produce dispersion without deviation. The angle of the prism P_2 is :
(A) 3^0 (B) 2.6^0 (C) 4^0 (D) 5.33^0

78. Light of wavelength 4000 Å is incident at small angle on a prism of apex angle 4°. The prism has
$n_v = 1.5$ & $n_r = 1.48$. The angle of dispersion produced by the prism in this light is:
(A) 0.2° (B) 0.08° (C) 0.192° (D) none of these

79. An object is placed 30 cm (from the reflecting surface) in front of a block of glass 10 cm thick having its farther side silvered. The image is found to be at 23.2 cm behind the silvered face, by an observer infront of the block. The refractive index of glass is :
(A) 1.41 (B) 1.46 (C) 200/ 132 (D) 1.61

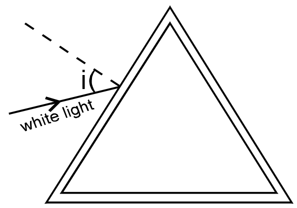
80. A ray of light strikes a plane mirror at an angle of incidence 45° as shown in the figure. After reflection, the ray passes through a prism of refractive index 1.50, whose apex angle is 4°. The angle through which the mirror should be rotated if the total deviation of the ray is to be 90° is :



(A) 1^0 clockwise (B) 1^0 anticlockwise (C) 2^0 clockwise (D) 2^0 anticlockwise

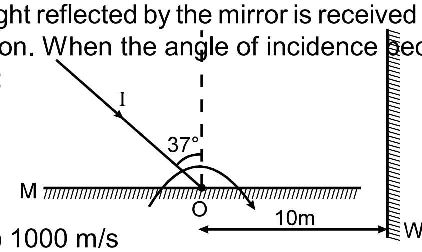
81. When the object is at distances u_1 & u_2 the images formed by the same lens are real and virtual respectively and of the same size. Then focal length of the lens is:
(A) $\frac{1}{2}\sqrt{u_1u_2}$ (B) $\frac{u_1+u_2}{2}$ (C) $\sqrt{u_1u_2}$ (D) $2(u_1 + u_2)$

82. A beam of white light is incident on hollow prism of glass. Then :



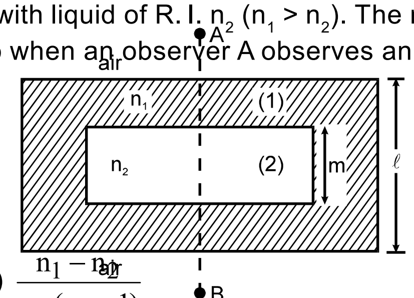
(A) the light emerging from prism gives no dispersion
(B) the light emerging from prism gives spectrum but the bending of all colours is away from base.
(C) the light emerging from prism gives spectrum, all the colours bend towards base, the violet the most and red the least.
(D) the light emerging from prism gives spectrum, all the colours bend towards base, the violet the least and red the most.

83. A light ray I is incident on a plane mirror M. The mirror is rotated in the direction as shown in the figure by an arrow at frequency $9/\pi$ rps. The light reflected by the mirror is received on the wall W at a distance 10 m from the axis of rotation. When the angle of incidence becomes 37° the speed of the spot (a point) on the wall is:



(A) 10 m/s (B) 1000 m/s
(C) 500 m/s (D) none of these

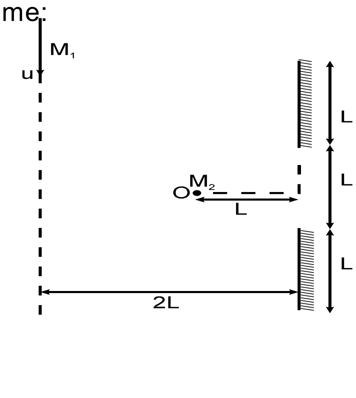
84. In a thick glass slab of thickness ℓ and refractive index n_1 a cuboidal cavity of thickness 'm' is carved as shown in the figure & is filled with liquid of R. I. n_2 ($n_1 > n_2$). The ratio of ℓ/m, so that shift produced by this slab is zero when an observer A observes an object B with paraxial rays is:



(A) $\frac{n_1 - n_2}{n_2 - 1}$ (B) $\frac{n_1 - n_2}{n_2 (n_1 - 1)}$

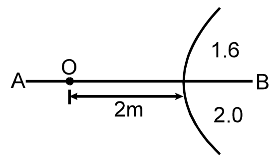
(C) $\frac{n_1 - n_2}{n_1 - 1}$ (D) $\frac{n_1 - n_2}{n_1 (n_2 - 1)}$

85. Two plane mirrors of length L are separated by distance L and a man M_2 is standing at distance L from the connecting line of mirrors as shown in figure. A man M_1 is walking in a straight line at distance 2 L parallel to mirrors at speed u, then man M_2 at O will be able to see image of M_1 for time:



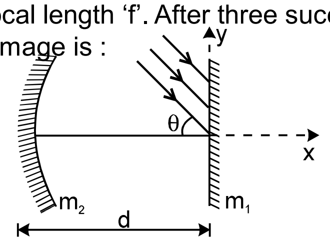
(A) $\frac{4L}{u}$ (B) $\frac{3L}{u}$ (C) $\frac{6L}{u}$ (D) $\frac{9L}{u}$

86. In the figure shown a point object O is placed in air. A spherical boundary of radius of curvature 1.0 m separates two media. AB is principal axis. The refractive index above AB is 1.6 and below AB is 2.0. The separation between the images formed due to refraction at spherical surface is:



(A) 12 m (B) 20 m (C) 14 m (D) 10 m

87. In the figure shown a thin parallel beam of light is incident on a plane mirror m_1 at small angle 'θ'. m_2 is a concave mirror of focal length 'f'. After three successive reflections of this beam the x and y coordinates of the image is :



(A) $x = f - d,\ y = f\theta$ (B) $x = d + f,\ y = f\theta$ (C) $x = f - d,\ y = -f\theta$ (D) $x = d - f,\ y = -f\theta$

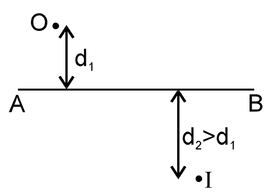
88. The distance between an object and its doubly magnified image by a concave mirror is: [Assume f = focal length]

(A) 3 f/2 (B) 2 f/3 (C) 3 f

(D) depends on whether the image is real or virtual.

89. In the figure shown, the image of a real object is formed at point I. AB is the principal axis of the mirror. The mirror must be:

(A) concave & placed towards right of I



(B) concave & placed towards left of I

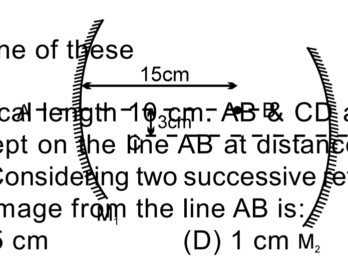
(C) convex & placed towards right of I

(D) convex & placed towards left of I.

90. An object is kept on the principal axis of a convex mirror of focal length 10 cm at a distance of 10 cm from the pole. The object starts moving at a velocity 20 mm/sec towards the mirror at angle 30° with the principal axis. What will be the speed of its image & direction with the principal axis at that instant.

(A) speed = $5\frac{\sqrt{7}}{4}$ mm/sec (B) speed = $5\sqrt{7}$ mm/sec

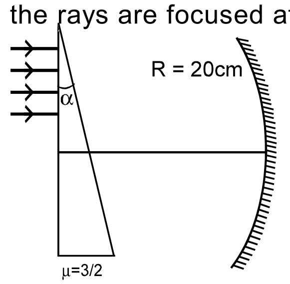
(C) $\tan^{-1}\frac{2}{\sqrt{3}}$ with the principal axis (D) none of these



91. M_1 & M_2 are two concave mirrors of the same focal length 10 cm. AB & CD are their principal axes respectively. A point object O is kept on the line AB at distance 15 cm from M_1. The distance between the mirrors 20 cm. Considering two successive reflections first on M_1 and then on M_2. The distance of final image from the line AB is:

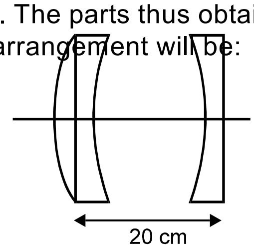
(A) 3 cm (B) 1.5 cm (C) 4.5 cm (D) 1 cm

92. A parallel beam of light is incident on the upper part of a prism of angle 1.8º & R.I. 3/2. The light coming out of the prism falls on a concave mirror of radius of curvature 20 cm. The distance of the point (where the rays are focused after reflection from the mirror) from the principal axis is:



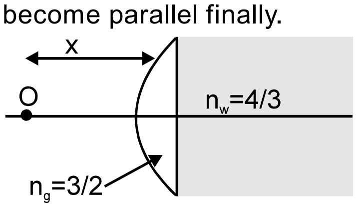
(A) 9 cm
(B) 1.5 7 mm
(C) 3.14 mm
(D) none of these

93. A symmetrical converging convex lens of focal length 10 cm & diverging concave symmetrical lens of focal length – 20 cm are cut from the middle & perpendicularly and symmetrically to their principal axis. The parts thus obtained are arranged as shown in the figure. The focal length of this arrangement will be:



(A) ∞ (B) 20 cm (C) 40 cm (D) 80 cm

94. An object ' O ' is kept in air in front of a thin plano convex lens of radius of curvature 10 cm. It's refractive index is 3/2 and the medium towards right of plane surface is water of refractive index 4/3. What should be the distance ' x ' of the object so that the rays become parallel finally.



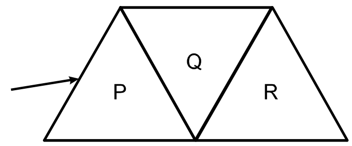
(A) 5 cm (B) 10 cm (C) 20 cm (D) none of these

95. For a prism of apex angle 45^0, it is found that the angle of emergence is 45^0 for grazing incidence. Calculate the refractive index of the prism.
(A) $(2)^{1/2}$ (B) $(3)^{1/2}$ (C) 2 (D) $(5)^{1/2}$

96. A concave lens of glass, refractive index 1.5, has both surfaces of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a
(A) convergent lens of focal length 3.5R (B) convergent lens of focal length 3.0 R.
(C) divergent lens of focal length 3.5 R (D) divergent lens of focal length 3.0 R
[JEE ’99, 2/100]

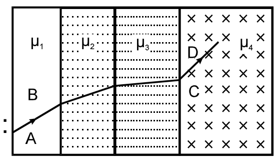
97. **[JEE 2001 (Screening 3/105 Each]**

(i) A given ray of light suffers minimum deviation in an equilateral prism P Additional prisms Q and R of identical shape and of the same material as P are now added as shown in the figure. The ray will now suffer.



(A) greater deviation
(B) no deviation
(C) same deviation as before
(D) total internal reflection

(ii) ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 & μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have:

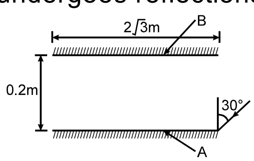


(A) $\mu_1 = \mu_2$ (B) $\mu_2 = \mu_3$ (C) $\mu_3 = \mu_4$ (D) $\mu_4 = \mu_1$

[JEE 2001 (Mains) 5/100 Each]

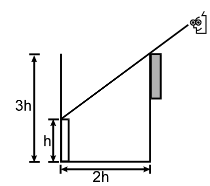
98. **[JEE Screening 2002, 3/105 Each]**

(i) Two plane mirrors A & B are aligned parallel to each other, as shown in the figure. A light ray is incident to an angle of 30º at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is:



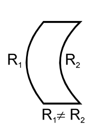
(A) 28 (B) 30 (C) 32 (D) 34

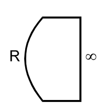
(ii) An observer can see through a pinhole the top end of a thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can see the lower end of the rod. Then the refractive index of the liquid is:

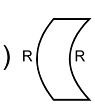


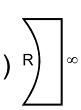
(A) $\frac{5}{2}$ (B) $\sqrt{\frac{5}{2}}$ (C) $\sqrt{\frac{3}{2}}$ (D) $\frac{3}{2}$

(iii) Which one of the following spherical lenses does not exhibit dispersion? The radii of curvature of the surface of the lenses are as given in the diagrams.

(A) 

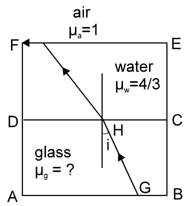
(B) 

(C) 

(D) 

99. **[JEE 2003 (Screening) 3/90 Each]**

(i) In ray of light (CH) is incident on the glass-water interface DC at an angle 'i'. It emerges in air along the water-air interface EF (see figure). If the refractive index of water μ_w is 4/3, the refractive index of glass μ_g is :



(A) $\frac{3}{4\sin i}$ (B) $\frac{1}{\sin i}$ (C) $\frac{4\sin i}{3}$ (D) $\frac{4}{3\sin i}$

(ii) A thin convex lens of focal length 30 cm forms an image 2 cm high, of an object at infinity. A thin concave lens of focal length 20 cm is placed 26 cm from the convex lens on the side of the image. The height of the image now is :

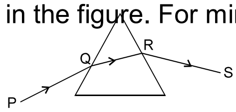
(A) 1.0 cm (B) 1.25 cm (C) 2 cm (D) 2.5 cm

100. A point object is situated at the centre of a solid glass sphere of radius 6cm and refractive index 1.5 . The distance of its virtual image from the surface of the sphere is.

[JEE 2004 (Scr.) 3/84]

(A) 4 cm (B) 6 cm (C) 9 cm (D) 12 cm

101. An equilaterial prism is kept on a horizontal surface. A typical ray of light PQRS is shown in the figure. For minimum deviation **[JEE 2004 (Scr.), 3/84]**



(A) the ray PQ must be horizontal (B) the ray RS must be horizontal
(C) the ray QR must be horizontal (D) any one of them can be horizontal

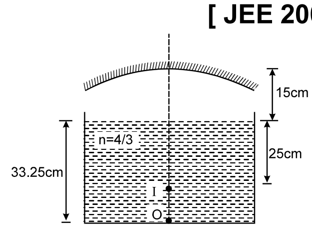
102. A ray of white light is incident on an interface between glass and air from glass towards air. The angle of incidence is such that the green light just suffers total internal reflection. The ray of light emerging from glass to air contains:

[JEE 2004 (Scr.), 3/84]

(A) red, orange and yellow colours (B) violet, indigo and blue colour
(C) all colours (D) all colours except green

103. Figure shows object O. Final image I is formed after two refractions and one reflection is also shown in figure. Find the focal length of mirror. (in cm) :

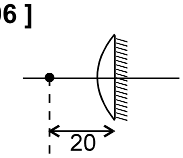
[JEE 2005 (Scr) 3/60]



(A) 10 (B) 15 (C) 20 (D) 25

104. A point object is placed at distance of 20 cm from a thin planoconvex lens of focal length 15 cm. The plane surface of the lens is now silvered. The image created by the system is at :

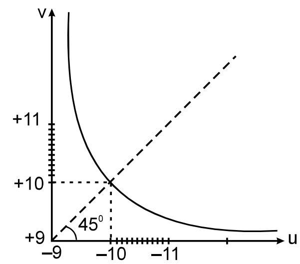
[JEE 2006]



(A) 60 cm to the left of the system. (B) 60 cm to the right of the system.
(C) 12 cm to the left of the system. (D) 12 cm to the right of the system.

105. The graph between object distance u and image distance v for a lens is given below. The focal length of the lens is:

[JEE 2006]



(A) 5 ± 0.1 (B) 5 ± 0.05 (C) 0.5 ± 0.1 (D) 0.5 ± 0.05

106. A biconvex lens of focal lengthf forms a circular image of radius r of sun in focal plane. Then which option is correct:

[JEE 2006]

(A) $\pi r^2 \propto f$ (B) $\pi r^2 \propto f^2$
(C) If lower half part is convered by black sheet, then area of the image is equal to $\pi r^2/2$
(D) if f is doubled, intensity will increase

EXERCISE– II (KEY)

1. B	2. B	3. C	4. C	5. D	6. C	7. C	8. B	9. C	10. D	11. B
12. A	13. A	14. D	15. C	16. C	17. C	18. C	19. B	20. C	21. C	22. A
23. A	24. C	25. C	26. B	27. A	28. C	29. B	30. C	31. A	32. D	33. B
34. D	35. A	36. A	37. B	38. A	39. B	40. C	41. C	42. B	43. A	44. D
45. C	46. B	47. B	48. C	49. A	50. A	51. D	52. A	53. A	54. A	55. C
56. C	57. D	58. D	59. D	60. C	61. B	62. D	63. A	64. B	65. A	66. A
67. B	68. A	69. A	70. C	71. D	72. D	73. D	74. C	75. B	76. D	77. A
78. D	79. C	80. B	81. B	82. A	83. B	84. B	85. C	86. A	87. D	88. A
89. B	90. C	91. B	92. B	93. D	94. C	95. D	96. A			

97. (i) C (ii) D 98. (i) B (ii) B (iii) C 99. (i) B (ii) D 100. B 101. C 102. A 103. C
104.C 105. B 106. B

EXERCISE - I

INTERFERENCE

1. **The displacements of two interfering light waves are $y_1 = 4\sin\omega t$ and $y_2 = 3\cos(\omega t)$. The amplitude of the resultant wave is (y_1 and y_2 are in CGS system)**

   1) 5cm 2) 7cm 3) 1 cm 4) zero

2. **Two coherent sources of different intensities send waves that interfere. The ratio of maximum to minimum intensity is 25. The intensity ratio of the sources is**

   1) 25 : 1 2) 5 : 1 3) 9 : 4 4) 625 : 1

3 **Two sources of intensity $2I$ and $8I$ are used in an interference experiment. The intensity at a point where the waves from two sources superimpose with a phase difference of (a) zero (b) $\pi/2$ $and\,(c)\,\pi$ is**

   1) $18I, 10I, 2I$ 2) $5I, 4I, I$ 3) $2I, I, \frac{I}{2}$ 4) $2I, 10I, 18I$

4. **The intensity of interference waves in an interference pattern is same as I_0. The resultant intensity at the point of observation will be**

   1) $I = 2I_0[1+\cos\phi]$ 2) $I = I_0[1+\cos\phi]$ 3) $I = \frac{[1+\cos\phi]}{I_0}$ 4) $I = \frac{[1+\cos\phi]}{2I_0}$

5. **In Young's double slit experiment, the constant phase difference between two sources is $\frac{\pi}{2}$. The intensity at a point equidistant from the slits in terms of maximum intensity I_0 is**

   1) I_0 2) $I_0/2$ 3) $3I_0/4$ 4) $3I_0$

6. **The path difference between two interfering waves at a point on the screen is $\lambda/6$ from central maximum. The ratio of intensity at this point and that at the central fringe will be**

   1) 0.75 2) 7.5 3) 85.3 4) 853

7. **In a Young's double slit experiment, 12 fringes are observed to be formed in a certain region of the screen when light of wavelength 600 nm is used. If the light of wavelength 400 nm is used, the number of fringes observed in the same region of the screen will be**

   1) 12 2) 18 3) 24 4) 8

8. **A double slit apparatus is immersed in a liquid of refractive index 1.33. It has slit separation of 1mm and distance between the plane of slits and screen 1.33 m. The slits are illuminated by a parallel beam of light whose wavelength in air is $6300A^0$. The fringe width is**

   1) $(1.33\times 0.63)mm$ 2) $\frac{0.63}{1.33}mm$ 3) $\frac{0.63}{(1.33)^2}mm$ 4) $0.63mm$

9. **The fringe width at a distance of 50cm from the slits in young's experiment for light of wavelength $6000A^0$ is 0.048cm. The fringe width at the same distance for $\lambda = 5000A^0$ will be**

1) 0.04cm 2) 0.4cm 3) 0.14cm 4)0.45cm

10. **In young's double slit experiment the two slits are illuminated by light of wavelength 5890^0A and the distance between the fringes obtained on the screen is 0.2^0. If the whole apparatus is immersed in water then the angular fringe width will be, if the refractive index of water is 4/3**

1) 0.30^0 2) 0.15^0 3) 15^0 4) 30^0

11. **A plate of thickness t made of material of refractive index μ is placed in front of one of the slits in a double slit experiment. What should be the minimum thickness t which will make the intensity at the centre of the fringe pattern zero?**

1) $(\mu-1)\frac{\lambda}{2}$ 2) $(\mu-1)\lambda$ 3) $\frac{\lambda}{2(\mu-1)}$ 4) $\frac{\lambda}{(\mu-1)}$

12. **In Young's double slit experiment the separation between the slits is halved and the distance between the slits and screen is doubled . The fringe width is**

1) unchanged 2) halved 3) doubled 4) quadrupled

13. **The maximum number of possible interference maxima for slit separation equal to twice the wavelength in Young's double slit experiment is**

1) infinite 2) five 3) three 4) zero

14. **Two identical coherent sources produce a zero order bright fringe on a screen. If β is the band width, the minimum distance between two points on either side of the bright fringe where the intensity is half that of maximum intensity is**

1) β/2 2) β/4 3) β/3 4) β/6

15. **In Young's double slit experiment, the 8th maximum with wavelength λ_1 is at a distance d_1 from the central maximum and the 6th maximum with wavelength λ_2 is at a distance d_2 from central maximum. Then, d_1/d_2 is equal to**

1) $\frac{4}{3}\left(\frac{\lambda_2}{\lambda_1}\right)$ 2) $\frac{4}{3}\left(\frac{\lambda_1}{\lambda_2}\right)$ 3) $\frac{3}{4}\left(\frac{\lambda_2}{\lambda_1}\right)$ 4) $\frac{3}{4}\left(\frac{\lambda_1}{\lambda_2}\right)$

DIFFRACTION

16. **First diffraction minima due to a single slit diffraction is at $\theta = 30^0$ for a light of wavelength $6000A^0$. The width of slit is**

1) $1\times10^{-6}cm$ 2) $1.2\times10^{-6}m$ 3) $2\times10^{-6}cm$ 4) $2.4\times10^{-6}m$

17. **In a single slit diffraction, the width of slit is 0.5 cm, focal length of lens is 40cm and wavelength of light is $4890\,A^0$. The distance of first dark fringe is**

1) $2\times10^{-5}\,m$ 2) $4\times10^{-5}\,m$ 3) $6\times10^{-5}\,m$ 4) $8\times10^{-5}\,m$

18. **Angular width of central maxima is $\pi/2$. When a slit of width 'a' is illuminated by a light of wavelength $7000A^0$ then a =**

1) $9\times10^{-9}m$ 2) $8.9\times10^{-7}m$ 3) $9\times10^{-7}m$ 4) $9.8\times10^{-7}m$

RESOLVING POWER

19. **The sun subtends an angle of $(1/2)^0$ on earth. The image of sun is obtained on the screen with the help of a convex lens of focal length 100 cm the diameter of the image obtained on the screen will be**

1) 18 cm 2) 1 mm 3) 50 cm 4) 8.73 mm

20. **The limit of resolution of microscope, if the numerical aperture of microscope is 0.12, and the wavelength of light used is 600 nm, is**

1) 0.3 μm 2) 1.2 μm 3) 2.5 μm 4) 3 μm

21. **The least resolvable angle by a telescope using objective of aperture 5 m is nearly** $\left(\lambda = 4000 A^0\right)$

1) $\frac{1}{50^0}$ 2) $\frac{1}{50}$ *minute* 3) $\frac{1}{50}$ sec 4) $\frac{1}{500}$ sec

22. **Wavelength of light used in an optical instrument are** $\lambda_1 = 4000 A^0$ **and** $\lambda_2 = 5000 A^0$**, then ratio of their respective resolving powers (corresponding to** λ_1 **and** λ_2**) is**

1) 16 : 25 2) 9 : 1 3) 4 : 5 4) 5 : 4

POLARISATION

23. **The angle of incidence at which reflected light is totally polarised for reflection from air to glass (refractive index *n*) is**

1) $\sin^{-1}(n)$ 2) $\sin^{-1}(1/n)$ 3) $\tan^{-1}(1/n)$ 4) $\tan^{-1}(n)$

24. **A light ray is incident on a transparent medium of** μ **= 1.732 at the polarising angle. The angle of refraction is**

1) 60^0 2) 30^0 3) 45^0 4) 90^0

25. **A ray of light in air is incident on a glass plate at polarising angle of incidence. It suffers a deviation of 22^0 on entering glass. The angle of polarization is**

1) 90^0 2) 56^0 3) 68^0 4) Zero

26. **The critical angle for total internal reflection for a substance is 45^0. The polarizing angle for this substance is** $\left(\tan 54^0 44' = \sqrt{2}\right)$

1) $46^0 16^1$ 2) $54^0 44^1$ 3) $46^0 44^1$ 4) $54^0 16^1$

27. **Unpolarized light of intensity I_0 is incident on a polarizer and the emerging light strikes a second polarizing filter with its axis at 45^0 to that of the first. The intensity of the emerging beam**

1) $\frac{I_0}{2}$ 2) $\frac{I_0}{4}$ 3) I_0 4) $\frac{I_0}{3}$

28. **The axes of the polariser and analyser are inclined to each other at** 60^0**. If the amplitude of polarised light emergent through analyser is A. The amplitude of unpolarised light incident on polariser is**

1) $\frac{A}{2}$ 2) A 3) $2A$ 4) $2\sqrt{2}A$

29. **Unpolarised light of intensity** I **is incident on a polarizer and the emerging light strikes a second polarizing filter with its axis at** 45^0 **to that of the first. Determine**
a) the intensity of the emerging beam and
b) its state of polarization

1) $\frac{I}{4}$ and parallel to second filter 2) $\frac{I}{4}$ and perpendicular to second filter

3) $\frac{I}{8}$ and parallel to second filter 4) $\frac{I}{8}$ and perpendicular to second filter

HUYGEN'S PRINCIPLE

30. A parallel beam of width 'a' is incident on the surface of glass slab $(\mu = 3/2)$ at an angle 'i' and the angle of refraction in glass is 'r'. The width of the refracted parallel beam will be

1) equal to a 2) less than a 3) more than a 4) exactly 2a/3

31. When a parallel beam of monochromatic light suffers refraction while going from a rarer medium into a denser medium, which of the following are correct?

a) the width of the beam decreases
b) the width of the beam increases
c) the refracted beam makes more angle with the interface
d) the refracted beam makes less angle with the interface

1) a, c true 2) b, d true 3) a, d true 4) b, c true

32. A parallel beam of light in incident on a liquid surface such that the wave front makes an angle 30^0 with the surface and has a width of $\sqrt{3}$ m, the width of the refracted beam is ___ (${}_a\mu_L = \sqrt{3}$)

1) 3 m 2) $\sqrt{3}$ m 3) $\frac{\sqrt{11}}{3}$ m 4) $\sqrt{\frac{11}{3}}$ m

EXERCISE- I - KEY

1) 1	2) 3	3) 1	4) 1	5) 2	6) 1	7) 2	8) 4	9) 1	10) 2	11) 3
12) 4	13) 2	14) 2	15) 2	16) 2	17) 2	18) 4	19) 4	20) 4	21) 3	22) 4
23) 4	24) 2	25) 2	26) 2	27) 2	28) 4	29) 1	30) 3	31) 4	32) 4	

EXERCISE - II

INTERFERENCE

1. The displacements of two interfering light waves are $y_1 = 2\sin\omega t$ and $y_2 = 5\sin\left(\omega t + \frac{\pi}{3}\right)$ the resultant amptitude is

1) 39 cm 2) $\sqrt{39}\,cm$ 3) 7 cm 4) $\sqrt{29}\,cm$

2. The intensity ratio of two waves is 9 : 1. If they produce interference, the ratio of maximum to minimum intensity will be

1) 4 : 1 2) 2 : 1 3) 9 : 1 4) 3 : 2

3. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\pi/2$ at point A and π at point B. then the difference between the resultant intensities at A and B is

1) $2I$ 2) $4I$ 3) $5I$ 4) $7I$

4. The maximum intensity in Young's double slit experiment is I_0. What will be the intensity of light in front of one of the slits on a screen where path difference is $\frac{\lambda}{4}$?

1) $\frac{I_0}{2}$ 2) $\frac{3}{4}I_0$ 3) I_0 4) $\frac{I_0}{4}$

5. In Young's double slit experiment, we get 60 fringes in the field of view of

monochromatic light of wavelength $4000\,A^o$. If we use monochromatic light of wavelength $6000\,A^o$, then the number of fringes obtained in the same field of view are

1) 60   2) 90   3) 40   4) 1.5

6. **The separation between successive fringes in a double slit arrangement is x. If the whole arrangement is dipped under water, what will be the new fringe separation? [The wavelength of light being used is 5000 Å]**

1) 1.5 x   2) x   3) 0.75 x   4) 2x

7. **In the Young's double slit experiment, a mica slip of thickness t and refractive index μ is introduced in the ray from first source S_1. By how much distance fringes pattern will be displaced?**
(d=distance between the slits and D is the distance between slits and screen)

1) $\frac{d}{D}(\mu-1)t$ 2) $\frac{D}{d}(\mu-1)t$ 3) $\frac{d}{(\mu-1)D}$ 4) $\frac{D}{d}(\mu-1)$

8. **In young's double slit experiment, the 10th maximum of wave length λ_1 is at a distance of y_1 from the central maximum. When the wavelength of the source is changed to λ_2, 5th maximum is at a distance of y_2 from its central maximum. Then $\frac{y_1}{y_2}$ is**

1) $\frac{2\lambda_1}{\lambda_2}$ 2) $\frac{2\lambda_2}{\lambda_1}$ 3) $\frac{\lambda_1}{2\lambda_2}$ 4) $\frac{\lambda_2}{2\lambda_1}$

9. **Two coherent monochormatic light sources are located at two vertices of an equilateral triangle. If the intensity due to each of the source independently is $1Wm^{-2}$ at the third vertex. The resultant intensity due to both the sources at that point (i.e at the third vertex) is (in Wm^{-2})**

1) zero   2) $\sqrt{2}$ 3) 2   4) 4

DIFFRACTION

10. **Light of wavelength $6000\,A^o$ is incident on a single slit. The first minimum of the diffraction pattern is obtained at 4 mm from the centre. The screen is at a distance of 2 m from the slit. The slit width will be**

1) 0.3 mm   2) 0.2 mm   3) 0.15 mm   4) 0.1 mm

11. **A plane wave of wavelength 6250Å is incident normally on a slit of width $2\times10^{-2}cm$. The width of the principal maximum on a screen distant 50 cm will be**

1) $312.5\times10^{-2}cm$ 2) $312.5\times10^{-4}cm$
3) $312\,cm$ 4) $312.5\times10^{-5}cm$

12. The distance between the first and the sixth minima in the diffraction pattern of a single slit is 0.5 mm. The screen is 0.5 m away from the slit. If the wavelength of light used is 5000 Å.Then the slit width will be

1) 5 mm   2) 2.5 mm   3) 1.25 mm   4) 1.0 mm

RESOLVING POWER

13. **The diameter of an objective of a telescope, which can just resolve two stars situated at angular displacement of 10^{-4} degee, should be**

$(\lambda = 5000\ A^0)$

1) 35 mm 2) 35 cm 3) 35 m 4) 3.5 cm

14. A telescope is used to resolve two stars separated by 4.6×10^{-6} rad. If the wavelength of light used is 5460 A^0, what should be the aperture of the objective of the telescope?

1) 0.448 m 2) 0.1448 m 3) 1.1448 m 4) 0.011 m

15. Two point sources distant 0.1 meter away viewed by a telescope. The objective is covered by a screen having a hole of 1 mm width. If the wavelength of the light used is 6500 A^0, then the maximum distance at which the two sources are seen just resolved, will be nearly

1) 125.0 m 2) 164 m 3) 131 m 4) 144 m

POLARISATION

16. Two polaroids are kept crossed to each other. Now one of them is rotated through an angle of 45^0. The percentage of incident light now transmitted through the system is

1) 15% 2) 25% 3) 50% 4) 60%

17. The amplitude of polarised light transmitted through a polariser is A. The amplitude of unpolarised light incident on it is

1) $A/2$ 2) $A/\sqrt{2}$ 3) 2A 4) $\sqrt{2}A$

18. Unpolarised lgiht of intensity 32 W/m^2 passes through a polariser and analyser which are at an angle of 30^0 with respect to each other. The intensity of the light coming from analyser is

1) $16\sqrt{3}W/m^2$ 2) 12 W/m^2 3) $16W/m^2$ 4) $14W/m^2$

19. The critical angle of a transparent crystal is 60^0. Then its polarizing angle is

1) $\theta = \tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ 2) $\theta = \sin^{-1}(\sqrt{2})$ 3) $\theta = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$ 4) $\theta = \cot^{-1}(\sqrt{2})$

20. When an unpolarised light of intensity I_0 is incident on a polarising sheet, the intensity of the light which does not get transmitted is

1) $1/2I_0$ 2) $1/4I_0$ 3) zero 4) I_0

EXERCISE- II -KEY

1) 2 2) 1 3) 2 4) 1 5) 3 6) 3 7) 2 8) 1 9) 4 10) 1 11) 1
12) 2 13) 2 14) 2 15) 1 16) 2 17) 4 18) 2 19) 1 20) 1

EXERCISE - III

INTERFERENCE

1. In Young's double slit experiment the intensity of light at a point on the screen where the path difference is λ is K. The intensity of light at a point where the path difference is $\frac{\lambda}{3}$ [λ is the wavelength of light used] is

1) K/4 2) K/3 3) K/2 4) K

2. In Young's double slit experiment, Let β be the fringe width and I_0 be the

intensity at the central bright fringe. At a distance $'x'$ from the central bright fringe, the intensity will be

1) $I_0 \cos\left(\frac{x}{\beta}\right)$ 2) $I_0 \cos^2\left(\frac{x}{\beta}\right)$ 3) $I_0 \cos^2\left(\frac{\pi x}{\beta}\right)$ 4) $\frac{I_0}{4} \cos^2\left(\frac{\pi x}{\beta}\right)$

3. **In Young's double slit experiment the fringe pattern is observed on a screen placed at a distance D. The slits are illuminated by light of wavelength λ. The distance from the central point where the intensity falls to half the maximum is**

1) $\frac{\lambda D}{3d}$ 2) $\frac{\lambda D}{2d}$ 3) $\frac{\lambda D}{d}$ 4) $\frac{\lambda D}{4d}$

4. **In a double slit experiment, the slit separation is 0.20 cm and the slit to screen distance is 100 cm. The positions of the first three minima, if wavelength of the source is 500 nm is**

1) $\pm 0.125cm, \pm 0.375cm, \pm 0.625cm$
2) $\pm 0.025cm, \pm 0.075cm, \pm 0.125cm$
3) $\pm 12.5cm, \pm 37.5cm, \pm 62.5cm$
4) $\pm 1.25cm, \pm 3.75cm, \pm 6.25cm$

5. **In a Young's double slit experiment, the fringes are displaced by a distance x when a glass plate of refractive index 1.5 is introduced in the path of one of the beams. Then this plate is replaced by another plate of the same thickness, the shift of fringes is $3/2\,x$. The refractive index of the second plate is**

1) 2.25 2) 2.0 3) 1.75 4) 1.25

6. **A double slit experiment is performed with light of wavelength 500 nm. A thin film of thickness $2\mu m$ and refractive index 1.5 is introduced in the path of the upper beam. The location of the central maximum will**

1) remain unshifted
2) shift downward by nearly two fringes
3) shift upward by nearly two fringes
4) shift downward by 10 fringes

7. **In Young's double slit experiment, an interference pattern is obtained on a screen by a light of wavelength $6000A^0$ coming from the coherent sources S_1 *and* S_2. At certain point p on the screen third dark fringe is formed. Then the path difference $S_1p - S_2p$ in micron is**

1) 0.75 2) 1.5 3) 3.0 4) 4.5

8. **In double slit experiment fringes are obtained using light of wavelength 4800 A^0 One slit is covered with a thin glass film of refractive index. 1.4 and another slit is covered by a film of same thickness but refractive index 1.7. By doing so, the central fringe is shifted to fifth bright fringe in the original pattern. The thickness of glass film is**

1) 2×10^{-3} mm 2) 4×10^{-3} mm 3) 6×10^{-3} mm 4) 8×10^{-3} mm

9. **In Young's double slit experiment, 5th dark fringe is obtained at a point. If a thin transparent film is placed in the path of one of waves, then 7th bright fringe is obtained at the same point. The thickness of the film in terms of wavelength λ and refractive index μ will be**

1) $\frac{1.5\lambda}{(\mu-1)}$ 2) $1.5(\mu-1)\lambda$ 3) $2.5(\mu-1)\lambda$ 4) $\frac{2.5\lambda}{(\mu-1)}$

10. **The Young's double slit experiment is performed with blue light and green light**

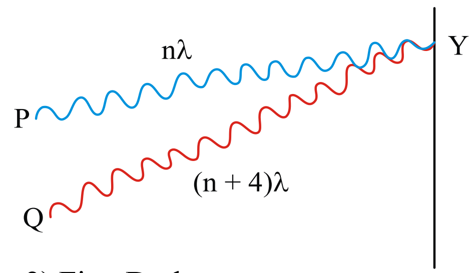
of wavelengths 4360 A^0 and 5460 A^0 respectively. If y is the distance of 4^{th} maxima from the central one, then

1) $y_b = y_g$ 2) $y_b > y_g$ 3) $y_b < y_g$ 4) $\frac{y_b}{y_g} = \frac{5460}{4360}$

11. In double slit experiment, the distance between two slits is 0.6 mm and these are illuminated with light of wavelength $4800\,A^0$. The angular width of dark fringe on the screen at a distance 120 cm from slits will be

1) $8\times10^{-4}\,radian$ 2) $6\times10^{-4}\,radian$ 3) $4\times10^{-4}\,radian$ 4) $16\times10^{-4}\,radian$

12. Fig shows a double slit experiment, P and Q are the two coherent sources. The path lengths PY and QY are nλ and (n + 4) λ respectively where n is whole number and λ is wavelength. Taking the central bright fringe as zero, what is formed at Y?



1) First Bright 2) First Dark
3) Fourth Bright 4) Second Dark

13. White light is used to illuminate two slits in Young's double slit experiment. Separation between the slits is b and the screen is at a distance d (>> b) from the slits. Then wavelengths missing at a point on the screen directly infront of one of the slits are

1) $\frac{b^2}{d}, \frac{b^2}{3d}$ 2) $\frac{b^2}{d}, \frac{b^2}{4d}$ 3) $\frac{b^2}{2d}, \frac{b^2}{3d}$ 4) $\frac{b^2}{2d}, \frac{b^2}{4d}$

DIFFRACTION

14. The Ist diffraction mininum due to single slit diffraction is θ, for a light of wave length $5000A^0$. If the width of the slit is $1\times10^{-4}cm$ then the value of θ

1) 30^0 2) 45^0 3) 60^0 4) 15^0

15. Light of wavelength $5000\times10^{-10}m$ is incident normally on a slit. The first minimum of the diffraction pattern is observed to lie at a distance of 5mm from the central maximum on a screen placed at a distance of 3m from the slit. Then the width of the slit is

1) 3 cm 2) 0.3 cm 3) 0.03 cm 4) 0.01 cm

16. A small aperture is illuminated with a parallel beam of $\lambda = 628nm$. The emergent beam has an angular divergence of 2^0. The size of the aperture is

1) $9\mu m$ 2) $18\mu m$ 3) $27\mu m$ 4) $36\mu m$

17. A beam of light of wavelength 600 nm from a distant source falls ona single slit 1.00 mm wide and the resulting diffraction pattern is observed on a screen 2m away. Then distance between the first dark fringes on either side of the central fringe is

1) 1.2 mm 2) 2.4 mm 3) 3.6 mm 4) 2.4 cm

RESOLVING POWER

18. A person wants to see two pillars distant 11 km, separately. The distance between the pillars must be approximately

1) 3m 2) 1m 3) 0.25 m 4) 0.5 m

19. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye? [Take wavelength of light = 500 nm] [AIEEE-2005]

1) 6m 2) 3 m 3) 5 m 4) 1 m

POLARISATION

20. A horizontal beam of vertically polarized light of intensity 43 W/m^2 is sent through two polarizing sheets. The polarizing direction of the first is 60^0 to the vertical, and that of the second is horizontal. The intensity of the light transmitted by the pair of sheets is (nearly)

1) 8.1 W/m^2 2) 7.3 W/m^2 3) 6.4 W/m^2 4) 3.8 W/m^2

21. Unpolarised light of intensity $32Wm^{-2}$ passes through three polarisers such that the transmission axis of the last polariser is crossed with first. If the intensity of the emerging light is $3Wm^{-2}$, the angle between the axes of the first two polarisers is

1) 45^0 2) 60^0 3) 30^0 4) zero

22. Two polaroids are oriented with their transmision axes making angle of 30^0 with each other. The fraction of incident un polarised light is transmitted

1) 37% 2) 37.5% 3) 3.36% 4) 36.5%

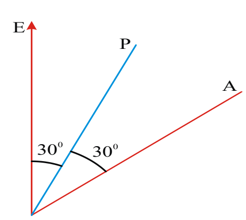
23. The polaroids P_1, P_2 & P_3 are arranged coaxially. the angle between P_1 and P_2 is 37^0. The angle between P_2 and P_3 is, if intensity of emerging light is one quarterth of intensity of unpolarized light

1) $\theta = \cos^{-1}\left(\frac{5}{4}\right)$ 2) $\theta = \cos^{-1}\left(\frac{4}{5}\right)$ 3) $\theta = \cos^{-1}\left(\frac{4}{5\sqrt{2}}\right)$ 4) $\theta = \cos^{-1}\left(\frac{5}{4\sqrt{2}}\right)$

24. A ray of light is going from air to glass such that the reflected light is found to be completely plane polarized. Also the angle of refraction inside the glass is found exactly equal to the angle of deviation suffered by the ray. The refractive index of the glass is

1) 1.5 2) $\sqrt{2}$ 3) $\sqrt{3}$ 4) 4/3

25. A plane polarized beam of intensity I is incident on a polariser with the electric vector inclined at 30^o to the optic axis of the polariser passes through an analyzer whose optic axis is inclined at 30^o to that of polariser. Intensity of light coming out of the analyzer is



1) (9/16)I 2) (3/4)I 3) (1/4)I 4) $\left(\sqrt{3}/2\right)I$

EXERCISE- III - KEY

1) 1 2) 3 3) 4 4) 1 5) 3 6) 3 7) 2 8) 4 9) 4 10) 3 11) 1
12) 3 13) 1 14) 1 15) 3 16) 4 17) 2 18) 1 19) 3 20) 1 21) 3 22) 2
23) 4 24) 3 25) 1

EXERCISE - IV

INTERFERENCE

1. In Young's double slit experiment the intensity of light at a point on the screen where the path difference λ is K. The intensity of light at a point where the path difference is $\frac{\lambda}{6}$ [λ is the wavelength of light used] is

1) K/4 2) K/3 3) 3K/4 4) K

2. In a Young's double slit experiment, D equals the distance of screen and d is the separation between the slits. The distance of the nearest point to the central maximum where the intensity is same as that due to a single slit is equla to

1) $\frac{D\lambda}{d}$ 2) $\frac{D\lambda}{2d}$ 3) $\frac{D\lambda}{3d}$ 4) $\frac{2D\lambda}{d}$

3. With two slits spaced 0.2 mm apart and a screen at a distance of 1 m, the third bright fringe is found to be at 7.5 mm from the central fringe. The wavelength of light used is

1) 400 nm 2) 500 nm 3) 550 nm 4) 600 nm

4. The central fringe of the interference pattern produced by the light of wavelength 6000 A is found to shift to the position of 4th dark fringe after a glass sheet of refractive index 1.5 is introduced. The thickness of glass sheet would be

1) 4.8 μm 2) 4.2 μm 3) 5.5 μm 4) 3.0 μm

5. In Young's double slit inteference experiment the wavelength of light used is 6000 Å. If the path difference between waves reaching a point P on the screen is 1.5 microns, then at that point P

1) Second bright band occurs 2) Second dark band occur
3) Third dark band occur 4) Third bright band occur

6. When a mica plate of thickness 0.1 mm is introduced in one of the interfering beams, the central fringe is displaced by a distance equal to 10 fringes. If the wavelength of the light is 6000 Å, the refractive index of the mica is

1) 1.06 2) 1.6 3) 2.4 4) 1.3

7. In Young's experiment inteference bands are produced on the screen placed at 1.5 m from the two slits 0.15 mm apart and illuminated by light of wavelength 6000 Å. If the screen is now taken away from the slit by 50 cm the change in the fringe width will be

1) $2\times10^{-4}m$ 2) $2\times10^{-3}m$ 3) $6\times10^{-3}m$ 4) $7\times10^{-3}m$

8. When a thin transparent plate of Refractive Index 1.5 is introduced in one of the interfearing beams produces 20 fringes shift. If it is replaced by another

thin plate of half that thickness and of refractive index 1.7, the number of fringes that undergo displacement is

1) 23 2) 14 3) 28 4) 7

9. **In young's double slit experiment one of the slits is wider than other, so that amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I, when they interfere at phase difference ϕ is given by**

1) $\frac{I_m}{9}(4+5\cos\phi)$ 2) $\frac{I_m}{3}\left(1+2\cos^2\frac{\phi}{2}\right)$

3) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$ 4) $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$

10. **In young's doulbe slit experiment, the two slits act as coherent sources of waves of equal amplitude A and wavelength λ. In another experiemnt with the same arrangement the two slits are made to act as incoherent sources of waves of same amplitude and wavelength. If the intensity at the middle point of the screen in the first case is I_1 and in the second case I_2, then the ratio $\frac{I_1}{I_2}$ is (AIEEE 2011)**

1) 4 2) 2 3) 1 4) 0.5

11. **A mixture of light, consisting of wavelength 590 nm and an uknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both light coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. The wavelength of the unknown light is (AIE 2009)**

1)393.4 nm 2)885.0 nm 3)442.5 nm 4)776.8 nm

12. **In Young's experiment using monochromatic light, the fringe pattern shifts by a certain distance on the screen when a mica sheet of refractive index 1.6 and thickness 2 micron is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the slits and the screen is doubled. It is found that the distance between successive maxima now is the same as the observed fringe shift upon the introduction of the mica sheet. The wavelength of light is**

1) 5762 Å 2) 5825 Å 3) 6000 Å 4) 6500 Å

DIFFRACTION

13. **Plane microwaves are incident on a long slit having a width of 5.0 cm. The wavelength of microwaves if the first diffraction minimum is formed at $\theta = 30^0$ is**

1) 2.5 cm 2) 5 cm 3) 7.5 cm 4) 10 cm

14. **A screen is placed 50 cm from a single slit, which is illuminated with 6000 A^0 light. if distance between the first and third minima in the diffraction pattern is 3.0 mm, then the width of the slit is**

1) 0.1 mm 2) 0.2 mm 3) 0.4 mm 4) 0.8 mm

15. **A slit of width 'd' is placed infront of a lens of focal length 0.5 m and is illuminated normally with light of wavelength 5.89×10^{-7} m. The first diffraction minima on**

either side of the central diffraction maximum are separated by $2\times10^{-3}m$. The width of the slit is

1) $1.47\times10^{-4}m$ 2) $2.94\times10^{-4}m$ 3) $1.47\times10^{-7}m$ 4) $2.92\times10^{-7}m$

POLARISATION

16. Un polarised light passes through a polariser and analyser which are at an angle of 45^0 with respect to each other. The intensity of polarised light coming from analyser is $5W/m^2$. The intensity of unpolarised light incident on polariser is

1) $5\sqrt{3}W/m^2$ 2) $10\ W/m^2$ 3) $20\ W/m^2$ 4) $5\frac{\sqrt{3}}{4}W/m^2$

17. A beam of ordinary light is incident on a system of four polaroids which are arranged in succession such that each polaroid is turned through 30^0 with respect to the preceding one. The percentage of the incident intensity that emerges out from the system is approximately

1) 56% 2) 6.25% 3) 21% 4) 14%

18. Two polaroid sheets are placed one over the other with their axes inclined to each other at an angle θ. If only 12.5% of the intensity of the light incident on the first sheet emerges out from the second sheet, the value of θ is

1) 30^0 2) 60^0 3) 45^0 4) 90^0

19. An unpolarised light is incident on a plate of refractive index $\sqrt{3}$ and the reflected light is found to be completely plane polarised. The angles of incidence and refraction are respectively

1) $60^0, 30^0$ 2) $30^0, 60^0$

3) $Sin^{-1}\left(\frac{1}{\sqrt{3}}\right),45^0$ 4) $Tan^{-1}\left(\frac{\sqrt{3}}{2}\right),30^0$

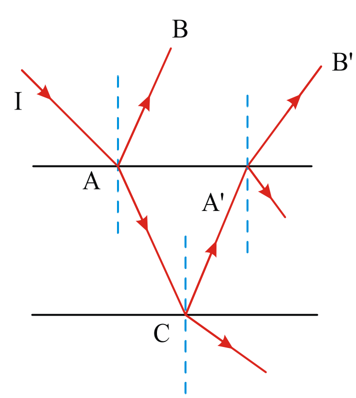
EXERCISE- IV -KEY

1) 3	2) 3	3) 2	4) 2	5) 3	6) 1
7) 2	8) 2	9) 4	10) 2	11) 3	12) 3
13) 1	14) 2	15) 2	16) 3	17) 3	18) 2
19) 1					

EXERCISE - V

INTERFERENCE OF LIGHT

1. A ray of light of intensity I is incident on a parallel glass slab at a point A as shown. It undergoes partial reflection and refraction. At each reflection 25% of incident energy is reflected. The rays AB and $A'B'$ undergo interference. The ratio I_{max}/I_{min} is



1) 4 : 1 2) 8 : 1 3) 7 :1 4) 49 : 1

2. Two coherent sources of intensity ratio β interfere, then $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ is

1) $\frac{\beta}{1+\beta}$ 2) $\frac{2\sqrt{\beta}}{1+\beta}$ 3) $\frac{2\sqrt{\beta}}{1+\sqrt{\beta}}$ 4) $\frac{2\beta}{1+\sqrt{\beta}}$

3. Monochromatic green light of wavelength 550 nm illuminates two parallel narrow slits $7.7\mu m$ apart. The angular deviation θ of third order (for m = 3) bright fringe a) in radian and b) in degree

1) 21.6, 12.4^0 2) 0.216, 1.24^0 3) 0.216, 12.4^0 4) 216, 1.24^0

4. A source emitting wavelength 480 nm and 600 nm is used in YDSE. The separation between the slits is 0.25 mm. the interference is observed 1.5 m away from the slits. The linear separation between first maxima of two wavelengths is

1) 0.72 mm 2) 0.72 cm 3) 7.2 cm 4) 7.2 mm

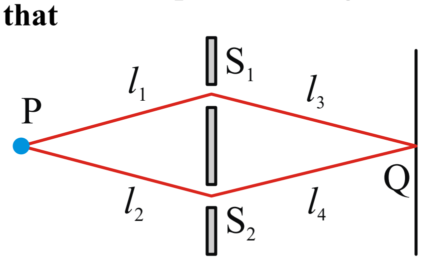
5. In the Young's double slit experiment, maximum number of bright bands observed (inclusive of the central bright band) is found to be 11. If λ is the wavelength of the monochromatic light used, the distance between the slits is

1) 5λ 2) 6λ 3) 10λ 4) 11λ

6. In a double slit experiment, interference is obtained from electron waves produced in an electron gun supplied with voltage V. If λ is wavelength of the beam, D is the distance of screen, d is the spacing between coherent source, h is Planck's constant, e is charge on electron and m is mass of electron, then fringe width is given as

1) $\frac{hD}{\sqrt{2meV}d}$ 2) $\frac{2hD}{\sqrt{meV}d}$ 3) $\frac{hd}{\sqrt{2meV}D}$ 4) $\frac{2hd}{\sqrt{meV}D}$

7. Two identical narrow slits S_1 and S_2 are illuminated by light of wavelength λ from a point source P. If, as shown in the diagram above the light is then allowed to fall on a screen, and if n is a positive integer, the condition for destructive interference at Q is that



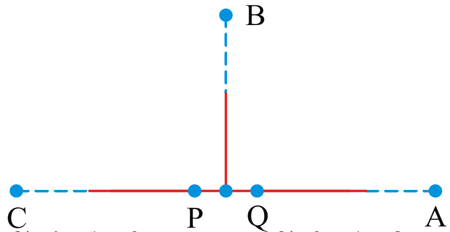
1) $(l_1 - l_2) = (2n+1)\lambda/2$

2) $(l_3 - l_4) = (2n+1)\lambda/2$

3) $(l_3 + l_3) - (l_2 + l_4) = n\lambda$

4) $(l_1 + l_3) - (l_2 + l_4) = (2n+1)\lambda/2$

8. Fig., here shows P and Q as two equally intense coherent sources emitting radiations of wavelength 20m. The separation PQ is 5m, and phase of P is ahead of the phase of Q by 90^o. A, B and C are three distant points of observation equidistant from the mid-point of PQ. The intensity of radiations of A, B, C will bear the ratio



1) 0 : 1 : 4 2) 4 : 1 : 0 3) 0 : 1 : 2 4) 2 : 1 : 0

9. **Two coherent sources separated by distance d are radiating in phase having wavelength λ. A detector moves in a big circle around the two sources in the plane of the two sources. The angular position of n = 4 interference maxima is given as**

1) $\sin^{-1}\frac{n\lambda}{d}$ 2) $\cos^{-1}\frac{4\lambda}{d}$ 3) $\tan^{-1}\frac{d}{4\lambda}$ 4) $\cos^{-1}\frac{\lambda}{4d}$

10. **In a double slit experiment, the separation between the slits is d and distance of the screen from slits is D. If the wavelength of light used is λ and I is the intensity of central bright fringe, then intensity at distance x from central maximum is**

1) $I\cos^2\left(\frac{\pi^2 xd}{\lambda D}\right)$ 2) $I^2\sin^2\left(\frac{\pi xd}{2\lambda D}\right)$ 3) $I\cos^2\left(\frac{\pi xd}{\lambda D}\right)$ 4) $I\sin^2\left(\frac{\pi xd}{\lambda D}\right)$

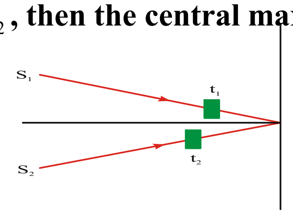
11. **The polaroids are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second polaroid. If a third polaroid whose polarization axis makes an angle θ with the polarization axis of first polaroid, is placed between these polariods then the intensity of light emerging from the last polaroid will be**

1) $\left(\frac{I_0}{8}\right)\sin^2 2\theta$ 2) $\left(\frac{I_0}{4}\right)\sin^2 2\theta$ 3) $\left(\frac{I_0}{2}\right)\cos^2\theta$ 4) $I_0\cos^4\theta$

12. **Two coherent point sources S_1 and S_2 vibrating in phase emit light of wavelength λ. The separation between the sources is 2λ. The smallest distance from s_2 on a line passing through S_2 and perpendicular to s_1s_2, where a minimum of intensity occurs is**

1) $\frac{7\lambda}{12}$ 2) $\frac{15\lambda}{4}$ 3) $\frac{\lambda}{2}$ 4) $\frac{3\lambda}{4}$

13. **In Young's double slit experiment S_1 and S_2 are two slits. Films of thickness t_1 and t_2 and refractive indices μ_1 and μ_2 are placed in front of S_1 and S_2 respectively. If $\mu_1 t_1 = \mu_2 t_2$, then the central maximum will**



1) Not shift
2) Shift towards S_2 irrespective of amounts of t_1 and t_2
3) Shift towards S_2 irrespective of amounts of t_1 and t_2
4) Shift towards S_1 if $t_2 > t_1$ and towards S_2 if $t_2 < t_1$

14. **A monochromatic beam of light is used for the formation of fringes on a screen by illuminating the two slits in the Young's double slit interference experiment. When a thin film of mica is interposed in the path of one of the interfering**

beams

1) the fringe-width increases
2) the fringe-width decreases
3) the fringe pattern disappears
4) fringe-width remains the same but the pattern shifts

15. What happens to the fringe pattern when the Young's double slit experiment is performed in water instead of air?

1) Shrinks 2) Disappears 3) Unchanged 4) Enlarged

16. Two periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is:

1) $\left(\sqrt{I_1}-\sqrt{I_2}\right)^2$ 2) $2\left(I_1+I_2\right)$ 3) I_1+I_2 4) $\left(\sqrt{I_1}+\sqrt{I_2}\right)^2$

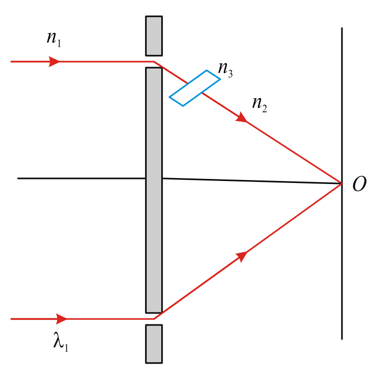
17. What is the minimum thickness of a soap bubble needed for constructive interference in reflected light if the light incident on the film has wavelengths 900 nm? Assume the refractive index for the film is $\mu=1.5$

1) 100 nm 2) 150 nm 3) 200 nm 4) 250 nm

18. Two identical coherent sources are placed on a diameter of a circle of radius R at separation x (<<R) symmetrically about the centre of the circle. The sources emit identical wavelength λ each. The number of points on the circle with maximum intensity is $(x=5\lambda)$

1) 20 2) 22 3) 24 4) 26

19. In a YDSE shown in Fig a parallel beam of light is incident on the slits from a medium of refractive index n_1. The wavelength of light in this medium is λ_1. A transparent slab of thickness 't' and refractive index n_3 is put in front of one slit. The medium between the screen and the plane of the slits is n_2. The phase difference between the light waves reaching point "O". (symmetrical, relative to the slits) is



1) $\frac{2\pi}{n_1\lambda_1}(n_3-n_2)t$ 2) $\frac{2\pi}{\lambda_1}(n_3-n_2)t$

3) $\frac{2\pi n_1}{n_2\lambda_1}\left(\frac{n_3}{n_2}-1\right)t$ 4) $\frac{2\pi n_1}{\lambda_1}\left(n_3-n_2\right)t$

20. In Young's double slit experiment, the 10th bright fringe is at a distance x from the central fringe. Then

a) the 10th dark fringe is at a distance of $19x/20$ from the central fringe

b) the 10th dark fringe is at a distance of $21x/20$ from the central fringe

c) the 5th dark fringe is at a distance of x/2 from the central fringe.

d) the 5th dark fringe is at a distance of $9x/20$ from the central fringe.

1) a,b,c only 2) b,c,d only 3) a,d only 4) a,b,c,d only

DIFFRACTION

21. If I_0 is the intensity of the principle maximum in the single slit diffraction pattern then, with doubling the slit width, the intensity becomes

1) I_0 2) $I_0/2$ 3) $\frac{1}{2}I_0$ 4) $4I_0$

22. Light of wavelength 6000 A^0 from a distant source falls on a slit 0.5mm wide. The distance between two dark bands on each side of the central bright band of the diffraction pattern observed on a screen placed at a distance 2m from the slit is

1) 1.2nm 2) 2.4nm 3) 3.6nm 4) 4.8mm

23. The ratio of radii of Fresnel's fourth to ninth zone is

1) 1 : 4 2) 4 : 0 3) 9 : 4 4) 2 : 3

24. A parallel beam of wavelength $\lambda = 4500A^0$ passes through a long slit of width $2\times10^{-4}m$. The angular divergence for which most of the light is diffracted is (in $\times10^{-5}$ radian)

1) $\frac{2\pi}{3}$ 2) $\frac{5\pi}{4}$ 3) $\frac{3\pi}{4}$ 4) $\frac{\pi}{3}$

POLARISATION

25. A polariser and an analyser are oriented so that the maximum amount of lights is transmitted. Fraction of its maximum value is the intensity of the transmitted light reduced when the analyzer is rotated through (intensity of incident light = I_o)

a) 30^0 b) 45^0 c) 60^0

1) 0.375 I_0, 0.25 I_0, 0.125 I_0 2) 0.25 I_0, 0.375 I_0, 0.125 I_0

3) 0.125 I_0, 0.25 I_0, 0.0375 I_0 4) 0.125 I_0, 0.375 I_0, 0.25 I_0

26. A polaroid examines two adjacent plane polarised beams A and B whose planes of polarisation are mutually perpendicular. In the first position of the analyser, beam B shows zero intensity. From this position a rotation 30^0 shows that the two beams have same intensity. The ratio of intensity of the two beams I_A and I_B

1) $1:3$ 2) $3:1$ 3) $\sqrt{3}:1$ 4) $1:\sqrt{3}$

27. An analyser is inclined to a polariser at an angle of 30^0. The intensity of light emerging from the analyser is $\frac{1}{n}$th of that is incident on the polariser. Then n is equal to

1) 4 2) 4/3 3) 8/3 4) 1/4

28. When a beam of light wavelength λ is incident on the surface of a liquid at an angle ϕ, the reflected ray in completely polarized. The wavelength of light in the liquid medium is

1) $\lambda Tan\phi$ 2) $\frac{\lambda}{Tan\phi}$ 3) $\frac{\lambda}{Cos\phi}$ 4) $\frac{\lambda}{Sin\phi}$

EXERCISE- V - KEY

1) 4	2) 2	3) 3	4) 1	5) 1	6) 1	7) 4	8) 4	9) 2	10) 3
11) 1	12) 1	13) 4	14) 4	15) 1	16) 2	17) 2	18) 1	19) 1	20) 3
21) 1	22) 4	23) 4	24) 2	25) 1	26) 1	27) 3	28) 2		

EXERCISE - VI

1. **Huygen's principle of secondary wavelets can be used to**
a) deduce the laws of reflection of light
b) deduce the laws of refraction of light
c) explain the transverse nature of light waves
d) predict the location of a wavefront as time passes
1) a, b only 2) a, c only 3) a, b, d only 4) b, c only

2. **Following statements which are true for light waves but not for sound waves are/is**
(I) The speed of waves is greater in vacuum than in a medium
(II) Waves of different frequencies travel with different speeds in a medium
(III) Waves travel with different speeds in different media.
1) (I) only 2) (I) and (III)
3) (II) and (III) 4) (I), (II) and (III)

3. **If white light is used in Young's double-slit experiment.**
a) bright white fringe is formed at the centre of the screen
b) fringes the different colours are observed on both sides of central fringe clearly only in the first order.
c) the first order violet fringe's are closer to the centre of the screen than the first order red fringes
d) The first order red fringes are closer to the centre of the screen than the first order violet fringes
1) Only a and d are true 2) Only a and b are true
3) Only a,b and c are true 4) All are true

4. **In a double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the order. Then in the interference pattern, the intensity.**
a) of maxima will increases
b) of maxima will decrease
c) of minima will increase
d) of minima will decrease
1) a,b only 2) b, c only 3) a, c only 4) c, b only

5. **In Young's double slit experiment for producing interference pattern, the fringe width depends on**
i) wave length
ii) distance between the two slits
iii) distance between the screen and the slits
iv) distance between source and the slits
1) i only 2)i, ii only 3)i, ii and iii 4) i, ii and iv

6. **Both in interference and diffraction phenomena, alternate dark and bright fringes are obtained on screen**
i) generally fringe width is same in interference and not same in diffraction
ii) the central fringe in interference has maximum brightness and the intensity gradually decreases on either side
iii) in interference the intensity of all bright fringes in same
iv) both the phenomena are produced from same coherent sources

1) i only 2) i and ii 3) i,ii and iv 4) i, ii and iii

7. When light is incident on a glass block at polarizing angle
a) reflected ray is plane polarized
b) reflected and refracted rays are perpendicular
c) reflected and refracted rays are partially polarized
d) refracted ray is partially polarised

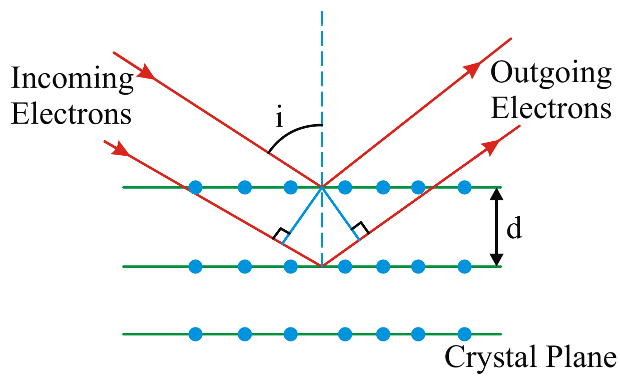
1) a, c and d are correct 2) a, b and d are correct
3) b, c and d are correct 4) a, b and c are correct

8. Consider the following statements A and B identify the correct answer
(A) Polarized light can be used to study the helical structure of nucleic acids
(B) Optic axis is a direction and not any particular line in the crystal.

1) A and B are correct 2) A and B are wrong
3) A is correct and B is wrong 4) A is wrong and B is correct

COMPREHENSION -I

Wave property of electrons implies that they will show diffraction effects. Davission and Germer demonstrated this by diffracting electrons from crystals. The law governing the diffraction from a crystal is obtained by requiring that electron waves reflected from the planes of atoms in a crystal interfere constructively (see figure) (AIEEE 2008)



9. Electrons accelerated by potential V are diffracted from a crystal. If $d = 1A^0$ **and** $i = 30^0$**, V should be about**

$(h = 6.6\times10^{-34} Js,\ m = 9.1\times10^{-31} kg,$

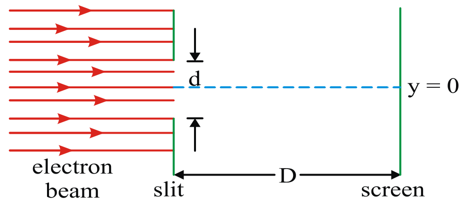
$e = 1.6\times10^{-19} C)$

1) 2000 V 2) 50 V 3) 500 V 4) 1000 V

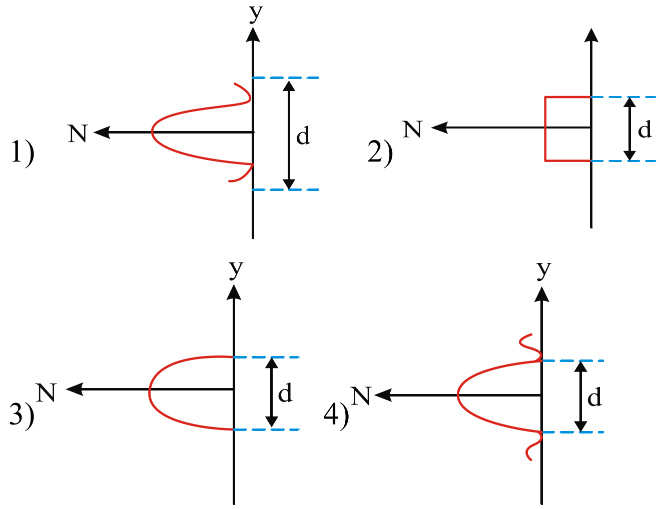
10. If a strong diffraction peak is observed when electrons are incident at an angle 'i' from the normal to the crystal planes with distance 'd' between them (see figure) de-Broglie wavelength λ_{dB} **of electrons can be calculated by the relationship (*n* is an integer)**

1) $d\sin i = n\lambda_{dB}$ 2) $2d\cos i = n\lambda_{dB}$ 3) $2d\sin i = n\lambda_{dB}$ 4) $d\cos i = n\lambda_{dB}$

11. In an experiment, electrons are made to pass through a narrow slit of width 'd' comparable to their de-Broglie wavelength. They are detected on a screen at a distance 'D' from the slit (see figure)



The following graphs that can be expected to represent the number of electrons 'N' detected as a function of the detector position 'y' (y=0 corresponds to the middle of the slit) is



COMPREHENSION -II

A Young's double slit experiment is conducted with slit separation 10mm, where the screen is 2m away from the slits. If wavelength of light used is $6000 A^0$**, answer the following**

12. **Fringe width in mm is**

1) 0.12 2) 0.24 3) 0.36 4) 0.48

13. **distance of 4th dark band from central fringe in mm is**

1) 0.14 2) 0.28 3) 0.42 4) 0.56

14 **If the wavelength is increased by** $1000 A^0$**, and placed the whole apparatus in water of refractive index 4/3, the new fringe width in mm is**

1) 0.210 2) 0.105 3) 0.315 4) 0.420

EXERCISE- VI - KEY

1) 3 2) 4 3) 3 4) 3 5) 3 6) 4 7) 2 8) 1 9) 2 10) 2 11) 4
12) 1 13) 3 14) 2

EXERCISE - I

PHOTO ELECTRIC EFFECT

1. The frequency of a photon associated with an energy of 3.31 eV is (given $h = 6.62 \times 10^{-34}$ Js)
1) 0.8×10^{15} Hz 2) 1.6×10^{15} Hz 3) 3.2×10^{15} Hz 4) 8.0×10^{15} Hz

2. A radiation of wave length 2500 A^0 is incident on a metal plate whose work function is 3.5 eV. Then the potential required to stop the fastest photo electrons emitted by the surface is ($h = 6.63\times10^{-34}$Js & $c= 3\times10^8$ m/s)
1) 1.86V 2) 3.00 V 3) 1.46V 4) 2.15 V

3. The work function of a metal is 2.5 eV. The maximum kinetic energy of the photoelectrons emitted if a radiation of wavelength 3000 A^0 falls on it is ($h = 6.63\times10^{-34}$Js and $c= 3 \times10^8$ m/s)
1) 1.12×10^{-19}J 2) 4.8×10^{-19}J 3) 3.2×10^{-19}J 4) 2.61×10^{-19}J

4. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectric emission from this substance is approximately
1) 220 nm 2) 310 nm 3) 540 nm 4) 400 nm

5. A laser used to weld detached retains emits light with a wavelength 652 nm in pulses that are of 20ms duration. The average power during each pulse is 0.6W. The energy in each pulse and in a single photon are
1) $7.5\times10^{15} eV, 2.7eV$ 2) $6.5\times10^{16} eV, 2.9eV$
3) $6.5\times10^{16} eV, 2.7eV$ 4) $7.5\times10^{16} eV, 1.9eV$

6. Electrons ejected from the surface of a metal, when light of certain frequency is incident on it, are stopped fully by a retarding potential of 3 volts. Photo electric effect in this metallic surface begins at a frequency $6 \times 10^{14} s^{-1}$. The frequency of the incident light in s^{-1} is [$h=6 \times 10^{-34}$J-sec;charge on the electron=1.6×10^{-19}C]
1) 7.5×10^{13} 2) 13.5×10^{13} 3) 14×10^{14} 4) 7.5×10^{15}

7. The threshold wavelength for emission of photoelectrons from a metal surface is 6×10^{-7}m. The work function of the material of the metal surface is .
1) 3.3×10^{-19}J 2) 6.67×10^{-19}J 3) 1.23×10^{-19}J 4) 2.37×10^{-19}J

8. The maximum velocity of an electron emitted by light of wavelength λ incident on the surface of a metal of workfunction ϕ is where h = Planck's constant, m = mass of electron and c=speed of light
1) $\left[\frac{2(hc+\lambda\phi)}{m\lambda}\right]^{1/2}$ 2) $\frac{2(hc-\lambda\phi)}{m}$ 3) $\left[\frac{2(hc-\lambda\phi)}{m\lambda}\right]^{1/2}$ 4) $\left[\frac{2(hc\lambda-\phi)}{m}\right]^{1/2}$

9. The work function of nickle is 5eV. When light of wavelength 2000A^0 falls on it, emits photoelectrons in the circuit. Then the potential difference necessary to stop the fastest electrons emitted is (given $h=6.67\times10^{-34}$Js)
1) 1.0V 2) 1.75V 3) 1.2V 4) 0.75V

MATTER WAVES

10. If an electron and a proton have the same KE, the ratio of the de Broglie

wavelengths of proton and electron would approximately be

1) 1 : 1837 2) 43 : 1 3) 1837 : 1 4) 1 : 43

11. **If electron is having a wavelength of 100 A°, then momentum is (gm cm s^{-1}) units**

1) 6.6 x 10^{-32} 2) 6.6 x 10^{-29} 3) 6.6x 10^{-25} 4) 6.6 x 10^{-21}

12. **The de-broglie wavelength of an electron and the wavelength of a photon are same. The ratio between the energy of the photon and the momentum of the electron is [M 2006]**

1) h 2) c 3) 1/h 4) 1/c

13. **A proton and an alpha particle are accelerated through the same potential difference. The ratio of wavelengths associated with proton and alpha particle respectively is**

1) $1:2\sqrt{2}$ 2) 2:1 3) $2\sqrt{2}:1$ 4) 4:1

14. **Ratio of debroglie wavelengths of uncharged particle of mass m at 27^0C to 127^0C is nearly**

1) 1.16 2) 0.16 3) 1.33 4)0.8

15. **A particle is projeted horizontally with a velocity 10m/s. What will be the ratio of de-Broglie wvelengths of the particle, when the velocity vector makes an angle 30^0 and 60^0 with the horizontal**

1) $\sqrt{3}:1$ 2) $1:\sqrt{3}$ 2) $2:\sqrt{3}$ 4) $\sqrt{3}:2$

16. **A positron and a proton are accelerated by the same accelerating potential. Then the ratio of the associated wavelengths of the positron and the proton will be [M = mass of proton, m = mass of positron]**

1) $\frac{M}{m}$ 2) $\sqrt{\frac{M}{m}}$ 3) $\frac{m}{M}$ 4) $\sqrt{\frac{m}{M}}$

EXERCISE- I - KEY

1) 1 2) 3 3) 4 4) 2 5) 4 6) 3 7) 1 8) 3 9) 3 10) 4 11) 4
12) 2 13) 3 14) 1 15) 1 16) 2

EXERCISE - II

PHOTO ELECTRIC EFFECT

1. **The threshold wavelength for a surface having a threshold frequency of 0.6 x 10^{15} Hz is (given c = 3 x 10^8 m/s)**

1) 4000 A° 2) 6000 A° 3) 5000A° 4) 3500A°

2. **Two photons of energies twice and thrice the work function of a metal are incident on the metal surface. Then the ratio of maximum velocities of the photoelectrons emitted in the two cases respectively, is**

1) $\sqrt{2}$:1 2) $\sqrt{3}$: 1 3) $\sqrt{3}$: $\sqrt{2}$ 4) 1 : $\sqrt{2}$

3. **The photo electric work function for a metal surface is 4.125 eV. The cut-off wavelength for this surface**

1) 4125 A° 2) 2062.5 A° 3) 3006.06 A° 4) 6000A°

4. **The energy of emitted photoelectrons from a metal is 0.9 eV. The work function of the metal is 2.2 eV. Then the energy of the incident photon is**

1) 0.9 eV 2) 2. 2 eV 3) 4. 4 eV 4) 3.1 eV

5. **A photoelectron is moving with a maximum velocity of 10^6 m/s. Given e=$1.6x10^{-19}$ c, and m = $9.1x 10^{-31}$ kg, the stopping potential is**

1) 2.5 V 2) 2.8 V 3) 2.0 V 4) 1.4 V

6. **A metal of work function 4eV is exposed to a radiation of wavelength 140×10^{-9}m.Then the stopping potential developed by it (h = 6.63×10^{-34}Js and c= 3×10^8 m/s)**

1) 6.42 V 2) 2.94 V 3) 4.86V 4) 3.2 V

7. **Threshold wavelength for a metal having work function w_o is λ .Then the threshold wavelength for the metal having work function 2 w_o is**

1) 4 λ 2) 2 λ 3) λ /2 4) λ /4

8. **The work function of metals A and B are in the ratio 1:2. If light of frequencies f and 2f are incident on metal surfaces A and B respectively, the ratio of the maximum kinetic energies of the photo electrons emitted is (2000 M)**

1) 1:1 2) 1:2 3) 1:3 4) 1:4

9. **The threshold wave length for photo electric emission from a material is 5,200A^0, photo electrons will be emitted when this material is illuminated with mnochromaic radiation from a**

1) 50 watt infrared lamp 2) 1 watt infrared lamp
3) 1 watt ultraviolet lamp 4) 50 watt sodium vapour lamp

MATTER WAVES

10. **A particle having a de Broglie wavelength of 1.0 A^o is associated with a momentum of (given h = 6.6 x 10^{-34} Js)**

1) 6.6 x 10^{-26} kg m/s 2) 6.6 x 10^{-25} kg m/s
3) 6.6 x 10^{-24} kg m/s 4) 6.6 x 10^{-22} kg m/s

11. **The de Broglie wavelength of an electron having 80 eV of energy is nearly** $(1\ eV = 1.6x10^{-19} J,$ **Mass of electron** $= 9' 10^{-31}$kg, **Planck's constant** $= 6.6' 10^{-34}$Js) **(nearly) (2001 E)**

1) 140 A^o 2) 0.14 A^o 3) 14 A^o 4) 1.4 A^o

12. **Electrons are accelerated through a p.d. of 150V. Given m = $9.1x10^{-31}$kg,e =$1.6x10^{-19}$ c,**
h = $6.62x10^{-34}$ Js, the de Broglie wavelength associated with it is

1) 1.5 A^o 2) 1.0 A^o 3) 3.0 A^o 4) 0.5 A^o

13. **If accelerating potential of an alpha particle is doubled than its new debrolgie wavelength becomes**

1) $\frac{1}{\sqrt{2}}$ times of initial 2) $\sqrt{2}$ times of initial

3) $\frac{1}{2}$ times of initial   4) 2 times of initial

14. The ratio of the deBroglie wavelenths of proton, deuteron and alpha particle accelerated through the same potential difference 100V is

1) $2:2:1$ 2) $1:2:2\sqrt{2}$ 3) $1:2:2\sqrt{2}$ 4) $2\sqrt{2}:2:1$

EXERCISE-II - KEY

1) 3 2) 4 3) 3 4) 4 5) 2 6) 3 7) 3 8) 2 9) 3 10) 3 11) 4
12) 2 13) 1 14) 4

EXERCISE - III

PHOTO ELECTRIC EFFECT

1. A photometal is illuminated by lights of wavelengths λ_1 and λ_2 respectively. The maximum kinetic enegies of electrons emitted in the two cases are E_1 and E_2 respectively. The work function of metal is.

1) $\frac{E_2\lambda_1 - E_1\lambda_2}{\lambda_1}$ 2) $\frac{E_1\lambda_1 - E_2\lambda_2}{\lambda_1 + \lambda_2}$ 3) $\frac{E_1\lambda_1 + E_2\lambda_2}{\lambda_1 - \lambda_2}$ 4) $\frac{E_2\lambda_2 - E_1\lambda_1}{\lambda_1 - \lambda_2}$

2. Light of wavelength λ strikes a photo sensitive surface and electrons are ejected with kinetic energy E. If the kinetic energy is to be increased to 2E, the wavelength must be changed to λ' where

1) $\lambda' = \frac{\lambda}{2}$ 2) $\lambda' = 2\lambda$ 3) $\frac{\lambda}{2} < \lambda' < \lambda$ 4) $\lambda' > \lambda$

3. Ultraviolet light of wavelength 300 nm and intensity 1.0 W/m^2 falls on the surface of a photoelectric material. If one percent of the incident photons produce photoelectrons, then the number of photoelectrons emitted from an area of 1.0 cm^2 of the surface is nearly (in per second)

1) 9.61 x 10^{14} 2) 4.12 x 10^{13} 3) 1.51 x 10^{12} 4) 2.13 x 10^{11}

4. Light rays of wavelengths 6000 A° and of photon intensity 39.6 watts/m^2 is incident on a metal surface. If only one percent of photons incident on the surface emit photo electrons, then the number of electrons emitted per second per unit area from the surface will be
[Planck constant = 6.64 x 10^{-34} J - S; Velocity of light = 3 x 10^8 ms^{-1}]

1) 12 x 10^{18} 2) 10 x 10^{18} 3) 12 x 10^{17} 4) 12 x 10^{15}

5. Light of wavelength 4000 A^o is incident on a metal surface of work function 2.5 eV. Given h=6.62 x 10^{-34} Js, c = 3 x 10^8 m/s, the maximum KE of photoelectrons emitted and the corresponding stopping potential are respectively

1) 0. 6 eV, 0.6 V   2) 2.5 eV, 2.5 V   3) 3.1 eV, 3.1 V   4) 0.6 eV, 0.3 V

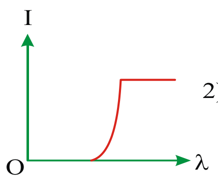
6. The K.E of the electron is E when the incident wavelength is λ. To increase the K.E of the electron to 2E, the incident wavelength must be

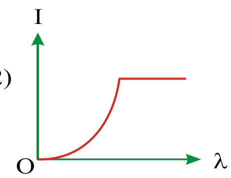
1) 2λ 2) $\frac{\lambda}{2}$ 3) $\frac{hc\lambda}{E\lambda + hc}$ 4) $\frac{2hc\lambda}{E\lambda + hc}$

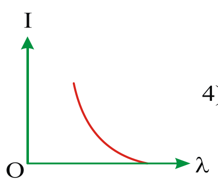
7. A photon of energy 15 eV collides with H-atom. Due to this collision, H-atom gets ionized .The maximum kinetic energy of emitted electron is :

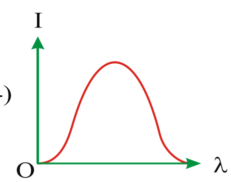
1)1.4 eV 2) 5 eV 3)15eV 4) 13.6eV

8. The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode in gradually changed. The plate current I of the photocell varies as follows :

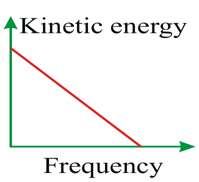
1) 

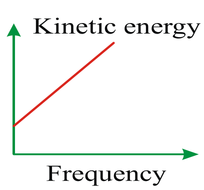
2) 

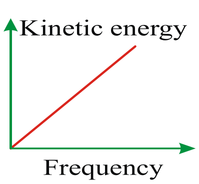
3) 

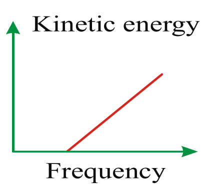
4) 

9. According to Einstein's photoelectric equation, the graph between the kinetic energy of photoelectrons ejected and the frequency of incident radiation is :

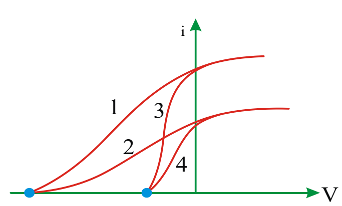
1) 

2) 

3) 

4) 

10. The graph shown in figure show the variation of photoelectric current (i) and the applied voltage (V) for two different materials and for two different intensities of the incident radiation.



Identify the pairs of curves that correspond to (a) different material (b) same intensity of incident radiations.

1) Curve 1 and 3, Curve 2 and 4\ 2) Curve 1 and 2, Curve 3 and 4
3) Curve 1 and 4, Curve 2 and 3 4) Curve 1 only, Curve 2 and 4

MATTER WAVES

11. A proton when accelerated through a p.d. of V volt has a wavelength λ associated with it. An α- particle in order to have the same wavelength λ must be accelerated through a p.d. of

1) V/8 volt 2) V/4 volt 3) V volt 4) 2V volt

12. An electron of mass m and charge e initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is

1) $\frac{-h}{eEt^2}$ 2) $\frac{-eEt}{E}$ 3) $\frac{-mh}{eEt^2}$ 4) $\frac{-h}{e.E}$

13. If the velocity of a particle is increased three times, then the percentage decrease in its de Broglie wavelength will be

1) 33.3% 2) 66.6% 3) 99.9% 4) 22.2%

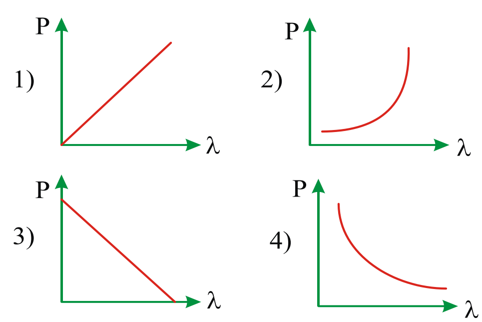
14. If the momentum of an electron is changed by p_m, then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be

1) $p_m/200$ 2) $p_m/100$ 3) $200p_m$ 4) $100p_m$

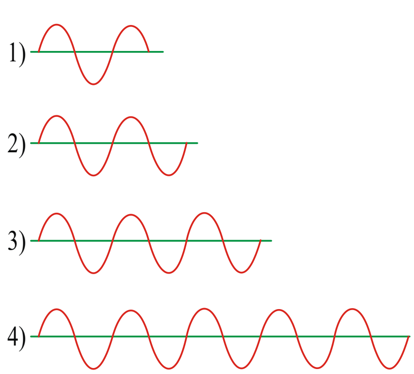
15. When the mass of an electron becomes equal to thrice its rest mass, its speed is

1) $\frac{2\sqrt{2}}{3}c$ 2) $\frac{2}{3}c$ 3) $\frac{1}{3}c$ 4) $\frac{1}{4}c$

16. Which of the following figures represents the variation of particle momentum with the associated de Broglie wave-length ?



17. The de Broglie wave present in fifth Bohr orbit is :



HEISEN-BERG UNCERTAINITY PRINCIPLE AND DAVISSON-GERMER EXPERIMENT

18. **The correctness of velocity of an electron moving with velocity 50 ms^{-1} is 0.005%. The accuracy with which its position can be measured will be**

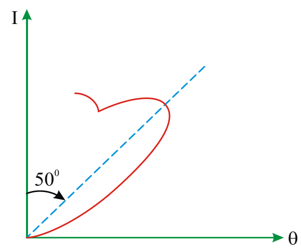
1) $4634\times10^{-3}m$ 2) $4634\times10^{-5}m$ 3) $4634\times10^{-6}m$ 4) $4634\times10^{-8}m$

19. **If the uncertainity in the position of an electron is 10^{-10} m, then the value of uncertainity in its momentum (in kg-ms^{-1}) will be**

1) 3.33×10^{-24} 2) 1.03×10^{-24} 3) 6.6×10^{-24} 4) 6.6×10^{-20}

20. **a) Name the experiment for which the adjacent graph, showing the variation of intensity of scattered electrons with the angle of scattering (θ) was obtained.**

b) Also name the important hypothesis that was confirmed by this experiment.



1) A) Davission and Germer experiment
B) de Broglie hypothesis
2) A) Photo electric effect
B) de Broglie hypothesis
3) A) Thermionic emission
B) de Broglie hypothesis
4) A) Photocell
B) de Broglie hypothesis

EXERCISE- III - KEY

1) 4 2) 3 3) 3 4) 3 5) 1 6) 3 7) 1 8) 3 9) 4 10) 1 11) 1
12) 1 13) 2 14) 3 15) 1 16) 4 17) 4 18) 2 19) 2 20) 2

EXERCISE - IV

PHOTO ELECTRIC EFFECT

1. **When a metal surface is illuminated by a monochromatic light of wave - length λ, then the potential difference required to stop the ejection of electrons is 3V. When the same surface is illuminated by the light of wavelength 2 λ, then the potential difference required to stop the ejection of electrons is V. Then for photoelectric effect, the threshold wavelength for the metal surface will be**

1) 6λ 2) $4\lambda/3$ 3) 4λ 4) 8λ

2. **If U.V. Light of wavelengths 800 A° and 700 A° can liberate electrons with kinetic energies of 1.8eV and 4 eV respectively from hydrogen atom in ground state, then the value of**

planck's constant is

1) 6.57×10^{-34} Js 2) 6.63×10^{-34} Js 3) 6.66×10^{-34} Js 4) 6.77×10^{-34} Js

3. **In a photoelectric effect experiment, photons of energy 5 eV are incident on a metal surface. They liberate photoelectrons which are just stopped by an electrode at a potential of -3.5 V with respect to the metal. The work function of the metal is**

1) 1.5 eV 2) 3.5 eV 3) 5. 0 eV 4) 8.5 eV

4. **The number of photons emitted per second by a 62W source of monochromatic light of wavelength 4800 A° is**

1) 1.5×10^{19} 2) 1.5×10^{20} 3) 2.5×10^{20} 4) 4×10^{20}

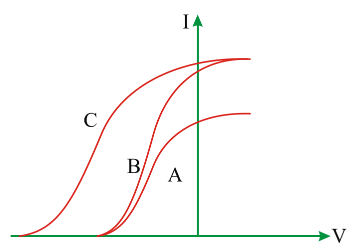
5. **Photons of frequencies 2.2×10^{15} Hz and 4.6×10^{15} Hz are incident on a metal surface. The corresponding stopping potentials were found to be 6.6 V and 16.5 V respectively.**
Given $e = 1.6 \times 10^{-19}$ c, the value of universal planck's constant is

1) 6.6×10^{-34} Js 2) 6.7×10^{-34} Js 3) 6.5×10^{-34} Js 4) 6.8×10^{-34} Js

6. **If stopping potentials corresponding to wavelengths 4000A⁰ and 4500A⁰ are 1.3V and 0.9V respectively, then the work function of the metal is**

1) 0.3eV 2) 1.3eV 3) 1.8eV 4) 5eV

7. **In a photoelectric experiment anode potential is plotted against plate current**



1) A and B will have same intensities while B and C will have different frequencies
2) B and C will have different intensities while A and B will have different frequencies.
3) A and B will have different intensities while B and C will have equal frequencies.
4) B and C will have equal intensities while A and B will have same frequencies.

MATTER WAVES

8. **An electron moves with a speed of $\frac{\sqrt{3}}{2}$ c. Then its mass becomes....times its rest mass.**

1) 2 2) 3 3) 3/2 4) 4

9. **Photons of energy 2.0 eV fall on a metal plate and release photoelectrons with a maximum velocity V. By decreasing λ by 25% the maximum velocity of photoelectrons is doubled. The work function of the metal of the material plate in eV is nearly**

1) 2.22 2) 1.985 3) 2.35 4) 1.80

10. **A proton when accelerated through a p.d of V volt has wavelength λ associated with it .An electron to have the same λ must be accelerated through a p.d of**

1) $\frac{V}{8}$ volt 2) 4V volt 3) 2V volt 4) 1838V volt

DUAL NATURE OF MATTER

11. **The momentum aphoton of electromagnetic radiation is $3.3\text{x}10^{-29}$ kgms^{-1}. The frequency of these waves is:**

1) $3.0\text{x}10^{3}$ Hz   2) $6.0\text{ x}10^{3}$ Hz   3)$7.5\text{ x}10^{12}$ Hz   4)1.5×10^{13} Hz

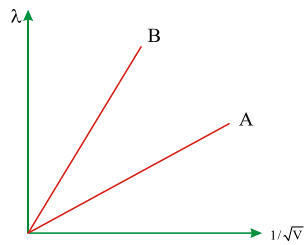
12. **If the energy of a particle is reduced to one fourth, then the percentage increase in its de Broglie wavelength will be**

1) 41%   2) 141%   3) 100%   4) 71%

13. **The de Broglie wavelength associated with an electron of velocity 0.3 c and rest mass $9.1\text{ x }10^{-31}$kg is**

1) $7.68\text{ x }10^{-10}$ m   2) $7.68\text{ x }10^{-12}$ m   3) $5.7\text{ x }10^{-12}$ m   4) $9.1\text{ x }10^{-12}$ m

14. **The two lines A and B shown in figure are the graphs of the de Broglie wavelength λ as a function of $\frac{1}{\sqrt{V}}$ (V is the accelerating potential) for two particles having the same charge.**



Which of the two represents the particle of heavier mass ?

1) A   2) B   3) Both A and B   4) Data insufficient

HEISEN-BERG UNCERTAINITY PRINCIPLE AND DAVISSON-GERMER EXPERIMENT

15. **The uncertainity in the position of a particle is equal to the de-Broglie wavelength. The uncertainity in its momentum will be**

1) $\frac{h}{\lambda}$ 2) $\frac{2h}{3\lambda}$ 3) $\frac{\lambda}{h}$ 4) $\frac{3\lambda}{2h}$

16. **If the uncertainity in the position of proton is $6\times10^{8}m$, then the minimum uncertainity in its speed will be**

1) $1\ cms^{-1}$ 2) $1\ ms^{-1}$ 3)$1\ mms^{-1}$ 4) $100\ ms^{-1}$

17. **From Davisson-Germer experiment an α particle and a proton are accelerated through the same pd V. Find the ratio of the de Broglie wavelengths associated with them**

1) $1:2\sqrt{2}$ 2) $2\sqrt{2}:1$ 3) $1:\sqrt{2}$ 4) $\sqrt{2}:1$

EXERCISE- IV - KEY

1) 3 2) 1 3) 1 4) 2 5) 1 6) 3 7) 4 8) 1 9) 4 10) 4 11) 4
12) 3 13) 2 14) 1 15) 1 16) 2 17) 1

EXERCISE - V

1. **When a surface 1 cm thick is illuminated with light of wave lenght λ the stopping potential is V_0,but when the same surface is illuminated by light of wavelength 3λ, the stopping potential is $\frac{V_0}{6}$. The threshold wavelength for metallic surface is:**

1) 4λ 2) 5λ 3) 3λ 4) 2λ

2. **A photon of energy 2.5 eV and wavelength λ falls on a metal surface and the ejected electrons have velocity 'v'. If the λ of the incident light is decreased by 20%, the maximum velocity of the emitted electrons is doubled. The work function of the metal is**

1) 2.6 eV 2) 2.23 eV 3) 2.5 eV 4) 2.29 eV

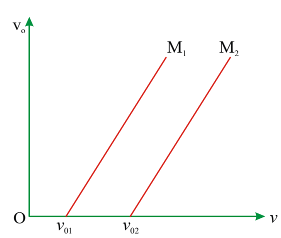
3. **When a metal surface is illuminated by light of wavelengths 400 nm and 250 nm, the maximum velocities of the photoelectrons ejected are V and 2V respectively. The work function of the metal is**

1) 2hc x 10^6 J 2) 1.5hc x 10^6 J 3) hc x 10^6 J 4) 0.5hc x 10^6 J

4. **A source of light is placed above a sphere of radius 10cm. How many photoelectrons must be emitted by the sphere before emission of photoelectrons stops? The energy of incident photon is 4.2 eV and the work function of the metal is 1.5 eV.**

1) 2.08 x 10^{18} 2) 1.875 x 10^8 3) 2.88 x 10^{18} 4) 4 x 10^{19}

5. **Figure shows the variation of the stopping potential (V_0) with the frequency (v) of the incident radiations for two different photosensitive material M_1 and M_2.What are the values of work functions for M_1 and M_2 respectively**



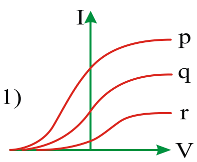
1) hv_{01}, hv_{02} 2) hv_{02}, hv_{01} 3) hv_{01}, hv_{01} 4) hv_{02}, hv_{02}

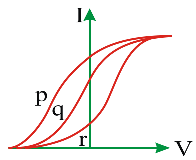
6. **From the above figure the values of stopping potentials for M_1 and M_2 for a frequency $v_3 (> v_{02})$ of the incident radiatioins are V_1 and V_2 respectively. Then the slope of the line is equal to**

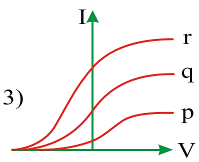
1) $\frac{V_2 - V_1}{v_{02} - v_{01}}$ 2) $\frac{V_1 - V_2}{v_{02} - v_{01}}$ 3) $\frac{V_2}{v_{02} - v_{01}}$ 4) $\frac{V_1}{v_{02} - v_{01}}$

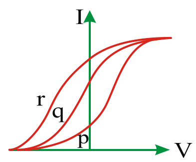
DUAL NATURE OF MATTER

7. **Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions $\phi_p = 2.0eV$, $\phi_q = 2.5eV$ and $\phi_r = 3.0eV$ respectively. A light beam containing wavelengths of 550 nm, 450 nm and 350 nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is : [Take $hc = 1240$ eV nm]**

1) 

2) 

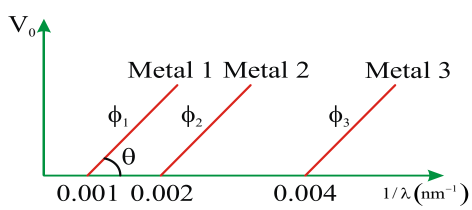
3) 

4) 

8. **An electron accelerated under a p.d. of V volt has a certain wavelength λ. Mass of the proton is 2000 times the mass of an electron. If the proton has to have the same wavelength λ, then it will have to be accelerated under p.d. of (volts)**

1) 100 2) 2000 3) V/2000 4) $\sqrt{2000}$

9. **The graph between the stopiing potential (V_0) and $(1/\lambda)$ is shown in figure, ϕ_1, ϕ_2 and ϕ_3 are work functions. Which of the following is correct**



1) $\phi_1 : \phi_2 : \phi_3 = 1:2:3$ 2) $\phi_1 : \phi_2 : \phi_3 = 4:2:1$

3) $\tan\theta$ is directly proportional to hc/e, where h is Planck's constant and c is the speed of light

4) ultraviolet light can be used to emit photoelectrons from metal 2 and metal 3 only.

10. **For certain photosensitive material, a stopping potential of 3.0 V is required for light of wavelength 300 nm, 2.0 V for 400 nm and 1.0V for 600nm. The work function of the material is (nearly)**

1) 2.5 ev 2) 1.5 ev 3) 2.0 ev 4) 1.0 ev

11. **An electron (mass m) with an initial velocity $v = v_0\hat{i}$ $(v_0 > 0)$ is in an electric field $E = -E_0\hat{i}$ (E_0 = constant > 0). Its de Broglie wavelength at time t is given by**

1) $\frac{\lambda_0}{\left(1+\frac{eE_0t}{mv_0}\right)}$ 2) $\lambda_0\left(1+\frac{eE_0t}{mv_0}\right)$ 3) λ_0 4) $\lambda_0 t$

12. **An electron (mass m) with an initial velocity $v = v_0\hat{i}$ is in an electric field $E = E_0\hat{j}$. If $\lambda_0 = \frac{h}{mv_0}$, its de Broglie wavelength at time t is given by**

1) λ_0 2) $\lambda_0\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}$ 3) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$ 4) $\frac{\lambda_0}{\left(1+\frac{e^2E_0^2t^2}{m^2v_0^2}\right)}$

13. **The kinetic energy of α-particles at a distance 5×10^{-14} m from the uranium nucleurs will be (in joules). Which is moving in a field of 1mega volt potential difference**

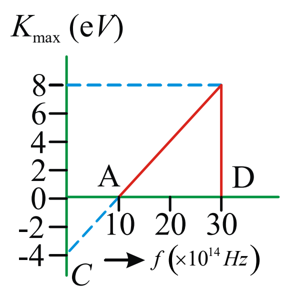
1) 6.4×10^{-13} 2) 4.3×10^{-13} 3) 2.1×10^{-13} 4) 3.4×10^{-14}

14. **The stopping potential for the photoelectric emitted from a metal surface of work function 1.7 eV is 10.4 V. Find the wavelength of the radiation used. Also identify the energy levels in hydrogen atom, which will emit this wavelength**

1) 1024 $A^0, n=3$ to $n=1$ 2) 1024 $A^0, n=2$ to $n=1$

3) 2044 $A^0, n=2$ to $n=1$ 4) 2044 $A^0, n=3$ to $n=1$

15. **A graph regarding photoeletric effect is shown between the maximum kinetic energy of electrons and the frequency of the incident light. On the basis of data as shown in the graph, calculate the work fucntion**



1) 2 eV 2) 4 eV 3) 4.2 eV 4) 2.5 eV

16. **Light of wavelength 180 nm ejects photoelectrons from a plate of metal whose work fucntion is 2 eV. If a unifrom magnetic of 5×10^{-5} T be applied parallel to the plate, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy**

1) 0.148 m 2) 0.2 m 3) 0.25 m 4) 0.3 m

17. **Light described at a place by the equation**

$$E = (100\,V/M)\times\left[\sin\left(5\times10^{15}s^{-1}\right)t + \sin\left(8\times10^{15}s^{-1}\right)t\right]$$

falls on a metal surface having work fucntion 2.0 eV. Calculate the maximum

kinetic energy of the photoelectrons

1) 3.27 eV 2) 5 eV 3) 1.27 eV 4) 2.5 eV

18. **The electric field associated with a light wave is given by $E = E_0 \times \sin\left[\left(1.57\times10^7 m^{-1}\right)\left(x - ct\right)\right]$. Find the stopping potential when this light is used in an experiment on photoelectric effect with the similar having work function 1.9 eV**

1) 1.2 V 2) 1.1 V 3) 2 V 4) 2.1 V

19. **Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength λ_0 of the emitted X-rays is**

1) $\lambda_0 = \frac{2mc\lambda^2}{h}$ 2) $\lambda_0 = \frac{2h}{mc}$ 3) $\lambda_0 = \frac{2m^2c^2\lambda^2}{h^2}$ 4) $\lambda_0 = \lambda$

20. **A photocell is illumuniated by small bright source placed 1m away. When the same source of light is placed 1/2m away, the number of electrons emitted by photocathode would**

1) increase by a factor of 2 2) decrease by a factor of 2
3) increase by a factor of 4 4) decrease by a factor of 4

EXERCISE- V - KEY

1) 2 2) 4 3) 1 4) 2 5) 1 6) 2 7) 1 8) 3 9) 3 10) 4 11) 1
12) 3 13) 3 14) 1 15) 2 16) 1 17) 1 18) 1 19) 1 20) 3

EXERCISE - VI

MULTIPLE ANSWER TYPE

1. **Photoelectric effect supports quantum nture of light because :**

1) there is a minimum frequency of light below which no photoelectrons are emitted
2) the maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity.
3) even when the metal surface is faintly illuminated, the photoelectrons leave the surface immediately
4) electric charge of the photoelectrons is quantized.

2. **If the wavelength of light in an experiment on photoelectric effect is doubled :**

1) the photoelectric emission will not take place
2) the photoelectric emission may or may not take place
3) the stopping potential will increase
4) the stopping potential will decrease

3. **The frequency and intensity of light source are both doubled. Which of the following statement (statements) is (are) true ?**

1) The saturation photocurrent gets doubled.
2) the saturation photocurrent remains almost the same
3) the maximum KE of the photoelectrons is more than doubled.

4) the maximum KE of the photoelectrons get doubled.

4. In which of the following situations, the heavier of the two particles has smaller de Broglie wavelength ? The two particles :

1) move with same speed
2) move with the same linear momentum
3) move with the same kinetic energy
4) have fallen through the same height

5. When a monochromatic point source of light is at a distance of 0.2m from a photoelectric cell, the cut-off voltage and the saturation current are respectively 0.6V and 18.0 mA. If the same source is placed 0.6m away from the photoelectric cell, then :

1) the stopping potential will be 0.2 V
2) the stopping potential will be 0.6 V
3) the saturation current will be 6.0 mA
4) the saturation current will be 2.0 mA

6. In a photoelectric experiment the wavelength of the incident light is decreased from $6000A^0$ to $4000A^0$ while the intensity of radiation remains the same. Choose the correct statement(s)

1) the cut-off potential will increase
2) the cut-off potential will decrease
3) the photoelectric current will increase
4) the kinetic energy of the emitted photoelectrons will increase

COMPREHENSION TYPE

Passage I:

Photoelectric threhold of silver is $\lambda = 3800\,\overset{o}{A}$. ultraviolet light of $\lambda = 2600\,\overset{o}{A}$ is incident on silver surface. (Mass of the electron $9.11\times10^{-31}kg$)

7. Calculate the value of work function in eV.

1) 1.77
2) 3.27
3) 5.69
4) 2.32

8. Calculate the maximum kinetic energy (in eV) of the emitted photoelectrons.

1) 1.51
2) 2.36
3) 3.85
4) 4.27

9. Calculate the maximum velocity of the photoelectrons.

1) 72.89×10^8
2) 57.89×10^8
3) 42.93×10^8
4) 68.26×10^8

Passage II:

A 100 W point source emits monochromatic light of wavelength $6000\,\overset{0}{A}$.

10. Calculate the total number of photons emitted by the source per second.

1) 5×10^{20}
2) 8×10^{20}
3) 6×10^{21}
4) 3×10^{20}

11. Calculate the photon flux (in SI unit) at a distance of 5 m from the source. Given $h = 6.6\times10^{-34}$ Js and $c = 3\times10^8\,ms^{-1}$.

1) 10^{15}
2) 10^{18}
3) 10^{20}
4) 10^{22}

12. **1.5 mW of $4000\overset{0}{A}$ light is directed at a photoelectric cell. if 0.10 per cent of the incident photons produce photoelectrons, find current in the cell. [Given $h = 6.6\times10^{-34}\,ms^{-1}$ and $e = 1.6\times10^{-19}\,C$]**

1) 0.59 μA 2) 1.16 μA 3) 0.48 μA 4) 0.79 μA

Passage III:

When a particle is restricted to move along x-axis between x=0 and x=a, where a is of nanometer dimension, its energy can take only certain specific values. The allowed energies of the particle moving in such a restricted region, corrospond to the formation of standing waves with nodes at its ends x = 0 abd x = a. The wavelength of this standing wave is related to the linear momentum p of the particle according to the de Broglie relation. The energy of the particle of mass m is related to its linear momentum as $E = p^2/2m$. Thus, the energy of the particle can be denoted by a quantum number 'n' taking values 1,2,3,..........(n=1, called the ground state) corrosponding to the number of loops in the standing wave. Use the model described above to answer the following three questions for a particle moving along the line from x=0 to x=a.

13. **The allowed energy for the particle for a particular value of n is proportional to**

1) a^{-2} 2) $a^{-3/2}$ 3) a^{-1} 4) a^{2}

14. **If the mass of the particle is $m = 1.0\times10^{-30}$ kg and a=6.6 nm, the energy of the particle in its ground state is closest to**

1) 0.8 meV 2) 8 meV 3) 80 meV 4) 800 meV

15. **The speed of the particle that can take discrete values is proportional to**

1) $n^{-3/2}$ 2) n^{-1} 3) $n^{1/2}$ 4) n

16. **Statement-I: When ultraviolet light is incident on a photo cell, its stopping potential is v_0 and the maximum kinetic energy of the photoelectrons is $K_{\max}$ increase.**

Statement-II: Photoelectrons are emitted with speeds ranging from zero to a maximum value because of the range of frequencies present in the incident light. [AIEEE-2010]

1) Statement I is true, Statement II is true; statement II is a correct explanation of statement I.

2) Statement I is true, Statement II is true, Statement II is NOT a correct explanation for statement I.

3) Statement I is false, Statement II is true

4) Statement I is true, Statemenet II is false

17. **Wavelengths associated with different particles are given in Column - I. Match these wavelengths with their values given in Column-II.**

Column-I

A) Wavelength associated with an electron accelerated through a pd of 1V

B) Wavelength associated with an α-particle accelerated through a pd of 1V

C) Wavelength associated with a proton accelerated through a pd of 1V

D) Wavelength associated with a photon of energy 124.2 eV

Column - II

p) 10nm

q) 0.10 A^0

r) 0.286 A^0

s) 12.27 A^0

18. In a permoting photoelectric experiment to study photoelectric effect, intensity of radiation (I), frequency of radiation (v), work function (ϕ_0) of the photosensitive emitter, distance (d) between emitter and collector are changed or kept constant. Match the changes given in Column - I to their effect given in Column - II.

Column - I

A) ϕ_0 is decreased, keeping v and I constant

B) d is increased, keeping I, v, ϕ_0 constant

C) v is increased, keeping I, ϕ_0, d constant

D) I is increased, keeping v, ϕ_0, d constant

Column - II

p) Saturation photoelectric current increases

q) stopping potential (V_0) increases

r) Maximum KE (K_{max}) of photoelectrons increases

s) Stopping potential remains the same

EXERCISE- VI - KEY

1) 1,2,3 2) 2,4 3) 1,3 4) 1,3,4 5) 2, 4 6) 1, 4 7) 2 8) 1

9) 1 10) 4 11) 2 12) 3 13) 1 14) 2 15) 4 16) 4

17) A-s, B-q, C-r, D- 18) A-q,r, B-s, C-q,r, D-p,s

EXERCISE - I

J.J.THOMSONS METHOD

1. **An electron passes undeflected through perpendicular electric and magnetic fields of intensity 3.4 x 10^3 V/m and 2 x 10^{-3} Wb/m^2 respectively. Then its velocity in m/s is**
1) 1.7 x 10^6 2) 6.8 x 10^6 3) 6.8 4) 1.7 x 10^8 m/s

2. **The ratio of specific charges of an electron to that of a hydrogen ion is**
1) 2:1 2) 1:1 3) 1: 1840 4) 1840:1

3. **An α - particle and a proton are subjected to the same electric field, then the ratio of the forces acting on them is**
1) 2: 3 2) 1: 2 3) 3 :2 4) 2 :1

4. **An electron is accelerated in an electric field of 40 V cm^{-1}. If e/m of electron is 1.76 X 10^{11} Ckg^{-1}, the acceleration is**
1) 14.0 x 10^{14} ms^{-2} 2) 14.0 x 10^{10}ms^{-2} 3) 7.0 x 10^{10}ms^{-2} 4) 7.04 x 10^{14}ms^{-2}

5. **An electron beam moving with a speed of 2.5×10^7 ms^{-1} enters into the magnetic field directed perpendicular to its direction of motion. The magnetic induction of the field is 4×10^{-3} wb/m^2. The intensity of the electric field applied so that the electron is undeflected due to the magnetic field is.**
1) 10^4N/C 2) 10^5N/C 3) 10^7N/C 4) 10^3N/C

6. **A particle carrying a charge moves perpendicular to a uniform magnetic field of induction B with a momentum p, then the radius of the circular path is**
1) Be/p 2) pe/B 3) p/Be 4) Bep

MILLIKAN OIL DROP EXPERIMENT

7. **A water drop of mass 3.2 x 10^{-18} kg and carrying a charge of** $1.6\times10^{-19}C$ **is suspended stationary between two plates of an electric field. Given g=10 m/s^2, the intensity of the electric field required is**
1) 2 V/m 2) 200 V/m 3) 20 V/m 4) 2000 V/m

8. **In a Millikan's oil drop experiment, an oil drop of mass 0.64 $\times$ 10^{-14} kg, carrying a charge 1.6$\times$$10^{-19}$ C remains stationary between two plates seperated by a distance of 5 mm. Given g=9.8 m/s^2; the voltage that must be applied between the plates being**
1) 980 V 2) 1960 V 3) 3920V 4) 2880V

ALPHA RAY SCATTERING

9. **$\alpha-$particles are projected towards the nuclei of the different metals, with the same kinetic energy. The distance of closest approach is minimum for**
1) Cu(Z=29) 2) Ag(Z=47) 3) Au(Z=79) 4) Pd(Z=46)

10. **In Rutherford experments on $\alpha-$ray scattering the number of particles scattered at 90^0 be 28 per minute. Then the number of particles scattered per minute by the same foil but at 60^0 are**
1) 56 2) 112 3) 60 4) 120

11. For a given impact parameter (b), if the energy increase then the scattering angle (θ) will

1) Decrease 2) increase 3) become zero 4) become

BOHR'S MODEL OF ATOM

12. Find the frequency of revolution of the electron in the first stationary orbit of H-atom

1) $6\times10^{14}\,Hz$ 2) $6.6\times10^{10}\,Hz$ 3) $6.6\times10^{-10}\,Hz$ 4) $6.6\times10^{15}\,Hz$

13. Let the potential energy of a hydrogen atom in the ground state be zero. Then its energy in the first excited state will be

1) 10.2eV 2) 13.6eV 3) 23.8eV 4) 27.2eV

14. According to bohr model, the diameter of first orbit of hydrogen atom will be

1) $1.A^0$ 2) $0.529A^0$ 3) $2.25A^0$ 4) $0.725A^0$

15. The angular momentum of electron is J.its magnetic moment will be

1) $\frac{mJ}{2e}$ 2) $\frac{eJ}{2m}$ 3) $\frac{2m}{eJ}$ 4) $\frac{emJ}{2}$

16. The radius of shortest orbit in one electron system is 18 pm.It may be.

1) ${}_1^1H$ 2) ${}_1^2H$ 3) He^+ 4) Li^+

17. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass, e is the charge on the elctron and ε_0 is the vacuum permittivity, the speed of the electron is: [CBSE 1998]

1) Zero 2) $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$ 3) $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$ 4) $\frac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

18. The energy necessary to remove the electron from n=10 state in hydrogen atom will be

1)1.36 eV 2)0.0136 eV 3)13.6 eV 4) 0.136 eV

19. The ratio of energies of first two excited states hydrogen atom is

1) 3/1 2) 1/4 3) 4/9 4) 9/4

ATOMIC SPECTRA

20. The number of different wavelengths may be observed in the spectrum from a hydrogen sample if the atoms are excited to third excited state is

1) 3 2)4 3)5 4)6

21. The ratio of the frequencies of the long wavelength limits of the Balmer and Lyman series of hydrogen is

1)27:5 2)5:27 3)4:1 4)1:4

22. When an electron jumps from higher orbit to the second orbit in hydrogen ,the radiation emitted out will be in $(R = 1.09\times10^7 m^{-1})$:

1)ultraviolet 2) visible region 3)infrared region 4)X-ray region

23. The energy required to seperate a hydrogen atom into a proton and an electron is 13.6eV. Then the velocity of electron in a hydrogen atom is

1) $2.2\times10^{4}m/s$ 2) $2.2\times10^{2}m/s$ 3) $2.2\times10^{6}m/s$ 4) $2.2\times10^{10}m/s$

EXERCISE-I - KEY

1) 1 2) 4 3) 4 4) 4 5) 2 6) 3 7) 2 8) 2 9) 1 10) 2 11) 1
12) 4 13) 3 14) 1 15) 2 16) 4 17) 3 18) 4 19) 4 20) 4 21) 1
22) 2 23) 3

EXERCISE - II

J.J.THOMSONS METHOD

1. **A cathode emits 1.8 x 10^{17} electrons/s and all the electrons reach the anode when it is given a positive potential of 400 V. Given e=1.6 x 10^{-19}C, the maximum anode current is**

1) 2.88 mA 2) 28.8 mA 3) 7.2 mA 4) 6.4 mA

2. **An electron of mass 9 x 10^{-31} kg moves with a speed of 10^{7} m/s. It acquires a K.E. of**

1) 562.50 eV 2) 1125 eV 3) 1250 eV 4) 281.25 eV

3. **Two electron beams having velocities in the ratio 1:2 are subjected to the same transverse magnetic field. The ratio of the deflections is**

1) 1:2 2) 2:1 3) 4:1 4) 1:4

4. **The velocity of electrons accelerated by potential difference of 1×10^{4} V (The charge of the elctron is 1.6×10^{-19} C and mass is 9.11×10^{-31}kg) is**

1) 5.93×10^{7} ms^{-1} 2) 2.94×10^{7} ms^{-1} 3) 6.87×10^{7} ms^{-1} 4) 3.98×10^{7} ms^{-1}

5. **Cathode ray tube is operating at 5 KV. Then the K.E. acquired by the electrons is**

1) 5 eV 2) 5 MeV 3) 5 KeV 4) 5 V

6. **A steam of similar negatively charged particals enters an electrical field normal to the electric lines of force with a velocity of $3\times10^{7}m/s$. The electric intensity is 1800 V/m. While through a distance of 100 m, the electron beam is deflected by 2mm. Then the specific charge value of in c/kg is**

1) 2×10^{10} 2) 2×10^{7} 3) 2×10^{11} 4) 2×10^{4}

MILLIKAN OIL DROP EXPERIMENT

7. **An oil drop having a mass 4.8×10^{-10}g. and charge 2.4×10^{-18}C stands still between two charged horizantal plates seperated by a distance of 1cm. If now the polarity of the plates is changed the instantaneous acceleration of the drop is (in ms^{-2}) (g=10ms^{-2})**

1) 5 2)10 3) 20 4) 40

8. **In millkan's oil drop experiment a charged drop of mass 1.8 X 10^{-14}kg is stationary between the plates. The distance between the plates is 0.9cm and potential difference is 2000 V. The number of electrons in the drop is (g = 10ms^{-2})**

1) 2 2) 4 3) 5 4) 1

ALPHA RAY SCATTERING

9. An $\alpha-$particle accelerated through V volt is fired towards a nucleus.Its distance of closest approach is r.If a proton is accelerated through the same potential and fired towards the same nucleus,the distance of closest approach of proton will be:

1) r 2) 2r 3) r/2 4) r/4

10. In $\alpha-$ray scattering, the scattering angle (θ) for impact parameter (b) to become zero is

1) 0^{o} 2) 90^{o} 3) 180^{o} 4) 45^{o}

11. The impact parameter at which the scattering angle is 90^{o}, $z=79$ and initial energy 10 MeV is

1) 1.137×10^{-14}m 2) 1.137×10^{-16}m 3) 2.24×10^{-17}m 4) 2.24×10^{-18}m

BOHR'S MODEL OF ATOM

12. When a hydrogen atom emits a photon of energy 12.1 eV,its orbital angular momentum changes by

1) $1.05\times10^{-34}J-s$ 2) $2.11\times10^{-34}J-s$ 3) $3.16\times10^{-34}J-s$ 4) $4.22\times10^{-34}J-s$

13. An electron is in an excited state in a hydrogen like atom. It has a total energy -3.4 eV. The kinetic energy of the electron is E and its de broglie wavelength is λ.

1) $E=6.8eV.\lambda=6.6\times10^{-10}m$ 2) $E=3.4eV,\lambda=6.6\times10^{-10}m$

3) $E=3.4eV,\lambda=6.6\times10^{-11}m$ 4) $E=6.8eV,\lambda=6.6\times10^{-11}m$

14. The ionisation potential of hydrogen atom is

1) $12.97V$ 2) $10.2V$ 3) $13.6V$ 4) $27.2V$

15. The energy of electron in an excited hydrogen atom is -3.4 eV. Its angular momentum according to bohr's theory will be

1) $\frac{h}{\pi}$ 2) $\frac{h}{2\pi}$ 3) $\frac{3h}{2\pi}$ 4) $\frac{3}{2\pi h}$

16. The velocity of an electron in its fifth orbit,if the velocity of an electron in the second orbit of sodium atom (atomicnumber=11)is v,will be:

1) v 2) $\frac{22v}{5}$ 3) $\frac{5}{2}v$ 4) $\frac{2}{5}v$

17. The ratio of the kinetic energy and the potential energy of electron in the hydrogen atom will be

1)1:2 2) -1:2 3) 2:1 4) -2:1

18. If the potential energy of a H-atom in the ground state be zero then its potential energy in the first excited state will be

1) 10.2 ev 2)20.4 eV 3) 23.8 eV 4)27.2 eV

ATOMIC SPECTRA

19. **The value of wavelength radiation emitted due to transition of electrons from n = 4 to**
n = 2 state in hydrogen atom will be

1) $\frac{5R}{36}$ 2) $\frac{16}{3R}$ 3) $\frac{36}{5R}$ 4) $\frac{3R}{16}$

20. **The maximum number of photons emitted by an H-atom,if atom is excited to states with principal quantum number four is:**
[AIEEE-2012]

1)4 2) 6 3) 2 4) 1

21. **For certain atom,there are energy levels A,B,C corresponding to energy values $E_A < E_B < E_c$. Choose the correct option if $\lambda_1, \lambda_2, \lambda_3$ are the wavelength of radiations corresponding to the transition from C to B,B to A and C to A respectively:**

1) $\lambda_3 = \lambda_1 + \lambda_2$ 2) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$ 3) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ 4) $3\lambda_2 = \lambda_3 + 2\lambda_2$

22. **If 13.6 eV is the energy required to saperate a hydrogen atom into a proton and an electron then its orbital radius is**

1) 5.3×10^{-11}m 2) 5.3×10^{-12}m 3) 7.6×10^{-13}m 4) 7.6×10^{-14}m

EXERCISE- II - KEY

1) 2 2) 4 3) 2 4) 1 5) 3 6) 1 7) 38) 3 9) 1 10) 3 11) 1
12) 2 13) 2 14) 3 15) 1 16) 4 17) 2 18) 2 19) 2 20) 2 21) 2 22) 1

EXERCISE - III

J.J.THOMSONS METHOD

1. **Two ions having masses in the ratio 1:1 and charges 1:2 are projected into uniform magnetic field perpendicular to the field with speeds in the ratio 2:3 .The ratio of the radii of circular paths along which the two particles move is**

1) 4:3 2) 2:3 3) 3:1 4) 1:4

2. **In Thomson's experiment, a magnetic field of induction 10^{-2} wb/m^2 is used. For an undeflected beam of cathode rays, a p.d. of 500 V is applied between the plates which are 0.5 cm apart. Then the velocity of the cathode ray beam is ...... m/s.**

1) 4 x 10^7 2) 2 x 10^7 3) 2 x10^8 4) 10^7

3. **A cathode ray beam is bent into an arc of a circle of radius 0.02 m by a field of magnetic induction 4.55 milli tesla. The velocity of electrons is (given e = 1.6x10^{-19} c and**
m = 9.1 x 10^{-31} kg)

1) 2×10^7m/s 2) 3×10^7m/s 3) 1.6×10^7 m/s 4) 3.2×10^7m/s

4. When two electrons enter into a magnetic field with different velocities, they deflect in different circular parts, in such a way that the radius of one path is double that of the other. 1×10^7 ms^{-1} is the velocity of electron in smaller circle of radius 2×10^{-3} m. The velocity of electron in the other circular path is :

1) 4×10^7 ms^{-1} 2) 4×10^6 ms^{-1} 3) 2×10^7 ms^{-1} 4) 2×10^6 ms^{-1}

MILLIKAN OIL DROP EXPERIMENT

5. A charged oil drop falls with terminal velocity V_0 in the absence of electric field. An electric field E keeps it stationary. The drop acquires additional charge q and starts moving upwards with velocity V_0. The initial charge on the drop was

1) 4q 2) 2q 3) q 4) q/2

6. A charged oil drop is moving with a velocity V_1. As it acquires an additional charge it moves up with the velocity V_2 in the same electric filed. It fall freely with a Velocity 'V' in the absence of electric field . The ratio of the charges before and after acquiring additional charge is

1) $\frac{V_1 + V}{V_2 - v_1}$ 2) $\frac{V_1 + V_2}{2V}$ 3) $\frac{V + V_1}{V + V_2}$ 4) $\frac{V_2 - 2V_1}{2V_1 + V}$

ALPHA SCATTERING

7. A proton strikes another proton at rest with speed V_o . Assume impact parameter to be zero. Their closest distance of approach is (mass of proton is m)

1) $\frac{e^2}{4\pi\varepsilon m\upsilon_o^2}$ 2) $\frac{e^2}{\pi\varepsilon_0 m\upsilon_o^2}$ 3) $\frac{e^2}{m\upsilon_0^2}$ 4) zero

8. A closest distance of approach of an α particle travelling with a velocity v towards Al_{13} nucleus is d. The closest distance of approach of an alpha particle travelling with velocity 4V towards Fe_{26} nucleus is

1) d/2 2) d/4 3) d/8 4) d/16

BOHR'S THEORY

9. The energy required to excite an electron from n=2 to n=3 energy state is 47.2 e V. The charge number of the nucleus, around which the electron revolving will be

1) 5 2) 10 3)15 4) 20

10. The debroglie wave length of an electron in the first Bohr orbit is

1) Equal to the circumference of the first orbit
2) 1/2 th circumference of the first orbit
3) 1/4 th circumference of the first orbit
4) 3/4th circumference of the first orbit

11. If the radius of first Bohr's orbit is x ,then de-Broglie wavelength of electron in 3rd orbit is nearly:

1) $2\pi x$ 2) $6\pi x$ 3) $9x$ 4) $x/3$

12. The angular momentum of the electron in third orbit of hydrogen atom , if the angular momentum in the second orbit of hydrogen atom is L is

1) L 2) 3L 3) (3/2) L 4) 2/3 L

13. The de-Broglie wave length of the electron in the second Bohr orbit is (given r_0=0.53A^0)

1) 3.33A^o 2) 6.66A^o 3) 9.99A^o 4) 1.06A^o

ATOMIC SPECTRA

14. The maximum wavelength of Brackett series of hydrogen atom will be ______ A^0

1) 35,890 2) 14,440 3) 62,160 4) 40,477

15. When a hydrogen atom emits a photon in going from n = 5 to n = 1, its recoil speed is almost

1) $10^{-4} m/s$ 2) $2\times10^{-2} m/s$ 3) $4 m/s$ 4) $8\times10^{-2} m/s$

16. An orbital electron in the ground state of hydrogen has the magnetic moment μ_1. This orbital electron is excited to 3rd excited state by some energy transfer to the hydrogen atom. The new magnetic moment of the electron is μ_2, then

1) $\mu_1 = 2\mu_2$ 2) $2\mu_1 = \mu_2$ 3) $16\mu_1 = \mu_2$ 4) $4\mu_1 = \mu_2$

EXERCISE-III - KEY

1) 1 2) 4 3) 3 4) 3 5) 3 6) 3 7) 28) 3 9) 1 10) 1 11) 2
12) 3 13) 2 14) 4 15) 3 16) 4

EXERCISE - IV

J.J.THOMSONS METHOD

1. A proton and an α-particle enter a magnetic field in a direction perpendicular to it. If the force acting on the proton is twice that acting on the α-particle, the ratio of their velocities is

1) 4 : 1 2) 1. : 4 3) 1 : 2 4) 2 : 1

2. A proton, a deuteron and an α-particle are accelerated through the same p.d. of V volt. The velocities acquired by them are in the ratio

1) 1 : 1 : $\sqrt{2}$ 2) 1 : $\sqrt{2}$: 1 3) 1 : 1 : 1 4) $\sqrt{2}$: 1 : 1

3. An electron starts from rest and travels 0.9 m in an electric field of 200 V/m. After this, it enters a magnetic field at right angles to its direction of motion. If the radius of circular path of the electron is 9 cm, the magnetic field induction is (Given e=1.6 x 10^{-19}C, m=9x10^{-31}kg)

1) 5 x 10^{-4} wb/m^2 2) 5 x 10^{-5} wb/m^2 3) 5 x 10^{-3} wb/m^2 4) 5 x 10^{-2} wb/m^2

MILLIKAN OIL DROP EXPERIMENT

4. **In the Millikan's experiment, the oil drop is subjected to a horizontal electric field of 2 N/C and the drop moves with a constant velocity making an angle of 45^0 with the horizontal. If the weight of the drop is W, then the electric charge, in coulomb, on the drop is**

1) W   2) W/2   3) W/4   4) W/8

ALPHA SCATTERING

5. **An α-Particle of energy 5 Mev is scattered through 180^0 by a fixed uranium nuclens.The closest distance is in the order of:**

1) $1A^o$ 2) $10^{-10} cm$ 3) $10^{-12} cm$ 4) $10^{-16} cm$

6. **An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to (AIEEE-2006)**

1) $\frac{1}{v}$ 2) $\frac{1}{ze}$ 3) v^2 4) $\frac{1}{m}$

BOHR'S THEORY

7. **In the Bohr model of hydrogen atom, the ratio of the kinetic energy and total energy of electron in the n^{th} quantum state will be**

1) 1   2) -1   3) 2   4) -12

8. **The number of revolutions done by an electron 'e' in one second in the first orbit of hydrogen atom is**

1) $6.57x10^{15}$ 2) 6.57×10^{13} 3) 1000   4) 6.57×10^{14}

9. **If $\left(\frac{0.51\times10^{-10}}{4}\right)$ m is the radius of smallest electron orbit in hydrogen like atom ,then this atom is :**

1) hydrogen atom   2) He^+ 3) Li^{2+} 4) Be^{3+}

10. **In Bohr's orbit of hydrogen atom m kg is mass of an electron and e coulomb is the charge on it .The ratio (in SI units) of magnetic dipole moment to that of the angular momentum of electron is:**

1) e/2m   2) e/m   3) 2e/m   4)2e/3m

11. **In a sample of hydrogen like atoms all of which are in ground state, a photon beam contain photons of various energies is passed. In absorption spectrum, five dark line are observed. The number of bright lines in the emission spectrum will be(assume that all transitions take place)**

1) 21   2) 10   3) 15   4) 12

ATOMIC SPECTRA

12. **Let f_1 be the frequency of the series limit of the lyman series, f_2 be the frequency**

of the first line of the lyman series,and f_3 be the frequency of the series limit of the balmer series .

1) $f_1 - f_2 = f_3$ 2) $f_2 - f_1 = f_3$ 3) $f_3 = \frac{1}{2}(f_1 + f_2)$ 4) $f_1 + f_2 = f_3$

13. **Ratio of difference of spacing between the energy levels with n=3 and n=4 and the spacing between the energy levels with n=8 and n=9 for a hydrogen like atom or ion is**

1) 0.71 2) 0.41 3) 2.43 4) 14.82

14. **A stationary hydrogen atom emits photon corresponding to the first line of Lyman series. If R is the Rydberg's constant and M is the mass of the atom, then the velocity acquired by the atom is (neglect energy absorbed by the photon)**

1) $\frac{3Rh}{4M}$ 2) $\frac{4M}{3Rh}$ 3) $\frac{Rh}{4M}$ 4) $\frac{4M}{Rh}$

EXERCISE-IV - KEY

1) 1 2) 4 3) 1 4) 2 5) 3 6) 4 7) 2 8) 1 9) 4 10) 1 11) 3 12) 1 13) 2 14) 1

EXERCISE - V

1. **Magnetic moment due to the motion of the electron in n^{th} energy state of hydrogen atom is proportional to**

1) n 2) n^0 3) n^5 4) n^3

2. **The ratio between total accelertion of the electron in singly ionized helium atom and hydrogen atom (both in ground state) is**

1) 1 2) 8 3) 4 4) 16

3. **The shortest wavelength of the Brackett series of a hydrogen like atom (atomic number =Z) is the same as the shortest wavelength of the Balmar series of hydrogen atom. The value of Z is**

1) 2 2) 3 3) 4 4) 6

4. **According to Bohr's theory of hydrogen atoms, the product of the binding energy of the electron in the n^{th} orbit and its radius in the n the orbit**

1) is proportional to n^2 2) is inversely proportional to n^3
3) has a constant value of 10.2eV-A^0 4) has constant value 7.2 eV-A^0

5. **If an electron drops from 4 th orbit to 2nd orbit in an H-atom,then**

1) it gains 2.55 eV of potential energy 2) it gains 2.55 eV of total energy
3) it emits a 2.55 eV electron 4) it emits a 2.55 eV photon

6. **The energy of an atom or ion in the ground state is -54.4 eV .it may be:**

1) He^+ 2) Li^{2+} 3) hydrogen 4)deuterium

7. **An atom absorbs 2 eV energy and is excited to next energy state. The wavelength of light absorbed will be**

1) 2000 A° 2) 4000 A°. 3) 8000 A° 4) 6206 A°

8. **When an electron in the hydrogen atom in ground state absorbs a photon of energy 12.1 eV, its angular momenturm**

1) decreases by $2.11\times10^{-34} J-s$ 2) decreases by $1.055\times10^{-34} J-s$

3) increases by $2.11\times10^{-34} J-s$ 4) increases by $1.055\times10^{-34} J-s$

9. Magnetic field at the centre (at nucleus) of the hydrogen like atoms (atomic number =Z) due to the motion of electron in n^{th} orbit is proportional to

1) $\frac{n^3}{Z^5}$ 2) $\frac{n^4}{Z}$ 3) $\frac{Z^2}{n^3}$ 4) $\frac{Z^3}{n^5}$

10. A neutron moving with a speed v makes a head on collision with a hydrogen atom in ground state kept at rest. The minimum kinetic energy of neutron for which inelastic collision will take place is (assume that mass of proton is nearly equal to the mass of neutron)

1) 10.2 eV 2) 20.4eV 3) 12.1eV 4) 16.8ev

11. A charged particle is moving in a uniform magnetic field in a circular path. The energy of the particle is doubled. If the initial radius of the circular path was R, the radius of the new circular path after the energy is doubled will be

1) R/2 2) $\sqrt{2}R$ 3) 2R 4) R/$\sqrt{2}$

12. An electron in hydrogen atom after absorbing an energy photon jumps from energy state n_1 to n_2. Then it returns to ground state after emitting six different wavelengths in emission spectrum. The energy of emitted photons is either equal to, less than or greater than the absorbed photons. Then n_1 and n_2 are

1) $n_2=4, n_1=3$ 2) $n_2=5, n_2=3$ 3) $n_2=4, n_1=2$ 4) $n_2=4, n_1=1$

13. The photon radiated from hydrogen corresponding to 2^{nd} line of Lyman series is absorbed by a hydrogen like atom 'X' in 2^{nd} excited stae. As a result then , the hydrogen-like atom 'X' makes a transition of n^{th} orbit.

1) X=He^+, n=4 2) X=Li^{++},n=6 3) X=He^+, n=6 4) X=Li^{++},n=9

14. In a hypothetical system, a particle of mass m and charge -3q is moving around a very heavy particle charge q. Assume that Bohr's model is applicable to this system.then velocity of mass m in first orbit is

1) $\frac{3q^2}{2\in_0 h}$ 2) $\frac{3q^2}{4\in_0 h}$ 3) $\frac{3q}{2\pi\in_0 h}$ 4) $\frac{3q}{4\pi\varepsilon_0 h}$

15. Consider a hydrogen-like atom whose energy in n^{th} excited state is given by

$$E_n = \frac{13.6Z^2}{n^2}$$

When this excited atom makes a transition from excited state to ground state, most energetic photons have energy E_{max}= 52.224 eV and least energetic photons have energy E_{min}= 1.224eV. Find the atomic number of atom and the state of excitation.

1) Z=2; n=5 2) Z=2, n=4 3) Z=3, n=6 4) Z=4, n =6

16. 29 electrons are removed from Zn-atom (Z=30) by certain means .The minimum energy needed to remove the 30th electron ,will be:

1)12.24 keV 2)408 keV 3)0.45 keV 4)765keV

17. The ionisation energy of Li^{2+} atom in ground state is :

1) 13.6 x 9 eV   2) 13.6J   3) 13.6 erg   4)13.6x10^{-19} J

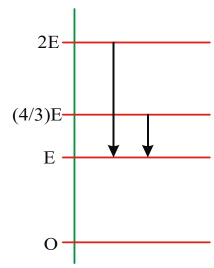
18. A photon of energy 15 eV collides with H-atom. Due to this collision, H-atom gets ionized .The maximum kinetic energy of emitted electron is :

1)1.4 eV   2) 5 eV   3)15eV   4) 13.6eV

19. Monochromatic radiation of wavelength λ is incident on a hydrogen sample in ground state.Hydrogen atoms absorb a fraction of light and subsequently emit radiation of six different wavelengths. Find the value of λ.

1) 80 nm   2) 97.5 nm   3) 105 nm   4) 60 nm

20. The figure shows energy levels of a certain atom, when the system moves from level 2E to E, a photon of wavelength λ is emitted. The wavelength of photon produced during its transition from level 4/3 E to E level is:



1) 3λ 2)3/4λ 3) λ/4   4)2λ

21. When the electron in hydrogen atom jumps from the second orbit to the first orbit, the wavelength of the radiation emitted is λ. When the electron jumps from the third to the first orbit, the wavelength of the radiation emitted is:

1) $\frac{9}{4}\lambda$ 2) $\frac{4}{9}\lambda$ 3) $\frac{27}{32}\lambda$ 4) $\frac{32}{27}\lambda$

22. The ratio of the largest to shortest wavelengths in Balmer series of hydrogen spectra is:

1) $\frac{25}{9}$ 2) $\frac{17}{6}$ 3) $\frac{9}{5}$ 4) $\frac{5}{4}$

23. An electron in a hydrogen atom makes a transition $n_1 \to n_2$, where n_1 and n_2 are principal quantum numbers of the states. Assume the Bohr's model to be valid. The time period of the elctron in the initial states is eight times to that of final state. What is ratio of $\frac{n_1}{n_2}$

1) 8:1   2) 4:1   3) 2:1   4) 1:2

24. Any radiation in the ultra violet region of Hydrogen spectrum is able to eject photoelectrons from a metal. Then the maximum value of threshold frequency of the metal is, nearly

1) 3.3x10^{15} HZ   2) 2.5x10^{15} HZ   3) 4.6 x 10^{14} HZ   4) 8.2x10^{14} HZ

25. A hydrogen atom emits a photon corresponding to an electron transition from n=5 to n=1. The recoil speed of hydrogen atom in nearly equal to

1) 10^{-4} m/s   2) 2x10^{-2} m/s   3) 4 m/s   4) 8x10^{-2} m/s

26. The wave number of energy emitted when electron jumps from fourth orbit to second orbit in hydrogen in 20,497 cm^{-1}. The wave number of energy for the same transition in He^+ is

1) 5,099 cm^{-1} 2) 20,497 cm^{-1} 3) 40,994 cm^{-1} 4) 81,988 cm^{-1}

27. In a Bohr atom the electron is replaced by a particle of mass 150 times the mass of the electron and the same charge. If a_0 is the radius of the first Bohr orbit of the orbital atom, then that of the new atom will be

1) 150 a_0 2) $\sqrt{150}\,a_0$ 3) $\frac{a_0}{\sqrt{150}}$ 4) $\frac{a_0}{150}$

28. If the wavelength of first member of Balmer series of hydrogen spectrum is 6564 A^0, the wavelength of second member of Balmer series will be:

1) 1215 A^0 2) 4848 A^0

3) 6050 A^0 4) data given is insufficient to calculate the value

29. A hydrogen like atom (atomic number Z) is in a higher excited state of quantam number 'n'. This excited atom can make a transition to the first excited state by emitting a photon of energy 27.2eV. Alternatively the atom from the same excited state can make a transition to second excited state by emitting a photon of energy 10.20 eV. The value of n and z are given (Ionization energy of hydrogen atom is 13.6eV)

1) n = 6 and z =3 2) n = 3 and z = 6 3) n = 8 and z = 4 4) n = 4 and z = 8

30. Photons from n=2 to n=1 in Hydrogen atom is made to fall on a metal surface with work function 1.2ev. The maximum velocity of photo electrons emitted is nearly equal to

1) $6x10^5$ m/s 2) $3x10^5$ m/s 3) $2x10^5$ m/s 4) $18x10^5$ m/s

31. Let ϑ_1 be the frequency of the series limit of the Lyman series and ϑ_2 be the frequency of the first line of the Lyman series and ϑ_3 be the frequency of the series limit of Balmar series, then

1) $\vartheta_1 - \vartheta_2 = \vartheta_3$ 2) $\vartheta_2 - \vartheta_1 = \vartheta_3$ 3) $2\vartheta_3 = \vartheta_1 + \vartheta_2$ 4) $\vartheta_1 + \vartheta_2 = \vartheta_3$

32. a)Find the wavelength of the radiation required to excite the electron in Li from the first to the third Bohr orbit,

b) How many spectral lines are observed in the emission spectrum of the above excited system?

1) 108.8 eV, 3 2) 13.6 eV, 4 3) 54.4 eV, 2 4) 10.2 eV, 3

33. Find the wavelengths in a hydrogen spectrum between the range 500nm to 700nm.

1) 540 nm 2) 580 nm 3) 654 nm 4) 696 nm

34. The largest wavelength in the ultraviolet region of the hydrogen spectrum is 122 nm. The smallest wavelength in the infrared region of the hydrogen spectrum (to the nearest integer) is (IITJEE 2007)

1) 802 nm 2) 823 nm 3) 1882 nm 4)1648 nm

35. The electric potential between a proton and an electron is given by $V = V_0 \ln \frac{r}{r_0}$, where r_0 is a constant. Assuming Bohr's model to be applicable, write variation

of r_n with *n*, *n* being the principal quantum number

1) $r_n \propto n$ 2) $r_n \propto 1/n$ 3) $r_n \propto n^2$ 4) $r_n \propto 1/n^2$

36. If elements of quantum number greater than *n* were not allowed, the number of possible elements in nature would be ?

1) $\frac{1}{2}n(n+1)$ 2) $\left\{\frac{n(n+1)}{2}\right\}^2$ 3) $\frac{1}{2}n(n+1)(2n+1)$ 4) $\frac{1}{3}n(n+1)(2n+1)$

37. Magnetic field at the centre (at nucleus) of the hydrogen like atoms (atomic number $= z$) due to the motion of electron in n^{th} orbit is praportional to

1) $\frac{n^3}{z^5}$ 2) $\frac{n^4}{z}$ 3) $\frac{z^2}{n^3}$ 4) $\frac{z^3}{n^5}$

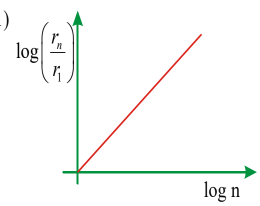
38. The recoil speed of a hydrogen atom after it emits a photon in going from $n=5$, state to $n=1$ state is (in ms^{-1})

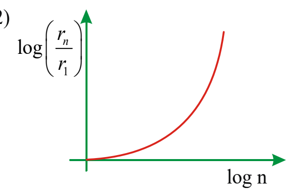
1) 4.718 2) 7.418 3) 4.178 4) 7.148

39. The binding energy of an electron in the ground state of He-atom is $E_0 = 24.7eV$. The energy required to remove both the electrons from the atom is

1) 24.6eV 2) 79.0eV 3) 54.4eV 4) none of these

40. In hydrogen atom, the radius of n^{th} Bohr orbit is V_n. The graph between $\log\left(\frac{r_n}{r_1}\right)$ and $\log n$ will be

1)


2)


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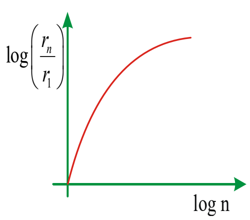
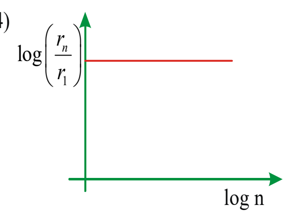
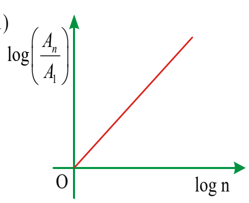
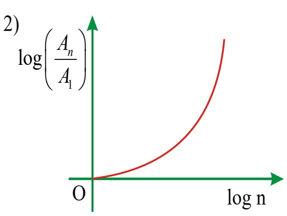
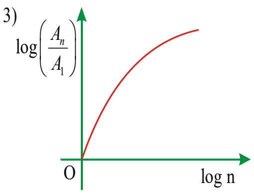


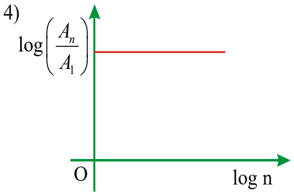
4)


41. In hydrogen atom, the area enclosed by n^{th} orbit is A_n. The graph between $\log\left(\frac{A_n}{A_1}\right)$ and $\log n$ will be

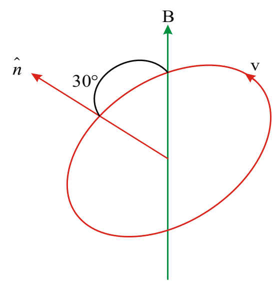
1)


2)


3) 

4) 

42. **An electron in the ground state of hydrogen atom is revolving in anticlockwise direction in the cicular orbit of radius R. The atom is placed in a uniform magnetic induction B such that the plane normal of electron orbit makes an angle 30^0 with B, as shown in figure. The torque experienced by electron willbe**



1) $\frac{ehB}{8\pi m}$ 2) $\frac{eh}{8\pi Bm}$ 3) $\frac{eB}{8\pi mh}$ 4) $\frac{hB}{8\pi em}$

43. **If we assume only gravitational attraction between proton and electron in hydrogen atom and the Bohr's quantization rule to be followed, then the expression for the ground state energy of the atom will be (the mass of proton is M and that of electron is m)**

1) $\frac{G^2M^2m^2}{h^2}$ 2) $\frac{2\pi^2G^2M^2m^3}{h^2}$ 3) $\frac{2\pi^2GM^2m^3}{h^2}$ 4) $\frac{h^2}{G^2M^2n^2}$

EXERCISE- V - KEY

1) 1	**2) 2**	**3) 1**	**4) 4**	**5) 4**	**6) 1**	**7) 4**	**8) 3**	**9) 4**	**10) 2**	**11) 2**
12) 3	**13) 4**	**14) 1**	**15) 1**	**16) 1**	**17) 1**	**18) 1**	**19) 2**	**20) 1**	**21) 3**	
22) 3	**23) 3**	**24) 1**	**25) 3**	**26) 4**	**27) 4**	**28) 2**	**29) 1**	**30) 4**	**31) 1**	**32) 1**
33) 3	**34) 2**	**35) 1**	**36) 4**	**37) 4**	**38) 3**	**39) 2**	**40) 1**	**41) 1**	**42) 1**	**43) 2**

EXERCISE -VI

COMPREHENSION TYPE

Passage-I:

A particle of charge equal to that of an electron, -e, and mass 208 times the mass of electron (called μ-meson)moves in a circular orbit around a nucleus of charge+3e.(Take the mass of the nucleus to be infinite). Assuming that Bohr model of the atom is applicable to this system:

1. Derive an expression for the radius of the n^{th} Bohr orbit

1) $\frac{\varepsilon_0 n^2 h^2}{208\pi m_e e^2}$ 2) $\frac{\varepsilon_0 n^2 h^2}{3\pi m_e e^2}$ 3) $\frac{\varepsilon_0 n^2 h^2}{624\pi m_e e^2}$ 4) $\frac{\varepsilon_0 n^2 h^2}{64\pi m_e e^2}$

2. Find the value of n for which the radius of the orbit is approximately the same as that of the first Bohr orbit for the hydrogen atom.

1) 10 2)15 3) 25 4) 30

3. Find the wavelength of the radiation emitted when the $\mu -$meson jumps from the third orbit to the first

1) 0.4500 A^0 2) 0.5500 A^0 3) 0.6500 A^0 4) None of these

(Rydberg's constant=1.097x$10^7 m^{-1}$)

Passage-II

Phtoelectrons are emitted when 4000 A^0 radiation is incident on a surface of work function 1.9eV. These photoelectrons pass through a region has a-particles to form He^+ ion, emitting a single photon in this process He^+ ions thus formed are in their fourth excited state.

4. Energy of the fourth excited state is approx

1) -4.2eV 2) -2.2eV 3) -3.2eV 4) -1.2eV

5. Energy released during the combination of He^+ ions is.

1) 5.38 eV 2) 3.38eV 3) 2.38eV 4) 1.38eV

6. Energy of emitted photon in range of 3eV& 4eV after combination is

1) 3.86eV 2) 3.24eV 3) 3.29eV 4) 5.24eV

Passage - III:

A sample of hydrogen gas in its ground state is irradiated with photons of 10.2eV energies. The radiation from the above sample is used to irradiate two other samples of excited ionized He^+ and excited ionized Li^{2+}, respectively. Both the ionized samples absorb the incident radiation.

7. How many spectral lines are obtained in the spectra of Li^{2+}

1) 10 2) 15 3) 20 4) 17

8. Which is the smallest wavelength that will be observed in spectra of He^+ ion?

1) 24.4nm 2) 28.8nm 3) 22.2nm 4) 30.6nm

9. How many spectral lines are observed in spectra of He^+ ion?

1) 2 2) 4 3) 6 4)8

10. Which is the smallest wavelength observed in the spectra of Li^{2+}?

1) 8.6nm 2) 10.4nm 3) 12.8nm 4)14.6nm

11. Consider the spectral line resulting from the transition n = 2 to n = 1 in the atoms and the ions given below. The shortest wavelength is produced by

1) hydrogen atom 2) deuterium atom
3) singly ionized helium 4) doubly ionized lithium

12. A gas of monoatomic hydrogen is bombared with a stream of electron that have been accelerated from rest through a potential difference of 12.75 volt. In the emission spectrum, one cannot observe any line of

1) Lyman series 2) Balmer series 3) Paschen series 4) Pfund series

13. An electron jumps from the 4^{th} orbit to 2^{nd} orbit of hydrogen atom. Given the Rydberg's constant $r = 10^5\ cm^{-1}$, the frequency in hertz of the emitted radiation will be

1) $\frac{3}{16}\times10^{5}$ 2) $\frac{3}{16}\times10^{15}$ 3) $\frac{9}{16}\times10^{15}$ 4) $\frac{3}{4}\times10^{15}$

14. With increasing quantum number, the energy difference between adjacent energy levels in atoms

1) decreases 2) increases 3) remains constant
4) decreases for low z and increases for high z

15. Which of the following statements are true regarding Bohr's model of hydrogen atom?

(I) orbiting speed of electron decreases as it shifts to discrete orbits away from the nucleus

(II) radii of allowed orbits of electron are proportional to the principal quantum number

(III) frequency with which electron orbits around the nucleus in discrete orbits is inversely proportional to the principal quantum number.

(IV) binding force with which the electrons are bound to the nucleus increases as it shifts to outer orbits.

Select the correct answer

1) I and III 2) II and IV 3) I, II and III 4) II, III and IV

16. A Hydrogen atom and a Li^{++} ion are both in the second excited state. If l_H and l_{Li} are their respective electronic angular momenta, and E_H and E_{Li} their respective energies, then

1) $l_H > l_{Li}$ and $|E_H|>|E_{Li}|$ 2) $l_H = l_{Li}$ and $|E_H|<|E_{Li}|$
3) $l_H = l_{Li}$ and $|E_H|>|E_{Li}|$ 4) $l_H < l_{Li}$ and $|E_H|<|E_{Li}|$

17. Consider the spectral line resulting from the transition $n = 2 \rightarrow n = 1$ in the atoms and ions given below, the shortest wavelength is produced by

1) Hydrogen atom 2) deuterium atom
3) Singly ionized helium 4) doubly ionized lithium

18. For hydrogen like system,

(I) Ratio of magnetic moment to angular momentum is e/2m.

(II) energy of the electron is directly proportional to $1/n^2$.

(III) angular momentum varies inversely with n.

(IV) radius of an orbit is inversely related to n.

1) I, II 2) II, IV 3) I, II, IV 4) III, IV

19. **As per Bohr model,**

(I) minimum energy required to remove an electron from ground state of doubly ionized Li atom(z = 3) is 122.4 eV.

(II) energy of transition n = 3 to m = 2 is less than that of m = 2 to n = 1.

(III) minimum energy required to remove an electron from ground state of singly-ionised He atom (z = 2) is 27.2 eV.

(IV) A transition from state n = 3 to n = 2 in a hydrogen atom results in U-V radiations

1) II, III, IV 2) I, II 3) II, III 4) I, III, IV

20. **Assertion: A discharge tube appears dark, when evacuated to very low pressures.**
Reasoning: No colour is left at such low pressures.

1) If both assertion and reason are true and reason is the correct explanation of assertion.
2) If both assertion and reason are true but reason is not the correct explanation of assertion.
3) If assertion is true and reason is false.
4) If assertion is false but reason is true

21. **Assertion: An electron in hydrogen atom passes from n = 4 to n = 1 level. The maximum number of photons that can be emitted is 6.**
Reasoning: maximum number of photons omitted can only be 4.

1) If both assertion and reason are true and reason is the correct explanation of assertion.
2)If both assertion and reason are true but reason is not the correct explanation of assertion.
3)If assertion is true and reason is false.
4)If assertion is false but reason is true

EXERCISE- VI - KEY

1) 3 2) 3 3) 2 4) 3 5) 2 6) 2 7) 28) 1 9)3 10) 2 11) 4
12) 4 13) 3 14) 1 15) 1 16) 2 17) 4 18) 1 19) 2 20) 3 21) 3

EXERCISE - I

SIZE OF THE NUCLEUS

1. **The density of a nucleus in which mass of each nucleon is 1.67×10^{-27}kg and $R_0 = 1.4\times10^{-15} m$ is**

1) $1.453\times10^{17} kg/m^3$ 2) $1.453\times10^{16} kg/m^3$
3) $1.453\times10^{21} kg/m^3$ 4) $1.453\times10^{10} kg/m^3$

2. **r_1 and r_2 are the radii of atomic nuclei of mass numbers 64 and 27 respectively. The ratio (r_1/r_2) is**

1) 64 / 27 2) 27 / 64 3) 4 / 3 4) 1

3. **The mass number of a nucleus is 216. The size of an atom without changing its chemical properties are called**

1) $7.2\times10^{-13} cm$ 2) $7.2\times10^{-11} cm$ 3) $7.2\times10^{-10} cm$ 4) $3.6\times10^{-11} cm$

MASS DEFECT, BINDING ENERGY, PACKING FRACTION AND MASS ENERGY RELATION

4. **Energy released as mass of 2 amu is converted into energy is**

1) 1.5 x 10^{-10} J 2) 3 x 10^{-10} J 3) 1863 J 4) 931.5 Mev

5. **A 1 MeV positron encounters a 1 MeV electron travelling in opposite direction. The total energy released is (in MeV)**

1) 2 2) 3.02 3) 1.02 4) 2.04

6. **The binding energies of the nuclei A and B are E_a and E_b respectively. Three nuclei of the element B fuse to give one nucleus of element 'A' and an energy 'Q' is released. Then E_a, E_b, Q are related**

1) $E_a - 3E_b = Q$ 2) $3E_b - E_a = Q$ 3) $E_a + 3E_b = Q$ 4) $E_b + 3E_a = Q$

7. **The binding energies per nucleon for deuterium and helium are 1.1 MeV and 7.0 MeV respectively. The energy in joules will be liberated when 10^6 deuterons take part in the reaction**

1) $18.88\times10^{-3} J$ 2) $18.88\times10^{-5} J$ 3) $18.88\times10^{-7} J$ 4) $18.88\times10^{-10} J$

8. **1 Kg of iron (specific heat 120 Cal $kg^{-1}C^{-1}$) is heated by 1000^0C. The increase in its mass is**

1) Zero 2) 5.6 x 10^{-8} Kg 3) 5.6 x 10^{-16} Kg 4) 5.6 x 10^{-12} Kg

9. **In nuclear fission, 0.1% mass is converted into energy. The energy released in the fission of 1Kg mass is**

1) 2.5 x 10^5 KWH 2) 2.5 x 10^7 KWH 3) 2.5 x 10^9 KWH 4) 2.5 x 10^{-7} KWH

α-DECAY, β – DECAY, γ – DECAY

10. After the emission of one α-particle followed by two β-particles from $^{238}_{92}U$, the number of neutrons in the newly formed nucleus is

1) 140 2) 142 3) 144 4) 146

11. A radioactive nucleus undergoes a series of decays according to the sequence $A \xrightarrow{\beta} A_1 \xrightarrow{\alpha} A_2 \xrightarrow{\alpha} A_3$. If the mass number and atomic number of A_3 are 172 and 69 respectively, then the mass number and atomic number of A is

1) 56, 23 2) 180, 72 3) 120, 52 4) 84, 38

12. The number of α and β particles emitted in the conversion of $_{90}Th^{232}$ to $_{82}Pb^{208}$ are

1) 6, 4 2) 4, 6 3) 8, 6 4) 6, 8

RADIOACTIVITY, HALF LIFE, MEAN LIFE, DECAY CONSTANT

13. The decay constant of a radio active element, which disintegrates to 10 gms from 20 gms in 10 minutes is

1) 0.693 min^{-1} 2) 6.93 min^{-1} 3) 0.693 sec^{-1} 4) 0.0693 min^{-1}

14. Half life period of radium is 1600 years. 2 gm of radium undergoes decay and gets reduced to 0.125 gms in

1) 3200 years 2) 25600 years 3) 8000 years 4) 6400 years

15. After a certain lapse of time, the fraction of radioactive polonium undecayed is found to be 12.5% of initial quantity. The duration of this time lapse is (if the half-life of polonium is 138 days)

1) 414days 2) 407 days 3) 421 days 4) 410 days

16. Two radioactive substances X and Y initially contain an equal number of atoms. Their half-lives are 1 hour and 2 hours respectively. Then the ratio of their rates of disintegration after two hours is

1) 1:1 2) 2:1 3) 1:2 4) 2:3

17. 1 g of a radio active substance disintegrates at the rate of 3.7×10^{10} disintegrations per second. The atomic mass of the substance is226. Calculate its mean life.

1) $1.2 \times 10^5 s$ 2) $1.39 \times 10^{11} s$ 3) $2.1 \times 10^5 s$ 4) 7.194×10^{10} S

NUCLEAR FISSION-NUCLEAR REACTOR

18. No. of uranium 235 nuclei required to undergo fission to give 9×10^{13} joule of energy is

1) 2.8125×10^{24} 2) 28.125×10^{24} 3) 281.25×10^{24} 4) 28215×10^{24}

19. The energy supplied by a power plant is 40 million kilowatt hour. It is supplied by annihilation of matter, the mass that is annihilated is.

1) 1.6 gm 2) 1.6 kg 3) 1.6 mg 4)1.6 amu.

NUCLEAR FUSION

20. The amount of energy released in the fusion of two $_1H^2$ to form a $_2He^4$ nucleus will be

[Binding energy per nucleon of $_1H^2$ = 1.1 Mev Binding energy per nucleon of $_2He^4$ =7 Mev]

1) 8.1 MeV 2) 5.9 MeV 3) 23.6 MeV 4) 2 MeV

PAIR PRODUCTION & PAIR ANNIHILATION

21. The minimum amount of energy released in annhilation of electron-positron is

1) 1.02MeV 2) 0.58MeV 3)185MeV 4) 200MeV

EXERCISE- I - KEY

1) 1 2) 3 3) 1 4) 2 5) 2 6) 1 7) 38) 4 9) 2 10) 2 11) 2
12) 1 13) 4 14) 4 15) 1 16) 3 17) 4 18) 1 19) 1 20) 3 21) 1

EXERCISE - II

SIZE OF THE NUCLEUS

1. Assume that the nuclear mass is of the order of 10^{-27}kg and the nuclear radius is of the order of 10^{-15}m.The nuclear density is of the order of

1) 10^2Kg/m^3 2) 10^{10}kg/m^3 3) 10^{17}Kg/m^3 4) 10^{31} kg/m^3

2. Highly energetic electrons are bombarded on a target of an element containing 30 neutrons. The ratio of radii of nucleus

1) 25 2) 26 3) 56 4) 30

MASS DEFECT, BINDING ENEGRY, PACKING FRACTION AND MASS ENERGY RELATION

3. Sun radiates energy at the rate of $3.6x10^{26}$J/ s. The rate of decrease in mass of sun is (Kgs^{1}).

1) 12 x 10^{10} 2) 1.3 x 10^{20} 3) 4 x 10^9 4) 3.6 x 10^{36}

4. A slow neutron strikes a nucleus of $^{235}_{92}U$ splitting it into lighter nuclei of $^{141}_{56}Ba$ and $^{92}_{36}Kr$ along with three neutrons. The energy released in this reaction is (The masses of uranium, barium and krypton of this reaction are 235.043933, 140.917700 and 91.895400 u respectively. The mass of a neutron is 1.008665u)

1) 740.69 MeV 2) 156.9 MeV 3) 186.9 MeV 4) 209.8 MeV

5. The energy required to separate the typical middle mass nucleus $^{120}_{50}Sn$ into its constituent nucleons ($Mass\ of\ ^{120}_{50}Sn = 119.902199u$; mass of proton=1.007825 u and mass of neutron = 1.008665 u)

1) 951 MeV 2) 805 MeV 3) 1021MeV 4)1212 MeV

6. The mass defect in a nucleus is 3.5 amu. Then the binding energy of the nucleus is

1) 32.58MeV 2) 325.85 MeV 3) 3260.25MeV 4) 3.258 MeV

7. Consider the nuclear reaction:

$X^{200} \to A^{110} + B^{90} + \text{energy}$ **The binding energy per nucleon for X^{200}, A^{110} and B^{90} is respectively 7.4MeV, 8.2MeV and 8.2Mev. The energy released is**

1) 200MeV 2) 160MeV 3) 110MeV 4) 90MeV

α-DECAY, β – DECAY, γ – DECAY

8. **The isotope $^{238}_{92}U$ decays successively to form $^{234}_{90}Th$, $^{234}_{91}Pa$, $^{234}_{92}U$, $^{230}_{90}Th$ and $^{226}_{88}Ra$, The radiations emitted in these five steps are**

1) $\alpha,\alpha,\alpha,\beta,\beta$ 2) $\alpha,\alpha,\beta,\beta,\alpha$ 3) $\alpha,\beta,\beta,\alpha,\alpha$ 4) $\beta,\beta,\alpha,\alpha,\alpha$

9. **The nuclide which disintegrates by emitting a β- particle to form $^{14}_{7}N$ contains**

1) 8 neutrons 2) 10 neutrons 3) 7 neutrons 4) 6 neutrons.

10. **A nucleus X initially at rest, undergoes alpha decay according to the equation $^{232}_{Z}X \to ^{A}_{90}Y + \alpha$ What fraction of the total energy released in the decay will be the kinetic energy of the alpha particle**

1) $\frac{90}{92}$ 2) $\frac{228}{232}$ 3) $\sqrt{\frac{228}{232}}$ 4) $\frac{1}{2}$

RADIOACTIVITY, HALF LIFE, MEAN LIFE, DECAY CONSTANT

11. **A radio active sample contains 600 radio active atoms. Its half life period is 30 minutes. The no. of radio active atoms remaining, if the decay occurs for 90 minutes is**

1) 300 2) 200 3) 400 4) 75

12. **Radio active carbon - 14, in a wood sample decays with a half life of 5700 years. The fraction of the radio active carbon - 14, that remains after a decay period of 17,100 years is**

1) 1/4 2) 3/4 3) 1/8 4) 7/8

13. **The half-life of ^{238}U for $\alpha-$ decay is 4.5×10^{9} years. The number of disintegrations per second occur in 1 g of ^{238}U is**

(Avogadro's number= $6.023\times10^{23} mol^{-1}$)

1) $1.532\times10^{4} s^{-1}$ 2) $1.325\times10^{4} s^{-1}$ 3) $1.412\times10^{4} s^{-1}$ 4) $1.235\times10^{4} s^{-1}$

14. **A certain substance decays to 1/32 of its initial activity in 25 days. The half-life is**

1) 1 day 2) 3 days 3) 5 days 4) 7 days

NUCLEAR FISSION-NUCLEAR REACTOR

15. **The energy released by the fission of 1 g of ^{235}U in joule, given that the energy released per fission is 200 MeV. (Avogadro's number $= 6.023\times10^{23}$)**

1) 8.202×10^{12} 2) 8.202×10^{8} 3) 8.202×10^{10} 4) 8.202×10^{14}

NUCLEAR FUSION

16. **The ratio of the amounts of energy released as a result of the fussion of 1 kg hydrogen (E_1) and fission of 1 kg of $_{92}U^{236}$ (E_2) will be**

1) 1.28 2) 3.28 3) 5.28 4) 7.28

EXERCISE- II - KEY

1) 3 2) 2 3) 3 4) 4 5) 3 6) 3 7) 28) 3 9) 1 10) 2 11) 4 12) 3 13) 4 14) 3 15) 3 16) 4

EXERCISE - III

SIZE OF THE NUCLEUS

1. **A nucleus x ^{235} splits into two nuclei having the mass numbers in the ratio 2:1. The ratio of the radii of those two nuclei is**

1) 2:1 2) 1:2 3) $2^{1/3}$:1 4) 1:$2^{1/3}$

2. **A match box of 5 cm x 5cm x 1 cm dimensions is filled with nuclear matter. Its weight is in the order of**

1) 10g 2) 10^8 g 3) 10^{12}g 4) 10^{15}g

MASS DEFECT, BINDING ENEGRY, PACKING FRACTION AND MASS ENERGY RELATION

3. **If the speed of light were 2/3 of its present value, the energy released in a given atomic explosion will be decreased by a fraction of**

1) 2/3 2) 4/9 3)4/3 4) 5/9

4. **The binding energy per nucleon of C^{12} is 7.68 MeV and that of C^{13} is 7.47 Mev. The energy required to remove one neutron from C^{13} is**

1) 495 MeV 2) 49.5 MeV 3) 4.95 MeV 4) 0.495 MeV

EXERCISE - I

SIZE OF THE NUCLEUS

1. **The density of a nucleus in which mass of each nucleon is 1.67×10^{-27}kg and $R_0 = 1.4\times10^{-15} m$ is**

1) $1.453\times10^{17} kg/m^3$ 2) $1.453\times10^{16} kg/m^3$

3) $1.453\times10^{21} kg/m^3$ 4) $1.453\times10^{10} kg/m^3$

2. **r_1 and r_2 are the radii of atomic nuclei of mass numbers 64 and 27 respectively. The ratio (r_1/r_2) is**

1) 64 / 27 2) 27 / 64 3) 4 / 3 4) 1

3. **The mass number of a nucleus is 216. The size of an atom without changing its chemical properties are called**

1) $7.2\times10^{-13}cm$ 2) $7.2\times10^{-11}cm$ 3) $7.2\times10^{-10}cm$ 4) $3.6\times10^{-11}cm$

MASS DEFECT, BINDING ENERGY, PACKING FRACTION AND MASS ENERGY RELATION

4. **Energy released as mass of 2 amu is converted into energy is**
1) 1.5 x 10^{-10} J 2) 3 x 10^{-10} J 3) 1863 J 4) 931.5 Mev

5. **A 1 MeV positron encounters a 1 MeV electron travelling in opposite direction. The total energy released is (in MeV)**
1) 2 2) 3.02 3) 1.02 4) 2.04

6. **The binding energies of the nuclei A and B are E_a and E_b respectively. Three nuclei of the element B fuse to give one nucleus of element 'A' and an energy 'Q' is released. Then E_a, E_b, Q are related**
1) $E_a - 3E_b = Q$ 2) $3E_b - E_a = Q$ 3) $E_a + 3E_b = Q$ 4) $E_b + 3E_a = Q$

7. **The binding energies per nucleon for deuterium and helium are 1.1 MeV and 7.0 MeV respectively. The energy in joules will be liberated when 10^6 deuterons take part in the reaction**
1) $18.88\times10^{-3}J$ 2) $18.88\times10^{-5}J$ 3) $18.88\times10^{-7}J$ 4) $18.88\times10^{-10}J$

8. **1 Kg of iron (specific heat 120 Cal $kg^{-1}C^{-1}$) is heated by 1000^0C. The increase in its mass is**
1) Zero 2) 5.6 x 10^{-8} Kg 3) 5.6 x 10^{-16} Kg 4) 5.6 x 10^{-12} Kg

9. **In nuclear fission, 0.1% mass is converted into energy. The energy released in the fission of 1Kg mass is**
1) 2.5 x 10^5 KWH 2) 2.5 x 10^7 KWH 3) 2.5 x 10^9 KWH 4) 2.5 x 10^{-7} KWH

α-DECAY, $\beta-$DECAY, $\gamma-$DECAY

10. **After the emission of one α-particle followed by two β-particles from $^{238}_{92}U$, the number of neutrons in the newly formed nucleus is**
1) 140 2) 142 3) 144 4) 146

11. **A radioactive nucleus undergoes a series of decays according to the sequence $A \xrightarrow{\beta} A_1 \xrightarrow{\alpha} A_2 \xrightarrow{\alpha} A_3$. If the mass number and atomic number of A_3 are 172 and 69 respectively, then the mass number and atomic number of A is**
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12. **The number of α and β particles emitted in the conversion of $_{90}Th^{232}$ to $_{82}Pb^{208}$ are**
1) 6, 4 2) 4, 6 3) 8, 6 4) 6, 8

RADIOACTIVITY, HALF LIFE, MEAN LIFE, DECAY CONSTANT

13. **The decay constant of a radio active element, which disintegrates to 10 gms from 20 gms in 10 minutes is**
1) 0.693 min^{-1} 2) 6.93 min^{-1} 3) 0.693 sec^{-1} 4) 0.0693 min^{-1}

14. **Half life period of radium is 1600 years.**
2 gm of radium undergoes decay and gets reduced to 0.125 gms in
1) 3200 years 2) 25600 years 3) 8000 years 4) 6400 years

15. **After a certain lapse of time, the fraction of radioactive polonium undecayed is found to be 12.5% of initial quantity. The duration of this time lapse is (if the half-life of polonium is 138 days)**
1) 414days 2) 407 days 3) 421 days 4) 410 days

16. **Two radioactive substances X and Y initially contain an equal number of atoms. Their half-lives are 1 hour and 2 hours respectively. Then the ratio of their rates of disintegration after two hours is**
1) 1:1 2) 2:1 3) 1:2 4) 2:3

17. **1 g of a radio active substance disintegrates at the rate of 3.7×10^{10} disintegrations per second. The atomic mass of the substance is226. Calculate its mean life.**
1) $1.2\times10^{5}s$ 2) $1.39\times10^{11}s$ 3) $2.1\times10^{5}s$ 4) 7.194×10^{10} S

NUCLEAR FISSION-NUCLEAR REACTOR

18. **No. of uranium 235 nuclei required to undergo fission to give 9×10^{13} joule of energy is**
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19. **The energy supplied by a power plant is 40 million kilowatt hour. It is supplied by annihilation of matter, the mass that is annihilated is.**
1) 1.6 gm 2) 1.6 kg 3) 1.6 mg 4)1.6 amu.

NUCLEAR FUSION

20. **The amount of energy released in the fusion of two $_1H^2$ to form a $_2He^4$ nucleus will be**
[Binding energy per nucleon of $_1H^2$ = 1.1 Mev Binding energy per nucleon of $_2He^4$ =7 Mev]
1) 8.1 MeV 2) 5.9 MeV 3) 23.6 MeV 4) 2 MeV

PAIR PRODUCTION & PAIR ANNIHILATION

21. **The minimum amount of energy released in annhilation of electron-positron is**
1) 1.02MeV 2) 0.58MeV 3)185MeV 4) 200MeV

EXERCISE- I - KEY

1) 1 2) 3 3) 1 4) 2 5) 2 6) 1 7) 38) 4 9) 2 10) 2 11) 2
12) 1 13) 4 14) 4 15) 1 16) 3 17) 4 18) 1 19) 1 20) 3 21) 1

EXERCISE - II

SIZE OF THE NUCLEUS

1. **Assume that the nuclear mass is of the order of 10^{-27}kg and the nuclear radius is**

of the order of 10^{-15}m.The nuclear density is of the order of

1) $10^2 Kg/m^3$ 2) $10^{10} kg/m^3$ 3) $10^{17} Kg/m^3$ 4) $10^{31} kg/m^3$

2. **Highly energetic electrons are bombarded on a target of an element containing 30 neutrons. The ratio of radii of nucleus**

1) 25 2) 26 3) 56 4) 30

MASS DEFECT, BINDING ENEGRY, PACKING FRACTION AND MASS ENERGY RELATION

3. **Sun radiates energy at the rate of $3.6 x 10^{26}$J/ s. The rate of decrease in mass of sun is (Kgs^{-1}).**

1) 12 x 10^{10} 2) 1.3 x 10^{20} 3) 4 x 10^9 4) 3.6 x 10^{36}

4. **A slow neutron strikes a nucleus of $^{235}_{92}U$ splitting it into lighter nuclei of $^{141}_{56}Ba$ and $^{92}_{36}Kr$ along with three neutrons. The energy released in this reaction is (The masses of uranium, barium and krypton of this reaction are 235.043933, 140.917700 and 91.895400 u respectively. The mass of a neutron is 1.008665u)**

1) 740.69 MeV 2) 156.9 MeV 3) 186.9 MeV 4) 209.8 MeV

5. **The energy required to separate the typical middle mass nucleus $^{120}_{50}Sn$ into its constituent nucleons ($Mass\ of\ ^{120}_{50}Sn = 119.902199u$; mass of proton=1.007825 u and mass of neutron =** 1.008665 u)

1) 951 MeV 2) 805 MeV 3) 1021MeV 4)1212 MeV

6. **The mass defect in a nucleus is 3.5 amu. Then the binding energy of the nucleus is**

1) 32.58MeV 2) 325.85 MeV 3) 3260.25MeV 4) 3.258 MeV

7. **Consider the nuclear reaction:**

$X^{200} \to A^{110} + B^{90} + \text{energy}$ **The binding energy per nucleon for** X^{200}, A^{110} and B^{90} **is respectively 7.4MeV, 8.2MeV and 8.2Mev. The energy released is**

1) 200MeV 2) 160MeV 3) 110MeV 4) 90MeV

α-DECAY, $\beta-$DECAY, $\gamma-$DECAY

8. **The isotope $^{238}_{92}U$ decays successively to form $^{234}_{90}Th$, $^{234}_{91}Pa$, $^{234}_{92}U$, $^{230}_{90}Th$ and $^{226}_{88}Ra$, The radiations emitted in these five steps are**

1) $\alpha,\alpha,\alpha,\beta,\beta$ 2) $\alpha,\alpha,\beta,\beta,\alpha$ 3) $\alpha,\beta,\beta,\alpha,\alpha$ 4) $\beta,\beta,\alpha,\alpha,\alpha$

9. **The nuclide which disintegrates by emitting a β- particle to form $^{14}_{7}N$ contains**

1) 8 neutrons 2) 10 neutrons 3) 7 neutrons 4) 6 neutrons.

10. **A nucleus X initially at rest, undergoes alpha decay according to the equation $^{232}_{z}X \to ^{A}_{90}Y + \alpha$ What fraction of the total energy released in the decay will be the kinetic energy of the alpha particle**

1) $\frac{90}{92}$ 2) $\frac{228}{232}$ 3) $\sqrt{\frac{228}{232}}$ 4) $\frac{1}{2}$

RADIOACTIVITY, HALF LIFE, MEAN LIFE, DECAY CONSTANT

11. A radio active sample contains 600 radio active atoms. Its half life period is 30 minutes. The no. of radio active atoms remaining, if the decay occurs for 90 minutes is

1) 300 2) 200 3) 400 4) 75

12. Radio active carbon - 14, in a wood sample decays with a half life of 5700 years. The fraction of the radio active carbon - 14, that remains after a decay period of 17,100 years is

1) 1/4 2) 3/4 3) 1/8 4) 7/8

13. The half-life of ^{238}U for $\alpha-$ decay is 4.5×10^{9} years. The number of disintegrations per second occur in 1 g of ^{238}U is

(Avogadro's number= $6.023\times10^{23}mol^{-1}$)

1) $1.532\times10^{4}s^{-1}$ 2) $1.325\times10^{4}s^{-1}$ 3) $1.412\times10^{4}s^{-1}$ 4) $1.235\times10^{4}s^{-1}$

14. A certain substance decays to 1/32 of its initial activity in 25 days. The half-life is

1) 1 day 2) 3 days 3) 5 days 4) 7 days

NUCLEAR FISSION-NUCLEAR REACTOR

15. The energy released by the fission of 1 g of ^{235}U in joule, given that the energy released per fission is 200 MeV. (Avogadro's number $= 6.023\times10^{23}$)

1) 8.202×10^{12} 2) 8.202×10^{8} 3) 8.202×10^{10} 4) 8.202×10^{14}

NUCLEAR FUSION

16. The ratio of the amounts of energy released as a result of the fussion of 1 kg hydrogen (E_1) and fission of 1 kg of $_{92}U^{236}$ (E_2) will be

1) 1.28 2) 3.28 3) 5.28 4) 7.28

EXERCISE- II - KEY

1) 3 2) 2 3) 3 4) 4 5) 3 6) 3 7) 28) 3 9) 1 10) 2 11) 4
12) 3 13) 4 14) 3 15) 3 16) 4

EXERCISE - III

SIZE OF THE NUCLEUS

1. A nucleus x ^{235} splits into two nuclei having the mass numbers in the ratio 2:1. The ratio of the radii of those two nuclei is

1) 2:1 2) 1:2 3) $2^{1/3}$:1 4) 1:$2^{1/3}$

2. A match box of 5 cm x 5cm x 1 cm dimensions is filled with nuclear matter. Its

weight is in the order of

1) 10g 2) 10^8 g 3) 10^{12}g 4) 10^{15}g

MASS DEFECT, BINDING ENEGRY, PACKING FRACTION AND MASS ENERGY RELATION

3. **If the speed of light were 2/3 of its present value, the energy released in a given atomic explosion will be decreased by a fraction of**

1) 2/3 2) 4/9 3)4/3 4) 5/9

4. **The binding energy per nucleon of C^{12} is 7.68 MeV and that of C^{13} is 7.47 Mev. The energy required to remove one neutron from C^{13} is**

1) 495 MeV 2) 49.5 MeV 3) 4.95 MeV 4) 0.495 MeV

5. **The binding energy per each nucleon in the neighbourhood of medium nuclei is 8.5 MeV and the binding energy per each nucleon is about 7.6 MeV in the neighbourhood of Uranium. The energy released in the fission of U^{236} is**

1) 212 eV 2) 212 MeV 3) 2.12 MeV 4) 0.9 MeV

α - DECAY, β – DECAY, γ – DECAY

6. **^{22}Ne nucleus, after absorbing energy, decays into two α - particals and an unknown nucleus. The unknown nucleus is**

1) Carbon 2) Nitrogen 3) Boron 4) oxygen

RADIOACTIVITY, HALF LIFE, MEAN LIFE, DECAY CONSTANT

7. **The mass of one curie of U^{234} is**

1) $3.7\times10^{10} g$ 2) $3.7\times10^{-10} g$ 3) $6.25\times10^{-34} g$ 4) $1.438\times10^{-11} g$

8. **A radio active isotope having a half life of 3 days was received after 9 days. It was found that there was only 4 gms of the isotope in the container. The initial weight of the isotope when packed was**

1) 8 g 2) 64 g 3) 48 g 4)32 g

9. **Half life of a radio active element is 5 min. 10 sec. Time taken for 90% of it to disintegrate is nearly**

1)100 min 2) 1000sec 3) 10^4 sec 4)10^4 min

10. **The half life of $^{238}_{92}U$ undergoing α – decay is 4.5×10^9 years. Its activity of 1 g sample is**

1) 1.23×10^4 Bq 2) 2.4×10^5 Bq 3) 1.82×10^6 Bq 4) 4.02×10^8 Bq

NUCLEAR FISSION-NUCLEAR REACTOR

11. **In a thermo nuclear reaction $10^{-3} Kg$ of hydrogen is converted into $0.99\times10^{-3} kg$ of helium. If the efficiency of the generator is 50%, the electrical energy generated in KWH is**

1) 10^5 2) 1.5×10^5 3)1.25×10^5 4)1.3×10^5

12. **A nuclear reactor generated power at 50% efficiency by fission of $_{92}U^{235}$ into**

equal fragment of $_{46}Pd^{116}$ with the emission of two γ-rays of 5.2 MeV each and three neutrons. The average B.E. per particle of U^{235} and Pd^{116} is 7.2 MeV and 8.2 MeV respectively. The amount of U^{235} consumed per hour to produce 1600Mw power is

1) 128 *gm* 2)1.4 *kg* 3) 140.5 *gm* 4)281 *gm*

NUCLEAR FUSION

13. **In nuclear fusion,One gram hydrogen is converted into 0.993gm.If the efficiency of the generator be 5%,then the energy obtained in KWH is**

1) 8.75×10^3 2) 4.75×10^3 3) 5.75×10^3 4) 3.73×10^3

PAIR PRODUCTION & PAIR ANNIHILATION

14. **A photon of energy 1.12 Mev splits into electron positron pair. The velocity of electron is (Neglect relativistic correction)**

1) $3 \times 10^8\ ms^{-1}$ 2) $1.33 \times 10^8\ ms^{-1}$ 3) $6 \times 10^8 ms^{-1}$ 4) $9 \times 10^8 ms^{-1}$

EXERCISE-III - KEY

1) 3 2) 4 3) 2 4) 3 5) 2 6) 1 7) 4 8) 4 9) 2 10) 1 11) 3 12) 1 13) 1 14) 2

EXERCISE - IV

SIZE OF THE NUCLEUS

1. **A nucleus splits into two nuclear parts having radii in the ratio 1:2. Their velocities are in the ratio**

1) 8:1 2) 6:1 3) 4:1 4) 2:1

MASS DEFECT, BINDING ENEGRY, PACKING FRACTION AND MASS ENERGY RELATION

2. **The atomic mass of $_7N^{15}$ is 15.000108 amu and that of $_8O^{16}$ is 15.994915 amu. The minimum energy required to remove the least tightly bound proton is (mass of proton is 1.007825 amu)**

1) 0.01 3018 amu 2) 12.13 MeV 3) 13.018 meV 4) 12.13 eV

3. **Assume that a neutron breaks into a proton and electron. The energy released during this process is (Mass of neutron=1.6725×10^{-27} Kg =mass of proton=1.6725×10^{-27} Kg, mass of electron = 9 $\times10^{-31}$ Kg.) [AIEEE 2012]**

1) 0.73 MeV 2) 7.10 MeV 3) 6.30 MeV 4) 5.4 MeV

α - DECAY, β – DECAY, γ – DECAY

4. **A nucleus with mass number 220 initially at rest emits an α – particle. If the Q value of the reaction is $5.5 MeV$ then the kinetic energy of the α – particle is**

1) 4.4 MeV 2) 5.4 MeV 3) 5.6 MeV 4) 6.5 MeV

RADIOACTIVITY, HALF LIFE, MEAN LIFE, DECAY CONSTANT

5. **If the activity of ^{108}Ag is 3 micro curie, the number of atoms present in it are(λ=0.005 sec^{-1})**
   1) 2.2 x 10^7 2) 2.2 x 10^6 3) 2.2 x 10^5 4) 2.2 x 10^4
6. **The half life period of Pb^{210} is 22 years. If 2g of Pb^{210} is taken, then after 11 years the amount of Pb^{210} will be present is**
   1) 0.1414 g 2) 1.414 g 3) 2.828 g 4) 0.707 g
7. **$^{221}_{87}Ra$ undergoes radiorctive decay with a half life of 4 days. The probability that a Ra nucleus will disintegrate in 8 days is**
   1) 1 2) 1/2 3) 1/4 4) 3/4

NUCLEAR FISSION-NUCLEAR REACTOR

8. **When $_{92}U^{235}$ undergoes fission. About 0.1% of the original mass is conveted into energy. Then the amount of $_{92}U^{235}$ should undergo fission per day in a nuclear reactor so that it provides energy of 200 mega watt electric power is**
   1) $9.6\times10^{-2}\,kg$ 2) $4.8\times10^{-2}\,kg$ 3) $19.2\times10^{-2}kg$ 4) $1.2\times10^{-2}\,kg$

PAIR PRODUCTION & PAIR ANNIHILATION

9. **A γ-ray photon creates an electron, positron pair. The rest mass of electron is 0.5 MeV. KE of the electron - positron pair system is 0.78 MeV. Then the energy of γ-ray photon is (in MeV)**
   1) 1.78 2) 0.28 3) 1.28 4) 0.14

LEVEL-IV - KEY

1) 1 2) 2 3) 1 4) 2 5) 1 6) 2 7) 4 8) 3 9) 1

EXERCISE - V

1. **50% of a radio active substance decays in 5 hours. The time required for the 87.5% decay is**
   1) 10hours 2) 15hours 3) 12.5hours 4) 17.5hours
2. **4 grams of radioactive substance A left 1/2 gm after some time. 1 gram of another radioactive substance B left 1/4 gm in the same period. If half life of B is 2 hours, the half life of A is**
   1) 3/4 hours 2) 4/3 hours 3) 1/4 hours 4) 1/2 hours
3. **One mole of a α emitter of half life equal to 2days was placed in a sealed tube for 4 days at S.T.P. volume of helium collected is**
   1) 22.4 lit 2) 16.8 lit 3) 11.2 lit 4) 5.6 lit
4. **3 rutherfords of a radio active isotope of half-life equal to 3 days was**

received after 12 days. Initial isotope packed was

1) 48 rutherfords 2) 12 rutherfords 3) 25 rutherfords 4) 36 rutherfords

5. **The half life of a radio active substance is 6 hours. The amount of the substance undergone disintegration when 36 gms of it undergoes decay for 18 hours is**

1) 31.5 gm 2) 4.5 gm 3) 18 gm 4) 9 gm

6. **The radio active nuclides A and B have half lives t and 2t respectively. If we start an experiment with one mole of each of them, the mole ratio after time interval of 6t will be**

1) 1 : 2 2) 1 : 8 3) 1 : 6 4) 1 : 1

7. **20% of a radio active element disintegrates in 1hr. The percentage of the radio active element disintegrated in 2hrs will be**

1) 36% 2) 64% 3) 60% 4) 40%

8. **The C^{14} to C^{12} ratio in a certain piece of wood is 25% of that in atmosphere. The half life period of C^{14} is 5,580 years. The age of wood piece is**

1) 5,580 years 2) 2790 years 3) 1395 years 4) 11,160 years

9. **A radioactive sample can decay by two different processes. The half-life for the first process is T_1 and that for the second process is T_2. The effective half-life T of the radioactive sample is**

1) $T = T_1 + T_2$ 2) $\frac{1}{T} = \frac{1}{T_1} + \frac{1}{T_2}$ 3) $T = \frac{T_1 + T_2}{T_1 T_2}$ 4) $T = \frac{T_1 - T_2}{T_1 T_2}$

10. **The age of the wood if only 1/16 part of original C^{14} is present in its piece is (T of C^{14} is 5,580 years)**

1) 5580 years 2) 11,160 years 3) 22320 years 4) 16740 years

11. **A piece of wood is found to have the $\frac{C^{14}}{C^{12}}$ ratio to be 0.5 times of that in a living plant The number of years back the plant died will be (T of C^{14} = 5,580 years)**

1) 2,790 years 2) 5,580 years 3) 11,160 years 4) 27,900 years

12. **A piece of wood collected from cro-Magnon caves gave 4 disintegrations / min. A freshly cut wood of the same weight gives 16 d.p.m. The cro-magnon man lived about (Half life of C^{14} is 5760 years. Assume the activity is due to C^{14} only)**

1) 5700 years ago 2) 2900 years ago 3) 11520 years ago 4) 1400 years ago

13. **The number of U^{238} nuclei in a rock sample equal to the number of Pb^{206} atoms. The half life of U^{238} is 4.5×10^9 years.The age of the rock is**

1) 4.5×10^9 y 2) 9×10^9 y 3) 13.5×10^9 y 4) 18×10^9 y

14. **Equal masses of two samples A and B of charcoal are burnt and the activity of resulting carbon-di-oxide from two samples is measured. The gas from sample A gives 10^4 counts per month and that from sample B gives 2.5×10^3 counts per month. The age difference of two sample is (half life of C^{14} is 5730 years)**

1) 5730y 2) 11460y 3) 17190y 4) 22920y

15. **The half life of a radioactive substance is 20 minutes.The approximate time interval $\left(t_2 - t_1\right)$ between the time t_2, when $\frac{2}{3}$ of it has decayed and time t_1 and $\frac{1}{3}$ of it had decayed is: (AIEEE-2011)**

1) 14 minutes 2) 20 minutes 3) 28 minutes 4) 7 minutes

16. **A charged capactor of capacitance C is discharged through a resistance R. A radio active sample decays with an average life t. Find R interms of C and t in order that the ratio of the electrostatic energy stored in the capacitor to the activity of the radio active sample remains constant with time**

1) $\frac{2t}{C}$ 2) $\frac{C}{2t}$ 3) 2t C 4) t C

17. **Uranium-238 decays to thorium-234 with half-life $5 \times 10^9\ yr$.The resulting nucleus is in the excited state and hence further emits $\gamma -$rays to come to the ground state. It emits $20\gamma -$rays per second. the emission rate will drop to $5\gamma -$rays per second in**

1) $1.25 \times 10^9\ yr$ 2) $10^{10}\ yr$ 3) $10^{-8}\ yr$ 4) $1.25 \times 10^{-9}\ s$

18. **A sample of radioactive material has mass m, decay constant λ and molecular weight M. Avagadro constant = N_A. The initial activity of the sample is**

1) λm 2) $\frac{\lambda m}{M}$ 3) $\frac{\lambda m N_A}{M}$ 4) $m N_A e^{\lambda}$

19. **A sample of radioactive material has mass m, decay constant λ and molecular weight M. Avagadro constant = N_A . The activity of the sample after time t will be**

1) $\left(\frac{mN_A}{M}\right)e^{-\lambda t}$ 2) $\left(\frac{mN_A\lambda}{M}\right)e^{-\lambda t}$ 3) $\left(\frac{mN_A}{M\lambda}\right)e^{-\lambda t}$ 4) $\frac{m}{\lambda}\left(1 - e^{-\lambda t}\right)$

20. **In moon rock sample the ratio of the number of stable argon-40 atoms present to the number of radioactive potassium-40 atoms is 7:1. Assume that all the argon atoms were produced by the decay of potassium atoms, with a half-life of $2.5 \times 10^9\ yr$. The age of the rock is**

1) $2.5 \times 10^9\ yr$ 2) $5.0 \times 10^9\ yr$ 3) $7.5 \times 10^9\ yr$ 4) $10^{10}\ yr$

21. **The half-life of a radioactive sample is T. If the activities of the sample at time t_1 adn t_2 ($t_1 < t_2$) are R_1 and R_2 respec tively, then the number of atoms disintegrated in time $t_2 - t_1$ is proportional to**

1) $\left(R_1 - R_2\right)T$ 2) $\left(R_1 + R_2\right)T$ 3) $\frac{R_1 R_2}{R_1 + R_2}T$ 4) $\frac{R_1 + R_2}{T}$

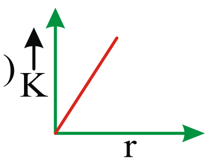
22. Considering a hypothetical annihilation of a stationary electron with a stationary positron, the wavelengthof resulting radiation? (with usual notations)

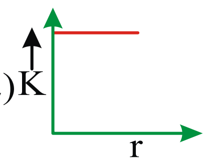
1) $\frac{h}{2m_0C}$ 2) $\frac{2h}{m_0C}$ 3) $\frac{h}{m_0C}$ 4) $\frac{h\sqrt{2}}{m_0C}$

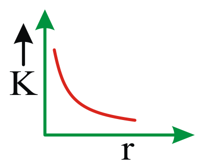
23. A radioactive nucleus can decay by two different processes. The half life for the first process is 2t and that for the second process is t. The effective disintegration constant of nucleus is

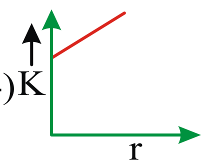
1) $\frac{3}{2tln2}$ 2) $\frac{3ln2}{2t}$ 3) $\frac{ln2}{3t}$ 4) $\frac{3ln2}{t}$

24. A proton with kinetic energy, K strikes another proton at rest. If the collision is head - on, find the correct graph between K and the distance of closest approach, r.

1) 

2) 

3) 

4) 

25. The fraction of a radiactive sample will decay during half of its half-life period is

1) $\frac{1}{\sqrt{2}}$ 2) $\frac{1}{\sqrt{2}-1}$ 3) $\frac{\sqrt{2}-1}{\sqrt{2}}$ 4) $\frac{1}{2}$

26. A small quantity of a solution containing N^{24} radio - nuclide of half - life T and activity R_0 is injected into blood of a person. $1cm^3$ of sample of blood taken from the blood of the person shows activity R_1. If the total volume of the blood in the body of the person is V, find the timer after which sample is taken.

1) $\frac{T}{\ln(2)}\left[1n\frac{R_0}{VR_1}\right]$ 2) $\frac{T}{\ln(2)}\left[1n\frac{VR_0}{R_1}\right]$

3) $\frac{T}{\ln(2)}\left[1n\frac{VR_1}{R_0}\right]$ 4) $\frac{T}{\ln(2)}\left[1n\frac{R_1}{VR_0}\right]$

27. A nucleus with mass number 220 initially at rest emits an α - particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of α -particle.

1) 4.4 MeV 2) 5.4 MeV 3) 5.6MeV 4) 6.5 MeV

28. Some amount of radioactive substance (half-life=10 days) is spread inside a room and consequently the level of radiation becomes 50times the permissible

level for normal occupancy of the room. The room be safe for occupation after

1) 20days 2) 34.8 days 3) 56.4 days 4) 62.9 days

29. In the options given below, let E denote the rest mass energy of a nucleus and n a neutron. The correct option is

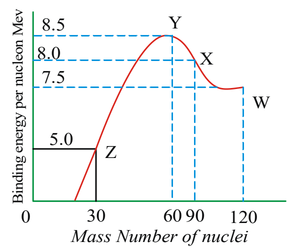
1) $E\left({}^{236}_{92}U\right) > E\left({}^{137}_{53}I\right) + E\left({}^{97}_{39}Y\right) + 2E(n)\backslash$ 2) $E\left({}^{236}_{92}U\right) < E\left({}^{137}_{53}I\right) + E\left({}^{97}_{39}Y\right) + 2E(n)$

3) $E\left({}^{236}_{92}U\right) < E\left({}^{140}_{56}Ba\right) + E\left({}^{94}_{36}Kr\right) + 2E(n)$ 4) $E\left({}^{236}_{92}U\right) = E\left({}^{140}_{56}Ba\right) + E\left({}^{94}_{36}Kr\right) + 2E(n)$

30. Four different radioactive elements are kept in separate containers. In the begining the container A has 200 g-atom with half-life of 2 days , B has 20 g-atom with half-life of 20 days, C has 2g-atom with half-life 200 days and D has 100g-atoms with half-life of 10 days. In the begining the maximum activity exhibited by the container is

1) A 2) B 3) C 4) D

31. Binding energy per nucleon versas mass number curve for nuclei is shown in the fig. W,X,Y and Z are four nuclei indicated on the curve. The process that would release energy is



1) $Y \rightarrow 2Z$ 2) $W \rightarrow X + Z$

3) $X \rightarrow Y + Z$ 4) $W \rightarrow 2Y$

32. When ${}_{3}Li^{7}$ nuclei are bombarded by protons, and the resultant nuclei are ${}_{4}Be^{8}$, the emitted particles will be. (AIEEE 2006)

1) alpha particles 2) beta particles 3) gamma photons 4) neutrons

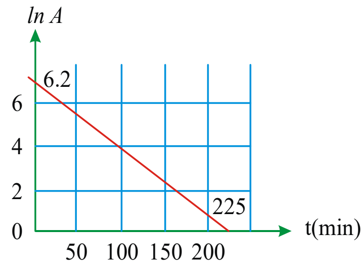
33. A sample of uranium is a mixture of three isotopes ${}_{92}U^{234}$, ${}_{92}U^{235}$ and ${}_{92}U^{238}$ present in the ratio 0.006%, 0.71% and 99.284% respectively. The half lives of then isotopes are 2.5×10^{5} years, 7.1×10^{8} years and 4.5×10^{9} years respectively. The contribution to activity (in %) of each isotope in the sample respectively

1) $51.41\%, 2.13\%, 46.46\%$ 2) $51.41\%, 46.46\%, 2.13\%$

3) $2.13\%, 51.41\%, 46.46\%$ 4) $46.46\%, 2.13\%, 51.41\%$

34. The table that follows shows some measurements of the decay rate of a sample of ${}^{128}I$, a radio nuclide often used medically as a tracer to measure the rate at which iodine is absorbed by the thyroid gland.

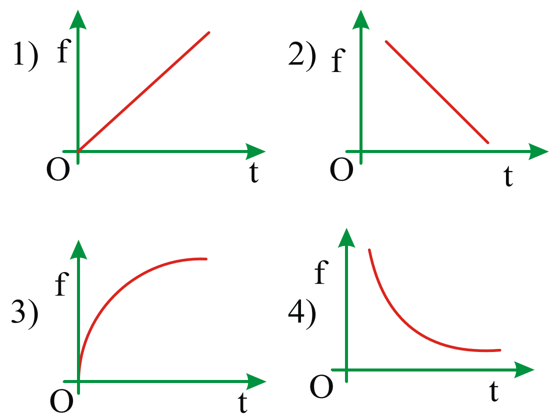
Time(min)	A(counts/s)	Time(min)	A (counts)/s
4	392.2	132	10.9
36	161.4	164	4.56
68	65.5	196	1.86
10	26.8	218	1.00



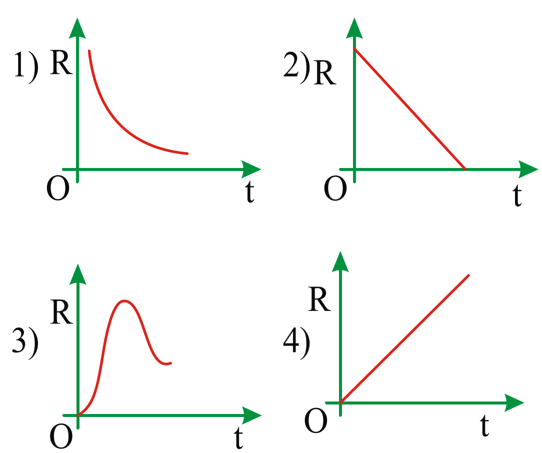
The half life $t_{1/2}$ for this radio nuclide.

1) 25 min 2) 50 min 3) 2.5 min 4) 5 min

35. The fraction *f* of radioactive element decayed change with respect to time (*t*). The curve representing the correct variation is



36. The rate of decay (R) of nuclei in a radiocative sample is plotted against time (*t*). Which of the following best represents the resulting curve?



37. The probability of survival of a radioactive nucleus for one mean life is

1) $\frac{1}{e}$ 2) $1-\frac{1}{e}$ 3) $\frac{\ln 2}{e}$ 4) $1-\frac{\ln 2}{e}$

38. **A radioactive isotope is being produced at a constant rate A. The isotope has a half -life T initially there are no nuclei, after a time t >>T, the number of nuclei becomes constant. The value of this constant is**

1) AT 2) $\frac{A}{T}\ln(2)$ 3) $AT\ln(2)$ 4) $\frac{AT}{\ln(2)}$

EXERCISE- V - KEY

1) 2	2) 2	3) 2	4) 1	5) 1	6) 2	7) 18) 4		9) 2	10) 3	11) 2
12) 3	13) 1	14) 2	15) 2	16) 1	17) 2	18) 3	19) 2	20) 3	21) 1	22) 3
23) 2	24) 3	25) 3	26) 1	27) 2	28) 3	29) 1	30) 1	31) 4	32) 3	33) 1
34) 1	35) 3	36) 1	37) 1	38) 4						

EXERCISE - VI

Comprehension-1:

The count rate meter is used to measure the activity of a given amount of a radio active element. At one instant, the meter shows 475 counts/minute. Exactly 5 minutes later, is shown 270 counts/minute then

1. The decay constant is

1) 0.82/ minute 2) 0.113/ minute 3) 0.166/ minute 4) 0.182/ minute

2. Mean life of the sample is

1) 6.35 minutes 2) 7.45 minutes 3) 8.85 minutes 4) 9.95 minutes

3. Half life of the sample is

1) 6.13 minutes 2) 8.42 minutes 3) 8.85 minutes 4) 9.92 minutes

Comprehension-2:

Atomic nucleus is central core of every atom in which the whole of positive charge and almost entire mass of atom is concentrated. It is a tiny sphere of radius R is given by $R = R_o A^{1/3}$, **where** $R_o = 1.4\times10^{-15} m$, **a constant and A is the mass number of the nucleus**

4. **A graph between '**$\log\left(\frac{R}{R_o}\right)$**, and 'log A'**

1) Is a parabola
2) Is a straight line passing through origin
3) Is a straight line have an intercept 4) Is an ellipse

5. **On increasing the value of 'A' the density of the nucleus**

1) Increases 2) Decreases 3) Remains constant 4) None

6. **The radius of the nucleus of mass number 125 is**

1) $175\times10^{-15} m$ 2) $35\times10^{-15} m$ 3) $70\times10^{-15} m$ 4) $7\times10^{-15} m$

Comprehension-3:

The questions given below are based on the following paragraph (AIEEE-2010)
A nucleus of mass M + Δm is at rest and decays into two daughter nuclei of equal mass $\frac{M}{2}$ each. speed of light is c.

7. **The binding energy per nucleon for the parent nucleus is E_1 and that for the daughter nuclei is E_2 then**
   1) $E_2 = 2E_1$ 2) $E_1 > E_2$ 3) $E_2 > E_1$ 4) $E_1 = 2E_2$

8. **The speed of daughter nuclei is**
   1) $c\frac{\Delta m}{M+\Delta m}$ 2) $c\sqrt{\frac{2\Delta m}{M}}$ 3) $c\sqrt{\frac{\Delta m}{M}}$ 4) $c\sqrt{\frac{\Delta m}{M+\Delta m}}$

9. **Choose correct statement from the following.**
   A)Large mass number nuclei undergo fission
   B)Low mass number nuclei undergo fusion
   C)For heavy nuclei the decrease in binding energy per nucleon shows the contribution of the increasing coulomb repulsion.
   1) A, B are correct 2) A, B, C are correct
   3) B , C are correct 4) A , C are correct

10. **Which of the following are not fundamental particles**
    i)Electron ii) Photon
    iii) a - Particle iv) Deutron
    1) Only i & ii are true 2) Only ii & iii are true
    3) Only i &iii are true 4) Only iii & iv are true

11. **When a nucleus with atomic number Z and mass number A undergoes a radioactive decay process**
    a) Both Z and A will decrease, if the process is α decay
    b) Z will decrease but A will not change, if the process is β^+ decay
    c) Z will increase but A will not change, if the process is β^- decay
    d) Z and A will remain unchanged, if the process is γ decay
    1) a & b are true 2) b & d are true 3) a, b & c are true 4) a, b, c, d are true

12. **A nuclide A undergoes a decay and another nuclide B undergoes b^- decay**
    a) All the α–particle emitted by A will have almost the same speed
    b) The β–particle emitted by A may have widely different speeds
    c) All the β–particle emitted by B will have almost the same speed
    d) The β–particle emitted by B may have widely different speeds
    1) a, b are true 2) b, c are true 3) b, d are true 4) a, d are true

13. **In the fission of U^{235}**
    i) Slow neutron is absorbed by U^{235}

ii) The products in the process are not same always, their atomic number varies from 34 to 58

iii) About 200 Mev energy is released per fission

iv) The product are always Ba and Kr

1)Only i, ii & iii are true 2)Only ii & iii are true

3)All are true 4)Only i , ii & iv are true

14. Which of the following statements are correct

i) Positron is predicted by Dirac and discovered by Anderson

ii) Liquid drop model of nucleus is developed by Bohr and Wheeler

iii) Carbon cycle was proposed by Bethe

iv) Fission reaction is first observed by OttoHahn and Strassman

1) All are true 2) Only i, ii & iv are true

3) Only i, iii & iv are true 4) Only iii & iv are true

15. Consider the following two statement A and B and identify the correct answer given below : A) Nuclear density is same for all nuclei

B) Radius of the nucleus (R) and its mass number (A) are related as $\sqrt{A} \alpha R^{1/6}$

1) A and B are true 2) A and B are false

3) A is true but B is false 4) A is false but B is true

16. Consider the following statements A, B and identify the correct choice in the given answers

A: Density of a nucleus is independent of its mass number

B: Beryllium is used as moderator in nuclear reactors

1) A and B are correct 2) A and B are wrong

3) A is correct, B is wrong 4) A is wrong, B is correct

17. Consider the following statements (A) and (B) and identify the correct answer given below.

Statement (A) : Positive values of packing fraction implies a large value of binding energy.

Statement (B) : The difference between the mass of the nucleus and the mass number of the nucleus is called packing fraction

1) (A) and (B) are correct 2) (A) and (B) are false

3) (A) is true (B) is false 4) A is false, B is true

EXERCISE- VI - KEY

1) 2 2) 3 3)1 4) 2 5) 3 6) 4 7) 3 8) 2 9) 2 10) 4 11) 4
12) 4 13) 1 14) 1 15) 3 16) 1 17) 2

* * * * *

EXERCISE-I

INTRINSIC, EXTRINSIC SEMICONDUCTORS AND DIODES

1. **The electrical conductivity of a semiconductor increases when electomagnetic radiation of wavelength shorter than 2480nm is incident on it. The band gap in (eV) for the semiconductor is**

1) $0.7eV$ 2) $0.5eV$ 3) $2.5eV$ 4) $1.2eV$

2. **Pure Si at 300 K has equal electron (n_i) concentrations of $1.5\times10^{16}m^{-3}$. Doping by indium increases n_h $4.5\times10^{22}m^{-3}$. n_e in the doped Si is**

1) 5×10^9 2) 7×10^9 3) 9×10^9 4) 8×10^9

3. **In a p-n junction the depletion region is 400nm wide and electric field of $5\times10^5Vm^{-1}$ exists in it. The minimum energy of a conduction electron, which can diffuse from n-side to the p-side is**

1) 4eV 2) 5eV 3) 0.4eV 4) 0.2eV

4. **The reverse bias in a junction diode is changed from 5V to 15V then the value of current changes from 38 μ A to 88 μ A. The resistance of junction diode will be**

1) 4 x $10^5\Omega$ 2) 3 x$10^5\Omega$ 3) 2 x $10^5\Omega$ 4) $10^6\Omega$

5. **A diode made of silicon has a barrier potential of 0.7V and a currrent of 20mA passes through the diode when a battery of emf 3V and a resistor is connected to it. The wattage of the resistor and diode are**

1) 0.046W, 0.014W 2) 4.6W, 0.14W 3) 0.46W, 0.14W 4) 46W, 14W

6. **In a half wave rectifier output is taken across a 90 ohm load resistor. If the resistance of diode in forward biased condition is 10ohm, the efficiency of rectification of ac power into dc power is**

1) 40.6% 2) 81.2% 3) 73.08 % 4) 36.54%

7. **In a full wave rectifier output is taken across a load resistor of 800 ohm. If the resistance of diode in forward biased condition is 200 ohm, the efficiency of rectification of ac power into dc power is**

1) 64.96% 2) 40.6% 3) 81.2% 4) 80%

TRANSISTORS

8. **In a P-N-P transistor, the collector current is 10 mA. If 90% of the holes reach the collector, then emitter current will be:**

1) 13 mA 2) 12 mA 3) 11 mA 4) 10 mA

9. **A transistor has a base current of 1mA and emitter current 100mA. The current transfer ratio will be**

1) 0.9 2) 0.99 3) 1.1 4) 10.1

10. **When the base -emitter voltage of a transistor connected in the common -emitter mode is changed by 20 mV the collector current is changed by 25 mA. Find the transconductance.**

1) $1.25\Omega^{-1}$ 2) $2.50\Omega^{-1}$ 3) $0.5\Omega^{-1}$ 4) $5.5\Omega^{-1}$

11. **In a transistor circuit the base current changes from 30 μA to 90 μA. If the**

current gain of the transistor is 30, the change in the collector current is

1) 4 mA 2) 2 m A 3) 3.6 mA 4) 1.8 mA

12. **The current gain of transistor in a common emitter circuit is 40. The ratio of emitter current to base current is**

1) 40 2) 41 3) 42 4) 43

13. **In a common base configuration the emitter current changes by 5mA when emitter voltage is changed by 200 mV at a fixed collector to base voltage. The input resistance is**

1) 40Ω 2) 1000Ω 3) 2.5Ω 4) 4Ω

14. **For a common base amplifier, the values of resistance gain and voltage gain are 3000 and 2800 respectively. The current gain will be**

1) 0.93 2) 0.83 3) 0.73 4) 0.63

15. **In a transistor amplifier β =62,R_L= 5000Ω and internal resistance of the transistor is 500Ω. Its power amplification will be**

1) 25580 2) 33760 3) 38440 4)55280

LOGIC GATES

16. **Decimal number 15 is equivalent to the binary number:**

1) 110001 2) 000101 3) 101101 4) 001111

17. **Binary number 1001001 is equivalent to the decimal number:**

1) 37 2) 73 3) 41 4) 32

18. **In the Binary number system 1+1=**

1)2 2)1 3)10 4)100

19. **If A = B = 1, then in terms of Boolean algebra the value of A.B + A is not equal to**

1) B.A+B 2) B+A 3) B 4) $\overline{A}.B$

20. **In the Boolean algebra, the following one which is not equal to A is**

1) A.A 2) A + A 3) $\overline{A}.A$ 4) $\overline{\overline{A}+\overline{A}}$

21. **The logic expression which is NOT true in Boolean algebra is**

1) $\left[\overline{1}+\overline{1}\right].1=0$ 2) $\left[\overline{1}+0\right].1=0$ 3) $\left[\overline{1}+0\right].\overline{1}=0$ 4) $\left[1+1\right].1=0$

EXERCISE-I - KEY

1) 2 2) 1 3) 4 4) 3 5) 1 6) 4 7) 1 8) 3 9) 2 10) 1 11) 4
12) 2 13) 1 14) 1 15) 3 16) 4 17) 2 18) 3 19) 4 20) 3 21) 4

EXERCISE-II

INTRINSIC, EXTRINSIC SEMICONDUCTORS AND DIODES

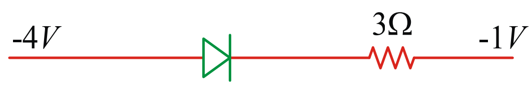
1. **The electrical conductivity of a semi conductor increases when electromagnetic radiation of wavelength shorter than 1240 nm is incident on it. The forbidden band energy for the semi conductor is (in eV)**
1) 0.5 2) 0.97 3) 0.7 4) 1.1

2. **A semiconductor is known to have an electron concentration of $5\times10^{13}/cm^3$ and hole concentration of $8\times10^{12}/cm^3$. The semiconductor is**
1) n-type 2) p-type 3) intrinsic 4) insulator

3. **A potential barrier of 0.5V exists across a p-n junction. If the width of depletion layer is 10^{-6}m, then intensity of electric field in this region will be**
1) 1×10^6 V/m 2) 5×10^5 V/m 3) 4×10^4 V/m 4) 2×10^6 V/m

4. **A p - n junction diode has breakdown voltage of 28V. If applied external voltage in reverse bias is 40V the current through it is**
1) Zero 2) infinite 3) 10 A 4) 15A

5. **The value of current in the following diagrams is (diode assumed to be ideal one)**



1) 0.1 amp 2) 0.01amp 3) 1 amp 4) zero

6. **A half -wave rectifier is used to convert 50Hz A.C. to D.C. voltage. The number of pulses per second in the rectified voltage are**
1) 50 2) 25 3) 100 4) 75

7. **If a full wave rectifier circuit is operating from 50Hz mains, the fundamental frequency in the ripple will be**
1) 25 Hz 2) 50 Hz 3) 70.7 Hz 4) 100 Hz

TRANSISTORS

8. **In an npn transistor the base and collector currents are 100 μA and 9mA respectively. Then the emitter current will be**
1) 9.1mA 2) 18.2mA 3) 3.91 μA 4) 18.2 μA

9. **A change of 8mA in the emitter current brings a change of 7.9mA in the collector current. The change in base current required to have the same change in the collector current is**
1) 0.01mA 2) 1A 3) 10mA 4) 0.1mA

10. **For a p-n-p transistor in CB configuration, the emitter current I_E is 1mA and α = 0.95. The base current and collector current are**
1) 0.95 mA, 0.05mA 2) 0.05mA, 0.95m 3) 9.5mA, 0.5mA 4) 0.5mA, 9.5mA

11. **If a change of 100 μ A in the base current of an n-p-n transistor in CE causes a change of 10mA in the collector current, the ac current gain of the transistor is**
1) 10 2) 100 3) 1000 4) 10000

12. **For a common emitter amplifier, current gain is 70. If the emitter current is 8.4mA, then the base current is**
1) 0.236mA 2) 0.118mA 3) 0.59mA 4) 8.3mA

13. **The base current of a transistor is 105 μ A and the collector current is 2.05mA.**

Then β of the transistor is

1) 1.952 2)19.52 3) 195.2 4) 1952

14. **For a transistor the value of α is 0.9. Its β value is**

1) 9 2) 0.9 3) 0.09 4) 90

15. **For a transistor the current amplification factor is 0.8. The transistor is connected in common emitter configuration, the change in collector current when the base current changes by 6mA is**

1) 6mA 2) 4.8mA 3) 24mA 4) 8mA

16. **A change of 400mV in base-emitter voltage causes a change of 200μA in the base current. The input resistance of the transistor is**

1) $1K\Omega$ 2) $6K\Omega$ 3) $2K\Omega$ 4) $8K\Omega$

17. **In a common base circuit, if the collector base voltage is changed by 0.6V, collector current changes by 0.02mA. The output resistance will be**

1) $10^4\Omega$ 2) $2 \times 10^4\Omega$ 3) $3 \times 10^4\Omega$ 4) $4 \times 10^4\Omega$

18. **A common emitter transistor amplifier has a current gain of 50. If the load resistance is 4k Ω, and input resistance is 500 Ω, the voltage gain of amplifier is**

1) 100 2) 200 3) 300 4) 400

LOGIC GATES

19. **Equivalent of decimal number 8 in the binary number is**

1)10 2)101 3)1000 4)1011

20. **The equivalent of 110in the decimal number is**

1)2 2)4 3)8 4)6

21. **If A = 1, B = 0 then the value of $\overline{A} + B$ in terms of Boolean algebra is**

1) A 2) B 3) B + A 4) $A.\overline{B}$

22. **In the Boolean algebra : A + B =**

1) $\overline{A} + \overline{B}$ 2) A.B 3) $\overline{\overline{A}} + \overline{\overline{B}}$ 4) $\overline{\overline{A}} + \overline{B}$

23. **The following one represents logic addition is**

1) 1 + 1 = 2 2) 1 + 1 = 10 3) 1 + 1 = 1 4) 1 + 1 = 11

24. **In the Boolean algebra : $\overline{A}.\overline{B}$ = ...**

1) $\overline{A + B}$ 2) A.B 3) $\overline{\overline{A} + \overline{B}}$ 4) A + B

25. **In the Boolean algebra, which gate is expressed as $Y = \overline{A + B}$**

1) OR 2) NAND 3) AND 4) NOR

26. **The truth table for NOT gate is**

1) $\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$ 2) $\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$ 3) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ 4) $\begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix}$

EXERCISE-II - KEY

1) 2 2) 1 3) 2 4) 2 5) 4 6) 1 7) 4 8) 1 9) 4 10) 2 11) 2
12) 2 13) 2 14) 1 15) 3 16) 3 17) 3 18) 4 19) 3 20) 4 21) 2 22) 3
23) 3 24) 1 25) 4 26) 3

EXERCISE-III

INTRINSIC,EXTRINSIC SEMI CONDUCTORS AND DIODES

1. **Mobilities of electrons and holes in a sample of intrinsic germanium at room temperature are $0.36m^2/Vs$ and $0.17m^2/Vs$. The electron and hole densities are each equal to 2.5 $\times 10^{19} m^{-3}$. The electrical conductivity of germanium is**

1) $0.47\,S/m$ 2) $5.18\,S/m$ 3) $2.12\,S/m$ 4) $1.09\,S/m$

2. **In a p-n junction diode the thickness of deplection layer is $2\times10^{-6}m$ and barrier potential is 0.3V. The intensity of the electrical field at the junction is**

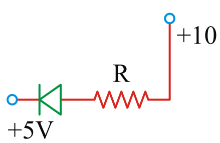
1) $0.6\times10^{-6}Vm^{-1}$ from n to p side 2) $0.6\times10^{-6}Vm^{-1}$ from p to n side

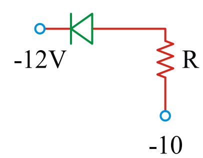
3) $1.5\times10^{5}Vm^{-1}$ from n to p side 4) $1.5\times10^{5}Vm^{-1}$ from p to n side

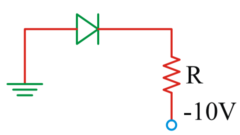
3. **A potential barrier V volts exists across a P-N junction. The thickness of the depletion region is 'd'. An electron with velocity 'v' approches P-N junction from N-side. The velocity of the electron acrossing the junction is**

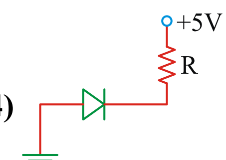
1) $\sqrt{v^2+\frac{2Ve}{m}}$ 2) $\sqrt{v^2-\frac{2Ve}{m}}$ 3) v 4) $\sqrt{\frac{2Ve}{m}}$

4. **In the following , reverse biased diode is**

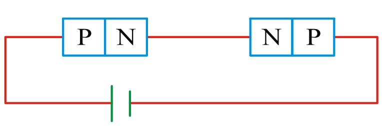
1) 

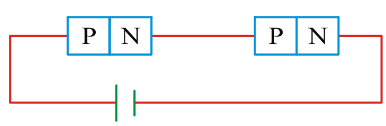
2) 

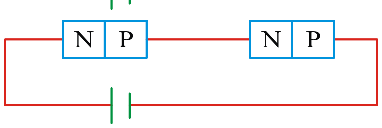
3) 

4) 

5. **Two similar p-n junctions can be connected in three different ways as shown in the figures. The two connections across which the potential difference is same are**

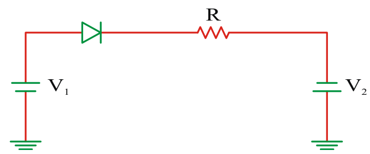
a) 

b) 

c) 

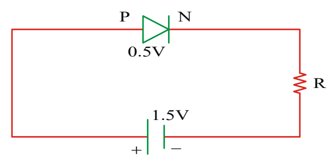
1) circuits a and b 2) circuits b and c 3) circuits a and c 4) all the circuits

6. **If $V_1 > V_2$, r is resistance offered by diode in forward bias then current through the diode is**



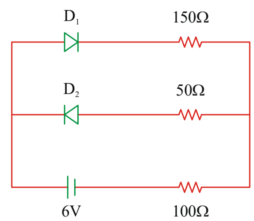
1) 0 2) $\frac{V_1 + V_2}{R + r}$ 3) $\frac{V_1 - V_2}{R + r}$ 4) None

7. A PN junction diode when forward biased has a drop of 0.5V which is assumed to be independent of current. The current in excess of 10mA through the diode produces large joule heating which damages the diode. If we want to use a 1.5V battery to forward bias the diode, the resistor used in series with the diode so that the maximum curent does not exceed 5mA is



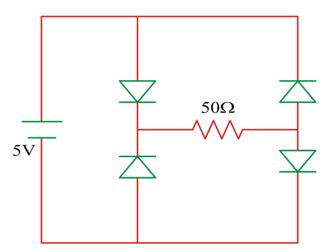
1) $2 \times 10^2 \Omega$ 2) $2 \times 10^5 \Omega$ 3) $2 \times 10^3 \Omega$ 4) $2 \times 10^4 \Omega$

8. The circuit shown in figure (1) Contains two diodes each with a forward resistance of 50 ohm and with infinite reverse resistance. If the battery voltage is 6 V, the current through the 100 ohm resistance is.



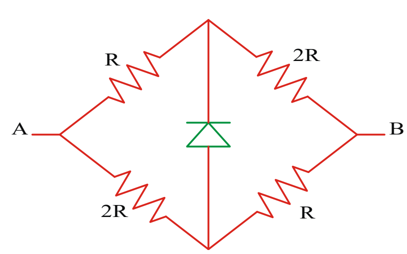
1) 0.01A 2) 0.02A 3) 0.03A 4) 0.04A

9. 4 ideal diodes are connected as shown in the circuit the current through 50 Ω is



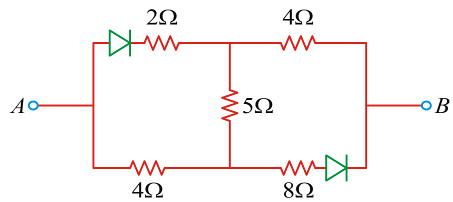
1) 0.1 A 2) 0.5 A 3) 0.6 A 4) 1 A

10. Find the effective resistance between A & B



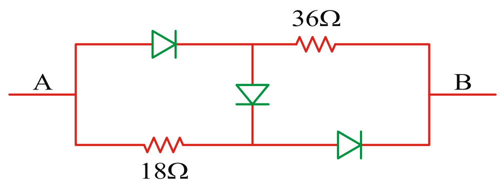
1) $\frac{2}{3R}$ 2) $\frac{3R}{2}$ 3) $\frac{2R}{3}$ 4) R

11 The equivalent resistance of the circuit across AB is given by



1) 4Ω 2) 13Ω 3) 4Ω *or* 13Ω 4) 4Ω zero

12. The equivalent resistance between A and B is



1) $36\Omega\, if\, V_A > V_B$ 2) 18Ω if $V_A < V_B$

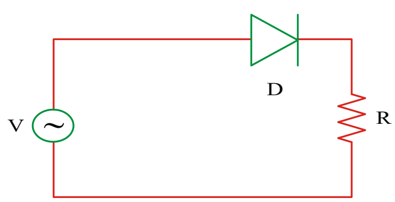
3) Zero if $V_A < V_B$ and $54\Omega\, if\, V_A > V_B$

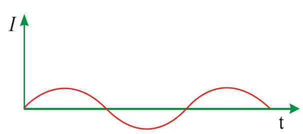
4) Zero if $V_A > V_B$ and $54\Omega\, if\, V_A < V_B$

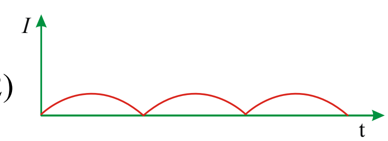
13. A junction diode is connected to a 10 V source and $10^3\,\Omega$ rheostat. The slope of load line on the characteristic curve of diode by (in A/V)

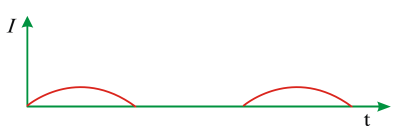
1) 10^{-1} 2) 10^{-2} 3) 10^{-3} 4) 10^{-4}

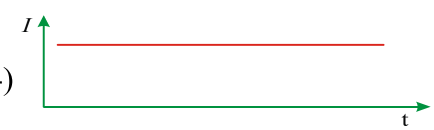
14. A p–n junction (D) shown in the figure can act as a rectifier. An alternating curent source (V) is connected in the circuit



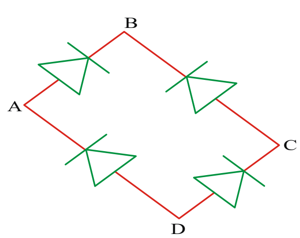
1) 

2) 

3) 

4) 

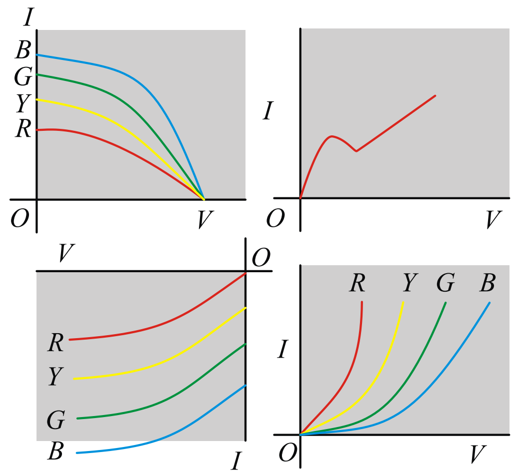
15. In the figure, the input is across terminals A and C and the output is across B and D. Then the output is



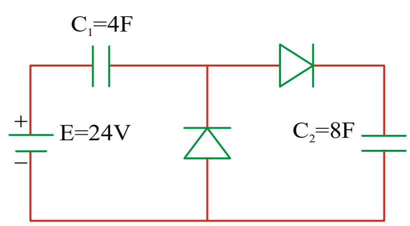
1) Zero 2) Same as the input

3) Full wave rectified 4) Half-wave rectified

16. The I-V characteristic of an LED is

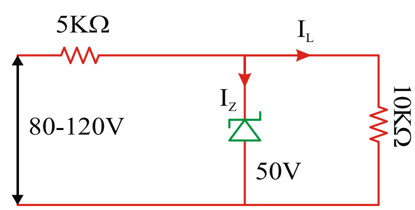


17. In the figure shown, the potential drop across each capacitor is (assume diodes to be ideal)



1) 12V, 12V 2) 16V, 8V 3) zero, 24V 4) 8V, zero

18. From the circuit shown below, the maximum and minimum values of zener diode current are



1) 6mA, 5mA 2) 14mA, 5mA 3) 9 mA, 1mA 4) 3mA, 2mA

TRANSISTORS

19. In an n-p-n transistor circuit, the collector current is 10mA. If 90% of the electrons emitted reach the collector.

1) the emitter current , the will be 9mA 2) the base current will be 1 mA

3) the emitter current will be 11mA 4) both 2 & 3

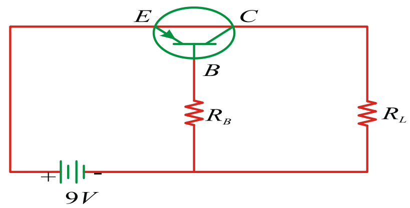
20. The constant α of a transistor is 0.9. What would be the change in the collector current corresponding to a change of 4 mA in the base current in a common emitter arrangement ?

1) 30mA 2) 63mA 3)36 mA. 4) 3.6 mA

21. A voltage amplifier operated from a 12 volt battery has a collector load $6k$W. Calculate the maximum collector current in the circuit.

1) 0.5mA 2) 1 mA 3) 3 mA 4) 2mA

22. In a transistor circuit shown here the base curent is $35\mu A$ The value of the resistor R_b is



1) $124k\Omega$ 2) $257k\Omega$ 3) $352k\Omega$ 4) None of these

23. In a single state transistor amplifier, when the signal changes by 0.02 V, the base current change by $10\mu A$ and collector current by 1mA. If collector load $R_C = 2kW$ and $R_L = 10k\Omega$, Calculate Current Gain, Input impedance, Effective a.c.load, Voltage gain and Power gain.

1)50, 2kΩ,1.66kΩ, 83, 8300 2) 100, 1kΩ,1.66kΩ, 83, 8300
3) 100, 2kΩ,1.66kΩ, 83, 830 4) 100, 2kΩ,1.66kΩ, 83, 8300

LOGIC GATES

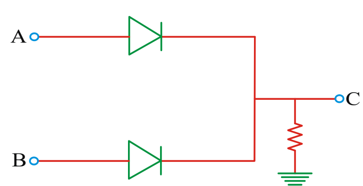
24. On subtracting 010101 from 101010, we get:

1) 001011 2) 001100 3) 010101 4) 011111

25. The minimum number of gates required to realise this expression $Z = DABC + DA\overline{BC}$ is

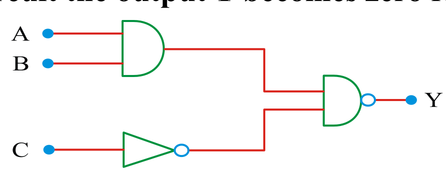
1) One 2) Two 3) Eight 4) Five

26. In the circuit below, A and B represent two inputs and C represents the output, the circuit reperesents



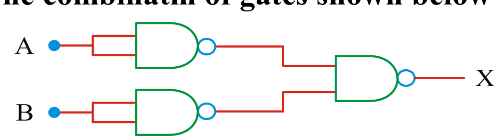
1) NOR gate 2) AND gate 3) gate 4) OR gate

27. In the following circuit the output Y becomes zero for the inputs



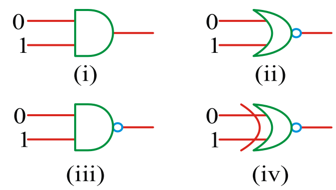
1) $A = 1, B = 0, C = 0$ 2) $A = 0, B = 1, C = 1$
3) $A = 0, B = 0, C = 0$ 4) $A = 1, B = 1, C = 0$

28. The combinatin of gates shown below yields



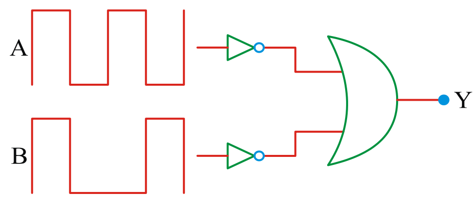
1) NAND gate 2) OR gate 3) NOT gate 4) XOR gate

29. The logic gate having an output of 1 is



1)(iv) 2)(i) 3)(ii) 4)(iii)

30. In a given circuit as shown the two input wave forms A and B are applied simultaneously

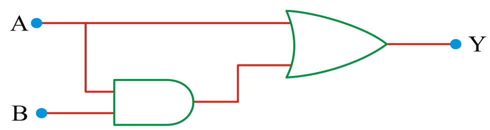


The resultant wave form at Y is

1)  3) 

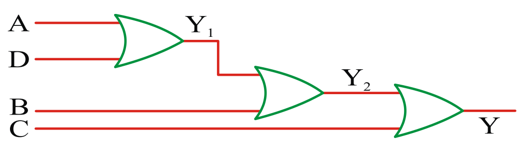
2)  4) 

31. The output of the combination of the gates shown in the figure below is



1) A + A. B 2) 3) $\left(A.B\right)+\left(\overline{A}.\overline{B}\right)$ 4) $\left(A+B\right)\left(\overline{A.B}\right)$

32. The expression of Y in following circuit is



1) ABCD 2) A+BCD 3) A +B+C+D 4) AB+CD

33. How many NAND gates are used in an OR gate ?

1) four 2) two 3) three 4) Five

EXERSISE-III - KEY

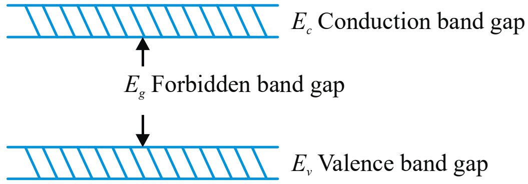
1) 3	2) 3	3) 2	4) 4	5) 2	6) 2	7) 1	8) 2	9) 1	10) 2	11) 3
12) 4	13) 3	14) 3	15) 3	16) 4	17) 2	18) 3	19) 4	20) 3	21) 4	22) 2
23) 4	24) 3	25) 1	26) 4	27) 4	28) 2	29) 4	30) 1	31) 1	32) 3	33) 3

EXERSISE-IV

INTRINSIC,EXTRINSIC SEMI CONDUCTORS AND DIODES

1. If the lattice constant of this semiconductor is decreased, then which of the

following is correct?



1) All $E_c, E_g \,\&\, E_v$ decrease 2) All $E_c, E_g \,\&\, E_v$ increase

3) E_c and E_v increase, but E_g decrease 4) E_c and E_v decrease but E_g increase

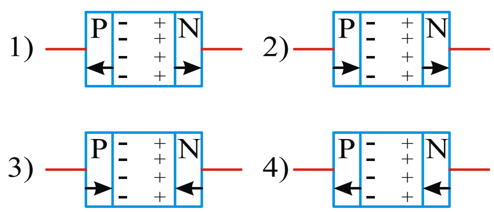
2. **A Ge specimen is doped with Al. The concentration of acceptor atoms is $10^{21}\ atoms/m^3$. Given that the intrinsic concentration of electron -hole pairs is $10^{19}/m^3$, the concentration of electrons in the specimen is**

1) $10^{17}/m^3$ 2) $10^{15}/m^3$ 3) $10^4/m^3$ 4) $10^2/m^3$

3. **The following data are for intrinsic germanium at 300 K.** $n_i = 2.4\times10^{19}/m^3$, $\mu_e = 0.39 m^2/Vs, \mu_h = 0.19 m^2/Vs$. **Calculate the conductivity of intrinsic germanium.**

1) $4.3\,Sm^{-1}$ 2) $1.21\,Sm^{-1}$ 3) $2.22\,Sm^{-1}$ 4) $4.22\,Sm^{-1}$

4. **The diagram correctly represent the direction of flow of charge carriers in the forward bias of p-n junction is**



5. **In the figurs shown below**

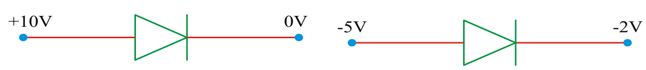


Fig. a Fig. b

1) In both Fig a and Fig b the diodes are forward biased
2) In both Fig, a and Fig b the diodes are reverse biased
3) In Fig a the diode is foward biased and in Fig b, the diode is reverse biased
4) In Fig a the diode is reverse biased and in fig b, it is forward biased

6. **A P-N junction diode can withstand currents up to 10 mA. Under forward bias, The diode has a potential drop of 0.5 V across it which is assumed to be independent of current.The maximum voltage of the battery used to forward bias the diode when a resistance of 200Ω is connected in series with it is**

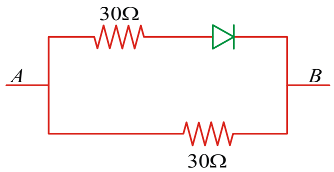
1) 2.5V 2) 2.6V 3) 2.7V 4) 2.8V

7. **A cell of emf 4.5V is connected to a junction diode whose barrier potential is 0.7V. If the external resistance in the circuit is 190 Ω, the current in the circuit is**

1) 20 mA 2) 2m A 3) 23mA 4) 200mA

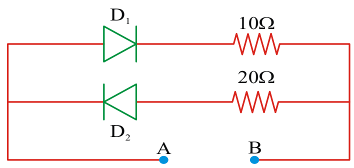
8. V_A *and* V_B **denote potentials of A and B, then the equivalent resistance between A**

and B in the adjoining circuit is(ideal diode)



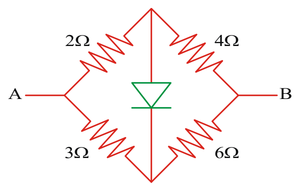
1) 15Ω *if* $V_A > V_B$ 2) 30Ω *if* $V_A < V_B$ 3) Both 1 and 2 4) neither 1 nor 2

9. Two ideal junction diodes D_1, D_2 are connected as shown in the figure. A 3V battery is connected between A and B. The current supplied by the battery if its positive terminal is connected to A is



1) 0.1A 2) 0.3 A 3) 0.9 A 4) 90 A

10. Find the effective resistance between A and B

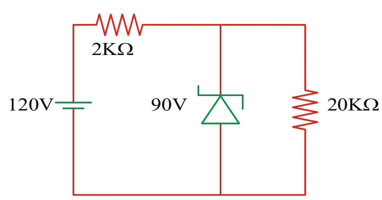


1) 5/18 Ω 2) 9/5 Ω 3) 18/5 Ω 4) 5/9 Ω

11. The peak voltage in the output of a half-wave diode rectifier fed with a sinusoidal signal without filter is 10V. The d.c. component of the output voltage is

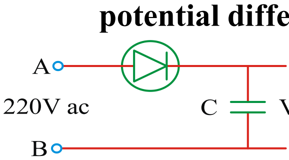
1) $10/\sqrt{2}\ V$ 2) $10/\pi\ V$ 3) 10 V 4) $20/\pi\ V$

12. In the figure shown the potential drop across the series resistor is



1) 30 V 2) 60 V 3) 90 V 4) 120 V

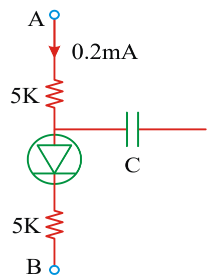
13. A 220V ac supply is connected between points A and B (Fig). What will be the potential difference V across the capacitor?



1) 220V 2) 110V

3) 0V 4) $220\sqrt{2}V$

14 In the circuit shown (Fig). if the diode forward voltage drop is 0.3V, the voltage difference between A and B is :



1) 1.3V

2) 2.3V

3) 0

4) 0.5V

TRANSISTORS

15. **In a n-p-n transistor 10^{10} electron enter the emitter in 10^{-6}s. If 2% of the electrons are lost in the base, the current transfer ratio and the current amplification factor are**

1) 0.98, 49 2) 0.49, 49 3) 0.98, 98 4) 0.49, 98

16. **In a common base mode of transistor, collector current is 5.488 mA for an emitter current of 5.60mA. The value of the base current amplification factor (β) will be:**

1) 48 2) 49 3) 50 4) 51

17. **Current amplification factor of a common base configuration is 0.88. Find the value of base current when the emitter current is 1 mA.**

1) 0.12 mA.2)0.1 mA 3) 0.5 mA 4) 0.2 mA

18. **For a transistor $\beta = 40$ and $I_B = 25\mu A$. Find the value of I_E.**

1) 1mA 2) 1.025mA 3) 2mA 4) 1.2 mA

19. **In a transistor if $\frac{I_C}{I_E} = \alpha$ and $\frac{I_C}{I_B} = \beta$, If α varies between $\frac{20}{21}$ and $\frac{100}{101}$, then the value of β lied between**

1)1-10 2)0.95-0.99 3)20-100 4)200-300

20. **For a transistor $x = \frac{1}{\alpha}$ & $y = \frac{1}{\beta}$ where α & β are current gains in common base and common emitter configuration. Then**

1) $x + y = 1$ 2) $x - y = 1$ 3) $2x = 1 - y$ 4) $x + y = 0$

21. **A voltage amplifier operated from a 12 volt battery has a collector load 6kW. Calculate the maximum collector current in the circuit.**

1) 0.5mA 2) 1 mA 3) 3 mA 4) 2mA

22. **A CE amplifier is designed with a transistor having $\alpha = 0.99$. Input impedance is 1 $k\Omega$ and load is $10\ k\Omega$. Voltage gain will be:**

1) 9900 2) 99000 3) 99 4) 990

23. **In a common emitter amplifier the load resistance of the output circuit is 792 times the resistance of the input circuit. If α = 0.99, the voltage gain is**

1) 79200 2) 39600 3) 7920 4) 3960

24. **In a transistor amplifier β = 62, R_L = 5000Ω and internal resistance of the transistor is 500Ω. Its power amplification will be**

1) 25580 2) 33760 3) 38440 4) 55760

25. **The tuned collector oscillator circuit used in the local oscillator of a radio receiver makes use of a tuned circuit with L = 60 μH and C = 400 pF. Calculate the frequency of oscillations.**

1) 1.03 KHz 2) 1.03 Hz 3) 1.03 GHz 4)1.03 MHz

LOGIC GATES

26. When we add binary numbers 111 and 111 we get the binary number:

1) 222 2) 1000 3) 1110 4) 000

27. If A= B=C=1 and $X = A\overline{BC} + B\overline{CA} + C\overline{AB}$**, then X=**

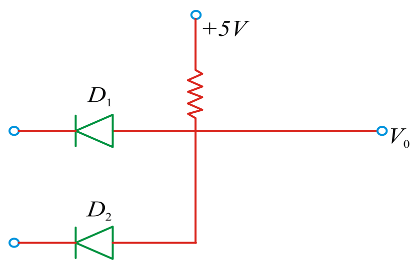
1) 0 2) 1 3) 100 4) 110

28. The input of A and B for the Boolean expression

$\left(\overline{A+B}\right).\left(\overline{A.B}\right) = 1$ **is**

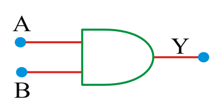
1) 0,0 2) 0, 1 3) 1,0 4) 1, 1

29. Write the name of the follwoing gate that the circuit shown in figure.



1)AND gate 2)OR gate 3)NOR gate 4)XOR gate

30. Consider a two-input AND gate of figure below. Out of the four entries for the Truth Table given here, the correct ones are



	Input		Output
	A	B	Y
1	0	1	0
2	1	0	0
3	1	1	1
4	0	0	1

1) All 2) 1 and 2 only 3) 1, 2 and 3 only 4) 1, 3 and 4 only

31. A Truth table is given below. The logic gate having following truth table is

A	**B**	**Y**
0	0	1
1	0	0
0	1	0
1	1	0

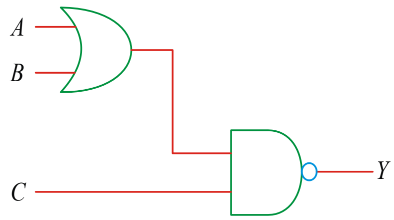
1)NAND gate 2)NOR gate 3)AND gate 4)OR gate

32. For a logic 0101 the waveform is

1)  2) 

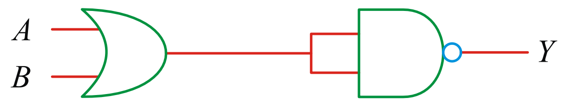
3)  4) 

33. For the given combination of gates, if the logic states of inputs A, B, C are as follows A=B=C=0 and A=B=1, C=0 then the logic states of output D are



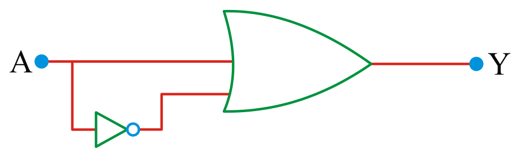
1) 0,0 2) 0,1 3) 1, 0 4) 1,1

34. Identify the gate represented by the block diagram as shown in fig.



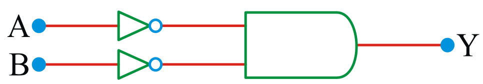
1) AND gate 2) NOT gate 3) NAND gate 4) NOR gate

35. The Boolean expression for the gate circuit shown below is



1) $A+\overline{A}=1$ 2) $A+1=1$ 3) $A+A=A$ 4) $A+0=A$

36. The output Y of the gate circuit shown in the figure below is



1) $\overline{A.B}$ 2) $\overline{A}.\overline{B}$ 3) $\overline{\overline{A.B}}$ 4) $\overline{A}+\overline{B}$

EXERSISE-IV - KEY

1) 4 2) 1 3) 3 4) 3 5) 3 6) 1 7) 1 8) 3 9) 2 10) 3 11) 2
12) 1 13) 4 14) 2 15) 1 16) 2 17) 1 18) 2 19) 3 20) 2 21) 4 22) 4
23) 1 24) 3 25) 4 26) 3 27) 1 28) 1 29) 1 30) 3 31) 2 32) 1 33) 4
34) 4 35) 1 36) 2

EXERSISE-V

1. If the ratio of the concentration of electrons to that of holes in a semi-conductors is $\frac{7}{5}$ and the ratio of currents is $\frac{7}{4}$, then the ratio of drift velocities is

1) 5/8 2) 4/5 3) 5/4 4) 4/7

2. If the resistivity of copper is $1.7\times10^{-6}\Omega$ cm, then the mobility of electrons in copper, if each atom of copper contributes one free electron for conduction, is [The atomic weight of copper is 63.54 and its density is 8.96 g/cc]:

1) $23.36cm^2/Vs$ 2) $503.03cm^2/Vs$ 3) $43.25cm^2/Vs$ 4) $88.0cm^2/Vs$

3. **A pure silicon crystal of length $l(0.1m)$ and area $A(10^{-4}m^2)$ has the mobility of electron (μ_e) and holes (μ_h) as $0.135m^2/Vs$ and $0.048m^2/Vs$, respectively, If the voltage applied across it is 2V and the intrinsic charge concen-tration is $n_i = 1.5\times10^6 m^{-3}$, then the total current flowing through the crystal is.**

1) $8.78\times10^{-17}A$ 2) $6.25\times10^{-17}A$ 3) $7.89\times10^{-17}A$ 4) $2.456\times10^{-17}A$

4. **Find the current produced at room temperature in a pure germanium plate of area $2\times10^{-4}m^2$ and of thickness 1.2×10^{-3} m when a potential of 5 V is applied across the faces. Concentration of carriers in germanium at room temperature is 1.6×10^6 per cubic metre. The mobilities of electrons and holes are $0.4m^2V^{-1}s^{-1}$ and $0.2m^2V^{-1}s^{-1}$ respectively. The heat energy generated in the plate in 100 second is**

1) $2.4\times10^{-11}J$ 2) $3.4\times10^{-11}J$ 3) $5.4\times10^{-11}J$ 4) $6.4\times10^{-11}J$

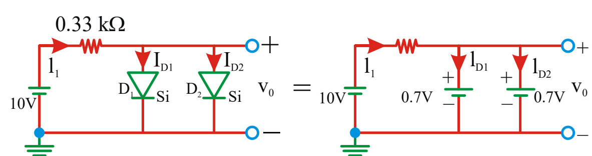
5. **An n-type semiconductor has impurity level 20meV below the conduction band. In a thermal collision, transferble energy is KT. The value of T for which electrons start to jump in conduction band is :**

1) 232 K 2) 348 K 3) 400 K 4) 600 K

6. **Assume that the number of hole-electron pair in an intrinsic semiconductor is proportional to $e^{-\Delta E/2KT}$. Here ΔE = energy gap and $k = 8.62\times10^{-5} eV/kelvin$ The energy gap for silicon is 1.1eV. The ratio of electron hole pairs at 300K and 400 K is :**

1) $e^{-5.31}$ 2) e^{-5} 3) e 4) e^2

7. **In the circuit shown in figure (1), the V_0, I_1, I_{D_1}, and I_{D_3} are respectively**



(A) (B)

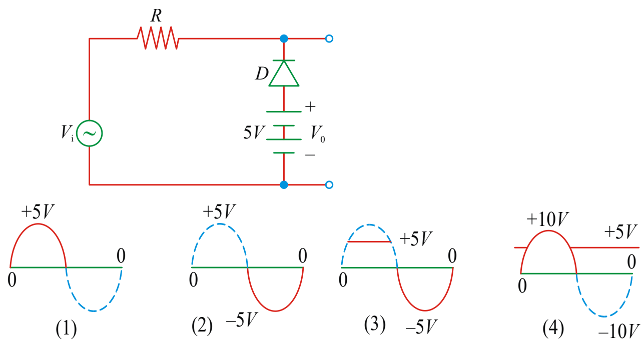
1) 0.5V, 25 mA, 15 mA 2) 0.7V, 28.18 mA, 14.09 mA
3) 0.4V, 15 mA, 20 mA 4) 0.3V, 15.06 mA, 20.18 mA

8. **For a junction diode , the ratio of forward current (I_f) and reverse current is**

[I_e = electronic charge,
V = voltage applied across junction,
k = Boltzmann constant
T = temperature in kelvin]

1) $e^{-v/kT}$ 2) $e^{V/kT}$ 3) $(e^{eV/kT}-1)$ 4) $(e^{V/kT}-1)$

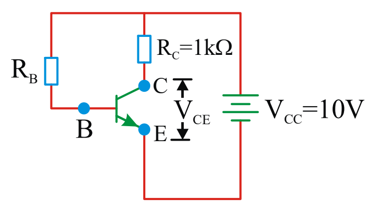
9. **In the diagram D an ideal diode and an alternating voltage of peak value 10V is connected as input V_1. Which of the following diagram represents the correct waveform of output voltage V_θ ?**



10. **For a CE-transistor amplifier, the audio signal voltage across the collector resistance of $2k\Omega$ is 2V. Suppose the current amplification factor of the transistor is 100. Find the input signal voltage and base current, if the base resistance is $1k\Omega$.**

1) 0.02V 2) 0.01V 3) 0.03V 4) 0.04V

11. **In the circuit, transistor has a current $(\beta)=100$. What should be the base resistor R_B neglect V_{BE}, so that $V_{CE}=5V$:**



1) 200 kΩ 2) 1 kΩ 3) 500 kΩ 4) 2 kΩ

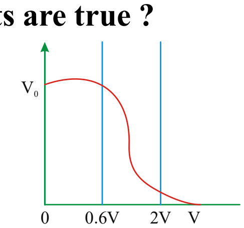
12. **An $N-P-N$ transistor is connected in common - emitter configuration in which collector supply is 8V and the voltage drop across the load resistance of 800 Ω connected in the collector circuit is 0.8V. If current amplification factor is 25/26 (If the internal resistance of the transistor is 200 Ω), the collector-emitter voltage, voltage gain and power gain are respectively.**

1) 5.2V, 1.86, 3 2) 6.2V, 186, 5.5
3) 7.2V, 3.86, 3.698 4) 8.2V, 4.91, 3.15

13 **For a CE transistor amplifier, the audio signal voltage across the collector resistance of $2k\Omega$ is 2V. Suppose the current amplification factor of the transistor is 100. The value of R_B in series with V_{BB} supply of 2V, if the DC base current has to be10 times the signal current is**

1) $4k\Omega$ 2) $14k\Omega$ 3) $28k\Omega$ 4) $54k\Omega$

14 **Figure shows the transfer characteristics of a base biased CE transistor.Which of the following statements are true ?**



A) At $V_1=0.4\ V$ transistor is in active state

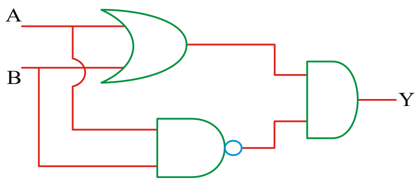
B) At $V_1=1\ V$ it can be used as an amplifier

C) At $V_1 = 0.5\,V$, It can be used as a switch turned off

D) At $V_1 = 2.5\,V$, it can be used as a switch turned on

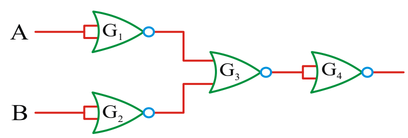
1)A,B,C 2)B,C,D 3)A,C,D 4)A,B,D

15. The following configuration of gates is equivalent to



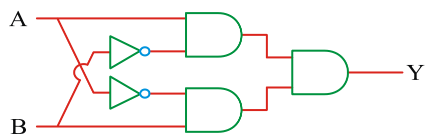
1) NAND gate 2) XOR gate 3) OR gate 4) NOR gate

16. The combination of the gates shown below produces



1) AND gate 2) XOR gate 3) NOR gate 4) NAND gate

17. Which of the following truth tables is true?



1)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	0

2)

A	B	Y
0	0	0
1	0	0
0	1	1
1	1	1

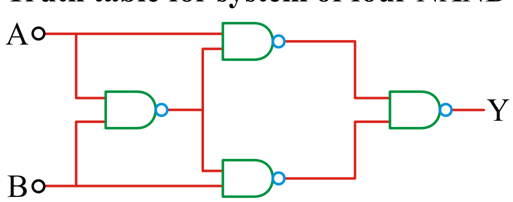
3)

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

4)

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	0

18. Truth table for system of four NAND gates as shown in figure is :



1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

2)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

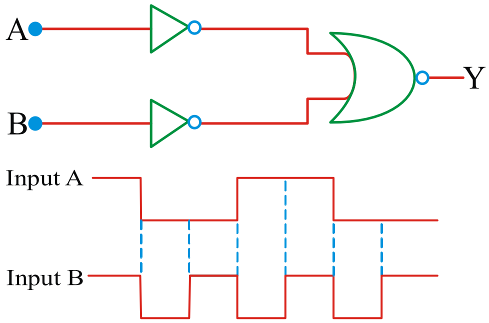
3)

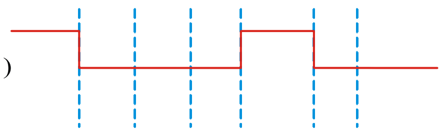
A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

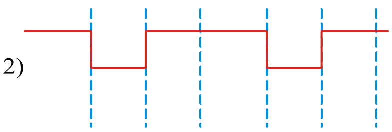
4)

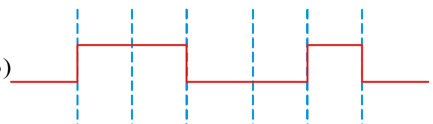
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

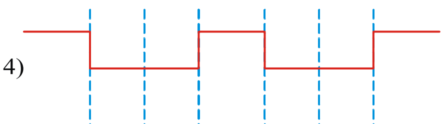
19. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct output waveform



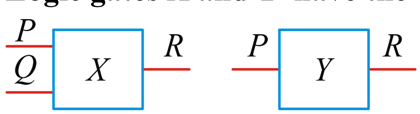
1) 

2) 

3) 

4) 

20. Logic gates X and Y have the truth tables shwon below



P	Q	R	P	R
0	0	0	0	1
1	0	0	1	0
0	1	0		
1	1	1		

When the output of X is connected to the input of Y, the resulting combination is equivalent to a single .

1) NOT gate 2) OR gate 3) NOR gate 4) NAND gate

EXERSISE-V - KEY

1) 3 2) 3 3)1 4) 4 5)1 6) 1 7) 2 8) 3 9) 4 10) 2 11)1
12) 3 13) 2 14) 2 15) 2 16) 4 17)1 18)1 19)1 20) 4

EXERSISE - VI

COMPREHENSION TYPE

PASSAGE - I

A block of pure silicon at 300K has a length of 10cm and an area of 1.0cm^2 . A battery of emf 2V is connected across it. The mobility of electron is $0.14\,m^2v^{-1}S^{-1}$ **and their number density is 1.5$\times$10^{16} m^{-3}. The mobility of holes is** $0.05\,m^2v^{-1}S^{-1}$

ELECTRONIC DEVICES

1. The electron current is

1) $6.72 \times 10^{-4} A$ 2) $6.72 \times 10^{-5} A$ 3) $6.72 \times 10^{-6} A$ 4) $6.72 \times 10^{-7} A$

2. The hole current is

1) $2.0 \times 10^{-7} A$ 2) $2.2 \times 10^{-7} A$ 3) $2.4 \times 10^{-7} A$ 4) 2.6

3. The total current in the block is

1) $2.4 \times 10^{-7} A$ 2) $6.72 \times 10^{-7} A$ 3) $4.32 \times 10^{-7} A$ 4) $9.12 \times 10^{-7} A$

PASSAGE:2

The input and output resistances in a common base amplifier circuits are 400 Ω and 400K Ω respectively. The emitter current is 2mA and current gain is 0.98.

4. The collector current is

1) 1.84mA 2)1.96mA 3)1.2mA 4)2.04mA

5. The base current is

1) 0.012mA 2) 0.022mA 3)0.032mA 4) 0.042mA

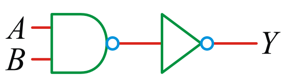
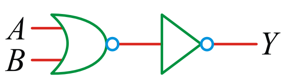
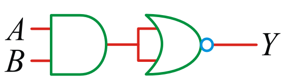
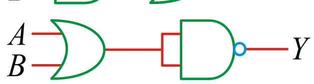
6. Voltage gain of transistor is

1)960 2)970 3)980 4)990

7. Power gain of transistor is

1) 950 2) 960 3)970 4)980

8. The logic circuits are given in column I and the Boolean expressions in column II.

Column - I	**Column - II**
A) 	**(P)** $y = \overline{A} + \overline{B}$
B) 	**(Q)** $y = \overline{A}.\overline{B}$
C) 	**(R)** $y = A.B$
D) 	**(S)** $y = A + B$

1) $A \to R, B \to S, C \to p, D \to Q$ 2) $A \to S, B \to R, C \to P, D \to Q$

3) $A \to P, B \to Q, C \to R, D \to S$ 4) $A \to S, B \to P, C \to Q, D \to R$

EXERSISE - VI - KEY

1) 4 2) 3 3) 4 4) 2 5) 4 6) 3 7) 2 8) 1

* * *

EXPERIMENTAL PHYSICS

1. The value of sin 60° is
(1) 0.9 (2) 0.8 (3) 0.87 (4) 0.866

2. A scale is graduated in millimetres. Length of pendulum is measured as 90.0 cm using it. Find the percentage error in this measurement.
(1) 0.1% (2) 0.2% (3) 0.3% (4) 0.4%

3. A thermometer whose scale divisions are 0.2°C apart is used to measure a rise of temperature from 20.2°C to 26.6°C. Find the percentage error in this measurement.
(1) 1% (2) 2% (3) 3% (4) 4%

4. The LC of a meter scale calibrated in cm where there is a line between n and $n+1$ lines ($n = 0, 1, 2, 3, \ldots, 100$) is
(1) 1 cm (2) 0.1 cm (3) 0.5 cm (4) 0.05 cm

5. The smallest length an instrument can measure accurately is called
(1) Absolute length (2) Pitch
(3) Least Count (LC) (4) Vernier constant (VC)

6. Which one of the following is not a systematic error?
(1) Zero error (2) incorrectly calibrated scale
(3) Mistime action of observer (4) lack of perfection in the observer

7. A precise experiment has
(1) a small systematic error (2) a small random error
(3) a large systematic error (4) a large random error

8. An accurate experiment has
(1) a small systematic error (2) a small random error
(3) a large systematic error (4) a large random error

9. The term error excludes mistakes. Then choose the correct one from the following options which is / are not considered as error(s)?
(i) faulty arithmetic (ii) misreading scales
(iii) faulty transcription (iv) zero error
(1) i and ii (2) i, ii and iii (3) i and iv (4) ii and iii

10. Choose the correct statement from the following statements given below:
(1) Accuracy is a measure of closeness of the measured value to the true value
(2) Accuracy is a measure of dispersion in experimental data
(3) Precision is a measure of closeness of the measured value to the true value
(4) Accuracy and precision are the same concepts.

11. **Statements (I):** The principle of screw gauge is the conversion of the circular motion of the screw head into the linear motion of the movable stud.

Statement (II): The instrument is named screw gauge because it used a screw to amplify a very small movement so that it can easily be read.

(1) Both I and II are true (2) I is true and II is false
(3) I is false but, II is true (4) Both I and II are false

12. Pitch of a screw gauge is
(1) The value of one scale division on the linear scale
(2) The value of one scale division in circular scale
(3) The smallest distance covered on the linear scale by circular scale with one complete rotation
(4) A part of the instrument

13. Least count of a screw gauge is
(1) The value of one scale division on the linear scale
(2) The value of one scale division in circular scale
(3) The smallest distance covered on the linear scale by circular scale with one complete rotation
(4) The smallest distance covered on the linear scale by circular scale with one circular division

14. The screw head is rotated in the same direction while measurement is made to avoid
(1) End correction (2) Back-lash error (3) Zero error (4) None

15. The radius of a hair cannot be measured by screw gauge because
(1) It is very less than the least count of the screw gauge
(2) It is bigger than the least count of the screw gauge
(3) It is larger than the pitch of the screw gauge
(4) It is larger than the LC and smaller than the pitch of the screw gauge

16. If L_s and L_v are the least counts of screw gauge and vernier calliper respectively than
(1) $L_s > L_v$ (2) $L_s = L_v$ (3) $L_s < L_v$ (4) None

17. Which one of the following instruments is more precise?
(1) A meter scale (2) Vernier calliper (3) Screw gauge
(4) all have same precisions

18. **Assertion (A):** A screw gauge is also called micrometer screw.
Reason (R): A screw gauge can measure distance correctly up to a micrometer.
(1) Both A and B are correct, and R is the correct explanation
(2) Both A and B are correct and R is not the correct explanation
(3) A is correct and R is incorrect
(4) A is false and R is correct

19. A screw gauge is made from
(1) Hard Iron (2) Soft iron (3) Gun metal (4) Tin

20. The main function of ratchet in screw gauge is to
(1) rotate circular scale (2) prevent the screw from under pressure

(3) hold screw gauge (4) None of the above

21. The least count of a vernier calliper is 0.01 cm. The length it can measure accurately up to

(1) 10^{-1} cm (2) 10^{-2} cm (3) 10^{-3} cm (4) 10^{-4} cm

22. Instrument used to measure the internal and external diameter of a tube is

(1) Screw gauge (2) Vernier calliper (3) Meter scale (4) Spherometer

23. **Statement (I):** The vernier scale uses the alignment of line segments displaced by a small amount to make fine measurements.

Statement (II): The statement I is the principle of a vernier.

(1) Both I and II are correct (2) I is correct and II is incorrect
(3) I is incorrect and II is correct (4) Both I and II are incorrect

24. **Statement (I):** Vernier constant is the difference between the value of one main scale division and one vernier division.

Statement (II): Vernier constant is calculated by dividing the smallest unit on main scale by the total numbers on the vernier scale.

(1) Both I and II are correct (2) I is correct and II is incorrect
(3) I is incorrect and II is correct (4) Both I and II are incorrect

25. The effect (error) where the direction and position of the object appear to differ when viewed from different line of sight is called

(1) Zero error (2) End correction (3) Parallax (4) Absolute error

26. **Assertion (A):** A spherical bob is used instead of conical or cylindrical bob to construct simple pendulum.

Reason (R): It is easier to locate the centre of gravity of spherical bob than that of conical and cylindrical bob.

(1) Both A and R are correct and R is the correct explanation
(2) Both A and R are correct and R is not the correct explanation
(3) A is correct and R is incorrect (4) A is false and R is correct

27. If L be the length of thread and D be the diameter of the spherical bob of a simple pendulum, then the length of the simple pendulum is

(1) $L - D$ (2) $L - D/2$ (3) $L + D$ (4) $L + D/2$

28. If T be the time period of the simple pendulum in (27) give by $2\pi\sqrt{l/g}$, where g is acceleration due to gravity, then l is equal to

(1) L (2) $L + D$ (3) $L + D/2$ (4) $L - D/2$

29. The time period of a second pendulum is

(1) 1 sec (2) 2 sec (3) 3 sec (4) 4 sec

30. Which of the following errors can be removed while doing a measurement?

(1) Random error (2) Systematic error (3) Absolute error (4) Percentage error

31. With the jaws of the calliper closed the zero of vernier scale lies on the left side of the zero of main scale. The zero error associated with the vernier calliper is
(1) Positive (2) Negative (3) Zero (4) None

32. With the studs of the screw gauge closed, if the zero of circular scale lies below the index line, then the zero error associated with the screw gauge is
(1) Positive (2) Negative (3) Zero (4) None

33. With the studs of the screw gauge closed, the zero of circular scale is above the reference line by 7 divisions. If the least count is 0.001 cm, then the zero error of the instrument
(1) +0.007 cm (2) –0.007 cm (3) +0.007 mm (4) –0.007 mm

34. Least count and accuracy of an instrument are related as
(1) Less is the least count, less is the accuracy
(2) Less is the least count, more is the accuracy
(3) More is the least count, more is the accuracy
(4) Name of the above

35. In vernier scale (angular) normally provided in spectrometer / sextant, 60 VSD coincide with 59 MSD (each division of angle 1°). Find the least count of the vernier.
(1) 10° (2) 30° (3) 0.1° (4) 1°

36. Choosing the correct statement(s). The accuracy of a vernier can be increased by
(i) Reducing the magnitude of main scale (M.S.) divisions
(ii) Increasing the number of vernier scale (V.S.) divisions
(iii) Increasing the magnitude of M.S. divisions
(iv) Decreasing the number of V.S. division
(1) (i) and (iii) (2) (i) and (ii) (3) (ii) and (iii) (4) (ii) and (iv)

37. **Assertion (A):** A simple pendulum experiment cannot be performed in space
Reason (R): The acceleration due to gravity is zero in space
(1) Both A and R are correct and R is the correct explanation
(2) Both A and R are correct and R is not the correct explanation
(3) A is correct and R is incorrect (4) A is false and R is correct

38. The magnitude of a velocity of bob in a simple pendulum experienced at mean position O is V_o and at two extreme positions A and B are V_A and V_B respectively. Then
(1) $V_{max} = V_o$ (2) $V_A = V_B \neq 0$ (3) $V_{min} = 0$ (4) $V_{max} = V_A = V_B$

39. In a simple pendulum experiment the graph of 1 vs T is
(1) Straight line (2) Hyperbola (3) Parabola (4) Ellipse

40. In a simple pendulum experiment the graph of 1 vs T^2 is
(1) Straight line (2) Hyperbola (3) Parabola (4) Ellipse

41. Choose the incorrect one about the line of action of three concurrent forces
(1) Converging (2) Diverging (3) Perpendicular to each other
(4) Parallel

42. The loss of weight of a body immersed in a liquid is equal to the weight of the liquid displacement. This is called …………… principle.
(1) Stoke’s (2) Bernoulli’s (3) Archimedes’ (4) Pascal’s

43. **Assertion (A):** Steel is more elastic than rubber.
Reason (R): Modulus of elasticity of rubber is more than that of steel
(1) Both A and R are true, and R is the correct explanation of A
(2) Both A and R are true, and R is not the correct explanation of A
(3) A is true but R is false (4) A is false but R is true

44. The level of a liquid rises inside a capillary tube when
(1) The magnitude of cohesive force is less than adhesive force
(2) The magnitude of cohesive force is more than adhesive force
(3) The magnitude of cohesive force is equal to that of adhesive force.
(4) None of the above

45. A beam balance is used to determine
(1) Weight (2) Mass (3) Acceleration due to gravity
(4) Force

46. The working of physical (beam) balance is based on
(1) Archimedes’ Principle (2) The principle of moments
(3) Le Chatelier’s principle (4) Pascal’s Law

47. The instrument that is used to measure the weight of an object in the lab is
(1) Gravesand’s apparatus (2) Simple pendulum
(3) Beam balance (4) Lever

48. In the above question (47) which one of the following laws is used to determine the weight of a given object?
(1) Pascal’s Law (2) Parallelogram law of vectors
(3) Hooke’s Law (4) Newton’s law

49. Which of the following thermodynamic variables is constant in Boyle’s law?
(1) Pressure (2) Volume (3) Temperature (4) Density

50. The apparatus that is used to determine the radius of curvature of a given spherical surface in
(1) Vernier calliper (2) Screw gauge (3) Spherometer (4) None

51. In a resonance tube experiment, the antinode is formed a little away from the open end. The distance between the open end and actual formation of antinode is called
(1) Amplitude correction (2) End correction
(3) Zero correction (4) Error correction

52. If *d* is the diameter of the resonance tube, the correction in above question (1) is given by
(1) 0.1 d (2) 0.2 d (3) 0.3 d (4) 0.4 d

53. If v is the speed of sound, and I_1 and I_2 are the lengths of air column in first and second resonance tube, then the frequency f of given fork (after correction) is given by

(1) $\frac{v}{2(l_2 - l_1)}$ (2) $\frac{v}{2(l_2 + l_1)}$ (3) $\frac{v}{2l_1}$ (4) $\frac{v}{2l_2}$

54. If c be the correction to above question (1), and I_1 and I_2 are the lengths of air columns in first and second resonance, then the relation between these two lengths of air columns is

(1) $l_2 = 3l_1 + 2c$ (2) $l_1 = 3l_2 + 2c$ (3) $l_2 = 3l_1 - 2c$ (4) $l_1 = 2l_2 - 2c$

55. The ratio of the first, second and third resonating lengths is

(1) 1:2:3 (2) 1:3:5 (3) 3:2:1 (4) 5:3:1

56. Choose the correct option(s). The method(s) use to determine the focal length of a convex lens in lab is / are

(i) u-v method (ii) Distance object method

(iii) l/u-l/v graph (iv) Lens displacement method (conjugate focal method)

(1) i and ii (2) i, ii and iii (3) I, iii and iv (4) All

57. The focal length f of a glass slab is

(1) $f = 0$ (2) $0 < f <$ Finite (3) $f =$ Infinite (4) None

58. The focal length of lens depends on

(1) Nature of material only (2) Radii of curvature only

(3) Both nature of material and radii of curvature (4) None of the above

59. The pair of positions at which the object and image can be interchanged are called

(1) Principal foci (2) Conjugate foci (3) Complex foci (4) None

60. When the north pole of a bar magnet is placed towards the geographic north of the earth, the null points will be formed.

(1) On the equatorial line (2) On the axial line

(3) Angular bisector of equatorial and axial line

(4) Insufficient information

61. When the north pole of a bar magnet is placed towards the geographic south of the earth, the null points will be formed.

(1) On the equatorial line (2) On the axial line

(3) Angular bisector of equatorial and axial line (4) None

62. The imaginary vertical plane passing through the axis of a freely suspended bar magnet is called

(1) Great circle (2) Magnetic meridian

(3) Geographic meridian (4) Small circle

63. Which one of the following relations differentiate prism form glass slab?

(1) Prism is made of crown glass whereas glass slab is made of flint glass

(2) Prism is made of flint glass whereas glass slab is made of crown glass

(3) In prism, angle between two refracting surfaces is not equal to zero, whereas in glass slab angle between two refracting surfaces is zero
(4) Light disperse after first refraction in prism, whereas no dispersion in case of glass slab in first refraction

64. Which colour travels fastest in glass?
(1) Violet (2) Blue (3) Green (4) Red

65. Refractive index of prism is the largest for
(1) Violet (2) Blue (3) Green (4) Red

66. A ray of light bends after refraction at the interface of two different media as the speed of light changes due to change in
(1) Frequency only (2) wavelength only
(3) Both frequency and wavelength
(4) Frequency changes but wavelength remains the same

67. Choose the correct option(s). At minimum deviation position.
(i) $i_1 = i_2$ (ii) $r_1 = r_2$
(iii) Refracted ray at first refracting surface is parallel to the base of prism
(1) i and ii (2) i, ii and iii (3) iv (4) i, ii, iii and iv

68. Tangent galvanometer works on the principle if Tangent law in magnetism given by (Provided B = a given magnetic field, B_H = Horizontal component of earth's magnetic field, θ = angle between the
(1) $B - B_H \tan\theta = 0$ (2) $B_H - B\tan\theta = 0$ (3) $B + B_H \tan\theta = 0$ (4) $B_H + B\tan\theta = 0$

69. If I be the current through the n circular coils of radius r in tangent galvanometer (T.G.) at a place where horizontal component of earth's magnetic field is B_H and θ be the angle of deflection, then the current is given by $i = K \tan\theta$, where the reduction factor K is
(1) $\frac{2nB_H}{\mu_0 r}$ (2) $\frac{2rB_H}{\mu_0 n}$ (3) $\frac{2\mu_0 B_H}{nr}$ (4) $\frac{2r\mu_0}{nB_H}$

70. The coil of the tangent galvanometer is arranged along magnetic meridian such that the angle between B and B_H becomes
(1) 0° (2) 60° (3) 90° (4) 180°

71. The purpose of commutator in the circuit is to
(1) Change the magnitude of current (2) Reverse the direction of current
(3) Change the magnitude of B (4) Change the angle of deflection

72. If the number of turns are increased in T.G., then choose the correct option(s) from the following
(i) θ increases (ii) B increases (iii) i increases
(1) i (2) i and ii (3) ii and iii (4) i, ii and iii

73. **Assertion (A):** A tangent galvanometer can be used to determine small current

Reason (R): A very small current can produce effective deflecting field at the centre of the coil, perpendicular to the plane.
(1) Both A and R are true, and R is the correct explanation of A
(2) Both A and R are true, and R is not the correct explanation of A
(3) A is true but R is false (4) Both A and R are false

74. **Assertion (A):** Ohm's law is not a fundamental law
Reason (R): A very small current can produce effective deflecting field at the centre of the coil, perpendicular to the plane
(1) Both A and R are true, and R is the correct explanation of A
(2) Both A and R are true, and R is not the correct explanation of A
(3) A is true but R is false (4) Both A and R are false

75. The principle of meter bridge is
(1) Kirchhoff's law (2) Ampere's law
(3) Balancing condition of Wheatstone's bridge (4) Ohm's law

76. If the connections are correct in meter bridge experiment, then when the jockey touches at the two ends of the wire, the deflection in the galvanometer will show
(1) Same direction (2) Opposite direction (3) No deflection
(4) Same deflection in the same direction

77. If I_0 and I are intensity of light at 0° and θ° (between polarizer and analyzer), then the Malus law is given by
(1) $I = I_0 \cos^2\theta$ (2) $I = I_0 \cos 2\theta$ (3) $I = I_0 \cos\theta$ (4) $I = \frac{I_0}{\cos\theta}$

78. In a plane polarized light, the electric field vector oscillates
(1) In different planes perpendicular to the direction of propagation
(2) In the same plane perpendicular to the direction of propagation
(3) In different planes parallel to the direction of propagation
(4) In the same plane parallel to the direction of propagation

79. Choose the correct option(s). The wave(s) which can be polarized is/are
i) Mechanical ii) Non-mechanical iii) Longitudinal only iv) Transverse only
(1) i and iii (2) i, ii and iii (3) i, ii and iv (4) i, ii, iii and iv

80. Choose the correction option(s). The wave nature of light is confirmed by the following natural phenomena(non)
i) Reflection ii) Refraction iii) Interference iv) Polarization
(1) i and ii (2) i, ii and iv (3) iii and iv (4) ii, iii and iv

81. An ordinary light (in air) is incident on a refractive medium at an angle of incidence 30° such that the reflected component of light gets plane polarized. Then the refractive index of the medium is
(1) 1.73 (2) 1.3 (3) 0.75 (4) 0.58

82. The material uses to prepare resistance in resistance box is

(1) Copper (2) Manganin (3) Nichrome (4) Brass

83. **Assertion (A):** Specific resistance of a resistance changes with length or diameter.
Reason (R): Resistance of resistor is directly proportional to its length and inversely proportional to its area of cross section
(1) Both A and R are true, and R is the correct explanation of A
(2) Both A and R are true, and R is not the correct explanation of A
(3) A is true but R is false (4) A is false and R is true

84. When the resistance in the right gap is increased in meter bridge experiment
(1) The balancing length increases or shifts towards right
(2) The balancing length decreases or shifts towards left
(3) The balancing length remains the same
(4) None of the above

85. **Assertion (A):** In meter bridge, a high resistance wire is used
Reason (R): Due to high resistance, small current flows through the circuit containing galvanometer, and thus protects it from damage
(1) Both A and R are true, and R is the correct explanation of A
(2) Both A and R are true, and R is not the correct explanation of A
(3) A is true but R is false (4) A is false and R is true

86. The majority of charge carriers in *p*- and *n*-type semiconductors are respectively
(1) Holes and electrons (2) Electrons and holes
(3) Both holes and –ions (4) +ions and electrons

87. The charge carries in an extrinsic semiconductor are
(1) Holes only (2) Electrons only (3) Both holes and electrons
(4) Majority holes and minority electrons

88. In general, the width of depletion layer is in the order of (in meter)
(1) 10^{-3} (2) 10^{-6} (3) 10^{-9} (4) 10^{-12}

89. In a reverse biased *p-n* junction, few minority charge carriers cross the depletion region constituting a small current called
(1) Instantaneous current (2) Drift current
(3) Leakage current (4) Direct current

90. Choose the correct option(s). In a given *p-n* junction diode, an arrow is marked from left to right. It indicates
i) P-type on the left and n-type on the right ii) n-type on the left and p-type on the right
iii) Direction of current in forward bias iv) Direction of current in reverse bias
(1) i and iii (2) i and iv (3) ii and iii (4) ii and iv

91. **Statement (I):** In a forward potential in forward bias of *p-n* junction diode current suddenly increases at a certain minimum potential.
Statement (II): The minimum potential in forward bias of a p-n junction diode at which forward current suddenly increase is called break down voltage

(1) Both I and II are true (2) I is true but II is false
(3) I is false but ii is true (4) Both I and II are false

92. Choose the correct option(s). In forward bias, the net current is due to
i) Diffuse current ii) Drift current iii) Holes iv) Electrons
(1) i and iii (2) i and iv (3) ii and iii (4) ii and iv

93. In a *p*-*n* junction diode, forward and reverse biased currents are measured, respectively in
(1) mA, μA (2) μA, mA (3) A, mA (4) A, A

94. At a certain reverse bias voltage in general *p*-*n* junction diode, the reverse current suddenly increases. This negative voltage is called
(1) Knee voltage (2) Break-down voltage
(3) Stopping voltage (4) Reverse voltage

95. A heavily doped *p*-*n* junction diode which works as a normal *p*-*n* junction diode in forward bias whereas in reverse bias it acquires a maximum reverse current at certain voltage, and hence uses only in reverse bias a voltage regulator. The *p*-*n* junction diode is
(1) Schottky diode (2) Zener diode (3) Varactor diode (4) Photo diode

96. The potential difference across a depletion region is called
(1) Stopping potential (2) Knee potential (3) Barrier potential (4) Junction potential

97. Most heavily doped segment of a translator acts as
(1) Emitter (2) base (3) collector
(4) can be any of three

98. In a circuit, a transistor is connected in such a way that emitter-base and collector-base are always biased respectively as
(1) Forward, reverse (2) Reverse, forward (3) forward, forward (4) Reverse, reverse

99. In a transistor is the value of β (common emitter current gain) is 100, then the value of α (common base current gain) is
(1) 0.01 (2) 0.1 (3) 0.99 (4) 1

100. **Statement (I):** An ideal *p*-*n* junction diode allows an uncontrolled current to flow in one direction.
Statement (II): A translator transfers the weak signal from low resistance circuit to high resistance circuit in a controlled manner.
(1) Both I and II are true (2) I is true but II is false
(3) I is false but ii is true (4) Both I and II are false

KEY

1) **3**	2) **1**	3) **3**	4) **3**	5) **3**	6) **4**	7) **2**	8) **1**	9) **2**	10) **1**
11) **1**	12) **3**	13) **4**	14) **2**	15) **1**	16) **1**	17) **3**	18) **1**	19) **3**	20) **2**
21) **2**	22) **2**	23) **1**	24) **1**	25) **3**	26) **1**	27) **4**	28) **3**	29) **2**	30) **2**
31) **2**	32) **2**	33) **1**	34) **2**	35) **4**	36) **2**	37) **1**	38) **1**	39) **3**	40) **1**
41) **4**	42) **3**	43) **3**	44) **1**	45) **2**	46) **2**	47) **1**	48) **2**	49) **3**	50) **3**
51) **2**	52) **3**	53) **1**	54) **1**	55) **2**	56) **4**	57) **3**	58) **3**	59) **2**	60) **1**
61) **2**	62) **2**	63) **3**	64) **4**	65) **1**	66) **2**	67) **2**	68) **1**	69) **2**	70) **3**
71) **2**	72) **2**	73) **4**	74) **1**	75) **3**	76) **2**	77) **1**	78) **2**	79) **3**	80) **3**
81) **4**	82) **2**	83) **4**	84) **2**	85) **1**	86) **1**	87) **3**	88) **2**	89) **3**	90) **1**
91) **2**	92) **1**	93) **1**	94) **2**	95) **2**	96) **3**	97) **1**	98) **1**	99) **3**	100) **1**