PHYSICS ERRORLESS PREPARATION

Based on Latest Pattern-2025

TOPIC WISE BOOK
PART -1

CHAPTER 14 COVERED WITH 52 TOPIC

RAHEIN
Education Pvt. Ltd.

ISBN: 97-8--81-9-598-7
9 788195 987542

PHYSICS FOR NEET/JEE

Dedicated to
My Son Riyansh Gautam whose time I stole to write this one

Indispensable for NEET/JEE Preparation on latest pattern

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ISBN: 97-8--81-9-598-7
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ASSIGNMENT BOOK OF PHYSICS

First Edition – January, 2025

Price: 350 Rs /-

Presenting by:

RAHEIN EDUCATION PRIVATE LIMITED, DELHI
(www.raheineducation.com)

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Topic 1: Units of Physical Quantities

1) If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the unit of b is

(a) km/s
(b) kms
(c) km/s^2
(d) kms^2

2) In a particular system, the unit of length, mass and time are chosen to be 10cm, 10g and 0.1s respectively. The unit of force in this system will be equivalent to

(a) 0.1 N
(b) 1 N
(c) 10 N
(d) 100 N

3) The unit of the Stefan-Boltzmann's constant is

(a) W/m^2K^4
(b) W/m^2
(c) W/m^2K
(d) W/m^2K^2

4) The unit of permittivity of free space, ε_0 is

(a) $Coulomb^2$/ $(Newton – metre)^2$
(b) Coulomb/ Newton – metre
(c) Newton – $meter^2$/ $Coulomb^2$
(d) $Coulomb^2$/ Newton – $meter^2$

5) The density of material in CGS system of units is $4g/cm^3$. In a system of units in which unit of length is 10cm and unit of mass is 100g, the value of density of material will be

(a) 0.4
(b) 40
(c) 400
(d) 0.04

6) A metal sample carrying a current along X- axis with density J_X is subjected to a magnetic field B_Z (along z-axis). The electric field E_Y developed along Y- axis is directly proportional to J_X as well as B_Z. The constant of proportionally has SI unit.

(a) $\frac{m^2}{A}$
(b) $\frac{m^3}{As}$
(c) $\frac{m^2}{As}$
(d) $\frac{As}{m^3}$

ANSWER KEY					
1	2	3	4	5	6
c	a	a	d	b	b

Topic 2: Dimension of Physical Quantities

1) If C and R denote capacitance and resistance the dimensional formula of CR is

(a) $[M^0L^0T^1]$ (b) $[M^0L^0T^0]$

(c) $[M^0L^0T^{-1}]$ (d) not express in terms of M, L, T.

2) The dimensional formula for angular momentum is

(a) $[M^0L^2T^{-2}]$ (b) $[ML^2T^{-1}]$

(c) $[MLT^{-1}]$ (d) $[ML^2T^{-2}]$

3) Of the following quantities, which one has dimension different from the remaining three?

(a) Energy per unit volume (b) Force per unit area

(c) Product of voltage and charge per unit volume (d) Angular momentum

4) Dimensional formula of self inductance is

(a) $[MLT^{-2}A^{-2}]$ (b) $[ML^2T^{-1}A^{-2}]$

(c) $[ML^2T^{-2}A^{-2}]$ (d) $[ML^2T^{-2}A^{-1}]$

5) The dimensional formula of torque is

(a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}]$

(c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-2}T^{-2}]$

6) The dimensional formula of pressure is

(a) $[MLT^{-2}]$ (b) $[ML^{-1}T^2]$

(c) $[ML^{-1}T^{-2}]$ (d) $[MLT^2]$

7) The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by a relation of the type $f = c\, m^x k^y$, where c is a dimensionless constant. The values of x and y are

(a) $x = \frac{1}{2}$, $y = \frac{1}{2}$ (b) $x = -\frac{1}{2}$, $y = -\frac{1}{2}$

(c) $x = \frac{1}{2}$, $y = -\frac{1}{2}$ (d) $x = -\frac{1}{2}$, $y = \frac{1}{2}$

8) According to Newton, the viscous force acting between liquid layers of area A and velocity gradient $\Delta V/\Delta Z$ is given by $F = -\eta A \frac{\Delta V}{\Delta Z}$ where η is constant called coefficient of viscosity. The dimensional formula of η is

(a) $ML^{-2}T^{-2}$ (b) $M^0L^0T^0$

(c) ML^2T^{-2} (d) $ML^{-1}T^{-1}$

9) The dimensions formula for permeability μ is given by

(a) $MLT^{-2}A^{-2}$
(b) M^0L^1T
(c) $M^0L^2T^{-1}A^2$
(d) None of the above

10) P represents radiation pressure, c represents speed of light and S represents radiation energy striking unit area per sec. The non zero integers x, y, z such that $P^x S^y c^z$ is dimensionless are

(a) x = 1, y = 1, z = 1
(b) x = –1, y = 1, z = 1
(c) x = 1, y = –1, z = 1
(d) x = 1, y = 1, z = –1

11) Turpentine oil is flowing through a tube of length l and radius r. The pressure difference between the two ends of the tube is p. The viscosity of oil is given by

$$\eta = \frac{p(r^2 - x^2)}{4vl}$$

where v is the velocity of oil at a distance x from the axis of the tube. The dimensions of η are

(a) $[M^0L^0T^0]$
(b) $[MLT^{-1}]$
(c) $[ML^2T^{-2}]$
(d) $[ML^{-1}T^{-1}]$

12) The time dependence of a physical quantity p is given by $p = p_0 \exp(-\alpha t^2)$, where α is a constant and t is the time. The constant α

(a) is dimensionless
(b) has dimensions T^{-2}
(c) has dimensions T^2
(d) has dimensions of p

13) Which of the following is a dimensional constant?

(a) Refractive index
(b) Poissons ratio
(c) Relative density
(d) Gravitational constant

14) Which one of the following will have the dimensions of time

(a) LC
(b) $\frac{R}{L}$
(c) $\frac{L}{R}$
(d) $\frac{C}{L}$

15) An equation is given as: $\left(P + \frac{a}{V^2}\right) = b\,\frac{\theta}{V}$ where P = Pressure, V = Volume & θ = Absolute temperature. If a and b are constants, then dimensions of a will be

(a) $[ML^5T^{-2}]$
(b) $[M^{-1}L^5T^{-2}]$
(c) $[ML^{-5}T^{-1}]$
(d) $[ML^5T^1]$

16) The force F on a sphere of radius a moving in a medium with velocity v is given by F = 6πηav. The dimensions of η are

(a) $[ML^{-3}]$
(b) $[ML^{-2}]$
(c) $[ML^{-1}]$
(d) $[ML^{-1}T^{-1}]$

17) The dimensional formula for magnetic flux is

(a) $[ML^2T^{-2}A^{-1}]$
(b) $[ML^3T^{-2}A^{-2}]$
(c) $[M^0L^{-2}T^2A^{-2}]$
(d) $[ML^2T^{-1}A^2]$

18) Which one of the following groups have quantities that do not have the same dimensions?

(a) pressure, stress
(b) velocity, speed
(c) force, impulse
(d) work, energy

19) The dimensions of Planck's constant are same as

(a) energy
(b) power
(c) momentum
(d) angular momentum

20) The dimensions of universal gravitational constant are

(a) $M^{-2}L^2T^{-1}$
(b) $M^{-1}L^3T^{-2}$
(c) ML^2T^{-1}
(d) $M^{-2}L^3T^{-2}$

21) The ratio of the dimensions of Planck's constant and that of the moment of inertia is the dimension of

(a) time
(b) frequency
(c) angular momentum
(d) velocity

22) The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a, b and c are constant. The dimensions of a, b and c are respectively

(a) L^2, T and LT^2
(b) LT^2, LT and L
(c) L, LT and T^2
(d) LT^{-2}, L and T

23) Dimensions of resistance in an electrical circuit, in terms of dimensions of mass M, of length L, of time T and of current I, would be

(a) ML^2T^{-2}
(b) $ML^2T^{-1}I^{-1}$
(c) $ML^2T^{-3}I^{-2}$
(d) $ML^2T^{-3}I^{-1}$

24) Which two of the following five physical parameters have the same dimensions?

(A) Energy density
(B) Refractive index
(C) Dielectric constant
(D) Young's modulus
(E) Magnetic field

(a) (B) and (D)
(b) (C) and (E)
(c) (A) and (D)
(d) (A) and (E)

25) If the dimensions of a physical quantity are given by $M^aL^bT^c$, then the physical quantity will be:

(a) Velocity if a = 1, b = 0, c = –1

(b) Acceleration if a = 1, b = 1, c = –2

(c) Force if a = 0, b = –1, c = –2

(d) Pressure if a = 1, b = –1, c = –2

26) The dimensions of $\frac{1}{2}\varepsilon_0 E^2$, where ε_0 is permittivity of free space and E is electric field, is:

(a) ML^2T^{-2}

(b) $ML^{-1}T^{-2}$

(c) ML^2T^{-1}

(d) MLT^{-1}

27) The dimensions of $(\mu_0\epsilon_0)^{-\frac{1}{2}}$ are

(a) $[L^{1/2}T^{-1/2}]$

(b) $[L^{-1}T]$

(c) $[LT^{-1}]$

(d) $[L^{-1/2}T^{1/2}]$

28) The pair of quantities having same dimensions is

(a) Young's modulus and energy

(b) impulse and surface tension

(c) angular momentum and work

(d) work and torque

29) If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of mass are:

(a) $[FVT^{-1}]$

(b) $[FVT^{-2}]$

(c) $[FV^{-1}T^{-1}]$

(d) $[FV^{-1}T]$

30) If dimensions of critical velocity υ_c of a liquid flowing through a tube are expressed as $[\eta_x\rho^y r^x]$, where η, ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by:

(a) –1, –1, 1

(b) –1, –1, –1

(c) 1, 1, 1

(d) 1, –1, –1

31) If energy (E), velocity (V) and time (T) are chosen as the fundamental quantities, the dimensional formula of surface tension will be:

(a) $[EV^{-1}T^{-2}]$

(b) $[EV^{-2}T^{-2}]$

(c) $[E^{-2}V^{-1}T^{-3}]$

(d) $[EV^{-2}T^{-1}]$

32) A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi\varepsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and e is charge]

(a) $c^2\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

(b) $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$

(c) $\frac{1}{c} G \frac{e^2}{4\pi\varepsilon_0}$ (d) $\frac{1}{c^2}\left[G \frac{e^2}{4\pi\varepsilon_0}\right]^{\frac{1}{2}}$

33) Identify the pair whose dimensions are equal

(a) torque and work (b) stress and energy

(c) force and stress (d) force and work

34) The physical quantities not having same dimensions are

(a) torque and work (b) moment and planck's constant

(c) stress and young's modulus (d) speed and $(\mu_0\varepsilon_0)^{-1/2}$

35) Dimensions of $\frac{1}{\mu_0\varepsilon_0}$, where symbols have their usual meaning, are

(a) $[L^{-1}T]$ (b) $[L^{-2}T^{2}]$

(c) $[L^{2}T^{-2}]$ (d) $[LT^{-1}]$

36) Which one of the following represents the correct dimensions of the coefficient of viscosity?

(a) $[ML^{-1}T^{-1}]$ (b) $[MLT^{-1}]$

(c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-2}T^{-2}]$

37) Out of the following pair, which one does NOT have identical dimensions?

(a) Impulse and momentum

(b) Angular momentum and planck's constant

(c) Work and torque

(d) Moment of inertia and moment of a force

38) Which of the following units denotes the dimensions $\frac{ML^2}{Q^2}$, where Q denotes the electric charge?

(a) Wb/m^2 (b) Henry (H)

(c) H/m^2 (d) Weber (Wb)

39) The dimensions of magnetic field in M, L, T and C (coulomb) is given as

(a) $[MLT^{-1}C^{-1}]$ (b) $[MT^{2}C^{-2}]$

(c) $[MT^{-1}C^{-1}]$ (d) $[MT^{-2}C^{-1}]$

40) Given that K = energy, V = velocity, T = time. If they are chosen as the fundamental units, then what is dimensional formula for surface tension?

(a) $[KV^{-2}T^{-2}]$ (b) $[K^{2}V^{2}T^{-2}]$

(c) $[K^{2}V^{-2}T^{-2}]$ (d) $[KV^{2}T^{2}]$

41) The dimensions of angular momentum, latent heat and capacitance are, respectively.

(a) $ML^2T^1A^2$, L^2T^{-2}, $M^{-1}L^{-2}T^2$

(b) ML^2T^{-2}, L^2T^2, $M^{-1}L^{-2}T^4A^2$

(c) ML^2T^{-1}, L^2T^{-2}, ML^2TA^2

(d) ML^2T^{-1}, L^2T^{-2}, $M^{-1}L^{-2}T^4A^2$

42) If the time period t of the oscillation of a drop of liquid of density d, radius r, vibrating under surface tension s is given by the formula $t = \sqrt{r^{2b}s^c d^{a/2}}$. It is observed that the time period is directly proportional to $\sqrt{\frac{d}{s}}$. The value of b should therefore be:

(a) $\frac{3}{4}$

(b) $\sqrt{3}$

(c) $\frac{3}{2}$

(d) $\frac{2}{3}$

43) Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then:

(a) $\epsilon_0 = [M^{-1}L^{-3}T^2A]$

(b) $\epsilon_0 = [M^{-1}L^{-3}T^4A^2]$

(c) $\epsilon_0 = [M^1L^2T^1A^2]$

(d) $\epsilon_0 = [M^1L^2T^1A]$

44) In terms of resistance R and time T, the dimensions of ratio $\frac{\mu}{\varepsilon}$ of the permeability μ and permittivity ε is:

(a) $[RT^{-2}]$

(b) $[R^2T^{-1}]$

(c) $[R^2]$

(d) $[R^2T^2]$

45) From the following combinations of physical constants (expressed through their usual symbols) the only combination, that would have the same value in different systems of units, is:

(a) $\frac{ch}{2\pi\varepsilon_0^2}$

(b) $\frac{e^2}{2\pi\varepsilon_0 G m_e^2}$ (m_e = mass of electron)

(c) $\frac{\mu_0\varepsilon_0}{c^2}\frac{G}{he^2}$

(d) $\frac{2\pi\sqrt{\mu_0\varepsilon_0}}{ce^2}\frac{h}{G}$

46) If the capacitance of a nanocapacitor is measured in terms of a unit '*u*' made by combining the electric charge '*e*' , Bohr radius 'a_0', Planck's constant 'h' and speed of light '*c*' then:

(a) $u = \frac{e^2h}{a_0}$

(b) $u = \frac{hc}{e^2a_0}$

(c) $u = \frac{e^2c}{ha_0}$

(d) $u = \frac{e^2a_0}{hc}$

47) If electronic charge e, electron mass m, speed of light in vacuum c and Planck's constant h are taken as fundamental quantities, the permeability of vacuum μ_0 can be expressed in units of:

(a) $\left(-\frac{h}{me^2}\right)$

(b) $\left(\frac{hc}{me^2}\right)$

(c) $\left(\frac{h}{ce^2}\right)$

(d) $\left(\frac{mc^2}{he^2}\right)$

48) In the following 'I' refers to current and other symbols have their usual meaning, Choose the option that corresponds to the dimensions of electrical conductivity:

(a) $M^{-1}L^{-3}T^{3}I$

(b) $M^{-1}L^{-3}T^{3}I^{2}$

(c) $M^{-1}L^{3}T^{3}I$

(d) $ML^{-3}T^{-3}I^{2}$

49) A, B, C and D are four different physical quantities having different dimensions. None of them is dimension less. But we know that the equation AD = C ln (BD) holds true. Then which of the combination is not a meaningful quantity?

(a) $\frac{C}{BD} - \frac{AD^2}{C}$

(b) $A^2 - B^2C^2$

(c) $\frac{A}{B} - C$

(d) $\frac{(A-C)}{D}$

50) Time (T), velocity (C) and angular momentum (h) are chosen as fundamental quantities instead of mass, length and time. In terms of these, the dimensions of mass would be:

(a) $[M] = [T^{-1}C^{-2}h]$

(b) $[M] = [T^{-1}C^{2}h]$

(c) $[M] = [T^{-1}C^{-2}h^{-1}]$

(d) $[M] = [TC^{-2}h]$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	b	d	c	a	c	d	d	a	c
11	12	13	14	15	16	17	18	19	20
d	b	d	c	a	d	a	c	d	b
21	22	23	24	25	26	27	28	29	30
b	d	c	c	d	b	c	d	d	d
31	32	33	34	35	36	37	38	39	40
b	d	a	b	c	a	d	b	c	a
41	42	43	44	45	46	47	48	49	50
d	c	b	c	b	d	c	b	d	a

Topic 3: Error in Measurement

1) A certain body weighs 22.42 gm and has a measured volume of 4.7 cc. The positive error in the measurement of mass and volume are 0.01gm and 0.1 cc. Then maximum error in the density will be

(a) 22% (b) 2%

(c) 0.2% (d) 0.02%

2) In a vernier calliper N divisions of vernier scale coincides with (N –1) divisions of main scale (in which length of one division is 1 mm). The least count of the instrument should be

(a) N (b) N – 1

(c) 1/10 N (d) 1/N – 1

3) The percentage errors in the measurement of mass and speed are 2% and 3% respectively. The error in kinetic energy obtained by measuring mass and speed will be

(a) 12% (b) 10%

(c) 8% (d) 2%

4) The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and length are 4% and 3% respectively, the maximum error in the measurement of density will be

(a) 7% (b) 9%

(c) 12% (d) 13%

5) If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be:

(a) 4% (b) 6%

(c) 8% (d) 2%

6) In an experiment our quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively, quantity P is calculated as follows P = $\frac{a^3b^2}{cd}$ % error in P is:

(a) 10% (b) 7%

(c) 4% (d) 14%

7) Two full turns of the circular scale of a screw gauge cover a distance o f 1mm on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of – 0.3 mm. While measuring the diameter of a thin wire, a student notes the main scale reading of 3mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is

(a) 3.32mm (b) 3.73mm

(c) 3.67mm (d) 3.38mm

8) 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

(a) 17.6 kg ms^{-1}
(b) 17.565 kg ms^{-1}
(c) 17.56 kg ms^{-1}
(d) 17.57 kg ms^{-1}

9) In an experiment the angles are required to be measured using an instrument, 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half a degree (=0.5°), then the least count of the instrument is:

(a) half minute
(b) one degree
(c) half degree
(d) one minute

10) The respective number of significant figures for the numbers 23.023, 0.0003, and 2.1×10^{-3} are

(a) 5, 1, 2
(b) 5, 1, 5
(c) 5, 5, 2
(d) 4, 4, 2

11) A screw gauge gives the following reading when used to measure the diameter of a wire.

Main scale reading: 0mm

Circular scale reading: 52 divisions

Given that 1mm on main scale corresponds to 100 divisions of the circular scale. The diameter of wire from the above data is

(a) 0.052cm
(b) 0.026cm
(c) 0.005cm
(d) 0.52cm

12) A student measured the diameter of a wire using a screw gauge with the least count 0.001 cm and listed the measurements. The measured value should be recorded as

(a) 5.3200 cm
(b) 5.3 cm
(c) 5.32 cm
(d) 5.320 cm

13) N divisions on the main scale of a vernier calliper coincide with (N+1) divisions of the vernier scale. If each division of main scale is 'a' units, then the least count of the instrument is

(a) a
(b) $\frac{a}{N}$
(c) $\frac{N}{N+1}\times a$
(d) $\frac{a}{N+1}$

14) A spectrometer gives the following reading when used to measure the angle of a prism.

Main scale reading: 58.5 degree

Vernier scale reading: 09 divisions

Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the Vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data is

(a) 58.59 degree
(b) 58.77 degree
(c) 58.65 degree
(d) 59 degree

15) Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is

(a) 6%
(b) zero
(c) 1%
(d) 3%

16) An experiment is performed to obtain the value of acceleration due to gravity g by using a simple pendulum of length L. In this experiment time for 100 oscillations is measured by using a watch of 1 second least count and the value is 90.0 seconds. The length L is measured by using a meter scale of least count 1mm and the value is 20.0 cm. The error in the determination of g would be:

(a) 1.7%
(b) 2.7%
(c) 4.4%
(d) 2.27%

17) In the experiment of calibration of voltmeter, a standard cell of e.m.f. 1.1 volt is balanced against 440 cm of potential wire. The potential difference across the ends of resistance is found to balance against 220cm of the wire. The corresponding reading of voltmeter is 0.5 volt. The error in the reading of voltmeter will be:

(a) – 0.15 volt
(b) 0.15 volt
(c) 0.5 volt
(d) – 0.05 volt

18) Match List - I (Event) with List - II (Order of the time interval for happening of the event) and select the correct option from the options given below the lists:

List – I		List - II	
(1)	Rotation period of earth	(i)	10^{5}s
(2)	Revolution period of earth	(ii)	10^{7}s
(3)	Period of light wave	(iii)	10^{-15}s
(4)	Period of sound wave	(iv)	10^{-3}s

(a) (1) - (i), (2) - (ii), (3) – (iii), (4) – (iv)

(b) (1) - (ii), (2) - (i), (3) – (iv), (4) – (iii)

(c) (1) - (i), (2) - (ii), (3) – (iv), (4) – (iii)

(d) (1) - (ii), (2) - (i), (3) – (iii), (4) – (iv)

19) A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it?

(a) A meter scale.

(b) A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and main scale has 10 divisions in 1 cm

(c) A screw gauge having 100 divisions in the circular scale and pitch as 1mm.

(d) A screw gauge having 50 divisions in the circular scale and pitch as 1mm.

20) The current voltage relation of a diode is given by $I = (e^{1000V/T} - 1)$ mA, where the applied voltage V is in volts and the temperature T is in degree Kelvin. If a student makes an error measuring ± 0.01 V while measuring the current of 5 mA at 300K, what will be the error in the value of current in mA?

(a) 0.2 mA
(b) 0.02 mA
(c) 0.5 mA
(d) 0.05 mA

21) Diameter of a steel ball is measured using a Vernier callipers which has divisions of 0.1 cm on its main scale (MS) and 10 divisions of it vernier scale (VS) match 9 divisions on the main scale. Three such measurements for a ball are given as:

S.No.	MS(cm)	VS divisions
1.	0.5	8
2.	0.5	4
3.	0.5	6

If the zero error is –0.03 cm, then mean corrected diameter is:

(a) 0.52 cm
(b) 0.59 cm
(c) 0.56 cm
(d) 0.53 cm

22) The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90s using a wrist watch of 1s resolution. The accuracy in the determining of g is:

(a) 1%
(b) 5%
(c) 2%
(d) 3%

23) A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is 90s, 91s, 95s, and 92s. If the minimum division in the measuring clock is 1s, then the reported mean time should be:

(a) 92 ± 1.8s
(b) 92 ± 3s
(c) 92 ± 1.5s
(d) 92 ± 5.0s

24) A screw gauge with a pitch of 0.5 mm and a circular scale with 50 divisions is used to measure the thickness of a thin sheet of Aluminium. Before starting the measurement, it is found that when the two jaws of the screw gauge are brought in contact, the 45^{th} division coincides with the main scale line and the zero of the main scale is barely visible. What is the thickness of the sheet reading is 0.5mm and the 25^{th} division coincides with the main scale line?

(a) 0.70mm (b) 0.50mm

(c) 0.75mm (d) 0.80mm

25) A physical quantity P is described by the relation P = $a^{1/2}b^2c^3d^{-4}$

If the relative errors in the measurement of a, b, c, and d respectively, are 2%, 1%, 3% and 5%, then the relative error in P will be :

(a) 8% (b) 12%

(c) 32% (d) 25%

26) The following observations were taken for determining surface tension T of water by capillary method:

Diameter of capillary, D = 1.25×10^{-2} m

Rise of water, h = 1.45×10^{-2} m

Using g = 9.80 m/s^2 and the simplified relation T = $\frac{rhg}{2} \times 10^3$ N/m, the possible error in surface tension is closest to:

(a) 2.4% (b) 10%

(c) 0.15% (d) 1.5%

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	c	c	d	b	d	d	a	d	a
11	12	13	14	15	16	17	18	19	20
a	d	d	c	a	b	d	a	b	a
21	22	23	24	25	26				
b	d	c	d	c	d				

Topic 4: Distance, Displacement & Uniform Motion

1) A car covers the first half of the distance between two places at 40 km/h and other half at 60 km/h. The average speed of the car is

(a) 40 km/h
(b) 48 km/h
(c) 50 km/h
(d) 60 km/h

2) A car moves a distance of 200m. It covers the first half of the distance at speed of 40km/h and the second half of distance at speed v. The average speed is 48km/h. Find the value of v.

(a) 56km/h
(b) 60km/h
(c) 50km/h
(d) 48km/h

3) A bus travelling the first one third distance at a speed of 10km/h, the next one third at 20km/h and the last one –third at 60km/h. The average speed of the bus is

(a) 9km/h
(b) 16km/h
(c) 18km/h
(d) 48km/h

4) If a car at rest accelerates uniformly to a speed of 144km/h in 20s, it covers a distance of

(a) 2880m
(b) 1440m
(c) 400m
(d) 20m

5) A car moves from X to Y with a uniform speed v_u and returns to Y with a uniform speed v_d. The average speed for this round trip is

(a) $\sqrt{v_u v_d}$
(b) $\frac{v_d v_u}{v_d + v_u}$
(c) $\frac{v_u + v_d}{2}$
(d) $\frac{2 v_d v_u}{v_d + v_u}$

6) A particle covers half of its total distance with speed v_1 and the rest half distance with speed v_2. Its average speed during the complete journey is

(a) $\frac{v_1 v_2}{v_1 + v_2}$
(b) $\frac{2 v_1 v_2}{v_1 + v_2}$
(c) $\frac{2 {v_1}^2 {v_2}^2}{{v_1}^2 + {v_2}^2}$
(d) $\frac{v_1 + v_2}{2}$

7) Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be:

(a) $\frac{t_1 t_2}{t_2 - t_1}$
(b) $\frac{t_1 t_2}{t_2 + t_1}$

(c) $t_1 - t_2$

(d) $\frac{t_1 + t_2}{2}$

8) A particle located at x = 0 at time t = 0, starts moving along with the positive x – direction with a velocity 'v' that varies as $v = \alpha\sqrt{x}$. The displacement of the particle varies with time as

(a) t^2

(b) t

(c) $t^{1/2}$

(d) t^3

9) The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is $x = 0$ at $t = 0$, then its displacement after unit time ($t = 1$) is

(a) $v_0 + g/2 + f$

(b) $v_0 + 2g + 3f$

(c) $v_0 + g/2 + f/3$

(d) $v_0 + g + f$

10) A car covers the first half of the distance between two places at 40 km/h and other half at 60 km/h. The average speed of the car is

(a) 40 km/h

(b) 45 km/h

(c) 48 km/h

(d) 60 km/h

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
b	b	c	c	d	b	b	a	c	c

Topic 5: Non – Uniform Motion

1) A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30km/h and 40km/h respectively. The velocity of the car midway between P and Q is

(a) 33.3 km/h

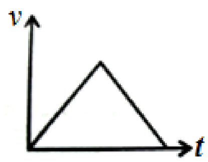
(b) $20\sqrt{2}$ km/h

(c) $25\sqrt{2}$ km/h

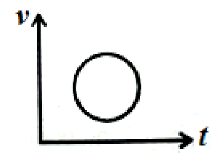
(d) 35 km/h

2) Which of the following curve does not represent motion in one dimension?

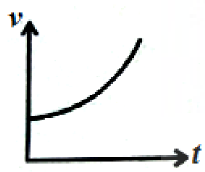
(a)



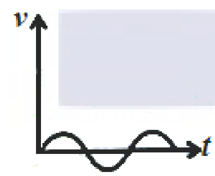
(b)



(c)



(d)



3) A body starts from rest, what is the ratio of the distance travelled by the body during the 4th and 3rd seconds?

(a) $\frac{7}{5}$

(b) $\frac{5}{7}$

(c) $\frac{7}{3}$

(d) $\frac{3}{7}$

4) A particle moves along a straight line such that its displacement at any time t is given by $s = (t^3 – 6t^2 + 3t + 4)$ meters. The velocity when the acceleration is zero is

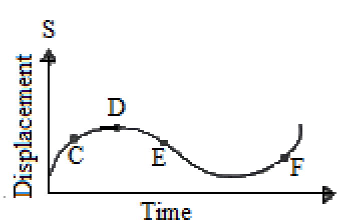
(a) 3 ms^{-1}

(b) –12 ms^{-1}

(c) 42 ms^{-1}

(d) –9 ms^{-1}

5) The displacement time graph of a moving particle is shown below



The instantaneous velocity of the particle is negative at the point

(a) D

(b) F

(c) C

(d) E

6) A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β and comes to rest. If the total time elapsed is t, then the maximum velocity acquired by the car is

(a) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$ (b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$

(c) $\frac{(\alpha+\beta)t}{\alpha\beta}$ (d) $\frac{\alpha\beta t}{\alpha+\beta}$

7) The displacement of a particle varies with time (t) as: $s = at^2 - bt^3$. The acceleration of the particle at any given time (t) will be equal to

(a) $\frac{a}{b}$ (b) $\frac{a}{3b}$

(c) $\frac{3b}{a}$ (d) $\frac{2a}{3b}$

8) A car moving with speed of 40km/h can be stopped by applying brakes at least after 2 m. If the same car is moving with a speed of 80km/h, what is the minimum stopping distance?

(a) 8 m (b) 6 m

(c) 4 m (d) 2 m

9) The displacement of a particle is represented by the following equation: $s = 3t^3 + 7t^2 + 5t + 8$ where s is in metre and t in second. The acceleration of the particle at t = 1s is

(a) 14 m/s^2 (b) 18 m/s^2

(c) 32 m/s^2 (d) zero

10) The displacement x of a particle varies with time t as $x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will

(a) be independent of α and β (b) drop to zero when α = β

(c) go on decreasing with time (d) go on increasing with time

11) A particle moves along a straight line OX. At a time t (in seconds) the distance x (in metres) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest?

(a) 40 m (b) 56 m

(c) 16 m (d) 24 m

12) A particle moving along x – axis has acceleration f, at time t, given by $f = f_0\left(1 - \frac{t}{T}\right)$, where f_0 and T are constants. The particle at t = 0 has zero velocity. In the time interval between t = 0 and the instant when f = 0, the particle's velocity (v_x) is

(a) $\frac{1}{2} f_0T^2$ (b) f_0T^2

(c) $\frac{1}{2} f_0T$ (d) f_0T

13) The position x of a particle with respect to time t along x – axis is given by $x = 9t^2 - t^3$ where x is in meters and t in second. What will be the position of this particle when it achieves maximum speed along the +ve x direction?

(a) 54 m

(b) 81 m

(c) 24 m

(d) 32 m

14) A particle moves in a straight line with a constant acceleration. It changes its velocity from $10ms^{-1}$ to $20ms^{-1}$ while passing through a distance 135m in t second. The value of t is:

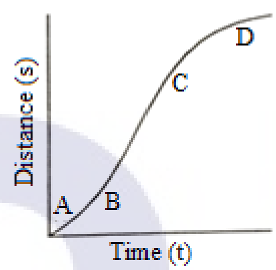
(a) 10

(b) 1.8

(c) 12

(d) 9

15)



A particle shows distance – time curve as given in this figure. The maximum instantaneous velocity of the particle is around the point:

(a) B

(b) C

(c) D

(d) A

16) The distance travelled by a particle starting from rest and moving with acceleration $\frac{4}{3}$ ms^{-2}, in the third second is:

(a) 6 m

(b) 4 m

(c) $\frac{10}{3}$ m

(d) $\frac{19}{3}$ m

17) A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2, then:

(a) $S_2 = 3 S_1$

(b) $S_2 = 4 S_1$

(c) $S_2 = S_1$

(d) $S_2 = 2 S_1$

18) A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to:

(a) $(\text{velocity})^{3/2}$

(b) $(\text{distance})^2$

(c) $(\text{distance})^{-2}$

(d) $(\text{velocity})^{2/3}$

19) A particle has initial velocity $(3\hat{i} + 4\hat{j})$ and has acceleration $(0.4\hat{i} + 0.3\hat{j})$. It's speed after 10 s is:

(a) 7 units
(b) $7\sqrt{2}$ units
(c) 8.5 units
(d) 10 units

20) A body is moving with velocity 30m/s towards east. After 10 seconds its velocity becomes 40m/s towards north. The average acceleration of the body is

(a) 1 m/s^2
(b) 7 m/s^2
(c) 6 m/s^2
(d) 5 m/s^2

21) The motion of a particle along a straight line is described by equation:

$$x = 8 + 12t - t^3$$

where x is in meter and t in second. The retardation of the particle when its velocity becomes zero, is:

(a) 24 ms^{-2}
(b) zero
(c) 6 ms^{-2}
(d) 12 ms^{-2}

22) A particle has initial velocity $(2\vec{i} + 3\vec{j})$ and acceleration $(0.3\vec{i} + 0.2\vec{j})$. The magnitude of velocity after 10 seconds will be:

(a) $9\sqrt{2}$ units
(b) $5\sqrt{2}$ units
(c) 5 units
(d) 9 units

23) The displacement 'x' (in meter) of a particle of mass 'm' (in kg) moving in one dimension under the action of a force, is related to time 't' (in sec) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

(a) 2 m
(b) 4 m
(c) zero
(d) 6 m

24) A particle of unit mass undergoes one dimensional motion such that its velocity varies according to $v(x) = bx^{-2n}$

where b and n are constants and x is the position of the particle. The acceleration of the particle as d function of x, is given by:

(a) $-2nb^2x^{-4n-1}$
(b) $-2b^2x^{-2n+1}$
(c) $-2nb^2e^{-4n+1}$
(d) $-2nb^2x^{-2n-1}$

25) If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between1s and 2s is:

(a) $\frac{3}{2}A + 4B$
(b) $3A + 7B$
(c) $\frac{3}{2}A + \frac{7}{3}B$
(d) $\frac{A}{2} + \frac{B}{3}$

26) Speeds of two identical cars are *u* and 4*u* at the specific instant. The ratio of the respective distances in which the two cars are stopped from that instant is

(a) 1:1

(b) 1: 4

(c) 1: 8

(d) 1:16

27) 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?

(a) 1 cm

(b) 2 cm

(c) 3 cm

(d) 4 cm

28) A car, moving with a speed of 50 km/hr, can be stopped by brakes after at least 6 m. If the same car is moving at a speed of 100 km/hr, the minimum stopping distance is

(a) 12m

(b) 18m

(c) 24m

(d) 6m

29) An automobile travelling with a speed of 60 km/hr, can brake to stop within a distance of 20m. If the car is going twice as fast i.e., 120 km/h, the stopping distance will be

(a) 60m

(b) 40m

(c) 20m

(d) 80m

30) The relation between time t and distance x is $t = ax^2 + bx$ where a and b are constants. The acceleration is

(a) $2bv^3$

(b) $-2abv^2$

(c) $2av^2$

(d) $-2av^3$

31) 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

(a) $\frac{1}{2}$ ms^{-2} towards north

(b) $\frac{1}{\sqrt{2}}$ ms^{-2} towards north – east

(c) $\frac{1}{\sqrt{2}}$ ms^{-2} towards north – west

(d) zero

32) A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15S, then

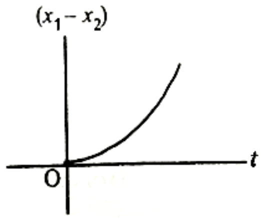
(a) $S = \frac{1}{6}ft^2$

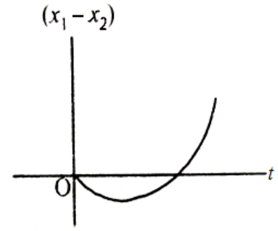
(b) $S = ft$

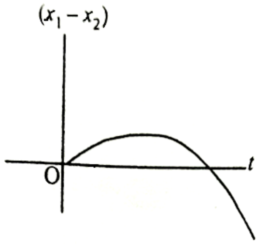
(c) $S = \frac{1}{4}ft^2$

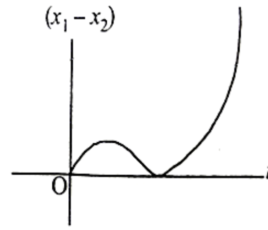
(d) $S = \frac{1}{72}ft^2$

33) 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’?

(a)


(b)


(c)


(d)


34) An object, moving with a speed of 6.25 m/s, is decelerated at a rate given by $\frac{dv}{dt} = -2.5\sqrt{v}$ where v is the instantaneous speed. The time taken by the object, to come to the rest, would be:

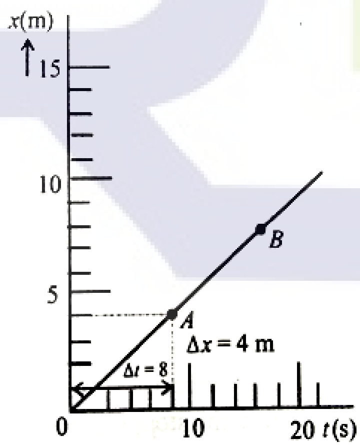
(a) 2 s

(b) 4 s

(c) 8 s

(d) 1 s

35) The graph of an object's motion (along the x - axis) is shown in the figure. The instantaneous velocity of the object at points A and B are v_A and v_B respectively. Then



(a) $v_A = v_B = 0.5$ m/s

(b) $v_A = 0.5$ m/s $< v_B$

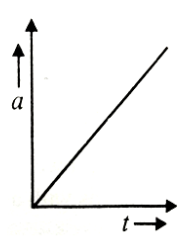
(c) $v_A = 0.5$ m/s $> v_B$

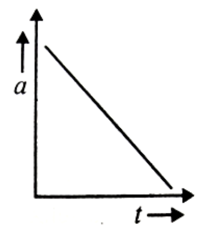
(d) $v_A = v_B = 2$ m/s

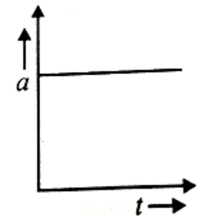
36) The distance travelled by a body moving along a line in time t is proportional to t^3.

The acceleration - time (a,t) graph for the motion of the body

(a)

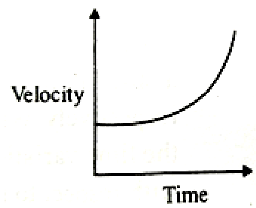

(b)


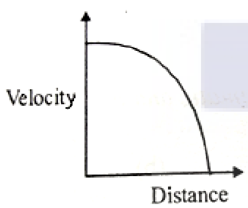
(c) 

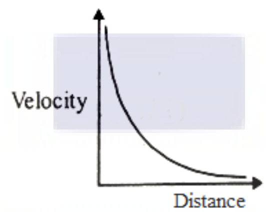
(d) 

37) Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?

(a)

(b) 

(c) 

(d) 

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	b	a	d	d	d	b	a	c	d
11	12	13	14	15	16	17	18	19	20
b	c	a	d	b	c	b	a	b	d
21	22	23	24	25	26	27	28	29	30
d	b	c	a	c	d	a	c	d	d
31	32	33	34	35	36	37			
c	d	b	a	a	b	c			

Topic 6: Relative Velocity

1) A train of 150 meter long is going towards north direction at a speed of 10m/s. A parrot flies at the speed of 5m/s towards south direction parallel to the railway track. The time taken by the parrot to cross the train is

(a) 12 sec
(b) 8 sec
(c) 15 sec
(d) 10 sec

2) A bus is moving with a speed of $10 ms^{-1}$ on a straight road. A scooterist wishes to overtake the bus in 100s. If the bus is at a distance of 1km from the scooterist, with what speed should the scooterist chase the bus?

(a) $40\ ms^{-1}$
(b) $25\ ms^{-1}$
(c) $10\ ms^{-1}$
(d) $20\ ms^{-1}$

3) A goods train accelerating uniformly on a straight railway track, approaches an electric pole standing on the side of the track. Its engine passes the pole with velocity u and the guard's room passes with velocity v. The middle wagon of the train passes the pole with a velocity.

(a) $\frac{u+v}{2}$
(b) $\frac{1}{2}\sqrt{u^2+v^2}$
(c) $\sqrt{uv}$
(d) $\sqrt{\left(\frac{u^2+v^2}{2}\right)}$

4) A person climbs up a stalled escalator in 60 s. If standing on the same but escalator running with constant velocity he takes 40 s. How much time is taken by the person to walk up the moving escalator?

(a) 37 s
(b) 27 s
(c) 24 s
(d) 45 s

5) The car is standing 200 m behind a bus, which is also at rest. The two start moving at the same instant but with different forward accelerations. The bus has acceleration $2 m/s^2$ and the car has acceleration $4 m/s^2$ .The car will catch up with the bus after a time of:

(a) $\sqrt{110}$ s
(b) $\sqrt{120}$ s
(c) $10\sqrt{2}$ s
(d) 15 s

ANSWER KEY				
1	2	3	4	5
d	d	d	c	c

Topic 7: Motion under Gravity

1) What will the ratio of the distances moved by a freely falling body from rest in 4th and 5th seconds of journey?

(a) 4 : 5

(b) 7 : 9

(c) 16 : 25

(d) 1:1

2) A body dropped from top of a tower fall through 40m during the last two seconds of its fall. The height of tower is (g = 10 m/s^2)

(a) 60 m

(b) 45 m

(c) 80 m

(d) 50 m

3) The water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far above the ground is the second drop at that instant? (Take g = 10 m/s^2)

(a) 1.25 m

(b) 2.50 m

(c) 3.75 m

(d) 5.00 m

4) Three different objects of masses m_1, m_2 and m_3 are allowed to fall from rest and from the same point O along three different frictionless paths. The speeds of the three objects on reaching the ground will be in the ratio of

(a) $m_1 : m_2 : m_3$

(b) $m_1 : 2m_2 : 3m_3$

(c) 1:1:1

(d) $\frac{1}{m_1} : \frac{1}{m_2} : \frac{1}{m_3}$

5) A stone released with zero velocity from the top of a tower, reaches the ground in 4 sec. The height of the tower is (g = 10 m/s^2)

(a) 20 m

(b) 40 m

(c) 80 m

(d) 160 m

6) A body is thrown vertically upward from the ground. It reaches a maximum height of 20 m in 5 sec.

After what time, it will reach the ground from its maximum height position?

(a) 2.5 sec

(b) 5 sec

(c) 10 sec

(d) 25 sec

7) If a ball is thrown vertically upwards with a velocity of 40m/s, then velocity of the ball after two seconds will be (g = 10 m/s^2)

(a) 15 m/s

(b) 20 m/s

(c) 25 m/s

(d) 28 m/s

8) A man throws balls with the same speed vertically upwards one after the other at an interval of 2 seconds. What should be the speed of the throw so that more than two balls are in the sky at any time?

[Given g = 9.8 m/s^2]

(a) Only with speed 19.6 m/s
(b) More than 19.6 m/s
(c) At least 9.8 m/s
(d) Any speed less than 19.6 m/s

9) If a ball is thrown vertically upwards with speed u, the distance covered during the last t seconds of its ascent is

(a) (u + gt)t
(b) ut
(c) $\frac{1}{2}gt^2$
(d) ut $-\frac{1}{2}gt^2$

10) A ball is thrown vertically upward. It has a speed of 10m/sec when it has reached one half of its maximum height. How high does the ball rise?

(a) 10 m
(b) 5 m
(c) 15 m
(d) 20 m

11) Two bodies, A (of mass 1kg) and B (of mass 3kg), are dropped from heights of 16m and 25m, respectively. The ratio of the time taken by them to reach the ground is

(a) 12/5
(b) 5/12
(c) 4/5
(d) 5/4

12) A man of 50kg mass is standing in a gravity free space at a height of 10m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2m/s. When the stone reaches the floor, the distance of the man above the floor will be:

(a) 9.9m
(b) 10.1m
(c) 10m
(d) 20m

13) A ball is dropped from a high rise platform at t = 0 starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at t = 18s.What is the value of v? (take g = 10m/s^2)

(a) 75m/s
(b) 55m/s
(c) 40m/s
(d) 60m/s

14) A boy standing at the top of a tower of 20m height drops a stone. Assuming g = 10 ms^{-2}, the velocity with which it hits the ground is

(a) 10.0 m/s
(b) 20.0m/s
(c) 40.0m/s
(d) 5.0m/s

15) A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1, h_2 and h_3 is

(a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ (b) $h_2 = 3\,h_1$ and $h_3 = 3\,h_2$

(c) $h_1 = h_2 = h_3$ (d) $h_1 = 2h_2 = 3h_3$

16) From a building two balls A and B are thrown such that A is thrown upwards and B downwards (both vertically). If v_A and v_B are their respective velocities on reaching the ground, then

(a) $v_B > v_A$ (b) $v_A = v_B$

(c) $v_A > v_B$ (d) their velocities depend on their masses

17) A ball is released from the top of a tower of height h meters. It takes T seconds to reach the ground. What is the position of the ball at $\frac{T}{3}$ second

(a) $\frac{8h}{9}$ meters from the ground (b) $\frac{7h}{9}$ meters from the ground

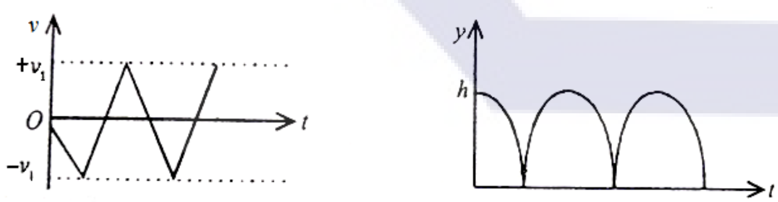
(c) $\frac{h}{9}$ meters from the ground (d) $\frac{17h}{18}$ meters from the ground

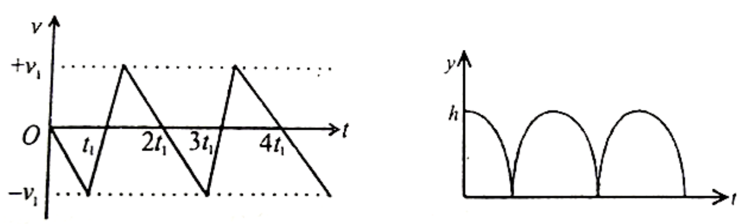
18) A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at $2 m/s^2$. He reaches the ground with a speed of 3 m/s. At what height, did he bail out?

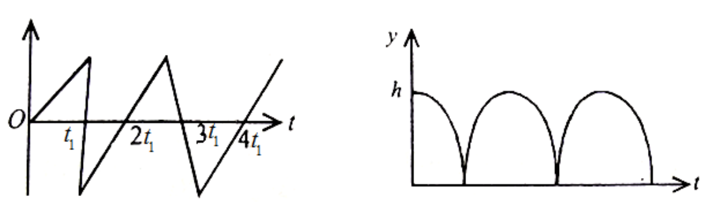
(a) 182m (b) 91m

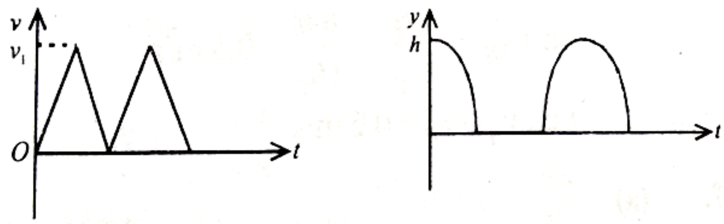
(c) 111m (d) 293m

19) Consider a rubber ball freely falling from a height h = 4.9m onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time and the height as a function of time will be:

(a)


(b)


(c)


(d) 

20) From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is:

(a) $2gH = n^2u^2$

(b) $gH = (n-2)^2u^2d$

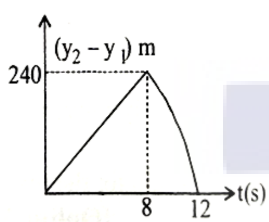
(c) $2gH = nu^2(n-2)$

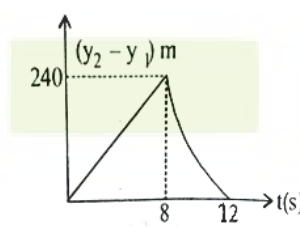
(d) $gH = (n-2)u^2$

21) Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first?

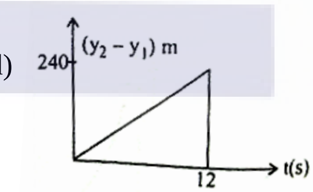
(Assume stone do not rebound after hitting the ground and neglect air resistance, take $g = 10\ m/s^2$)

(*The figures are schematic and not drawn to scale*)

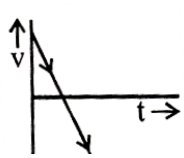
(a) 

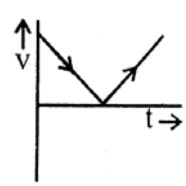
(b) 

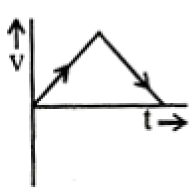
(c)

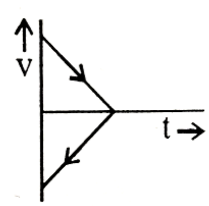
(d) 

22) A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time.

(a) 

(b) 

(c) 

(d) 

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	b	c	c	c	b	b	b	c	a
11	12	13	14	15	16	17	18	19	20
c	b	a	b	a	b	a	d	b	c
21	22								
b	a								

Topic 8: Vectors

1) The magnitudes of vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ are 3, 4 and 5 units respectively. If $\vec{A} + \vec{B} = \vec{C}$, then the angle between $\vec{A}$ and $\vec{A}$ is

(a) π/2 (b) $\cos^{-1} 0.6$

(c) $\tan^{-1} 7/5$ (d) π/4

2) The angle between $\vec{A}$ and $\vec{A}$ is θ. The value of the triple product $\vec{A}.(\vec{B} \times \vec{A})$ is

(a) A^2B (b) zero

(c) $A^2B\sin\theta$ (d) $A^2B\cos\theta$

3) The resultant of $(\vec{A} \times 0)$ will be equal to

(a) zero (b) A

(c) zero vector (d) unit vector

4) A body constrained to move in y – direction, is subjected to a force given by

$\vec{F} = (-2\hat{\imath} + 15\hat{\jmath} + 6\hat{k})$ N. What is the work done by this force in moving the body through a distance of 10m along y – axis?

(a) 190J (b) 160J

(c) 150J (d) 20J

5) Which of the following is not a vector quantity?

(a) speed (b) velocity

(c) torque (d) displacement

6) Which of the following is not a vector quantity?

(a) displacement (b) electric field

(c) work (d) acceleration

7) Find the torque of a force $\vec{F} = -3\hat{\imath} + \hat{\jmath} + 5\hat{k}$ acting at the point $\vec{r} = 7\hat{\imath} + 3\hat{\jmath} + \hat{k}$.

(a) $-2\hat{\imath} + 3\hat{\jmath} + 5\hat{k}$ (b) $-14\hat{\imath} + 3\hat{\jmath} + 16\hat{k}$

(c) $4\hat{\imath} + 4\hat{\jmath} + 6\hat{k}$ (d) $14\hat{\imath} - 38\hat{\jmath} + 16\hat{k}$

8) If a unit vector is represented by $0.5\hat{\imath} + 0.8\hat{\jmath} + c\hat{k}$, the value of c is

(a) 1 (b) $\sqrt{0.11}$

(c) $\sqrt{0.01}$ (d) 0.39

9) The angle between two vectors of magnitude 12 and 18 units when their resultant is 24 units, is

(a) 63°51' (b) 75°52'

(c) 82°31'

(d) 89°16'

10) What is the linear velocity if angular velocity vector $\vec{\omega} = 3\hat{\imath} - 4\hat{\jmath} + \hat{k}$ and position vector $\vec{r} = 5\hat{\imath} - 6\hat{\jmath} + 6\hat{k}$

(a) $6\hat{\imath} + 2\hat{\jmath} - 3\hat{k}$

(b) $-18\hat{\imath} - 13\hat{\jmath} + 2\hat{k}$

(c) $18\hat{\imath} + 13\hat{\jmath} - 2\hat{k}$

(d) $6\hat{\imath} - 2\hat{\jmath} + 8\hat{k}$

11) A particles moves with a velocity $\vec{v} = 6\hat{\imath} - 4\hat{\jmath} + 3\hat{k}$ m/s under the influence of a constant force $\vec{F} = 20\hat{\imath} + 15\hat{\jmath} - 5\hat{k}$ N. The instantaneous power applied to the particle is

(a) 45 J/s

(b) 35 J/s

(c) 25 J/s

(d) 195 J/s

12) The angle between the two vectors $\vec{A} = 3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$ and $\vec{B} = 3\hat{\imath} + 4\hat{\jmath} - 5\hat{k}$ will be

(a) zero

(b) 45°

(c) 90°

(d) 180°

13) The vector sum of two forces is perpendicular to their vector differences. In that case, the forces

(a) cannot be predicted

(b) are equal to each other

(c) are equal to each other in magnitude

(d) are not equal to each other in magnitude

14) If $\vec{A} \times \vec{B} = \sqrt{3}\,\vec{A}.\vec{B}$ then the value of $|\vec{A} + \vec{B}|$ is

(a) $(A^2 + B^2 + \sqrt{3}\,AB)^{1/2}$

(b) $(A^2 + B^2 + AB)^{1/2}$

(c) $\left(A^2 + B^2 + \frac{AB}{\sqrt{3}}\right)^{1/2}$

(d) A + B

15) If the angle between the vectors $\vec{A}$ and $\vec{B}$ is θ, the value of the product $(\vec{B} \times \vec{A}).\vec{A}$ is equal to

(a) $BA^2 \sin\theta$

(b) $BA^2 \cos\theta$

(c) $BA^2 \sin\theta \cos\theta$

(d) zero

16) If a vector $2\hat{\imath} + 3\hat{\jmath} + 8\hat{k}$ is perpendicular to the vector $4\hat{\jmath} - 4\hat{\jmath} + \alpha\hat{k}$, then the value of α is

(a) 1/2

(b) – 1/2

(c) 1

(d) –1

17) The vector $\vec{A}$ and $\vec{B}$ are such that $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$

The angle between the two vectors is

(a) 60°

(b) 75°

(c) 45°

(d) 90°

18) $\vec{A}$ and $\vec{B}$ are two vectors and θ is the angle between them, if $|\vec{A} \times \vec{B}| = \sqrt{3}\,(\vec{A}.\vec{B})$, the value of θ is

(a) 45°

(b) 30°

(c) 90°

(d) 60°

19) Six vectors, $\vec{a}$ through $\vec{f}$ have the magnitudes are directions indicated in the figure. Which of the following statements is true?

(a) $\vec{b} + \vec{c} = \vec{f}$

(b) $\vec{d} + \vec{c} = \vec{f}$

(c) $\vec{d} + \vec{e} = \vec{f}$

(d) $\vec{b} + \vec{e} = \vec{f}$

20) Vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ are such that $\vec{A}.\vec{B} = 0$ and $\vec{A}.\vec{C} = 0$. Then the vector parallel to $\vec{A}$ is

(a) $\vec{B}$ and $\vec{C}$

(b) $\vec{A} \times \vec{B}$

(c) $\vec{B} + \vec{C}$

(d) $\vec{B} \times \vec{C}$

21) A particle is moving such that its position coordination (x, y) are

(2m, 3m) at time t = 0

(6m, 7m) at time t = 2s and

(13m, 14m) at time t = 5s

Average velocity vector ($\overrightarrow{V_{av}}$) from t = 0 to t = 5s is:

(a) $\frac{1}{5}(13\hat{\imath} + 14\hat{\jmath})$

(b) $\frac{7}{3}(\hat{\imath} + \hat{\jmath})$

(c) $2(\hat{\imath} + \hat{\jmath})$

(d) $\frac{11}{5}(\hat{\imath} + \hat{\jmath})$

22) If vectors $\vec{A} = \cos\omega t\hat{\imath} + \sin\omega t\hat{\jmath}$ and $\cos\frac{\omega t}{2}\hat{\imath} + \sin\frac{\omega t}{2}\hat{\jmath}$ are functions of time, then the value of t at which they are orthogonal to each other is:

(a) $t = \frac{\pi}{2\omega}$

(b) $t = \frac{\pi}{\omega}$

(c) $t = 0$

(d) $t = \frac{\pi}{4\omega}$

23) If the magnitude of sum of two vectors is equal to the magnitude of differences of the two vectors, the angle between these vectors is:

(a) 0°

(b) 90°

(c) 45°

(d) 180°

24) If $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$, then the angle between A and B is

(a) $\frac{\pi}{2}$

(b) $\frac{\pi}{3}$

(c) π

(d) $\frac{\pi}{4}$

25) A vector $\vec{A}$ is rotated by a small angle $\Delta\theta$ radian ($\Delta\theta$ << 1) to get a new vector $\vec{B}$ In that case $\left|\vec{B} - \vec{A}\right|$ is:

(a) $|\vec{A}|\Delta\theta$

(b) $\left|\vec{B}\right| \Delta\theta\, |\vec{A}|$

(c) $|\vec{A}| \left(1 - \frac{\Delta\theta^2}{2}\right)$

(d) 0

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	b	c	c	a	c	d	b	b	b
11	12	13	14	15	16	17	18	19	20
a	c	c	b	d	b	d	d	c	d
21	22	23	24	25					
d	b	b	c	a					

Topic 9: Motion in a Plane with Constant Acceleration

1) A bullet is fired from a gun with a speed of 1000 m/s in order to hit a target 100m away. At what height above the target should the gun be aimed? (The resistance of air is negligible and g = 10 m/s^2)

(a) 5 cm (b) 10 cm

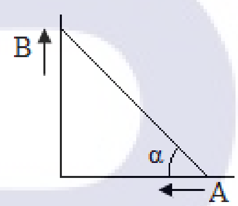
(c) 15 cm (d) 20 cm

2) The position vector of a particle is $\vec{r} = (a \cos \omega t)\hat{\imath} + (a \sin \omega t)\hat{\jmath}$. The velocity of the particle is

(a) directed towards the origin (b) directed away from the origin

(c) parallel to the position vector (d) perpendicular to the position vector

3) Two particles A and B are connected by a rigid rod AB. The rod slides along perpendicular rails as shown here. The velocity of A to the left is 10m/s. What is the velocity of B when angle α = 60°?



(a) 5.8 m/s (b) 9.8 m/s

(c) 10 m/s (d) 17.3 m/s

4) A body of 3 kg moves in the XY plane under the action of a force given by $6t\hat{\imath} + 4t\hat{\jmath}$. Assuming that the body is at rest at time t = 0, the velocity of the body at t = 3s is

(a) $6\hat{\imath} + 6\hat{\jmath}$ (b) $18\hat{\imath} + 6\hat{\jmath}$

(c) $18\hat{\imath} + 12\hat{\jmath}$ (d) $12\hat{\imath} + 18\hat{\jmath}$

5) A particle moves in a plane with constant acceleration in a direction different from the initial velocity. The path of the particle is

(a) an ellipse (b) a parabola

(c) an arc of a circle (d) a straight line

6) A particle starting from origin (0, 0) moves in the (x, y) plane. Its coordinates at a later time are ($\sqrt{3}$, 3). The path of the particle makes with the x – axis an angle of

(a) 45° (b) 60°

(c) 0° (d) 30°

7) The x and y coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$ respectively, where x and y are in meters and t in seconds. The acceleration of the particle at t = 2s is

(a) $5\ m/s^2$ (b) $-4\ m/s^2$

(c) $-8\ m/s^2$ (d) 0

8) The co-ordinates of a moving particle 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

(a) $3t\sqrt{\alpha^2 + \beta^2}$ (b) $3t^2\sqrt{\alpha^2 + \beta^2}$

(c) $t^2\sqrt{\alpha^2 + \beta^2}$ (d) $\sqrt{\alpha^2 + \beta^2}$

9) A particle has an initial velocity of $3\hat{\imath} + 4\hat{\jmath}$ and an acceleration of $0.4\hat{\imath} + 0.3\hat{\jmath}$. Its speed after 10s is:

(a) $7\sqrt{2}$ units (b) 7 units

(c) 8.5 units (d) 10 units

10) A particle is moving with velocity $\vec{v} = k\,(y\hat{\imath} + x\hat{\jmath})$, where k is a constant. The general equation for its path is

(a) $y = x^2$ + constant (b) $y^2 = x$ + constant

(c) xy = constant (d) $y^2 = x^2$ + constant

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	d	d	c	b	b	b	b	a	d

Topic 10: Projectile Motion

1) Two bodies of same mass are projected with the same velocity at an angle 30° and 60° respectively. The ratio of their horizontal ranges will be

(a) 1:1
(b) 1: 2
(c) 1: 3
(d) 2 : $\sqrt{2}$

2) The maximum range of a gun of horizontal terrain is 16 km. If g = 10 ms^{-2}, then muzzle velocity of a shell must be

(a) 160 ms^{-1}
(b) $200\sqrt{2}$ ms^{-1}
(c) 400 ms^{-1}
(d) 800 ms^{-1}

3) If a body A of mass M is thrown with velocity v at an angle of 30° to the horizontal and another body B of the same mass is thrown with same speed at an angle of 60° to the horizontal, the ratio of horizontal range of A and B will be

(a) 1 : 3
(b) 1 : 1
(c) 1: $\sqrt{3}$
(d) $\sqrt{3}$: 1

4) Two projectile are fired from the same point with the same speed at angles of projection 60° and 30° respectively. Which one of the following is true?

(a) Their maximum height will be same
(b) Their range will be same
(c) Their landing velocity will be same
(d) Their time of flight will be same

5) For angles projection of a projectile $(45° - \theta)$ and $(45° + \theta)$, the horizontal ranges described by the projectile are in the ratio of

(a) 1 : 3
(b) 1 : 2
(c) 2 : 1
(d) 1 : 1

6) A particle of mass m is projected with velocity v taking an angle of 45° with the horizontal. When the particle lands on the level ground the magnitude of the change in its momentum will be:

(a) 2mv
(b) mv/$\sqrt{2}$
(c) mv$\sqrt{2}$
(d) zero

7) A projectile is fired at an angle of 45° with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection is

(a) 60°
(b) $\tan^{-1}\left(\frac{1}{2}\right)$

(c) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(d) 45°

8) A missile is fired for maximum range with an initial velocity of 20 m/s. If g = 10 m/s^2, the range of the missile is

(a) 40 m

(b) 50 m

(c) 60 m

(d) 20 m

9) The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectiles is:

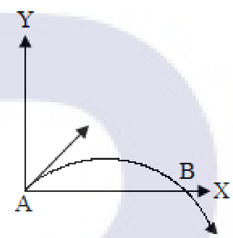
(a) $\theta = \tan^{-1}\left(\frac{1}{4}\right)$

(b) $\theta = \tan^{-1}(4)$

(c) $\theta = \tan^{-1}(2)$

(d) $\theta = 45°$

10) The velocity of a projectile at the initial point A is $(2\hat{\imath} + 3\hat{\jmath})$ m/s. It's velocity (in m/s) at point B is



(a) $-2\hat{\imath} + 3\hat{\jmath}$

(b) $2\hat{\imath} - 3\hat{\jmath}$

(c) $2\hat{\imath} + 3\hat{\jmath}$

(d) $-2\hat{\imath} - 3\hat{\jmath}$

11) A projectile is fired from the surface of the earth with a velocity of 5 ms^{-1} and angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 ms^{-1} at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) given g = 9.8 m/s^2

(a) 3.5

(b) 5.9

(c) 16.3

(d) 110.8

12) A boy playing on the roof of a 10 m high building throws a ball with a speed of 10m/s at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the height of 10m from the ground? [g = 10m/s^2, sin 30° = $\frac{1}{2}$, cos 30° = $\frac{\sqrt{3}}{2}$]

(a) 5.20m

(b) 4.33m

(c) 2.60m

(d) 8.66m

13) 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 angle of projection θ?

(a) No

(b) Yes, 30°

(c) Yes, 60°

(d) Yes, 45°

14) A projectile can have the same range 'R' for two angles of projection. If 'T_1' and 'T_2' to be time of flights in the two cases, then the product of the two time of flights is directly proportional to

(a) R

(b) $\frac{1}{R}$

(c) $\frac{1}{R^2}$

(d) R^2

15) A water fountain on the ground sprinkles water all around it. If the speed of water coming out of the fountain is v, the total area around the fountain that gets wet is:

(a) $\pi \frac{v^4}{g^2}$

(b) $\frac{\pi}{2} \frac{v^4}{g^2}$

(c) $\pi \frac{v^2}{g^2}$

(d) $\pi \frac{v^2}{g}$

16) A boy can throw a stone up to a maximum height of 10m. The maximum horizontal distance that the boy can throw the same stone up to will be

(a) $20\sqrt{2}$ m

(b) 10 m

(c) $10\sqrt{2}$ m

(d) 20 m

17) A ball projected from ground at an angle of 45° just clears a wall in front. If point of projection is 4m from the foot of wall and ball strikes the ground at a distance of 6m on the other side of the wall, the height of the wall is:

(a) 4.4m

(b) 2.4m

(c) 3.6m

(d) 1.6m

18) The maximum range of a bullet fired from a toy pistol mounted on a car at rest is R_0 = 40m. What will be the acute angle of inclination of the pistol for maximum range when the car is moving in the direction of firing with uniform velocity v = 20m/s, on a horizontal surface? (g = 10m/s^2)

(a) 30°

(b) 60°

(c) 75°

(d) 45°

19) A projectile is given an initial velocity of $(\hat{i} + 2\hat{j})$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If g = 10m/s^2, the equation of its trajectory is:

(a) $y = x - 5x^2$

(b) $y = 2x - 5x^2$

(c) $4y = 2x - 5x^2$

(d) $4y = 2x - 25x^2$

20) The position of a projectile launched from the origin at t = 0 is given by $\vec{r} = (40\hat{i} + 50\hat{j})$ m at t = 2s. If the projectile was launched at an angle θ from the horizontal, then θ is

(a) $\tan^{-1}\frac{2}{3}$

(b) $\tan^{-1}\frac{3}{2}$

(c) $\tan^{-1}\frac{7}{4}$ (d) $\tan^{-1}\frac{4}{5}$

21) The initial speed of bullet fired from a rifle is 630m/s. The rifle is fired at the centre of a target 700m away at the same level as the target. How far above the centre of the target?

(a) 1.0m (b) 4.2m

(c) 6.1m (d) 9.8m

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	c	b	b	d	c	b	a	b	b
11	12	13	14	15	16	17	18	19	20
a	d	c	a	a	d	b	b	b	c
21									
c									

Topic 11: Relative Velocity in Two Dimensions & Uniform Circular Motion

1) An electric fan has blades of length 30 cm measured from the axis of rotation. If the fan is rotating at 120 rpm, the acceleration of a point on the tip of the blade is

(a) 1600 ms^{-2} (b) 47.4 ms^{-2}

(c) 23.7 ms^{-2} (d) 50.55 ms^{-2}

2) A boat is sent across a river with a velocity of 8km h^{-1}. If the resultant velocity of boat is 10kmh^{-1}, then the velocity of the river is

(a) 12.8 kmh^{-1} (b) 6 kmh^{-1}

(c) 8 kmh^{-1} (d) 10 kmh^{-1}

3) When a body moves with a constant speed along a circle

(a) its velocity remains constant (b) no force acts on it

(c) no work is done on it (d) no acceleration is produced in it

4) A body is whirled in a horizontal circle of radius 20cm. It has an angular velocity of 10 rad/s. What is its linear velocity at any point on circular path

(a) $\sqrt{2}$ m/s (b) 2 m/s

(c) 10 m/s (d) 20 m/s

5) A ball of mass 0.25kg attached to the end of a string of length 1.96m is moving in a horizontal circle. The string will break if the tension is more than 25N. What is the maximum speed with which the ball can be moved?

(a) 14m/s (b) 3 m/s

(c) 5 m/s (d) 3.92 m/s

6) A person swims in a river aiming to reach exactly opposite point on the bank of a river. His speed of swimming is 0.5m/s at an angle of 120° with the direction of flow of water. The speed of water in stream is

(a) 1.0m/s (b) 0.5m/s

(c) 0.25m/s (d) 0.43m/s

7) A stone tied with a string, is rotated in a vertical circle. The minimum speed with which the string has to be rotated

(a) is independent of the mass of the stone

(b) is independent of the length of the string

(c) decreases with increasing mass of the stone

(d) decreases with increasing length of the string

8) A boat which has a speed of 5km/hr in still water crosses a river of width 1km along the shortest possible path in 15 minutes. The velocity of the river water in km/hr is

(a) 3 (b) 4

(c) $\sqrt{21}$ (d) 1

9) A small sphere is attached to a cord and rotates in a vertical circle about a point O. If the average speed of the sphere is increased, the cord is most likely to break at the orientation when the mass is at

(a) bottom point B (b) the point C

(c) the point D (d) top point A

10) Two particles of mass M and m are moving in a circle of radii R and r. If their time – periods are same, what will be the ratio of their linear velocities?

(a) MR : mr (b) M : m

(c) R : r (d) 1 : 1

11) A particle moves along a circle of radius $\left(\frac{20}{\pi}\right)$ m with a constant tangential acceleration. If the velocity of the particle is 80 m/s at the end of the second revolution after motion has begun, the tangential acceleration is

(a) 40 π m/s^2 (b) 40 m/s^2

(c) 640 π m/s^2 (d) 160 π m/s^2

12) A stone is tied to a string of length *l* and is whirled in a vertical circle with other end of the string as the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in velocity as it reaches a position where the string is horizontal (g being acceleration due to gravity) is

(a) $\sqrt{2gl}$ (b) $\sqrt{2(u^2 - gl)}$

(c) $\sqrt{u^2 - gl}$ (d) $u - \sqrt{u^2 - 2gl}$

13) The circular motion of a particle with constant speed is

(a) periodic but not simple harmonic (b) simple harmonic but not periodic

(c) periodic and simple harmonic (d) neither periodic nor simple harmonic

14) A stone tied to the end of a string of 1m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 seconds, what is the magnitude and direction of acceleration of the stone?

(a) $\pi^2 ms^{-2}$ and direction along the radius towards the center

(b) $\pi^2 ms^{-2}$ and direction along the radius away from the center

(c) $\pi^2 ms^{-2}$ and direction along the tangent to the circle

(d) $\pi^2/4 ms^{-2}$ and direction along the radius towards the center

15) Two boys are standing at the ends A and B of a ground where AB = a. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is

(a) $a/\sqrt{v^2 + v_1^2}$

(b) $a/(v + v_1)$

(c) $a/(v - v_1)$

(d) $\sqrt{a^2 / v^2 + v_1^2}$

16) A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 seconds in every circular loop. The average velocity and average speed for each circular loop respectively, is

(a) 0, 10m/s

(b) 10m/s, 10m/s

(c) 10m/s, 0

(d) 0, 0

17) A particle moves in a circle of radius 5 cm with constant speed and time period 0.2πs. The acceleration of the particle is

(a) 15 m/s^2

(b) 25 m/s^2

(c) 36 m/s^2

(d) 5 m/s^2

18) The position vector of a particle $\vec{R}$ as a function of time is given by:

$$\vec{R} = 4\sin(2\pi t)\,\hat{\imath} + 4\cos(2\pi t)\,\hat{\jmath}$$

Where R is in meter, t in seconds and $\hat{\imath}$ and $\hat{\jmath}$ denote unit vectors along x – and y – directions, respectively.

Which one of the following statements is wrong for the motion of particle?

(a) Magnitude of acceleration vector is $\frac{v^2}{R}$ where v is the velocity of particle

(b) Magnitude of the velocity of particle is 8 meter/second

(c) path of the particle is a circle of radius 4 meter

(d) Acceleration vector is along $\vec{R}$

19) A ship A is moving Westwards from the origin $10 kmh^{-1}$ and a ship B 100km South of A, is moving Northwards with a speed of $10 kmh^{-1}$. The time after which the distance between them becomes shortest, is:

(a) 5 h

(b) $5\sqrt{2}$ h

(c) $10\sqrt{2}$ h

(d) 0 h

20) A particle moves so that its position vector is given by $\vec{r} = \cos \omega t\hat{x} + \sin \omega t\hat{y}$. Where ω is constant. Which of the following is true?

(a) Velocity and acceleration both are perpendicular to $\vec{r}$

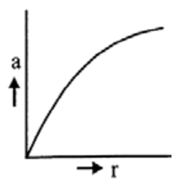
(b) Velocity and acceleration both are parallel to $\vec{r}$

(c) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin

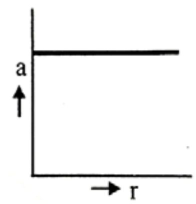
(d) Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin

21) If a body moving in circular path maintains constant speed of $10ms^{-1}$, then which of the following correctly describes relation between acceleration and radius?

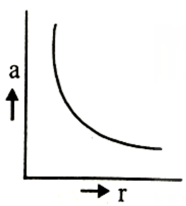
(a)



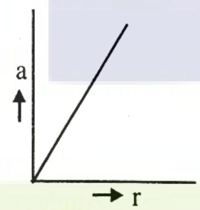
(b)



(c)



(d)



ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	b	c	b	a	c	a	a	a	c
11	12	13	14	15	16	17	18	19	20
b	b	a	a	d	a	d	b	a	c
21									
c									

Topic 12: Ist, IInd and IIIrd Laws of Motion

1) A particle of mass m is moving with a uniform velocity v_1. It is given an impulse such that its velocity becomes v_2. The impulse is equal to

(a) $m[|v_2| - |v_1|]$

(b) $\frac{1}{2}m[v_2^2 - v_1^2]$

(c) $m[v_1 + v_2]$

(d) $m[v_2 - v_1]$

2) A 600kg rocket is set for a vertical firing. If the exhaust speed is $1000 ms^{-1}$, the mass of the gas ejected per second to supply the thrust needed to overcome the weight of rocket is

(a) $117.6 kgs^{-1}$

(b) $58.6 kgs^{-1}$

(c) $6 kgs^{-1}$

(d) $76.4 kgs^{-1}$

3) Physical independence of force is consequences of

(a) third law of motion

(b) second law of motion

(c) first law of motion

(d) all of these laws

4) A satellite in a force free space sweeps stationary interplanetary dust at a rate $(dM/dt) = \alpha v$. The acceleration of satellite is

(a) $\frac{-2\alpha v^2}{M}$

(b) $\frac{-\alpha v^2}{M}$

(c) $\frac{-\alpha v^2}{2M}$

(d) $-\alpha v^2$

5) If the force on a rocket moving with a velocity of 300m/sec is 345 N, then the rate of combustion of the fuel, is

(a) 0.55kg/sec

(b) 0.75 kg/sec

(c) 1.15 kg/sec

(d) 2.25 kg/sec

6) A ball of mass 150g, moving with an acceleration $20 m/s^2$, is hit by a force, which acts on it for 0.1 sec. The impulse force is

(a) 0.5 N

(b) 0.1 N

(c) 0.3 N

(d) 1.2 N

7) A 10N force is applied on a body produces an acceleration of $1 m/s^2$. The mass of the body is

(a) 5 kg

(b) 10 kg

(c) 15 kg

(d) 20 kg

8) A 5000 kg rocket is set for vertical firing. The exhaust speed is $800 ms^{-1}$. To give an initial upward acceleration of $20 ms^{-2}$, the amount of gas ejected per second to supply the needed thrust will be $(g = 10 ms^{-2})$

(a) 127.5 kg s^{-1} (b) 187.5 kg s^{-1}

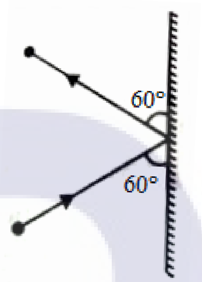
(c) 185.5 kg s^{-1} (d) 137.5 kg s^{-1}

9) A bullet is fired a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5 t$ where, F is in Newton and t in second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

(a) 1.8 N – s (b) zero

(c) 9 N – s (d) 0.9 N – s

10) A 3kg ball strikes a heavy rigid wall with a speed of 10m/s at an angle of 60°. It gets reflected with the same speed and angle as shown here. If the ball is in contact with the wall for 0.20s, what is the average force exerted on the ball by the wall?



(a) 150 N (b) zero

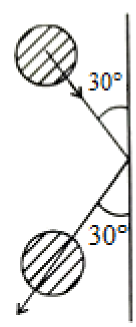
(c) $150\sqrt{3}$ N (d) 300 N

11) If a cricketer catches a ball of mass 150gm moving with a velocity of 20m/s, then he experiences a force of (Time taken to complete the catch is 0.1 sec).

(a) 300 N (b) 30 N

(c) 3 N (d) 0.3 N

12) A 0.5 kg ball moving with speed of 12 m/s strikes a hard wall at an angle of 30° with the wall. It is reflected with the same speed and at the same angle. If the ball is in contact with the wall for 0.25 seconds, the average force acting on the wall is



(a) 24 N (b) 12 N

(c) 96 N (d) 48 N

13) Sand is being dropped on a conveyor belt at the rate of M kg/s. The force necessary to keep the belt moving with a constant velocity of v m/s will be:

(a) Mv Newton
(b) 2 Mv Newton
(c) $\frac{Mv}{2}$ Newton
(d) zero

14) A body under the action of a force $\vec{F} = 6\hat{\imath} - 8\hat{\jmath} + 10\hat{k}$, acquires an acceleration of 1 m/s^2. The mass of this body must be

(a) 10 kg
(b) 20 kg
(c) $10\sqrt{2}$ kg
(d) $2\sqrt{10}$ kg

15) A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is

(a) MV
(b) 1.5 MV
(c) 2 MV
(d) zero

16) A stone is dropped from a height h. It hits the ground with a certain momentum P. If the same stone is dropped from a height 100% more than stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by:

(a) 68%
(b) 41%
(c) 200%
(d) 100%

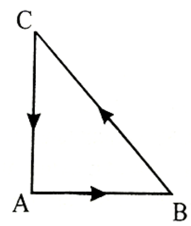
17) The force 'F' acting on a particle of mass 'm' is indicated by the force – time graph shown below. The change in momentum of the particle over the time interval from zero to 8s is:

(a) 24 Ns
(b) 20 Ns
(c) 12 Ns
(d) 6 Ns

18) A solid sphere, a hollow sphere and a ring are released from top of an inclined plane (frictionless) so that they slide down the plane. Then maximum acceleration down the plane is for (no rolling)

(a) solid sphere
(b) hollow sphere
(c) ring
(d) all same

19) Three forces start acting simultaneously on a particle moving with velocity, $\vec{v}$. These forces are represented in magnitude and direction by the three sides of a triangle ABC. The particle will now move with velocity



(a) less than $\vec{v}$

(b) greater than $\vec{v}$

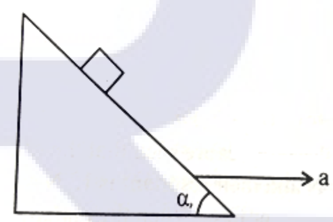
(c) $|\vec{v}|$ in the direction of the largest force BC

(d) $\vec{v}$, remaining unchanged

20) A rocket with a lift - off mass 3.5×10^4 kg is blasted upwards with an initial acceleration of $10 m/s^2$. Then the initial thrust of the blast is

(a) 3.5×10^5 N
(b) 7.0×10^5 N
(c) 14.0×10^5 N
(d) 1.75×10^5 N

21) A block is kept on a frictionless inclined surface with angle of inclination 'α'. The inclined is given an acceleration 'a' to keep the block stationery. Then a is equal to



(a) g cosec α
(b) g/tan α
(c) g tan α
(d) g

22) A particle of mass 0.3 kg subject to a force F = –kx with k = 15N/m. What will be its initial acceleration if it is released from a point 20cm away from the origin?

(a) $15 m/s^2$
(b) $3 m/s^2$
(c) $10 m/s^2$
(d) $5 m/s^2$

23) A player caught a cricket ball of mass 150g moving at a rate of 20 m/s. If the catching process is completed in 0.1s, the force of the blow exerted by the ball on the hand of the player is equal to

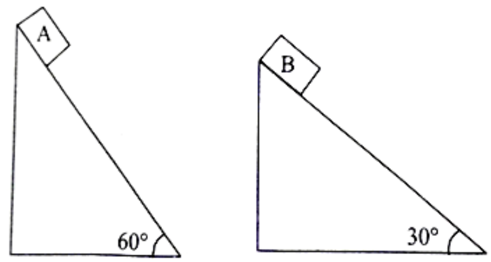
(a) 150N
(b) 3N
(c) 30N
(d) 300N

24) A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2m while applying the force and the ball goes upto 2m height further, find the magnitude of the force. (Considering $g = 10m/s^2$).

(a) 4N
(b) 16N

(c) 20N (d) 22N

25) Two fixed frictionless inclined planes making an angle 30° and 60° with the vertical are shown in the figure. Two blocks A and B are placed on the two planes. What is the relative vertical acceleration of A with respect to B?



(a) 4.9 ms^{-2} in horizontal direction (b) 9.8 ms^{-2} in vertical direction

(c) Zero (d) 4.9 ms^{-2} in vertical direction

26) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: If you push on a cart being pulled by a horse so that it does not move, the cart pushes you back with an equal and opposite force.

Statement 2: The cart does not move because the force described in statement 1 cancel each other.

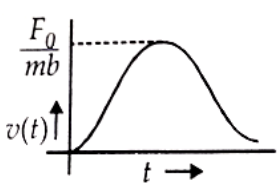
(a) Statement 1is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

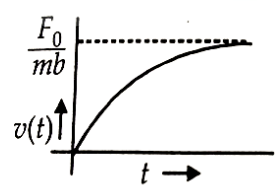
(b) Statement 1is false, Statement 2 is true.

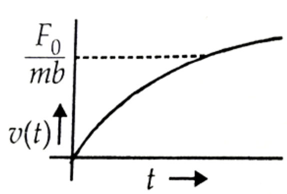
(c) Statement 1is true, Statement 2 is false.

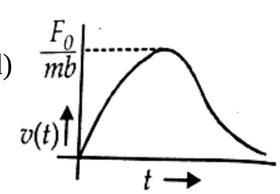
(d) Statement 1is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

27) A particle of mass m is at rest at the origin at time t = 0. It subjected to a force $F(t) = F_0 e^{-bt}$ in the x direction. Its speed v(t) is depicted by which of the following curves?

(a)


(b)


(c)


(d)


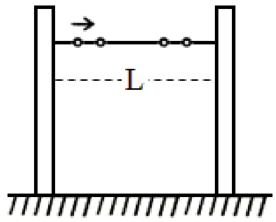
28) A body of mass 5kg under the action of constant force $\vec{F} = F_x\hat{\imath} + F_y\hat{\jmath}$ has velocity at t = 0s as $\vec{v} = (6\hat{\imath} - 2\hat{\jmath})$ m/s and at t = 10s as $\vec{v} = +6\hat{\jmath}$ m/s. The force $\vec{F}$ is:

(a) $(-3\hat{\imath} + 4\hat{\jmath})$N (b) $\left(-\frac{3}{5}\hat{\imath} + \frac{4}{5}\hat{\jmath}\right)$N

(c) $(3\hat{\imath} - 4\hat{\jmath})$N

(d) $\left(\frac{3}{5}\hat{\imath} - \frac{4}{5}\hat{\jmath}\right)$N

29) A large number (n) if identical beads, each of mass m and radius r are strung on a thin smooth rigid horizontal rod of length L (L >> r) and are at rest at random positions. The rod is mounted between two rigid supports (see figure). If one of the beads is now given a speed v, the average force experienced by each support after a long time is (assume all collisions are elastic):



(a) $\frac{mv^2}{2(L-nr)}$

(b) $\frac{mv^2}{L-2nr}$

(c) $\frac{mv^2}{L-nr}$

(d) zero

30) A particle of mass m is acted upon by a force F given by the empirical law F = $\frac{R}{t^2}$ $v(t)$. If this law is to be tested experimentally by observing the motion starting from rest, the best way is to plot:

(a) log $v(t)$ against $\frac{1}{t}$

(b) v(t) against t^2

(c) log $v(t)$ against $\frac{1}{t^2}$

(d) log $v(t)$ against

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
d	c	c	b	c	c	b	b	d	c
11	12	13	14	15	16	17	18	19	20
b	a	a	c	c	b	c	d	d	b
21	22	23	24	25	26	27	28	29	30
c	c	c	d	d	a	c	a	b	a

Topic 13: Motion of Connected Bodies, Pulley & Equilibrium of Forces

1) A monkey is decending from the branch of a tree with constant acceleration. If the breaking strength is 75% of the weight of the monkey, the minimum acceleration with which monkey can slide down without breaking the branch is

(a) g
(b) $\frac{3g}{4}$
(c) $\frac{g}{4}$
(d) $\frac{g}{2}$

2) A mass of 1 kg is suspended by a thread. It is

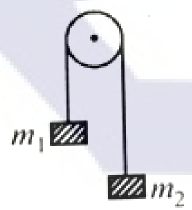
(i) lifted up with an acceleration $4.9 m/s^2$

(ii) lowered with an acceleration $4.9 m/s^2$

The ratio of the tensions is

(a) 3 : 1
(b) 1 : 2
(c) 1 : 3
(c) 2 : 1

3) Two blocks m_1 = 5 gm and m_2 = 10 gm are hung vertically over a light frictionless pulley as shown here. What is the acceleration of the masses they are left free?



(a) g/3
(b) g/2
(c) g
(d) g/5

4) A lift weighing 1000kg is moving upwards with an acceleration of $1 m/s^2$. The tension in the supporting cable is

(a) 980 N
(b) 10800 N
(c) 9800 N
(d) 8800 N

5) A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25kg. What is the maximum acceleration with which the monkey can climb up along the rope? ($g = 10 m/s^2$)

(a) $2.5 m/s^2$
(b) $5 m/s^2$
(c) $10 m/s^2$
(d) $25 m/s^2$

6) A man weighing 80 kg, stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of $5 m/s^2$. What would be the reading on the scale? ($g = 10 m/s^2$)

(a) 1200 N

(b) zero

(c) 400 N

(d) 800 N

7) A block of mass m is placed on a smooth wedge of inclination θ. The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block (g is the acceleration due to gravity) will be

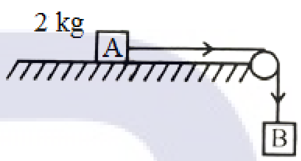
(a) $mg/\cos\theta$

(b) $mg \cos\theta$

(c) $mg \sin\theta$

(d) mg

8) The coefficient of static friction, μ_S, between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. ($g = 10 m/s^2$)



(a) 0.4 kg

(b) 2.0 kg

(c) 4.0 kg

(d) 0.2 kg

9) The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is:

(a) $4\ ms^{-2}$ upwards

(b) $4\ ms^{-2}$ downwards

(c) $14\ ms^{-2}$ upwards

(d) $30\ ms^{-2}$ downwards

10) Three forces acting on a body are shown in the figure. To have the resultant force only along the y–direction, the magnitude of the minimum additional force needed is:

(a) 0.5 N

(b) 1.5 N

(c) $\frac{\sqrt{3}}{4}$ N

(d) $\sqrt{3}$ N

11) A person of mass 60 kg is inside a lift of mass 940kg and presses the button on control panel. The lift starts moving upwards with an acceleration $1.0\ m/s^{-2}$. If $g = 10\ ms^{-2}$, the tension in the supporting cable is

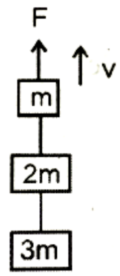
(a) 8600 N

(b) 9680 N

(c) 11000 N

(d) 1200 N

12) Three blocks with masses m, 2m and 3m are connected by strings as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m? (g is the acceleration due to gravity)



(a) 2mg

(b) 3mg

(c) 6mg

(d) zero

13) A balloon with mass ‘m’ is descending down with an acceleration ‘a’ (where a < g). How much mass should be removed from it so that it starts moving up with an acceleration ‘a’?

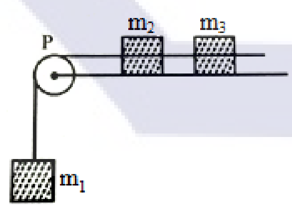
(a) $\frac{2ma}{g+a}$

(b) $\frac{2ma}{g-a}$

(c) $\frac{ma}{g+a}$

(d) $\frac{ma}{g-a}$

14) A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is: (Assume $m_1 = m_2 = m_3 = m$)



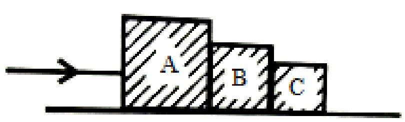
(a) $\frac{g\,(1-g\mu)}{g}$

(b) $\frac{2g\mu}{3}$

(c) $\frac{g\,(1-2\mu)}{3}$

(d) $\frac{g\,(1-2\mu)}{2}$

15) Three blocks A, B and C of masses 4kg, 2kg and 1kg respectively, are in contact on a frictionless surface, as shown. If a force of 14 N is applied on the 4kg block then the contact force between A and B is



(a) 6 N

(b) 8 N

(c) 18 N

(d) 2 N

16) One end of string of length l is connected to a particle of mass 'm' and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed 'v' the net force on the particle (directed towards centre) will be (T represents the tension in the string) :-

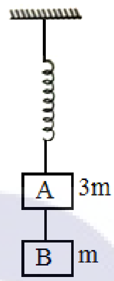
(a) $T + \frac{mv^2}{l}$

(b) $T - \frac{mv^2}{l}$

(c) Zero

(d) T

17) Two blocks A and B of masses 3m and m respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in figure. The magnitudes of acceleration of A and B immediately after a string is cut, are respectively :-



(a) $\frac{g}{3}$, g

(b) g, g

(c) $\frac{g}{3}$, $\frac{g}{3}$

(d) g, $\frac{g}{3}$

18) One end of a massless rope, which passes over a massless and frictionless pulley P is tied to a hook C while the other end is free. Maximum tension that the rope can bear is 360N. With what value of maximum safe acceleration (in ms^{-2}) can a man of 60kg climb on the rope?

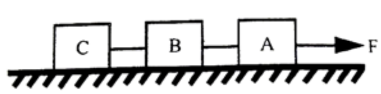
(a) 16

(b) 6

(c) 4

(d) 8

19) Three identical blocks of masses m = 2 kg are drawn by a force F = 10.2 N with an acceleration of 0.6 ms^{-2} on a friction less surface, then what is the tension (in N) in the string between the blocks B and C?



(a) 92

(b) 3.4

(c) 4

(d) 9.8

20) A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is g/8, then the ratio of the masses is

(a) 8 : 1

(b) 9 : 7

(c) 4 : 3
(d) 5 : 3

21) Two forces are such that the sum of their magnitudes is 18N and their resultant is 12N which is perpendicular to the smaller force. Then the magnitudes of the forces are

(a) 12N, 6N
(b) 13N, 5N
(c) 10N, 8N
(d) 16N, 2N

22) When forces F_1, F_2, F_3 are acting on a particle of mass m such that F_2 and $F_3$are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed then the acceleration of the particle is

(a) F_1/m
(b) $F_2 F_3/mF_1$
(c) $(F_2 - F_3)/m$
(d) F_2/m

23) A lift is moving down with acceleration a. A man in the lift drops a ball inside the lift. The acceleration of the ball as observed by the man in the lift and a man standing stationary on the ground are respectively

(a) g, g
(b) g − a, g − a
(c) g − a, g
(d) a, g

24) A light spring balance hangs from the hook of the other light spring balance and a block of mass M kg hangs from the former one. Then the true statement about the scale reading is

(a) both the scales read M kg each

(b) the scale of the lower one reads M kg and of the upper one zero

(c) the reading of the two scales can be anything but the sum of the reading will be M kg

(d) both the scales read M/2 kg each

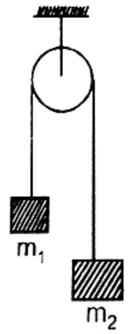
25) A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force P is applied at the free end of the rope, the force exerted by the rope on the block is

(a) $\frac{Pm}{M+m}$
(b) $\frac{Pm}{M-m}$
(c) P
(d) $\frac{PM}{M+m}$

26) A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2, the reading of the spring balance will be

(a) 24 N
(b) 74 N
(c) 15 N
(d) 49 N

27) Two masses m_1 = 5g and m_2 = 4.8 kg tied to a string are hanging over a light frictionless pulley. What is the acceleration of the masses when left free to move? (g = 9.8m/s^2)



(a) 5 m/s^2 (b) 9.8 m/s^2

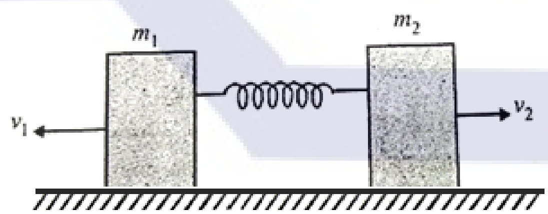
(c) 0.2 m/s^2 (d) 4.8 m/s^2

28) A block of mass m is connected to another block of mass M by a spring (massless) of spring constant k. The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then a constant force F starts acting on the block of mass M to pull it. Find the force of the block of mass m.

(a) $\frac{MF}{(m+M)}$ (b) $\frac{mF}{M}$

(c) $\frac{(M+m)F}{m}$ (d) $\frac{mF}{(m+M)}$

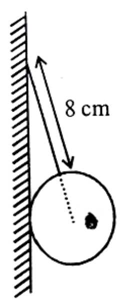
29) A spring is compressed between two blocks of masses m_1 and m_2 placed on a horizontal frictionless surface as shown in the figure. When the blocks are released, they have initial velocity of v_1 and v_2 as shown. The blocks travel distances x_1 and x_2 respectively before coming to rest. The ratio $\left(\frac{x_1}{x_2}\right)$ is



(a) $\frac{m_2}{m_1}$ (b) $\frac{m_1}{m_2}$

(c) $\sqrt{\frac{m_2}{m_1}}$ (d) $\sqrt{\frac{m_1}{m_2}}$

30) A uniform sphere of weight W radius 5cm is being held by a string as shown in the figure. The tension in the string will be:



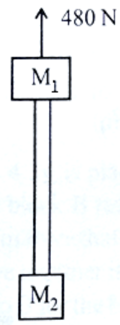
(a) $12\frac{W}{5}$

(b) $5\frac{W}{12}$

(c) $13\frac{W}{5}$

(d) $13\frac{W}{12}$

31) Two blocks of mass M_1 = 20 kg and M_2 =12 kg are connected by a metal rod of mass 8 kg. The system is pulled vertically up by applying a force of 480 N as shown. The tension at the mid - point of the rod is:



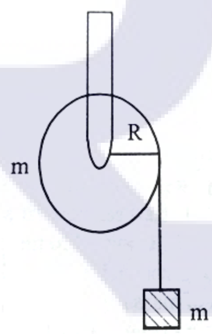
(a)144 N

(b) 96 N

(c) 240 N

(d) 192 N

32) A mass 'm' is supported by a massless string wound around a uniform hollow cylinder of mass m and radius R. If the string does not slip on the cylinder, with what acceleration will the mass fall or release?



(a) $\frac{2g}{3}$

(b) $\frac{g}{2}$

(c) $\frac{2g}{3}$

(d) g

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	a	a	b	a	a	a	a	a	a
11	12	13	14	15	16	17	18	19	20
c	d	a	c	a	d	a	c	b	b
21	22	23	24	25	26	27	28	29	30
b	a	c	a	d	a	c	d	a	d
31	32								
d	b								

Topic 14: Friction

1) Starting from rest, a body slides down a 45° inclined plane in twice the time is takes to slide down the same distance in the absence of friction. The coefficient of friction between the body and the inclined plane is

(a) 0.80
(b) 0.75
(c) 0.25
(d) 0.33

2) A heavy uniform chain lies on horizontal table top. If the coefficient of friction between the chain and the table surface is 0.25, then the maximum fraction of the length of the chain that can hang over one edge of the table is

(a) 20%
(b) 25%
(c) 35%
(d) 15%

3) Consider a car moving along a straight horizontal road with a speed of 72 km/h. If the coefficient of static friction between the tyres and the road is 0.5, the shortest distance in which the car can be stopped is (taking $g = 10m/s^2$)

(a) 30m
(b) 40m
(c) 72m
(d) 20m

4) A block has been placed on an inclined plane with the slope angle θ, blocks slides down the plane at constant speed. The coefficient of kinetic friction is equal to

(a) $\sin\theta$
(b) $\cos\theta$
(c) g
(d) $\tan\theta$

5) A person slides freely down a frictionless inclined plane while his bag falls down vertically from the same height. The final speeds of the man (V_M) and the bag (V_B) should be such that

(a) $V_M < V_B$
(b) $V_M = V_B$
(c) they depend on the masses
(d) $V_M > V_B$

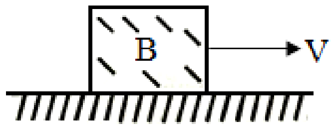
6) A block of mass 1kg is placed on a truck which accelerates with acceleration $5m/s^2$. The coefficient of static friction between the block and truck is 0.6. The frictional force acting on the block is

(a) 5 N
(b) 6 N
(c) 5.88 N
(d) 4.6 N

7) A 100 N force acts horizontally on a block of 10 kg placed on a horizontal rough surface of coefficient of friction $\mu = 0.5$. If the acceleration due to gravity (g) is taken as $10ms^{-2}$, the acceleration of the block (in ms^{-2}) is

(a) 2.5
(b) 10
(c) 5
(d) 7.5

8) A block B is pushed momentarily along a horizontal surface with an initial velocity V. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time



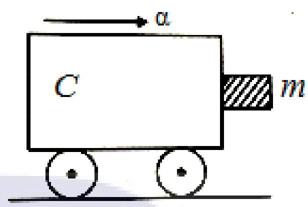
(a) gμ/V

(b) g/V

(c) V/g

(d) V/(gμ)

9) A block of mass m is in contact with the cart C as shown in the **Figure**.



The coefficient of static friction between the block and the cart is μ. The acceleration α of cart that will prevent the block from falling satisfies:

(a) $\alpha > \frac{mg}{\mu}$

(b) $\alpha > \frac{g}{\mu m}$

(c) $\alpha \geq \frac{g}{\mu}$

(d) $\alpha < \frac{g}{\mu}$

10) A conveyer belt is moving at a constant speed of 2m/s. A box is gently dropped on it. The coefficient of friction between them is μ = 0.5. The distance that the box will move relative to belt before coming to rest on it taking $g = 10ms^{-2}$, is

(a) 1.2m

(b) 0.6m

(c) zero

(d) 0.4m

11) The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

(a) $\mu = \frac{2}{\tan\theta}$

(b) μ = 2tan θ

(c) μ = tan θ

(d) $\mu = \frac{1}{\tan\theta}$

12) A plank with a box on it at one end is gradually raised about the outer end. As the angle of inclination with the horizontal reaches 30° the box starts to slip and slides 4.0m down the plank in 4.0s. The coefficients of static and kinetic friction between the box and the plank will be respectively:

(a) 0.6 and 0.5 (b) 0.5 and 0.6

(c) 0.4 and 0.3 (d) 0.6 and 0.6

13) A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is

(a) $\frac{(m_2-\mu_k m_1)g}{(m_1+m_2)}$ (b) $\frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$

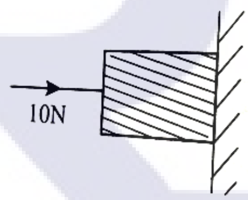
(c) $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$ (d) $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

14) A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10s. Then the coefficient of friction is

(a) 0.02 (b) 0.03

(c) 0.04 (d) 0.06

15) A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2.The weight of the block is



(a) 20N (b) 50N

(c) 100N (d) 2N

16) A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10N, the mass of the block (in kg) is (take $g = 10\ m/s^2$)

(a) 1.6 (b) 4.0

(c) 2.0 (d) 2.5

17) Consider a car moving on a straight road with a speed of 100 m/s. The distance at which car can be stopped is [$\mu_k = 0.5$]

(a) 1000 m (b) 800 m

(c) 400 m (d) 100 m

18) The upper half of an inclined plane with inclination ϕ is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by

(a) $2 \cos \phi$ (b) $2 \sin \phi$

(c) $\tan \phi$ (d) $2 \tan \phi$

19) A smooth block is released at rest on a 45° incline and then slides a distance '*d*'. The time taken to slide is '*n*' times as much to slide on rough incline than on a smooth incline. The coefficient of friction is

(a) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$ (b) $\mu_k = 1 - \frac{1}{n^2}$

(c) $\mu_s = \sqrt{1 - \frac{1}{n^2}}$ (d) $\mu_s = 1 - \frac{1}{n^2}$

20) If a spring of stiffness 'k' is cut into parts 'A' and 'B' of length $l_A : l_B = 2 : 3$, then the stiffness of spring 'A' is given by

(a) $\frac{3k}{5}$ (b) $\frac{2k}{5}$

(c) k (d) $\frac{5k}{2}$

21) The minimum force required to start pushing a body up rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ from the horizontal such that $\tan \theta = 2\mu$ then the ratio $\frac{F_1}{F_2}$ is

(a) 1 (b) 2

(c) 3 (d) 4

22) An insect crawls up a hemispherical surface very slowly. The coefficient of friction between the insect and the surface is 1/3. If the line joining the centre of the hemispherical surface to the insect makes an angle α so that the insect does not slip is given by

(a) $\cot \alpha = 3$ (b) $\sec \alpha = 3$

(c) $\operatorname{cosec} \alpha = 3$ (d) $\cos \alpha = 3$

23) A block weight W rests on a horizontal floor with coefficient of static friction μ. It is desired to make the block move by applying minimum amount of force. The angle θ from the horizontal at which the force should be applied and magnitude of the force F are respectively.

(a) $\theta = \tan^{-1}(\mu)$, $F = \frac{\mu W}{\sqrt{1+\mu^2}}$ (b) $\theta = \tan^{-1}\left(\frac{1}{\mu}\right)$, $F = \frac{\mu W}{\sqrt{1+\mu^2}}$

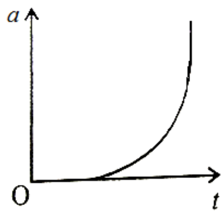
(c) $\theta = 0$ $F = \mu W$ (d) $\theta = \tan^{-1}\left(\frac{\mu}{1+\mu}\right)$, $F = \frac{\mu W}{\sqrt{1+\mu}}$

24) A body starts from rest on a long inclined plane of slope 45°. The coefficient of friction between the body and the plane varies as $\mu = 0.3\ x$, where x is distance travelled down the plane. The body will have maximum speed (for $g = 10\ m/s^2$) when x =

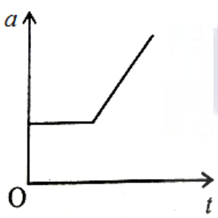
(a) 9.8 m (b) 27 m

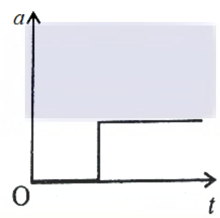
(c) 12 m (d) 3.33 m

25) A block is placed on a rough horizontal plane. A time dependent horizontal force $F = kt$ acts on the block, where k is a positive constant. The acceleration time graph of the block is:

(a)


(b)

(c)


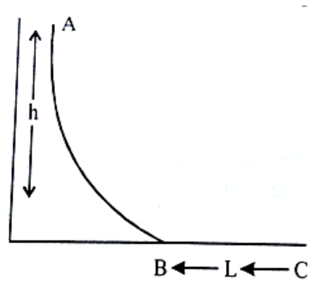
(d)


26) 4 kg is placed on another block B of ma ... ıck B rests on a smooth horizontal table. If the minimum force that can be applied on A so that both the blocks move together is 12N, the maximum force that can be applied to B for the blocks to move together will be:

(a) 30N (b) 25N

(c) 27N (d) 48N

27) A small ball of mass m starts at a point A with speed v_0 and moves along a frictionless track AB as shown. The track BC has coefficient of friction μ. The ball comes to stop at C after travelling a distance L which is:



(a) $\frac{2h}{\mu} + \frac{v_0^2}{2\mu g}$ (b) $\frac{h}{\mu} + \frac{v_0^2}{2\mu g}$

(c) $\frac{h}{2\mu} + \frac{v_0^2}{\mu g}$ (d) $\frac{h}{2\mu} + \frac{v_0^2}{2\mu g}$

28) A heavy box is t dragged along a rough horizontal floor. To do so, person A pushes it at an angle 30° from the horizontal and requires a minimum force F_A, while person B pulls the box at an angle 60° from

the horizontal and needs minimum force F_B. If the coefficient of friction between the box and the floor is $\frac{\sqrt{3}}{5}$, the ratio $\frac{F_A}{F_B}$ is

(a) $\sqrt{3}$

(b) $\frac{5}{\sqrt{3}}$

(c) $\sqrt{\frac{3}{2}}$

(d) $\frac{2}{\sqrt{3}}$

29) Consider a cylinder of mass M resting on a rough horizontal rug that is pulled out from under it with acceleration ‘a’ perpendicular to the axis of the cylinder. What is $F_{friction}$ at point P? It is assumed that the cylinder does not slip.

(a) Mg

(b) Ma

(c) $\frac{Ma}{2}$

(d) $\frac{Ma}{3}$

30) A block of mass m is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is:

(a) $\frac{1}{6}$ m

(b) $\frac{2}{3}$ m

(c) $\frac{1}{3}$ m

(d) $\frac{1}{2}$ m

31) A block of mass m = 10 kg rests on a horizontal table. The coefficient of friction between the block and the table is 0.05. When hit by a bullet of mass 50g moving with speed v, that gets embedded in it, the block moves and comes to stop after moving a distance of 2m on the table. If a freely falling object were to acquire speed $\frac{v}{10}$ after being dropped from height H, then neglecting energy losses and taking g =10 ms^{-2}, the value of H is close to:

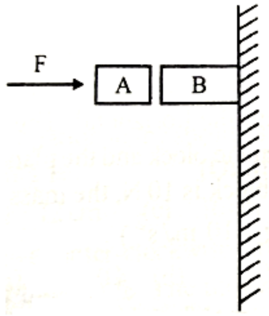
(a) 0.05 km

(b) 0.02 km

(c) 0.03 km

(d) 0.04 km

32) Given in the figure are two blocks A and B of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is:



(a) 120 N

(b) 150 N

(c)100 N

(d) 80 N

33) A rocket is fired vertically from the earth with an acceleration of 2g, where g is the gravitational acceleration. On an inclined plane inside the rocket, making an angle θ with the horizontal, a point object of mass m is kept. The minimum coefficient of friction μ_{min} between the mass and the inclined surface such that the mass does not move is:

(a) tan 2θ

(b) tan θ

(c) 3 tan θ

(d) 2 tan θ

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	a	b	d	b	a	c	d	c	d
11	12	13	14	15	16	17	18	19	20
b	a	b	d	d	c	a	d	b	d
21	22	23	24	25	26	27	28	29	30
c	a	a	d	b	c	b	d	d	a
31	32	33							
d	a	b							

Topic 15: Circular Motion, Banking of Road

1) When milk is churned, cream gets separated due to

(a) centripetal force
(b) centrifugal force
(c) frictional force
(d) gravitational force

2) A particle of mass M is moving in a horizontal circle of radius R with uniform speed V. When it moves from one point to a diametrically opposite point, its

(a) kinetic energy changes by $MV^2/4$
(b) momentum does not change
(c) momentum changes by 2MV
(d) kinetic energy changes by MV^2

3) What will be the maximum speed of car on a road turn of radius 30m if the coefficient of friction between the tyres and the road is 0.4 (Take g = 9.8 m/s^2)

(a) 10.84 m/s
(b) 9.84 m/s
(c) 8.84 m/s
(d) 6.84 m/s

4) A body of mass 0.4 kg is whirled in a vertical circle making 2 rev/sec. If the radius of the circle is 1.2m, then tension in the string when the body at the top of the circle , is

(a) 41.56 N
(b) 89.86 N
(c) 109.86 N
(d) 115.86 N

5) A 500kg car takes a round turn of radius 50 m with a velocity of 36 km/h. The centripetal force is

(a) 250 N
(b) 750 N
(c) 1000 N
(d) 1200 N

6) A car of mass m is moving on a level circular track of radius R. If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by

(a) $\sqrt{\mu_s mRg}$
(b) $\sqrt{Rg/\mu_s}$
(c) $\sqrt{mRg/\mu_s}$
(d) $\sqrt{\mu_s Rg}$

7) A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°, the speed of the car is:

(a) $20ms^{-1}$
(b) $30\ ms^{-1}$
(c) $5\ ms^{-1}$
(d) $10\ ms^{-1}$

8) A car is moving in a circular horizontal track of radius 10m with a constant speed of 10m/s. A bob is suspended from the roof of the car by a light wire of length 1.0m. The angle made by the wire with the vertical is

(a) 0°
(b) $\frac{\pi}{3}$

(c) $\frac{\pi}{6}$

(d) $\frac{\pi}{4}$

9) Two stones of masses m and 2m are whirled in horizontal circles, the heavier one in radius $\frac{r}{2}$ and the lighter one in radius r. The tangential speed of lighter stone is n times that of the value of heavier stone when they experiences same centripetal forces. The value of n is:

(a) 3

(b) 4

(c) 1

(d) 2

10) What is the minimum velocity with which a body of mass m must enter a vertical loop of radius R so that it can complete the loop?

(a) $\sqrt{gR}$

(b) $\sqrt{2gR}$

(c) $\sqrt{3gR}$

(d) $\sqrt{5gR}$

11) A car is negotiating a curved road of radius R. The road is banked at an angle θ. The coefficient of friction between the tyres of the car and the road is μ_s. The maximum safe velocity on this road is:

(a) $\sqrt{gR^2 \frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$

(b) $\sqrt{gR \frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$

(c) $\sqrt{\frac{g}{R} \frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$

(d) $\sqrt{\frac{g}{R^2} \frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$

12) The minimum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150m and coefficient of friction 0.6 to avoid skidding is

(a) 60

(b) 30

(c) 15

(d) 25

13) Which of the following statements is **FALSE** for a particle moving in a circle with a constant angular speed?

(a) The acceleration vector points to the centre of the circle

(b) The acceleration vector is tangent to the circle

(c) The velocity vector is tangent to the circle

(d) The velocity and the acceleration vectors are perpendicular to each other.

14) An angular ring with inner and outer radii R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of the forces experienced by the two particles situated on the inner and outer parts of the ring, $\frac{F_1}{F_2}$ is

(a) $\left(\frac{R_1}{R_2}\right)^2$

(b) $\frac{R_2}{R_1}$

(c) $\frac{R_1}{R_2}$

(d) 1

15) For a particle in uniform circular motion, the acceleration $\vec{a}$ at a point P(R, θ) on the circle of radius R is (Here θ is measured from the x - axis)

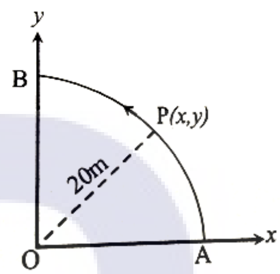
(a) $-\frac{v^2}{R}\cos\theta\,\hat{\imath}+\frac{v^2}{R}\sin\theta\,\hat{\jmath}$

(b) $-\frac{v^2}{R}\sin\theta\,\hat{\imath}+\frac{v^2}{R}\cos\theta\,\hat{\jmath}$

(c) $-\frac{v^2}{R}\cos\theta\,\hat{\imath}-\frac{v^2}{R}\sin\theta\,\hat{\jmath}$

(d) $\frac{v^2}{R}\hat{\imath}+\frac{v^2}{R}\hat{\jmath}$

16) A point P moves in counter – clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of 'P' when t = 2 is nearly



(a) 13m/s^2

(b) 12m/s^2

(c) 7.2m/s^2

(d) 14m/s^2

17) A boy of mass 'm' is tied to one end of a spring and whirled round in a horizontal plane with a constant angular velocity. The elongation in the spring is 1 cm. If the angular velocity is doubled the elongation in the spring is 5 cm. The original length of the spring is:

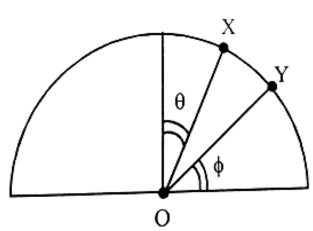
(a) 15 cm

(b) 12 cm

(c) 16 cm

(d) 10 cm

18) A particle is released on a vertical smooth semicircular track from point X so that OX makes angle θ from the vertical (See figure). The normal reaction of the track on the particle vanishes at point Y where OY makes angle ϕ with the horizontal. Then:



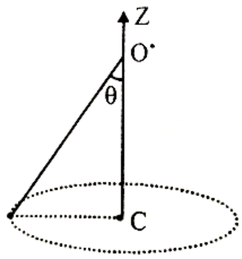
(a) $\sin\phi = \cos\phi$

(b) $\sin\phi = \frac{1}{2}\cos\theta$

(c) $\sin\phi = \frac{2}{3}\cos\theta$

(d) $\sin\phi = \frac{3}{4}\cos\theta$

19) A conical pendulum of length 1 m makes an angle θ = 45° w.r.t. Z – axis and moves in a circle in the XY plane. The radius of the circle is 0.4 m and its centre is vertically below O. The speed of the pendulum, in its circular path, will be (Take $g = 10ms^{-2}$)



(a) 0.4m/s
(b) 4m/s
(c) 0.2m/s
(d) 2m/s

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	c	a	a	c	d	c	d	d	d
11	12	13	14	15	16	17	18	19	
b	b	b	c	c	d	a	c	d	

Topic 16: Work

1) A bullet of mass 10g leaves a rifle at an initial velocity of 1000m/s and strikes the earth at the same level with a velocity of 500m/s. The work done in joules overcoming the resistance of air will be

(a) 375 (b) 3750

(c) 5000 (d) 500

2) A position dependent force, $F = (7 - 2x + 3x^2)$ N acts on a small body of mass 2kg and displaces it from x = 0 to x = 5m. Work done in joule is

(a) 35 (b) 70

(c) 135 (d) 270

3) A force acts on a 30 gm particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in metres and t is in seconds. The work done during the first 4 seconds is

(a) 576mJ (b) 450mJ

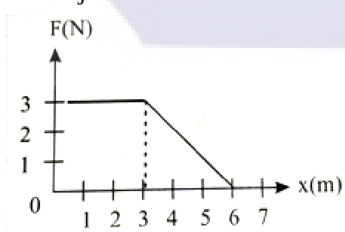
(c) 490mJ (d) 530mJ

4) A force of 250N is required to lift a 75kg mass through a pulley system. In order to lift the mass through 3m, the rope has to be pulled through 12m. The efficiency of system is

(a) 50% (b) 75%

(c) 33% (d) 90%

5) A force F acting on an object varies with distance x as shown here. The force is in N and x in m. The work done by the force in moving the object from x = 0 to x = 6m is



(a) 18.0J (b) 13.5J

(c) 9.0J (d) 4.5J

6) 300J of work is done in sliding a 2 kg block up an inclined plane of height 10m. Taking $g = 10m/s^2$, work done against friction is

(a) 100J (b) zero

(c) 1000J (d) 200J

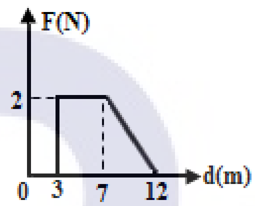
7) A body of mass 3kg is under a constant force which causes a displacement s in metres in it, given by the relation $s = \frac{1}{3}t^2$, where t is in seconds. Work done by the force in 2 seconds is

(a) $\frac{3}{8}$ J
(b) $\frac{8}{3}$ J
(c) $\frac{19}{5}$ J
(d) $\frac{5}{19}$ J

8) A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is

(a) $mg(h+d) - \frac{1}{2}kd^2$
(b) $mg(h-d) - \frac{1}{2}kd^2$
(c) $mg(h-d) + \frac{1}{2}kd^2$
(d) $mg(h+d) + \frac{1}{2}kd^2$

9) Force F on a particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12m is



(a) 18 J
(b) 21 J
(c) 26 J
(d) 13 J

10) A uniform force of $(3\hat{i} + \hat{j})$ newton acts on a particle of mass 2 kg. The particle is displaced from position $(2\hat{i} + \hat{k})$ meter to position $(4\hat{i} + 3\hat{j} - \hat{k})$ meter. The work done by the force on the particle is

(a) 6 J
(b) 13 J
(c) 15 J
(d) 9 J

11) Two similar springs P and Q have spring constants K_P and K_Q, such that $K_P > K_Q$. They are stretched, first by the same amount (case a,) then by the same force (case b). The work done by the springs W_P and W_Q are related as, in case (a) and case (b), respectively

(a) $W_P = W_Q$; $W_P = W_Q$
(b) $W_P > W_Q$; $W_Q > W_P$
(c) $W_P < W_Q$; $W_Q < W_P$
(d) $W_P = W_Q$; $W_P > W_Q$

12) Consider a drop of rain water having mass 1g falling from a height of 1km. It hits the ground with a speed of 50m/s. Take 'g' constant with a value 10m/s^2. The work done by the (i) gravitational force and the (ii) resistive force of air is

(a) (i) 1.25 J (ii) −8.25 J
(b) (i) 100 J (ii) 8.75 J
(c) (i) 10 J (ii) −8.75 J
(d) (i) −10 J (ii) −8.25 J

13) A spring of force constant 800N/m has an extension of 5cm. The work done in extending it from 5cm to 15cm is

(a) 16 J (b) 8 J

(c) 32 J (d) 24 J

14) A spring of spring constant 5×10^3N/m is stretched initially by 5cm from the unstretched position. Then the work required to stretch it further by another 5cm is

(a) 12.50 N–m (b) 18.75 N–m

(c) 25.00 N–m (d) 6.25 N–m

15) A force $\vec{F} = (5\vec{\imath} + 3\vec{\jmath} + 2\vec{k})$ N is applied over a particle which displaces it from its origin to the point $\vec{r} = (2\vec{\imath} - \vec{\jmath})$m. The work done on the particle in joules is

(a) +10 (b) +7

(c) –7 (d) +13

16) A uniform chain of length 2m is kept on a table such that a length of 60cm hangs freely from the edge of the table. The total mass of the chain is 4kg. What is the work done in pulling the entire chain on the table?

(a) 12 J (b) 3.6 J

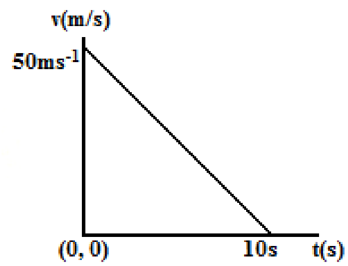
(c) 7.2 J (d) 1200 J

17) When a rubber – band is stretched by a distance x, it exerts restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber – band by L is:

(a) $aL^2 + bL^3$ (b) $\frac{1}{2}(aL^2 + bL^3)$

(c) $\frac{aL^2}{2} + \frac{bL^3}{3}$ (d) $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

18) Velocity – time graph for a body of mass 10kg is shown in figure. Work – done on the body in first two seconds of the motion is:



(a) −9300J (b) 12000J

(c) –4500J (d) –12000J

19) A time dependent force F = 6t acts on a particle of mass 1kg. If the particle starts from rest, the work done by the force during the first 1 second will be

(a) 9 J

(b) 18 J

(c) 4.5 J

(d) 22 J

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	c	a	b	b	a	b	a	d	d
11	12	13	14	15	16	17	18	19	
b	c	b	b	b	b	c	c	c	

Topic 17: Energy

1) Two bodies of masses m and 4m are moving with equal kinetic energies. The ratio of their linear momenta will be

(a) 1 : 4
(b) 4 : 1
(c) 1 : 2
(d) 2 : 1

2) A 4kg mass and 1kg are moving with equal kinetic energies. The ratio of the magnitude of their linear momenta is

(a)1 : 2
(b) 1 : 1
(c) 2 : 1
(d) 4 : 1

3) Two masses of 1g and 9g are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is

(a) 1 : 9
(b) 9 : 1
(c) 1 : 3
(d) 3 : 1

4) Consider a car moving along a straight horizontal road with a speed of 72km/h. If the coefficient of static friction between road and tyres is 0.5, the shortest distance in which the car can be stopped is

(a) 30 m
(b) 40 m
(c) 72 m
(d) 20 m

5) If the momentum of a body is increased by 50% then the percentage increase in its kinetic energy is

(a) 50%
(b) 100%
(c) 125%
(d) 200%

6) The kinetic energy acquired by a mass (m) in travelling distance (s) starting from rest under the action of a constant force is directly proportional to

(a) $1/\sqrt{m}$
(b) 1/m
(c) $\sqrt{m}$
(d) m^0

7) Two bodies of masses m and 4m are moving with equal K.E. The ratio of their linear momenta is

(a) 4 : 1
(b) 1 : 1
(c) 1 : 2
(d) 1 : 4

8) A rubber ball is dropped from a height of 5m on a plane, where the acceleration due to gravity is not shown. On bouncing it rises to 1.8m. The ball loses its velocity on bouncing by a factor by a factor of

(a) $\frac{16}{25}$
(b) $\frac{2}{5}$
(c) $\frac{3}{5}$
(d) $\frac{9}{25}$

9) Two bodies with kinetic energies in the ratio 4 :1 are moving with equal linear momentum. The ratio of their masses is

(a) 1 : 2
(b) 1 : 1
(c) 4 : 1
(d) 1 : 4

10) In a simple pendulum of length l the bob is pulled aside from its equilibrium position through an angle θ and then released. The bob passes through the equilibrium position with speed

(a) $\sqrt{2gl(1+\cos\theta)}$
(b) $\sqrt{2gl\sin\theta}$
(c) $\sqrt{2gl}$
(d) $\sqrt{2gl(1-\cos\theta)}$

11) If the kinetic energy of a particle is increased by 300%, the momentum of the particle will increase by

(a) 20%
(b) 200%
(c) 100%
(d) 50%

12) When a long spring is stretched by 2cm, its potential energy is U. If the spring is stretched by 10cm, the potential energy stored in it will be

(a) 25 U
(b) U/5
(c) 5 U
(d) 10 U

13) A ball of mass 2kg and another of mass 4kg are dropped together from a 60 feet tall building. After a fall of 30 feet each towards earth, their respective kinetic energies will be in the ratio of

(a) $1 : \sqrt{2}$
(b) $\sqrt{2} : 1$
(c) 1 : 4
(d) 1 : 2

14) A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2. Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$ then

(a) $E_1 = E_2$
(b) $E_1 < E_2$
(c) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$
(d) $E_1 > E_2$

15) A body of mass 1kg is thrown upwards with a velocity 20m/s. It momentarily comes to rest after attaining of height of 18m. How much energy is lost due to air friction? ($g = 10 m/s^2$)

(a) 30 J
(b) 40 J
(c) 10 J
(d) 20 J

16) An engine pumps water continuously through a hose. Water leaves the hose with a velocity v and m is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water?

(a) mv^2
(b) $\frac{1}{2}mv^2$
(c) $\frac{1}{2}m^2v^2$
(d) $\frac{1}{2}mv^3$

17) The potential energy of a system increases if work is done

(a) upon the system by a non conservative force

(b) by the system against a conservative force

(c) by the system against a non conservative force

(d) upon the system by a conservative force

18) A particle with total energy E is moving in a potential energy region U(x). Motion of the particle is restricted to the region when

(a) U(x) > E

(b) U(x) < E

(c) U(x) = 0

(d) U(x) $\leq$ E

19) A person holding a rifle (mass of person and rifle together is 100 kg) stands on a smooth surface and fires 10 shots horizontally, in 5s. Each bullet has a mass of 10g with a muzzle velocity of 800 ms^{-1}. The final velocity acquired by the person and the average force exerted on the person are

(a) $-1.6ms^{-1}$; 8 N

(b) $-0.08ms^{-1}$; 16 N

(c) $-0.8ms^{-1}$; 8 N

(d) $-1.6ms^{-1}$; 16 N

20) A block of mass 10kg, moving in x direction with a constant speed of $10ms^{-1}$, is subjected to a retarding force F = 0.1 × J/m during its travel from x = 20m to 30 m. Its final KE will be:

(a) 450 J

(b) 275 J

(c) 250 J

(d) 475 J

21) A particle of mass 10 g moves along a circle of radius 6.4cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to 8×10^{-4}J by the end of the second revolution after the beginning of the motion?

(a) 0.1 m/s^2

(b) 0.15 m/s^2

(c) 0.18 m/s^2

(d) 0.2 m/s^2

22) A ball whose kinetic energy is E, is projected at an angle of 45° to the horizontal. The kinetic energy of the ball at the highest point of its flight will be

(a) E

(b) $E/\sqrt{2}$

(c) $E/2$

(d) zero

23) A wire suspended vertically from one of its ends is stretched by attaching a weight of 200N to the lower end. The weight stretches the wire by 1mm. Then the elastic energy stored in the wire is

(a) 0.2 J

(b) 10 J

(c) 20 J

(d) 0.1 J

24) A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particles takes place in a plane. It follows that

(a) its kinetic energy is constant

(b) its acceleration is constant

(c) its velocity is constant

(d) it moves in a straight line

25) A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to

(a) x

(b) e^x

(c) x^2

(d) $\log_e x$

26) A spherical ball of mass 20kg is stationary at the top of a hill of height 100m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30m and finally rolls down to a horizontal base at a height of 20m above the ground. The velocity attained by the ball is

(a) 20 m/s

(b) 40 m/s

(c) $10\sqrt{30}$ m/s

(d) 10 m/s

27) A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is

(a) Mg $(\sqrt{2} + 1)$

(b) Mg $\sqrt{2}$

(c) $\frac{\text{Mg}}{\sqrt{2}}$

(d) Mg $(\sqrt{2} - 1)$

28) The potential energy of a 1kg particle free to move along the x – axis is given by $V(x) = \left(\frac{x^2}{4} - \frac{x^2}{2}\right)$J. The total mechanical energy of the particle is 2J. Then, the maximum speed (in m/s) is

(a) $\frac{3}{\sqrt{2}}$

(b) $\sqrt{2}$

(c) $\frac{1}{\sqrt{2}}$

(d) 2

29) A particle of mass 100g is thrown vertically upwards with a speed of 5m/s. The work done by the force of gravity during the time the particle goes up is

(a) −0.5 J

(b) −1.25 J

(c) 1.25 J

(d) 0.5 J

30) A particle is projected of 60° to the horizontal with a kinetic energy K. The kinetic energy at the highest point is

(a) K/2

(b) K

(c) Zero

(d) K/4

31) A 2kg block slides on a horizontal floor with a speed of 4m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15N and spring constant is 10,000 N/m. The spring compresses by

(a) 8.5cm

(b) 5.5cm

(c) 2.5cm

(d) 11.0cm

32) An athlete in the Olympics games covers a distance of 100m in10s. His kinetic energy can be estimated to be in the range

(a) 200J - 500J
(b) 2×10^5J - 3×10^5J
(c) 20,000J - 50,000J
(d) 2,000J - 5,000J

33) The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$,where a and b are constants and x is the distance between the atoms. If the dissociation energy of the molecule is

$D = [U(x = \infty) - U_{\text{at equilibrium}}]$, D is

(a) $\frac{b^2}{2a}$
(b) $\frac{b^2}{12a}$
(c) $\frac{b^2}{4a}$
(d) $\frac{b^2}{6a}$

34) A time t = 0 a particle starts moving along the x – axis. If its kinetic energy increases uniformly with time 't', the net force acting on it must be proportional to

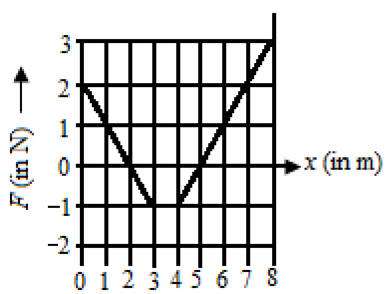
(a) constant
(b) t
(c) $\frac{1}{\sqrt{t}}$
(d) $\sqrt{t}$

35) A particle gets displaced by

$\Delta\bar{r} = (2\hat{\imath} + 3\hat{\jmath} + 4\hat{k})$ m under the action of a force $\vec{F} = (7\hat{\imath} + 4\hat{\jmath} + 3\hat{k})$. The change in its kinetic energy is

(a) 38 J
(b) 70 J
(c) 52.5 J
(d) 126 J

36) The force $\vec{F} = F\hat{\imath}$ on a particle of mass 2kg, moving along the x – axis is given in the figure as a function of its position x. The particle is moving with a velocity of 5m/s along the x – axis at x = 0. What is the kinetic energy of the particle at x = 8m?



(a) 34 J
(b) 34.5 J
(c) 4.5 J
(d) 29.4 J

37) Two springs of force constants 300N/m (Spring A) and 400N/m (Spring B) are joined together in series. The combination is compressed by 8.75cm. The ratio of energy stored in A and B is $\frac{E_A}{E_B}$. Then $\frac{E_A}{E_B}$ is equal to:

(a) $\frac{4}{3}$
(b) $\frac{16}{9}$
(c) $\frac{3}{4}$
(d) $\frac{9}{16}$

38) A spring of unstretched length l has a mass m with one end fixed to a rigid support. Assuming spring to be made of a uniform wire, the kinetic energy possessed by it if its free end is pulled with uniform velocity v is:

(a) $\frac{1}{2}$ mv^2
(b) mv^2
(c) $\frac{1}{3}$ mv^2
(d) $\frac{1}{6}$ mv^2

39) A bullet looses $\left(\frac{1}{n}\right)^{th}$ of its velocity passing through one plank. The number of such planks that are required to stop the bullet can be:

(a) $\frac{n^2}{2n-1}$
(b) $\frac{2n^2}{n-1}$
(c) infinite
(d) n

40) A block of mass m = 0.1kg is connected to a spring of unknown spring constant k. It is compressed to a distance x from its equilibrium position and released from rest. After approaching half the distance $\left(\frac{x}{2}\right)$ from equilibrium position, it hits another block and comes to rest momentarily, while the other block moves with a velocity 3ms^{-1}.

The total initial energy of the spring is:

(a) 0.3 J
(b) 0.6 J
(c) 0.8 J
(d) 1.5 J

41) A particle is moving in a circle of radius r under the action of a force F = αr^2 which is directed towards centre of the circle. Total mechanical energy (kinetic energy + potential energy) of the particle is (take potential energy = 0 for r = 0):

(a) $\frac{1}{2}$ αr^3
(b) $\frac{5}{6}$ αr^3
(c) $\frac{4}{3}$ αr^3
(d) αr^3

42) A person trying to lose weight by burning fat lifts a mass of 10kg upto a height of 1m 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he

use up considering the work done only when the weight is lifted up? Fat supplies 3.8×10^{7}J of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take $g = 9.8ms^{-2}$:

(a) 9.89×10^{-3}kg
(b) 12.89×10^{-3}kg
(c) 2.45×10^{-3}kg
(d) 6.45×10^{-3}kg

43) A point particle of mass m, moves long the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR.

The value of the coefficient of friction μ and the distance x (=QR), are, respectively close to:

(a) 0.29 and 3.5m
(b) 0.29 and 6.5m
(c) 0.2 and 6.5m
(d) 0.2 and 3.5m

44) An object is dropped from a height h from the ground. Every time it hits the ground it looses 50% of its kinetic energy. The total distance covered as $t \to \infty$ is:

(a) 3h
(b) ∞
(c) $\frac{5}{3}$ h
(d) $\frac{8}{3}$ h

45) A body of mass $m = 10^{-2}$kg is moving in a medium and experiences a frictional force $F = -kv^{2}$. Its initial speed is $v_0 = 10ms^{-1}$. If after 10s, its energy is $\frac{1}{8}mv_0^2$, the value of k will be:

(a) $10^{-4}kgm^{-1}$
(b) $10^{-1}kgm^{-1}s^{-1}$
(c) $10^{-3}kgm^{-1}$
(d) $10^{-3}kgs^{-1}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	c	c	b	c	d	c	b	d	d
11	12	13	14	15	16	17	18	19	20
c	a	d	b	d	d	d	d	c	d
21	22	23	24	25	26	27	28	29	30
a	c	d	a	c	b	d	a	b	d
31	32	33	34	35	36	37	38	39	40
b	d	c	c	a	d	a	d	a	b
41	42	43	44	45					
b	b	a	a	a					

Topic 18: Power

1) How much water, a pump of 2kW can raise in one minute to a height of 10m, take g = 10m/s^2?

(a) 1000 litres
(b) 1200 litres
(c) 100 litres
(d) 2000 litres

2) Water falls from a height of 60m at the rate of 15kg/s to operate a turbine. The losses due to frictional force are 10% of energy. How much power is generated by the turbine? (g = 10m/s^2)

(a) 8.1 kW
(b) 10.2 kW
(c) 12.3 kW
(d) 7.0 kW

3) An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2m/s. The mass per unit length of water in the pipe is 100kg/m. What is the power of the engine?

(a) 400 W
(b) 200 W
(c) 100 W
(d) 800 W

4) A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest

(a) at the highest position of the body

(b) at the instant just before the body hits the earth

(c) it remains constant all through

(d) at the instant just after the body is projected

5) A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to:

(a) t^2P_0
(b) $t^{1/2}$
(c) $t^{-1/2}$
(d) $\frac{1}{\sqrt{m}}$

6) One coolie takes 1 minute to raise a suitcase through a height of 2m but the second coolie takes 30s to raise the same suitcase to the same height. The powers of two coolies are in the ratio of

(a) 1 : 2
(b) 1 : 3
(c) 2 : 1
(d) 3 : 1

7) The heart of man pumps 5 litres of blood through the arteries per minute at a pressure of 150mm of mercury. If the density of mercury be 13.6×10^3 kg/m^3 and g =10m/s^2 then the power of heart in watt is:

(a) 2.35
(b) 3.0
(c) 1.50
(d) 1.70

8) A particle of mass m is driven by a machine that delivers a constant power of k watts. If the particle starts from rest the force on the particle at time t is

(a) $\sqrt{mk}\, t^{-1/2}$

(b) $\sqrt{2mk}\, t^{-1/2}$

(c) $\frac{1}{2}\sqrt{mk}\, t^{-1/2}$

(d) $\frac{\sqrt{mk}}{2}\, t^{-1/2}$

9) A body of mass 1kg begins to move under the action of a time dependent force $\vec{F} = (2t\hat{i} + 2t^2\hat{j})$ N, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis. What power will be developed by the force at the time t?

(a) $(2t^2 + 3t^3)$ W

(b) $(2t^2 + 4t^4)$ W

(c) $(2t^3 + 3t^4)$ W

(d) $(2t^3 + 3t^5)$ W

10) A body is moved along a straight line by a machine delivering a constant power. The distance moved by the body in time 't' is proportional to

(a) $t^{3/4}$

(b) $t^{3/2}$

(c) $t^{1/4}$

(d) $t^{1/2}$

11) A body of mass 'm', accelerates uniformly from rest to 'v_1' in time 't_1'. The instantaneous power delivered to the body as a function of time 't' is

(a) $\frac{mv_1t^2}{t_1}$

(b) $\frac{mv_1^2t}{t_1^2}$

(c) $\frac{mv_1t}{t_1}$

(d) $\frac{mv_1^2t}{t_1}$

12) A 70kg man leaps vertically into the air from a crouching position. To take the leap the man pushes the ground with a constant force F to raise himself. The center of gravity rises by 0.5m before he leaps. After the leap the c.g. rises by another 1m. The maximum power delivered by the muscles is: (Take g = $10ms^{-2}$)

(a) 6.26×10^3 Watts at the start

(b) 6.26×10^3 Watts at take off

(c) 6.26×10^4 Watts at the start

(d) 6.26×10^4 Watts at take off

13) A wind – powered generator 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 v, the electrical power output will be most likely proportional to

(a) v^4

(b) v^2

(c) v^3

(d) v

14) A car of weight W is on inclined road that rises by 100m over a distance of 1Km and applies a constant frictional force $\frac{W}{20}$ on the car. While moving uphill on the road at a speed of $10ms^{-1}$, the car needs power P. If it need power $\frac{P}{2}$ while moving downhill at speed v then value of v is:

(a) $20ms^{-1}$ (b) $5ms^{-1}$

(c) $15ms^{-1}$ (d) $10ms^{-1}$

15) A particle of mass M is moving in a circle of fixed radius R in such a way that its centripetal acceleration at time t is given by n^2Rt^2 where n is a constant. The power delivered to the particle by the force acting on it, is:

(a) $\frac{1}{2}Mn^2R^2t^2$ (b) Mn^2R^2t

(c) MnR^2t^2 (d) MnR^2t

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	a	a	b	b	a	d	d	d	b
11	12	13	14	15					
b	b	d	c	b					

Topic 19: Collisions

1) The co – efficient of restitution e for a perfectly elastic collision is

(a) 1
(b) 0
(c) ∞
(d) –1

2) A body of mass 5kg explodes at rest into three fragments with masses in the ratio 1 : 1 : 3. The fragments with equal masses fly in mutually perpendicular directions with speeds of 21m/s. The velocity of heaviest fragment in m/s will be

(a) $7\sqrt{2}$
(b) $5\sqrt{2}$
(c) $3\sqrt{2}$
(d) $\sqrt{2}$

3) Two identical ball A and B moving with velocities +0.5 m/s and −0.3m/s respectively, collide head on elasticity. The velocities of the balls A and B after collision, will be, respectively

(a) +0.5 m/s and +0.3m/s
(b) −0.3m/s and +0.5 m/s
(c) +0.3m/s and 0.5 m/s
(d) −0.5m/s and +0.3 m/s

4) A shell is fired from a cannon, it explodes in mid air, its total

(a) momentum increases
(b) momentum decreases
(c) K.E. increases
(d) K.E. decreases

5) A body of mass m moving with velocity 3km/h collides with a body of mass 2m at rest. Now the coalesced mass starts to move with a velocity

(a) 1km/h
(b) 2 km/h
(c) 3 km/h
(d) 4 km/h

6) A metal ball of mass 2kg moving with a velocity of 36km/h has a head on collision with a stationary ball of mass 3kg. If after the collision, the two balls move together, the loss in kinetic energy due to collision is

(a) 140 J
(b) 100 J
(c) 60 J
(d) 40 J

7) A molecule of mass m of an ideal gas collides with the wall of a vessel with a velocity v and returns back with the same velocity. The change in linear momentum of molecule is

(a) 2 mv
(b) 4 mv
(c) 8 mv
(d) 10 mv

8) Two equal masses m_1 and m_2 moving along the same straight line with velocities +3m/s and – 5m/s respectively, collide elastically. Their velocities after the collision will be respectively.

(a) $-3m/s$ & $+5m/s$

(b) $+4m/s$ for both

(c) $-4m/s$ & $+4m/s$

(d) $-5m/s$ & $+3m/s$

9) A bomb of mass 1kg thrown vertically upwards with a speed of 100m/s. After 5 seconds it explodes into two fragments. One fragment of mass 400gm is found to go down with a speed of 25m/s. What will happen to the second fragment just after the explosion? ($g = 10m/s^2$)

(a) It will go upward with speed 40m/s

(b) It will go upward with speed 100m/s

(c) It will go upward with speed 60m/s

(d) It will also go downward with speed 40m/s

10) A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1/E_2 is

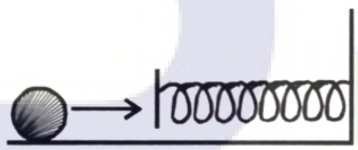
(a) m_1v_2/m_2v_1

(b) m_2/m_1

(c) m_1/m_2

(d) 1

11) A mass of 0.5kg moving with a speed of 1.5m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k = 50N/m$. The maximum compression of the spring would be



(a) 0.5m

(b) 0.15m

(c) 0.12m

(d) 1.5m

12) A bomb of mass 30kg at rest explodes into two pieces of masses 18kg and 12kg. The velocity of 18kg mass is $6ms^{-1}$. The kinetic energy of the other mass is

(a) 324 J

(b) 486 J

(c) 256 J

(d) 524 J

13) A shell of mass 200gm is ejected from a gun of mass 4kg by an explosion that generates 1.05kJ of energy. The initial velocity of the shell is:

(a) $100\ ms^{-1}$

(b) $80\ ms^{-1}$

(c) $40\ ms^{-1}$

(d) $120\ ms^{-1}$

14) An explosion blows a rock into three parts. Two parts go off at right angles to each other. These two are, 1kg first part moving with a velocity of $12ms^{-1}$ and 2kg second part moving with a velocity of $8ms^{-1}$. If the third part flies off with a velocity of $4\ ms^{-1}$, its mass would be:

(a) 7 kg

(b) 17 kg

(c) 3 kg

(d) 5 kg

15) A ball moving with velocity 2 m/s collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in m/s) after collision will be:

(a) 0, 1
(b) 1, 1
(c) 1, 0.5
(d) 0, 2

16) A mass m moving horizontally (along the x – axis) with velocity v collides and sticks to mass of 3m moving vertically upward (along the y – axis) with velocity 2v. The final velocity of the combination is

(a) $\frac{1}{4}v\hat{\imath} + \frac{3}{2}v\hat{\jmath}$
(b) $\frac{1}{3}v\hat{\imath} + \frac{2}{3}v\hat{\jmath}$
(c) $\frac{2}{3}v\hat{\imath} + \frac{1}{3}v\hat{\jmath}$
(d) $\frac{3}{2}v\hat{\imath} + \frac{1}{4}v\hat{\jmath}$

17) Two spheres A and B of masses m_1 and m_2 respectively collide. A is at rest initially and B is moving with velocity v along x – axis. After collisions B has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass A moves after collision in the direction.

(a) Same as that of B
(b) Opposite to that of B
(c) $\theta = \tan^{-1}(1/2)$ to the x – axis
(d) $\theta = \tan^{-1}(-1/2)$ to the x – axis

18) A solid cylinder of mass 3 kg is rolling on a horizontal surface with a velocity $4ms^{-1}$. It collides with a horizontal spring of force constant $200Nm^{-1}$. The maximum compression produced in the spring will be:

(a) 0.5m
(b) 0.6m
(c) 0.7m
(d) 0.2m

19) An explosion break a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1kg moves with a speed of $12ms^{-1}$ and the second part of 2 kg moves with speed $8ms^{-1}$. If the third part flies off with speed 4 ms^{-1} then its mass is

(a) 5 kg
(b) 7 kg
(c) 17 kg
(d) 3 kg

20) A body of mass (4m) is lying in x – y plane at rest. It suddenly explodes into three pieces. Two pieces, each of mass (m) move perpendicular to each other with equal speeds (v). The total kinetic energy generated due to explosion is:

(a) mv^2
(b) $\frac{3}{2}mv^2$
(c) $2\ mv^2$
(d) $4\ mv^2$

21) A ball is thrown vertically downwards from a height of 20m with an initial velocity v_0. It collides with the ground loses 50 percent of its energy in collision and rebounds to the same height. The initial velocity v_0 is:

(a) 20 ms^{-1}
(b) $28ms^{-1}$
(c) 10 ms^{-1}
(d) 14 ms^{-1}

22) On a frictionless surface a block of mass M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed $\frac{v}{3}$. The second block's speed after the collision is:

(a) $\frac{3}{4}$ v

(b) $\frac{3}{\sqrt{2}}$ v

(c) $\frac{\sqrt{3}}{2}$ v

(d) $\frac{2\sqrt{2}}{3}$

23) Two particles A and B, move with constant velocities $\vec{v}_1$ and $\vec{v}_2$. At initial moment their position vectors are $\vec{r}_1$ and $\vec{r}_2$ respectively. The condition for particles A and B for their collision is:

(a) $\vec{r}_1 . \vec{v}_1 = \vec{r}_2 . \vec{v}_2$

(b) $\vec{r}_1 \times \vec{v}_1 = \vec{r}_2 \times \vec{v}_2$

(c) $\vec{r}_1 - \vec{r}_2 = \vec{v}_1 - \vec{v}_2$

(d) $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} = \frac{\vec{v}_2 - \vec{v}_1}{|\vec{v}_2 - \vec{v}_1|}$

24) Consider the following two statements:

A. Linear momentum of a system of particles is zero.

B. Kinetic energy of a system of particles is zero. Then

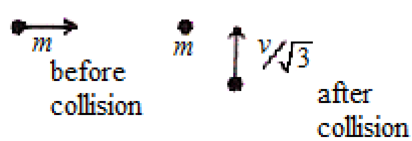
(a) A does not imply B and B does not imply A

(b) A implies B but B does not imply A

(c) A does not imply B but B implies A

(d) A implies B and B implies A

25) A mass 'm' moves with a velocity 'v' and collides inelastically with another identical mass. After collisions the 1st mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision.



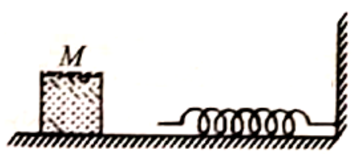
(a) $\sqrt{3}$v

(b) v

(c) $\frac{v}{\sqrt{3}}$

(d) $\frac{2}{\sqrt{3}}$ v

26) The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant k and compresses it by length L. The maximum moment of the block after collision is



(a) $\frac{kL^2}{2M}$

(b) $\sqrt{Mk}$ L

(c) $\frac{ML^2}{k}$

(d) zero

27) A bomb of mass 16kg at rest explodes into two pieces of masses 4kg and 12kg. The velocity of the 12kg mass is $4ms^{-1}$. The kinetic energy of the other mass is

(a) 144J

(b) 288J

(c) 192J

(d) 96J

28) A block of mass 0.50kg is moving with a speed of $2.00ms^{-1}$ on a smooth surface. It strikes another mass of 1.00kg and then they move together as a single body. The energy loss during the collision is

(a) 0.16 J

(b) 1.00 J

(c) 0.67 J

(d) 0.34 J

29) **Statement – 1:** Two particles moving in the same direction do not lose all their energy in a completely inelastic collision.

Statement – 2: Principal of conservation of momentum holds true for all kinds of collisions.

(a) Statement – 1is true, Statement – 2 is true; Statement – 2 is the correct explanation of Statement – 1.

(b) Statement – 1is true, Statement – 2 is true; Statement – 2 is not the correct explanation of Statement – 1.

(c) Statement – 1is false, Statement – 2 is true.

(d) Statement – 1is true, Statement – 2 is false.

30) A projectile moving vertically upwards with a velocity of $200ms^{-1}$ breaks into two equal parts at a height of 490m. One part starts moving vertically upwards with a velocity of $400ms^{-1}$. How much time it will take, after the breakup with the other part to hit the ground?

(a) $2\sqrt{10}$ s

(b) 5 s

(c) 10 s

(d) $\sqrt{10}$ s

31) Two bodies A and B of mass *m* and 2*m* respectively are placed on smooth floor. They are connected by a spring of negligible mass. A third body C of mass *m* is placed on the floor. The body C moves with a velocity v_0 along the line joining A and B and collides elastically with A. At a certain time after the collision it is found that the instantaneous velocities of A and B are same and the compression of the spring is x_0. The spring constant *k* will be

(a) $m\frac{v_0^2}{x_0^2}$

(b) $m\frac{v_0}{2x_0}$

(c) $2m\frac{v_0}{x_0}$

(d) $\frac{2}{3}m\left(\frac{v_0}{x_0}\right)^2$

32) A moving particle of mass *m*, makes a head on elastic collision with another particle of mass 2*m*, which is initially at rest. The percentage loss in energy of the colliding particle on collision, is close to

(a) 33%
(b) 67%
(c) 90%
(d) 10%

33) A projectile of mass *M* is fired so that the horizontal range is 4km. At the highest point the projectile explodes in two parts of masses *M*/4 and 3*M*/4 respectively and the heavier part starts falling down vertically with zero initial speed. The horizontal range (distance from point of firing) of the lighter part is:

(a) 16km
(b) 1km
(c) 10km
(d) 2km

34) This question has statement I and statement II. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement – I: A point particle of mass m moving with speed υ collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\frac{1}{2}mv^2\right)$ then $f = \left(\frac{m}{M+m}\right)$

Statement –II: Maximum energy loss occurs when the particles get stuck together as a result of the collision.

(a) Statement – I is true, Statement – II is true; Statement – II is the correct explanation of Statement – I.

(b) Statement – I is true, Statement – II is true; Statement – II is not the correct explanation of Statement – I.

(c) Statement – I is true, Statement – II is false.

(d) Statement – I is false, Statement – II is true.

35) Three masses m, 2m and 3m are moving in x – y plane with speed 3u, 2u and u respectively as shown in figure. The three masses collide at the same point at P and stick together. The velocity of resulting mass will be:

(a) $\frac{u}{12}\left(\hat{i}+\sqrt{3}\hat{j}\right)$
(b) $\frac{u}{12}\left(\hat{i}-\sqrt{3}\hat{j}\right)$
(c) $\frac{u}{12}\left(-\hat{i}+\sqrt{3}\hat{j}\right)$
(d) $\frac{u}{12}\left(-\hat{i}-\sqrt{3}\hat{j}\right)$

36) A bullet of mass 4g is fired horizontally with a speed of 300m/s into 0.8kg block of wood at rest on a table. If the coefficient of friction between the block ant the table is 0.3, how far will the block slide approximately?

(a) 0.19m
(b) 0.379m

(c) 0.569m

(d) 0.758m

37) A particle of mass m moving in the x direction with speed $2v$ is hit by another particle of mass $2m$ moving in the y direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to:

(a) 56%

(b) 62%

(c) 44%

(d) 50%

38) A neutron moving with a speed 'v' makes a head on collision with a stationary hydrogen atom in ground state. The minimum kinetic energy of the neutron for which inelastic collision will take place is:

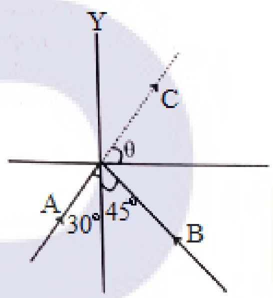
(a) 20.4eV

(b) 10.2eV

(c) 12.1eV

(d) 16.8eV

39) Two particles A and B of equal mass M are moving with the same speed v as shown in the figure. They collide completely inelastically and move as a single particle C. The angel θ that the path of C makes with the X – axis is given by:



(a) $\tan\theta = \dfrac{\sqrt{3}+\sqrt{2}}{1-\sqrt{2}}$

(b) $\tan\theta = \dfrac{\sqrt{3}-\sqrt{2}}{1-\sqrt{2}}$

(c) $\tan\theta = \dfrac{1-\sqrt{2}}{\sqrt{2}(1+\sqrt{3})}$

(d) $\tan\theta = \dfrac{1-\sqrt{3}}{1+\sqrt{2}}$

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
a	a	b	c	a	c	a	d	b	b
11	12	13	14	15	16	17	18	19	20
b	b	a	d	a	a	c	b	a	b
21	22	23	24	25	26	27	28	29	30
a	d	d	c	d	b	b	c	a	c
31	32	33	34	35	36	37	38	39	
d	c	c	d	d	b	a	a	a	

Topic 20: Centre of Mass, Centre of Gravity & Principle of Moments

1) In carbon monoxide molecule, the carbon and the oxygen atoms are separated by a distance 1.12×10^{-10} m. The distance of the centre of mass from the carbon atom is

(a) 0.64×10^{-10} m (b) 0.56×10^{-10} m

(c) 0.51×10^{-10} m (d) 0.48×10^{-10} m

2) The centre of mass of a system of particles does not depend upon

(a) masses of the particles (b) forces acting on the particles

(c) position of the particles (d) relative distances between the particles

3) A solid sphere of radius R is placed on a smooth horizontal surface. A horizontal force F is applied at height h from the lowest point. For the maximum acceleration of the centre of mass,

(a) h = R

(b) $h = 2R$

(c) $h =0$

(d) The acceleration will be same whatever h may be

4) If the linear density (mass per unit length) of a rod of length 3m is proportional to x, where x is the distance from one end of the rod, the distance of the centre of gravity of the rod from this end is

(a) 2.5m (b) 1 m

(c) 1.5m (d) 2m

5) Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i} + 2\hat{j} + \hat{k}$ and $-3\hat{i} - 2\hat{j} + \hat{k}$ respectively. The centre of mass of this system has a position vector:

(a) $-2\hat{i} - \hat{j} + \hat{k}$ (b) $2\hat{i} - \hat{j} - 2\hat{k}$

(c) $-\hat{i} + \hat{j} + \hat{k}$ (d) $-2\hat{i} + 2\hat{k}$

6) Two particles which are initially at rest, move towards each other under the action of their internal attraction. If their speeds are v and $2v$ at any instant, then the speed of centre of mass of the system will be:

(a) $2v$ (b) zero

(c) 1.5 (d) v

7) Three masses are placed on the x - axis: 300g at origin, 500g at x = 40cm and 400g at x = 70cm. The distance of the centre of mass from the origin is:

(a) 40cm (b) 45cm

(c) 50cm (d) 30cm

8) Two persons of masses 55 kg NS 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water the centre of mass of the system shifts by:

(a) 3.0 m (b) 2.3 m

(c) zero (d) 0.75 m

9) Which of the following statements are correct?

(A) Centre of mass of a body always coincides with the centre of gravity of the body.

(B) Centre of mass of a body is the point at which the total gravitational torque on the body is zero.

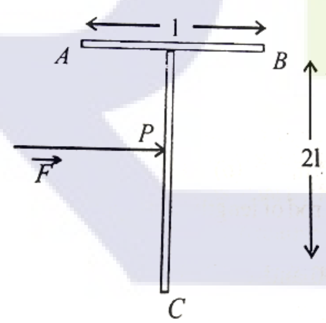
(C) A couple on a body produce both translational and rotational and rotation motion in a body.

(D) Mechanical advantages greater than one means that small effort can be used to lift a large load.

(a) (A) and (B) (b) (B) and (C)

(c) (C) and (D) (d) (B) and (D)

10) A 'T' shaped object with dimensions shown in the figure, is lying on a smooth floor. A force '$\vec{F}$'is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect to C.



(a) $\frac{3}{2}l$ (b) $\frac{2}{3}l$

(c) l (d) $\frac{4}{3}l$

11) A body A of mass M while falling vertically downwards under gravity breaks into two parts; a body B of mass $\frac{1}{3}$ M and a body C of mass $\frac{2}{3}$ M. The centre of mass of bodies B and C taken together shifts compared to that of body A towards

(a) does not shift (b) depends on height of breaking

(c) body B (d) body C

12) Consider a two particle system with particles having masses m_1 and m_2. If the first particle is pushed towards the centre of mass through a distance d, by what distance should the second particle is moved, so as to keep the centre of mass at the same position?

(a) $\frac{m_2}{m_1} d$

(b) $\frac{m_1}{m_1+m_2} d$

(c) $\frac{m_1}{m_2} d$

(d) d

13) A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumstances of the discs coincide. The centre of mass of the new disc is α/R form the center of the biggest disc. The value of α is

(a) 1/4

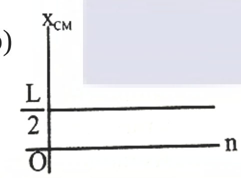
(b) 1/3

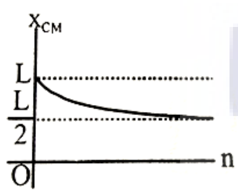
(c) 1/2

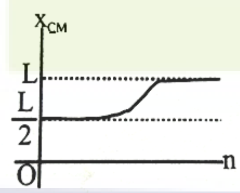
(d) 1/6

14) A thin rod of length 'L' is lying along the x – axis with its ends at x = 0 and x = L. Its linear density (mass/length) varies with x as $k\left(\frac{x}{L}\right)^n$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best approximates the dependence of x_{CM} on n?

(a)

(b) 

(c) 

(d) 

15) A boy of mass 20kg is standing on a 80kg free to move long cart. There is negligible friction between cart and ground. Initially, the boy is standing 25m from a wall. If he walks 10m on the cart towards the wall, then the final distance of the boy from the wall will be

(a) 15m

(b) 12.5m

(c) 15.5m

(d) 17m

16) A thin bar of length L has a mass per unit length λ, that increases linearly with distance from one end. If its total mass is M and its mass per unit length at the lighter end is λ_0, then the distance of the centre of mass from the lighter end is:

(a) $\frac{L}{2} - \frac{\lambda_0 L^2}{4M}$

(b) $\frac{L}{3} + \frac{\lambda_0 L^2}{8M}$

(c) $\frac{L}{3} + \frac{\lambda_0 L^2}{4M}$

(d) $\frac{2L}{3} + \frac{\lambda_0 L^2}{6M}$

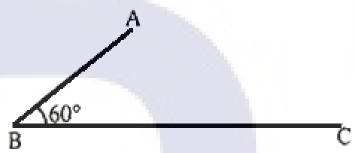
17) A uniform thin rod AB of length L has linear mass density $\mu(x) = a + \frac{bx}{L}$, where x is measured from A. If the CM of the rod lies at a distance of $\left(\frac{7}{12}\right)L$ from A, then a and b are related as:

(a) a = 2b
(b) 2a = b
(c) a = b
(d) 3a = 2b

18) Distance of the centre of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is R and its height is h then z_0 is equal to:

(a) $\frac{5h}{8}$
(b) $\frac{3h^2}{8R}$
(c) $\frac{h^2}{4R}$
(d) $\frac{3h}{4}$

19) In the figure shown ABC is a uniform wire. If centre of mass of wire lies vertically below point A, then $\frac{BC}{AB}$ is close to:



(a) 1.85
(b) 1.5
(c) 1.37
(d) 3

20) In a physical balance working on the principle of moments, when 5mg weight is placed on the left pan, the beam becomes horizontal. Both the empty pans of the balance are of equal mass. Which of the following statements is correct?

(a) Left arm is longer than the right arm
(b) Both the arms are of same length
(c) Left arm is shorter than the right arm
(d) Every object that is weighed using this balance appears lighter than its actual weight.

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	b	d	d	a	b	a	c	d	d
11	12	13	14	15	16	17	18	19	20
a	c	b	a	d	c	b	d	c	c

Topic 21: Angular Displacement, Velocity and Acceleration

1) Two racing cars of masses m and 4m moving in circles of radii r and 2r respectively. If their speeds are such that each makes a complete circle in the same time, then the ratio of the angular speeds of the first to the second car is

(a) 8 : 1
(b) 4 : 1
(c) 2 : 1
(d) 1 : 1

2) The angular speed of an engine wheel making 90 revolutions per minute is

(a) 1.5π rad/s
(b) 3π rad/s
(c) 4.5π rad/s
(d) 6π rad/s

3) If a flywheel makes 120 revolutions/minute, then its angular speed will be

(a) 8π rad/ sec
(b) 6π rad/sec
(c) 4π rad/sec
(d) 2π rad/sec

4) Two racing cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that each makes a complete circle in the same time t. The ratio of the angular speeds of the first to the second car is

(a) 1 : 1
(b) $m_1 : m_2$
(c) $r_1 : r_2$
(d) $m_1m_2 : r_1r_2$

5) A wheel of radius 1m rolls forward half a revolution on a horizontal ground. The magnitude of the displacement of the point of the wheel initially in contact with the ground is

(a) π
(b) 2π
(c) $\sqrt{2}\pi$
(d) $\sqrt{\pi^2 + 4}$

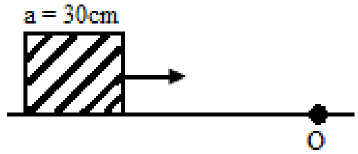
6) A wheel has angular acceleration of 3.0 rad/sec^2 and an initial angular speed of 2.00 rad/sec. In a time of 2 sec it has rotated through an angle (in radian) of

(a) 10
(b) 12
(c) 4
(d) 6

7) Two point masses of mass $m_1 = fM$ and $m_2 = (1 - f)M$ ($f < 1$) are in outer space (far from gravitational influence of other objects) at a distance R from each other. They move in circular orbits about their centre of mass with angular velocities ω_1 for m_1 and ω_2 for m_2. In that case

(a) $(1 - f)\, \omega_1 = f\, \omega$
(b) $\omega_1 = \omega_2$ and independent of f
(c) $f\omega_1 = (1 - f)\, \omega_2$
(d) $\omega_1 = \omega_2$ and depend on f

8) A cubical block of side 30cm is moving with velocity $2ms^{-1}$ on a smooth horizontal surface. The surface has a bump at a point O as shown in figure. The angular velocity (in rad/s) of the block immediately after it hits the bump, is:



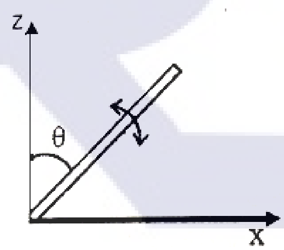
(a) 13.3
(b) 5.0
(c) 9.4
(d) 6.7

9) Concrete mixture is made by mixing cement, stone and sand in a rotating cylindrical drum. If the drum rotates too fast, the ingredients remain stuck to the wall of the drum and proper mixing of ingredients does not take place. The maximum rotational speed of the drum in revolutions per minute (rpm) to ensure proper mixing is close to:

(Take the radius of the drum to be 1.25 m and its axle to be horizontal):

(a) 27.0
(b) 0.4
(c) 1.3
(d) 8.0

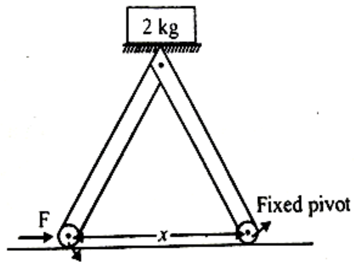
10) A slender uniform rod of mass M and length *l* is pivoted at one end so that it can rotate in a vertical plane (see figure). There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it makes an angle θ with the vertical is



(a) $\frac{3g}{2l}\cos\theta$
(b) $\frac{2g}{3l}\cos\theta$
(c) $\frac{3g}{2l}\sin\theta$
(d) $\frac{2g}{2l}\sin\theta$

11) The machine as shown has 2 rods of length 1m connected by a pivot at the top. The end of one rod is connected to the connected to the floor by a stationary pivot and the end of the other rod has a roller that rolls along the floor in a slot.

As the roller goes back and forth, a 2kg weight moves up and down. If the roller is moving towards right at a constant speed, the weight moves up with a:



(a) constant speed

(b) decreasing speed

(c) increasing speed

(d) speed which is $\frac{3}{4}$ th of that of the roller when the weight is 0.4m above the ground

ANSWER KEY										
1	2	3	4	5	6	7	8	9	10	11
d	b	c	a	d	a	b	b	a	c	b

Topic 22: Torque, Couple and Angular Momentum

1) A solid homogeneous sphere of mass M and radius R is moving on a rough horizontal surface, partly rolling and partly sliding. During this kind of motion of the sphere

(a) total kinetic energy is conserved

(b) the angular momentum of the sphere about the point of contact with the plane is conserved

(c) only the rotational kinetic energy about the centre of mass is conserved

(d) angular momentum about the centre of mass is conserved

2) A particle of mass m = 5 is moving with a uniform speed $v = 3\sqrt{2}$ in the XOY plane along the line y = x + 4. The magnitude of the angular momentum of the particle about the origin is

(a) 60 units

(b) $40\sqrt{2}$ units

(c) zero

(d) 7.5 units

3) Angular momentum is

(a) vector (axial)

(b) vector (polar)

(c) scalar

(d) none of the above

4) The angular momentum of a body with mass (m), moment of inertia (I) and angular velocity (ω) rad/s is equal to

(a) $I\omega$

(b) $I\omega^2$

(c) $\frac{I}{\omega}$

(d) $\frac{I}{\omega^2}$

5) A couple produces

(a) a motion

(b) purely linear motion

(c) Purely rotational motion

(d) linear and rotational

6) A weightless ladder 20 ft long rests against a frictionless wall at an angle of 60° from the horizontal. A 150 pound man is 4 ft from the top of the ladder. A horizontal force is needed to keep it from slipping. Choose the correct magnitude of the force from the following

(a) 175lb

(b) 100lb

(c) 120lb

(d) 69.2lb

7) A constant torque of 1000 N-m turns a wheel of moment of inertia 200 kg-m^2 about an axis through its centre. Its angular velocity after 3 seconds is

(a) 1 rad/s

(b) 5 rad/s

(c) 10 rad/s

(d) 15 rad/s

8) A boy suddenly comes and sits on a circular rotating table. What will remain conserved?

(a) Angular velocity
(b) Angular momentum
(c) Linear momentum
(d) Kinetic energy

9) A disc is rotating with angular velocity ω. If a child sits on it, what is conserved?

(a) Linear momentum
(b) Angular momentum
(c) Kinetic energy
(d) Moment of inertia

10) A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Four objects each of mass m, are kept gently to the opposite ends of two perpendicular diameters of the ring. The angular velocity of the ring will be

(a) $\frac{(M-4m)\omega}{M+4m}$
(b) $\frac{M\omega}{4m}$
(c) $\frac{M\omega}{M+4m}$
(d) $\frac{(M+4m)\omega}{M}$

11) A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of discs is

(a) $\frac{(I_1+I_2)\omega}{I_1}$
(b) $\frac{I_2\omega}{I_1+I_2}$
(c) ω
(d) $\frac{I_1\omega}{I_1+I_2}$

12) Consider a system of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the centre of mass of particles through a distance d, by what distance would the particle of mass m_2 move so as to keep the centre of mass m_2 move so as to keep the centre of mass of particles at the original position?

(a) $\frac{m_2}{m_1}d$
(b) $\frac{m_1}{m_1+m_2}d$
(c) $\frac{m_1}{m_2}d$
(d) d

13) A wheel having moment of inertia 2kg-m^2 about its vertical axis, rotates at the rate of 60rpm about this axis. The torque which can stop the wheel's rotation in one minute would be

(a) $\frac{\pi}{18}$ N - m
(b) $\frac{2\pi}{15}$ N - m
(c) $\frac{\pi}{12}$ N - m
(d) $\frac{\pi}{15}$ N - m

14) Two bodies have their moments of inertia I and 2I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momenta will be in the ratio

(a) 2 : 1
(b)1 : 2

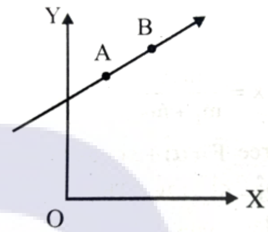
(c) $\sqrt{2} : 1$ (d) $1 : \sqrt{2}$

15) A tube of length L is filled completely with an incompressible liquid of mass M and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

(a) $\frac{ML^2\omega}{2}$ (b) $ML\omega^2$

(c) $\frac{ML^2\omega^2}{2}$ (d) $\frac{ML\omega^2}{2}$

16) A particle of mass m moves in the XY plane with a velocity v along the straight line AB. If the angular momentum of the particle with respect to origin O is L_A when it is at A and L_B when it is at B, then



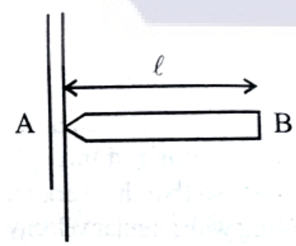
(a) $L_A = L_B$

(b) The relationship between L_A and L_B depends upon the slope of the line AB

(c) $L_A < L_B$

(d) $L_A > L_B$

17) A uniform rod AB of length l, and mass m is free to rotate about point A. The rod is released from rest in horizontal position. Given that the moment of inertia of the rod about A is $\frac{ml^2}{3}$ the initial angular acceleration of the rod will be



(a) $\frac{mgl}{2}$ (b) $\frac{3}{2}gl$

(c) $\frac{3g}{2l}$ (d) $\frac{2g}{3l}$

18) If $\vec{F}$ is the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then:

(a) $\vec{r} \cdot \vec{\tau} > 0$ and $\vec{F} \cdot \vec{\tau} < 0$ (b) $\vec{r} \cdot \vec{\tau} = 0$ and $\vec{F} \cdot \vec{\tau} = 0$

(c) $\vec{r} \cdot \vec{\tau} = 0$ and $\vec{F} \cdot \vec{\tau} \neq 0$ (d) $\vec{r} \cdot \vec{\tau} \neq 0$ and $\vec{F} \cdot \vec{\tau} = 0$

19) A thin circular ring of mass M and radius R is rotating in a horizontal plane about an axis vertical to its plane with a constant angular velocity ω. If two objects each of mass m be attached gently to the opposite ends of a diameter of the ring, the ring will then rotate with an angular velocity:

(a) $\frac{\omega M}{M+2m}$

(b) $\frac{\omega (M+2m)}{M}$

(c) $\frac{\omega M}{M+m}$

(d) $\frac{\omega (M-2m)}{M+2m}$

20) A circular disk of moment of inertia I_t is rotating in a horizontal plane, its symmetry axis, with a constant angular speed ω_i. Another disk of moment of inertia I_b is dropped coaxially onto the rotating disk. Initially the second disk has zero angular speed. Eventually both the disks rotate with a constant angular speed ω_f. The energy lost by the initially rotating disk to friction is:

(a) $\frac{1}{2}\frac{I_b^2}{(I_t+I_b)}\omega_i^2$

(b) $\frac{I_t^2}{(I_t+I_b)}\omega_i^2$

(c) $\frac{I_b-I_t}{(I_t+I_b)}\omega_i^2$

(d) $\frac{1}{2}\frac{I_b I_t}{(I_t+I_b)}\omega_i^2$

21) The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at

(a) t = 1s

(b) t = 0.5s

(c) t = 0.25s

(d) t = 2s

22) A circular platform is mounted on a frictionless vertical axle. Its radius R = 2m and its moment of inertia about the axle is $200 kgm^2$. It is initially at rest. A 50kg man stands on the edge of the platform and begins to walk along the edge at the speed of $1 ms^{-1}$ relative to the ground. Time taken by the man to complete one revolution is

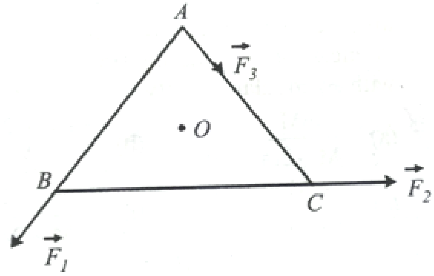
(a) πs

(b) $\frac{3\pi}{2}$ s

(c) 2πs

(d) $\frac{\pi}{2}$ s

23) ABC is an equilateral triangle with O as its centre. $\vec{F}_1$, $\vec{F}_2$ and $\vec{F}_3$ represent three forces acting along the sides AB, BC and AC respectively. If the total torque about O is zero the magnitude of $\vec{F}_3$ is:



(a) $F_1 + F_2$

(b) $F_1 - F_2$

(c) $\frac{F_1 + F_2}{2}$

(d) $2(F_1 + F_2)$

24) When a mass is rotating in a plane about a fixed point, its angular momentum is directed along:

(a) a line perpendicular to the plane of rotation

(b) the line making an angle of 45° to the plane of rotation

(c) the radius

(d) the tangent to the orbit

25) Two discs are rotating about their axes, normal to the discs and passing through the centres of the discs. Disc D_1 has 2kg mass and 0.2m radius and initial angular velocity of 50 rad s^{-1}. Disc D_2 has 4kg mass, 0.1m radius and initial angular velocity of 200 rad s^{-1}. The two discs are brought in contact face to face, with their axes of rotation coincident. The final angular velocity (in rad s^{-1}) of the system is

(a) 40
(b) 60
(c) 100
(d) 120

26) A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is

(a) $\frac{g}{L}$
(b) $\frac{2g}{L}$
(c) $\frac{2g}{3L}$
(d) $\frac{3g}{2L}$

27) A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions s^{-2} is:

(a) 25N
(b) 50N
(c) 78.5N
(d) 157N

28) A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is:

(a) 2
(b) zero
(c) 1
(d) –1

29) Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about and axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum is given by:

(a) $x = \frac{m_1}{m_2} L$

(b) $x = \frac{m_2}{m_1} L$

(c) $x = \frac{m_2 L}{m_1+m_2}$

(d) $x = \frac{m_1 L}{m_1+m_2}$

30) An automobile moves on a road with a speed of 54 km h^{-1}. The radius of its wheels is 0.45 m and the moment of inertia of the wheel about its axis of rotation is 3 kg m^2. If the vehicle is brought to rest in 15s, the magnitude of average torque transmitted by its brakes to the wheel is:

(a) 8.58 kg $m^2 s^{-2}$

(b) 10.86 kg $m^2 s^{-2}$

(c) 2.86 kg $m^2 s^{-2}$

(d) 6.66 kg $m^2 s^{-2}$

31) A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at distance x from A. The normal reaction on A is

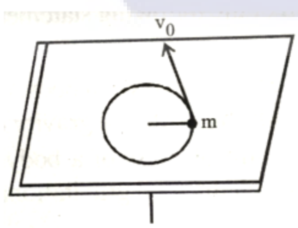
(a) $\frac{Wd}{x}$

(b) $\frac{W(d-x)}{x}$

(c) $\frac{W(d-x)}{d}$

(d) $\frac{Wx}{d}$

32) A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to string which passes through a smooth hole in the plane as shown.



The tension in the string is increased gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is

(a) $\frac{1}{4} mv_0^2$

(b) $2mv_0^2$

(c) $\frac{1}{2} mv_0^2$

(d) mv_0^2

33) A uniform circular disc of radius 50cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad s^{-2}.Its net acceleration in ms^{-2} at the end of 2.0s is approximately:

(a) 8.0

(b) 7.0

(c) 6.0

(d) 3.0

34) A rope is wound around a hallow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N?

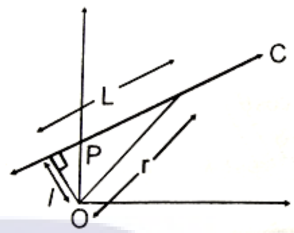
(a) 0.25 rad/s^2

(b) 25 rad/s^2

(c) 5 m/s^2

(d) 25 m/s^2

35) A particle of mass *m* moves along line PC with velocity v as shown. What is the angular momentum of the particle about P?



(a) mvL

(b) mv*l*

(c) mvr

(d) zero

36) Let $\vec{F}$ be the force acting on a particle having position vector $\vec{r}$, and $\vec{T}$ be the torque of this force about the origin. Then

(a) $\vec{r}.\vec{T} = 0$ and $\vec{F}.\vec{T} \neq 0$

(b) $\vec{r}.\vec{T} \neq 0$ and $\vec{F}.\vec{T} = 0$

(c) $\vec{r}.\vec{T} \neq 0$ and $\vec{F}.\vec{T} \neq 0$

(d) $\vec{r}.\vec{T} = 0$ and $\vec{F}.\vec{T} = 0$

37) A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same, which one of the following will not be affected?

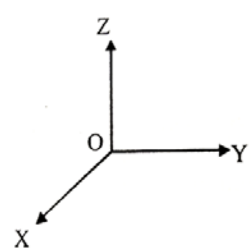
(a) Angular velocity

(b) Angular momentum

(c) Moment of inertia

(d) Rotational kinetic energy

38) A force of $-F\hat{k}$ acts on O, the origin of the coordinate system. The torque about the point (1, −1) is



(a) F $(\hat{\imath} - \hat{\jmath})$

(b) −F $(\hat{\imath} + \hat{\jmath})$

(c) F $(\hat{\imath} + \hat{\jmath})$

(d) −F $(\hat{\imath} - \hat{\jmath})$

39) A thin circular ring of mass m and radius R is rotating about its axis with a constant angular velocity ω. Two objects each of mass M are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity $\omega' =$

(a) $\frac{\omega(m+2M)}{m}$

(b) $\frac{\omega(m-2M)}{(m+2M)}$

(c) $\frac{\omega m}{(m+M)}$

(d) $\frac{\omega m}{(m+2M)}$

40) Angular momentum of the particle rotating with a central force is constant due to

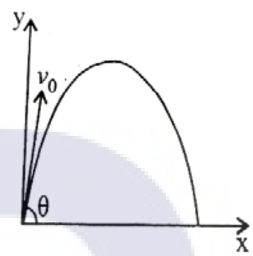
(a) constant torque

(b) constant force

(c) constant linear momentum

(d) zero torque

41) A small particle of mass m is projected at an angle θ with the x – axis with an initial velocity v_0 in the x – y plane as shown in the figure. At a time $t < \frac{v_0 \sin\theta}{g}$, the angular momentum of the particle is



(a) $-mgv_0t^2 \cos\theta\,\hat{j}$

(b) $mgv_0t \cos\theta\,\hat{k}$

(c) $-\frac{1}{2} mgv_0t^2 \cos\theta\,\hat{k}$

(d) $\frac{1}{2} mgv_0t^2 \cos\theta\,\hat{i}$

42) A thin horizontal circular disc is rotating about a vertical axis passing through its centre. An insect is at rest at a point near the rim of the disc. The insect now moves along a diameter of the disc to reach its other end. During the journey of the insect, the angular speed of the disc.

(a) continuously decreases

(b) continuously increases

(c) first increases and then decreases

(d) remains unchanged

43) A stone of mass m, tied to the end of a string, is whirled around in a circle on a horizontal frictionless table. The length of the string is reduced gradually keeping the angular momentum of the stone about the centre of the circle constant. Then, the tension in the string is given by $T = Ar^n$, where A is a constant, r is the instantaneous radius of the circle. The value of n is equal to

(a) −1

(b) −2

(c) −4

(d) −3

44) A bullet of mass 10g and speed 500m/s is fired into a door and gets embedded exactly at the centre of the door. The door is 1.0m wide and weighs 12kg. It is hinged at one end and rotates about a vertical axis practically without friction. The angular speed of the door just after the bullet embeds into it will be:

(a) 6.25rad/sec

(b) 0.625rad/sec

(c) 3.35rad/sec

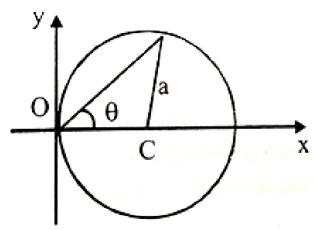
(d) 0.335rad/sec

45) A particle of mass 2kg is moving such that at time t, its position, in meter, is given by $\vec{r}(t) = 5\hat{i} - 2t^2\hat{j}$. The angular momentum of the particle at t = 2s about the origin in $kgm^{-2}s^{-1}$ is:

(a) $-80\hat{k}$ (b) $(10\hat{i} - 16\hat{j})$

(c) $-40\hat{k}$ (d) $40\hat{k}$

46) A particle is moving in a circular path of radius a, with a constant velocity v as shown in the figure. The centre of circle is marked by 'C'. The angular momentum from the origin O can be written as:



(a) va (1 + cos 2θ) (b) va (1 + cos θ)

(c) va cos 2θ (d) va

47) A ball of mass 160g is thrown up at an angle of 60° to the horizontal at a speed of $10ms^{-1}$. The angular momentum of the ball at the highest point of the trajectory with respect to the point from which the ball is thrown is nearly ($g = 10ms^{-2}$)

(a) 1.73kg m^2/s (b) 3.0kg m^2/s

(c) 3.46kg m^2/s (d) 6.0kg m^2/s

48) A bob of mass m attached to an inextensible string of length *l* is suspended from a vertical support. The bob rotates in a horizontal circle with an angular speed ω rad/s about the vertical. About the point of suspension:

(a) angular momentum is conserved.

(b) angular momentum changes in magnitude but not in direction.

(c) angular momentum changes in direction but not in magnitude.

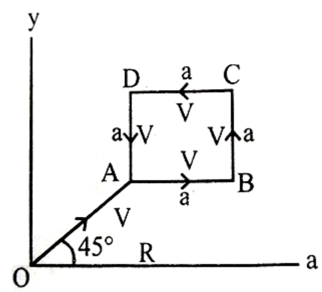
(d) angular momentum changes both in direction and magnitude.

49) A particle of mass 2kg is on a smooth horizontal table and moves in a circular path of radius 0.6m. The height of the table from the ground is 0.8m. If the angular speed of the particle is 12rad s^{-1}, the magnitude of its angular momentum about a point on the ground right under the centre of the circle is:

(a) 14.4kg m^2s^{-1} (b) 8.64kg m^2s^{-1}

(c) 20.16kg m^2s^{-1} (d) 11.52kg m^2s^{-1}

50) A particle of mass m is moving along the side of a square of side 'a', with a uniform speed v in the *x* – *y* plane as shown in the figure:



Which of the following statements is false for the angular momentum $\vec{L}$ about the origin?

(a) $\vec{L} = mv\left[\frac{R}{\sqrt{2}} + a\right]\hat{k}$ when the particle is moving from B to C.

(b) $\vec{L} = \frac{mv}{\sqrt{2}} R\hat{k}$ when the particle is moving from D to A.

(c) $\vec{L} = \frac{mv}{\sqrt{2}} R\hat{k}$ when the particle is moving from A to B.

(d) $\vec{L} = mv\left[\frac{R}{\sqrt{2}} - a\right]\hat{k}$ when the particle is moving from C to D.

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	a	a	a	c	d	d	b	b	c
11	12	13	14	15	16	17	18	19	20
d	c	d	d	d	a	c	b	a	d
21	22	23	24	25	26	27	28	29	30
a	c	a	a	c	d	d	d	c	d
31	32	33	34	35	36	37	38	39	40
c	b	a	b	d	d	b	c	d	d
41	42	43	44	45	46	47	48	49	50
c	c	d	b	a	a	c	c	a	a

Topic 23: Moment of Inertia and Rotational K.E

1) A ring of mass m and radius r rotates about an axis passing through its centre and perpendicular to its plane with angular velocity ω. Its kinetic energy is

(a) $\frac{1}{2}mr^2\omega^2$

(b) $mr\omega^2$

(c) $mr^2\omega^2$

(d) $\frac{1}{2}mr\omega^2$

2) A fly wheel rotating about a fixed axis has a kinetic energy of 360 joule when its angular speed is 30 radian/sec. The moment of inertia of the wheel about the axis of rotation is

(a) 0.6 kg m^2

(b) 0.15 kg m^2

(c) 0.8 kg m^2

(d) 0.75 kg m^2

3) The moment of inertia of a body about a given axis is 1.2 kg m^2. Initially, the body is at rest. In order to produce a rotational kinetic energy of 1500 joule, an angular acceleration of 25 radian/sec^2 must be applied about that axis for a duration of

(a) 4 seconds

(b) 2 seconds

(c) 8 seconds

(d) 10 seconds

4) Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis is perpendicular to its plane and passing through a point on its rim will be

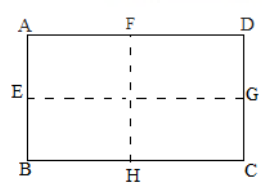
(a) 5 I

(b) 3 I

(c) 6 I

(d) 4 I

5) In a rectangle ABCD (BC = 2AB). The moment of inertia is minimum along axis through



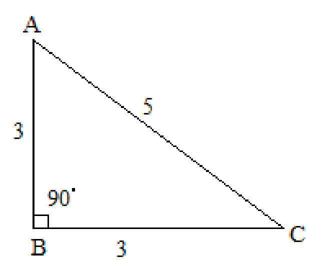
(a) BC

(b) BD

(c) HF

(d) EG

6) ABC is a triangular plate of uniform thickness. The sides are in the ratio shown in the figure. I_{AB}, I_{BC}, and I_{CA} are the moments of inertia of the plate about AB, BC and CA as axes respectively. Which one of the following relations is correct?



(a) $I_{AB} > I_{BC}$ (b) $I_{BC} > I_{AB}$

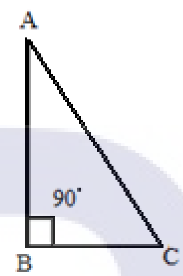
(c) $I_{AB} + I_{BC} = I_{CA}$ (d) I_{CA} is maximum

7) The moment of inertia of a disc of mass M and radius R about an axis, which is tangential to the circumference of the disc and parallel to its diameter, is

(a) $\frac{3}{2}$ MR^2 (b) $\frac{2}{3}$ MR^2

(c) $\frac{5}{4}$ MR^2 (d) $\frac{4}{5}$ MR^2

8) There is a flat uniform triangular plate ABC such that AB = 4cm, BC = 3cm and angle ABC = 90°. The moment of inertia of the plate about AB, BC and CA as axis is respectively I_1, I_2 and I_3. Which one of the following is true?



(a) $I_3 > I_2$ (b) $I_2 > I_1$

(c) $I_3 > I_1$ (d) $I_1 > I_2$

9) A composite disc is to be made using equal masses of aluminum and iron so that it has as high a moment of inertia as possible. This is possible when

(a) the surfaces of the discs are made of iron with aluminium inside

(b) the whole of aluminium is kept in the core and the iron at the outer rim of the disc

(c) the whole iron is kept in the core and the aluminium at the outer rim of the disc

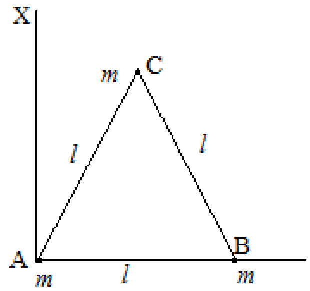
(d) the whole disc is made with thin alternate sheets of iron and aluminium

10) A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K. If radius of the ball be R, then the fraction of total energy associated with its rotational energy will be

(a) $\frac{R^2}{K^2+R^2}$ (b) $\frac{K^2+R^2}{R^2}$

(c) $\frac{K^2}{R^2}$ (d) $\frac{K^2}{K^2+R^2}$

11) Three particles each of mass m gram, are situated at the vertices of an equilateral triangle ABC of side *l* cm (as shown in the figure). The moment of inertia of the system about a line AX perpendicular to AB and in the plane ABC, in gram - cm^2 units will be



(a) $\frac{3}{2}ml^2$

(b) $\frac{3}{4}ml^2$

(c) $2\ ml^2$

(d) $\frac{5}{4}ml^2$

12) The ratio of the radii of gyration of circular disc about a tangential axis in the plane of the disc and of a circular ring of the same radius about a tangential axis in the plane of the ring is

(a) $1 : \sqrt{2}$

(b) $1 : 3$

(c) $2 : 1$

(d) $\sqrt{5} : \sqrt{6}$

13) The moment of inertia of a uniform circular disc of radius R and mass M about an axis touching the disc at its diameter and normal to the disc is

(a) $\frac{2}{5}MR^2$

(b) $\frac{3}{2}MR^2$

(c) $\frac{1}{2}MR^2$

(d) MR^2

14) A thin rod of length L and mass M is bent at its midpoint into two halves so that the angle between them is 90°. The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is:

(a) $\frac{ML^2}{24}$

(b) $\frac{ML^2}{12}$

(c) $\frac{ML^2}{6}$

(d) $\frac{\sqrt{2}ML^2}{24}$

15) Four identical thin rods each of mass M and length l, form a square frame. Moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is:

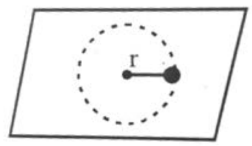
(a) $\frac{2}{3}Ml^2$

(b) $\frac{13}{3}Ml^2$

(c) $\frac{1}{3}Ml^2$

(d) $\frac{4}{3}Ml^2$

16) A small mass attached to a string rotates on frictionless table top as shown. If the tension in the string is increased by pulling the string causing the radius of the circular motion to decrease by a factor of 2, the kinetic energy of the mass will



(a) remain constant

(b) increase by a factor of 2

(c) Increase by a factor of 4

(d) decrease by a factor of 2

17) The moment of inertia of a thin uniform rod mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

(a) $I_0 + ML^2/2$

(b) $I_0 + ML^2/4$

(c) $I_0 + 2ML^2$

(d) $I_0 + ML^2$

18) The moment of inertia of a uniform circular disc is maximum about an axis perpendicular to the disc and passing through:

(a) B

(b) C

(c) D

(d) A

19) The ratio of radii of gyration of a circular ring and a circular disc, of the same mass and radius, about an axis passing through their centers and perpendicular to their planes are

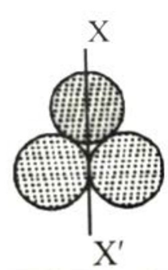
(a) $\sqrt{2} : 1$

(b) $1 : \sqrt{2}$

(c) 3 : 2

(d) 2 : 1

20) Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX' which is touching to two shells and passing through diameter of third shell. Moment of inertia of the system consisting of these spherical shells about XX' axis is



(a) $3mr^2$

(b) $\frac{16}{5} mr^2$

(c) $4 mr^2$

(d) $\frac{11}{5} mr^2$

21) From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre?

(a) 15 $MR^2/32$ (b) 13 $MR^2/32$

(c) 11 $MR^2/32$ (d) 9 $MR^2/32$

22) Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is :-

(a) $\frac{1}{4}I(\omega_1 - \omega_2)^2$ (b) $I(\omega_1 - \omega_2)^2$

(c) $\frac{1}{8}(\omega_1 - \omega_2)^2$ (d) $\frac{1}{2}I(\omega_1 + \omega_2)^2$

23) Initial angular velocity of a circular disc of mass M is ω_1. Then two small spheres of mass m are attached gently to diametrically opposite points on the edge of the disc. What is the final angular velocity of the disc?

(a) $\left(\frac{M+m}{M}\right)\omega_1$ (b) $\left(\frac{M+m}{m}\right)\omega_1$

(c) $\left(\frac{M}{M+4m}\right)\omega_1$ (d) $\left(\frac{M}{M+2m}\right)\omega_1$

24) Moment of inertia of a circular wire of mass M and radius R about its diameter is

(a) $MR^2/2$ (b) MR^2

(c) $2MR^2$ (d) $MR^2/4$

25) A particle performing uniform circular motion has angular frequency is doubled & its kinetic energy halved, then the new angular momentum is

(a) $\frac{L}{4}$ (b) 2L

(c) 4L (d) $\frac{L}{2}$

26) A circular disc X of radius R is made from an iron plate of thickness t, and another disc Y of radius 4R is made from an iron plate of thickness $\frac{t}{4}$. Then the relation between the moment of inertia I_X and I_Y is

(a) $I_Y = 32I_X$ (b) $I_Y = 16I_X$

(c) $I_Y = I_X$ (d) $I_Y = 64I_X$

27) One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about their diameters are respectively I_A and I_B such that

(a) $I_A < I_B$ (b) $I_A > I_B$

(c) $I_A = I_B$

(d) $\frac{I_A}{I_B} = \frac{d_A}{d_B}$

28) The moment of inertia of a uniform semicircular disc of mass M and radius r about a line perpendicular to the plane of the disc through the centre is

(a) $\frac{2}{5}$ Mr^2

(b) $\frac{1}{4}$ Mr

(c) $\frac{1}{2}$ Mr^2

(d) Mr^2

29) Four points masses, each of value m, are placed at the corners of a square ABCD of side l. The moment of inertia of this system about an axis passing through A and parallel to BD is

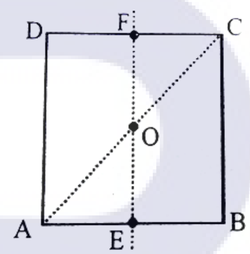
(a) $2ml^2$

(b) $\sqrt{3}ml^2$

(c) $3ml^2$

(d) ml^2

30) For the given uniform square lamina ABCD, whose centre is O,



(a) $I_{AC} = \sqrt{2}\, I_{EF}$

(b) $\sqrt{2}\, I_{AC} = I_{EF}$

(c) $I_{AD} = 3I_{EF}$

(d) $I_{AC} = I_{EF}$

31) Consider a uniform square plate of side 'a' and mass 'M'. The amount of inertia of this plate about an axis perpendicular to its plane and passing through one of its corners is

(a) $\frac{5}{6}$ Ma^2

(b) $\frac{1}{12}$ Ma^2

(c) $\frac{7}{12}$ Ma^2

(d) $\frac{2}{3}$ Ma^2

32) A thin uniform rod of length l and mass m is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is ω. Its centre of mass rises to a maximum height of

(a) $\frac{1}{6}\frac{l\omega}{g}$

(b) $\frac{1}{2}\frac{l^2\omega^2}{g}$

(c) $\frac{1}{6}\frac{l^2\omega^2}{g}$

(d) $\frac{1}{3}\frac{l^2\omega^2}{g}$

33) A pulley of radius 2m is rotated about is axis by a force $F = (20t - 5t^2)$ newton (where t is measured in seconds) applied tangentially. If the moment of inertia of the pulley about its axis of rotation is 10kg-m^2 the number of rotations made by the pulley before its direction of motion is reversed, is:

(a) more than 3 but less than 6

(b) more than 6 but less than 9

(c) more than 9

(d) less than 3

34) A mass m hangs with the help of a string wrapped around a pulley on a frictionless bearing. The pulley has mass m and radius R. Assuming pulley to be a perfect uniform circular disc, the acceleration of the mass m, if the string does not slip on the pulley, is:

(a) g

(b) $\frac{2}{3}$ g

(c) $\frac{g}{3}$

(d) $\frac{3}{2}$ g

35) A circular hole of diameter R is cut from a disc of mass M and the radius R; the circumference of the cut passes through the centre of the disc. The moment of inertia of the remaining portion of the disc about an axis perpendicular to the disc and passing through its centre is

(a) $\left(\frac{15}{32}\right) MR^2$

(b) $\left(\frac{1}{8}\right) MR^2$

(c) $\left(\frac{3}{8}\right) MR^2$

(d) $\left(\frac{13}{32}\right) MR^2$

36) A solid sphere having mass m and radius r rolls down an inclined plane. Then its kinetic energy is

(a) $\frac{5}{7}$ rotational and $\frac{2}{7}$ translational

(b) $\frac{2}{7}$ rotational and $\frac{5}{7}$ translational

(c) $\frac{2}{5}$ rotational and $\frac{3}{5}$ translational

(d) $\frac{1}{2}$ rotational and $\frac{1}{2}$ translational

37) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: When moment of inertia I of a body rotating about an axis with angular speed ω increases, its angular momentum L is unchanged but the kinetic energy K increases if there is no torque applied on it.

Statement 2: L = Iω, kinetic energy of rotation = $\frac{1}{2}$ $I\omega^2$

(a) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

(b) Statement 1 is false, Statement 2 is true.

(c) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

(d) Statement 1 is true, Statement 2 is false.

38) A ring of mass M and radius R is rotating about its axis with angular velocity ω. Two identical bodies each of mass m are now gently attached at the two ends of a diameter of the ring. Because of this, the kinetic energy loss will be:

(a) $\frac{m(M+2m)}{M}\,\omega^2R^2$

(b) $\frac{Mm}{(M+m)}\,\omega^2R^2$

(c) $\frac{Mm}{(M+2m)}\omega^2R^2$

(d) $\frac{(M+m)}{(M+2m)}\omega^2R^2$

39) Consider a thin uniform square sheet made of a rigid material. If its side is ‘a’ mass m and moment of inertia I about one of its diagonals, then:

(a) $I > \frac{ma^2}{12}$

(b) $\frac{ma^2}{24} < I < \frac{ma^2}{12}$

(c) $I = \frac{ma^2}{24}$

(d) $I = \frac{ma^2}{12}$

40) From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its center and perpendicular to one of its faces is:

(a) $\frac{4MR^2}{9\sqrt{3}\pi}$

(b) $\frac{4MR^2}{3\sqrt{3}\pi}$

(c) $\frac{MR^2}{32\sqrt{2}\pi}$

(d) $\frac{MR^2}{16\sqrt{2}\pi}$

41) A circular hole of radius $\frac{R}{4}$ is made in a thin uniform disc having mass M and radius R, as shown in figure. The moment of inertia of the remaining portion of the disc about an axis passing through the point O and perpendicular to the plane of the disc is:

(a) $\frac{219MR^2}{256}$

(b) $\frac{237MR^2}{512}$

(c) $\frac{19MR^2}{512}$

(d) $\frac{197MR^2}{256}$

42) Moment of inertia of an equilateral triangular lamina ABC, about the axis passing through its center O and perpendicular to its plane I_0 as shown in the figure. A cavity DEF is cut out from the lamina, where D, E, F are the mid points of the sides. Moment of inertia of the remaining part of lamina about the same axis is:

(a) $\frac{7}{8}I_0$

(b) $\frac{15}{16}I_0$

(c) $\frac{3I_0}{4}$

(d) $\frac{31I_0}{32}$

43) The moment of inertia of a uniform cylinder of length *l* and radius R about its perpendicular bisector is I. What is the ratio *l*/R such that the moment of inertia is minimum?

(a) 1

(b) $\frac{3}{\sqrt{2}}$

(c) $\sqrt{\frac{3}{2}}$

(d) $\frac{\sqrt{3}}{2}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	c	b	c	d	b	c	b	b	d
11	12	13	14	15	16	17	18	19	20
d	d	c	b	d	c	b	a	a	c
21	22	23	24	25	26	27	28	29	30
b	a	c	a	a	d	a	c	c	d
31	32	33	34	35	36	37	38	39	40
d	c	a	b	d	b	b	c	d	a
41	42	43							
b	b	c							

Topic 24: Rolling Motion

1) If a sphere is rolling, the ratio of the translational energy to total kinetic energy is given by

(a) 7 : 10
(b) 2 : 5
(c) 10 : 7
(d) 5 : 7

2) The speed of a homogenous solid sphere after rolling down an inclined plane of vertical height h from rest without sliding is

(a) $\sqrt{\frac{10}{7}gh}$
(b) $\sqrt{gh}$
(c) $\sqrt{\frac{6}{5}gh}$
(d) $\sqrt{\frac{4}{3}gh}$

3) A solid sphere, disc and solid cylinder all of the same mass and made of the same material are allowed to roll down (from rest) on the inclined plane, then

(a) solid sphere reaches the bottom first

(b) solid sphere reaches the bottom last

(c) disc will reach the bottom first

(d) all reach the bottom at the same time

4) A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclination plane will be

(a) $\frac{g}{2}$
(b) $\frac{g}{3}$
(c) $\frac{g}{4}$
(d) $\frac{2g}{3}$

5) A spherical ball rolls on a table without slipping. Then the fraction of its total energy associated with rotation is

(a) 2/5
(b) 2/7
(c) 3/5
(d) 3/7

6) A solid cylinder and a hollow cylinder both of the same mass external diameter are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first?

(a) Both together
(b) Solid cylinder
(c) One with higher density
(d) Hollow cylinder

7) A solid cylinder of mass m and radius R rolls down an inclined plane of height h without slipping. The speed of its centre of mass when it reaches the bottom is

(a) $\sqrt{(2gh)}$

(b) $\sqrt{4gh/3}$

(c) $\sqrt{3gh/4}$

(d) $\sqrt{4g/h}$

8) A drum of radius R and mass M, rolls down without slipping along an inclined plane of angle θ. The frictional force

(a) dissipates energy as heat

(b) decreases the rotational motion

(c) decreases the rotational and translational motion

(d) converts translational energy to rotational energy

9) A small object of uniform density rolls up a curved surface with an initial velocity 'v'. It reaches upto a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is a

(a) solid sphere

(b) hollow sphere

(c) disc

(d) ring

10) The ratio of the accelerations for a solid sphere (mass 'm' and radius 'R') rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is:

(a) 5 : 7

(b) 2 : 3

(c) 2 : 5

(d) 7 : 5

11) A disk and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first?

(a) Disk

(b) Sphere

(c) Both reach at the same time

(d) Depends on their masses

12) A round uniform body of radius R, mass M and moment of inertia I rolls down (without slipping) an inclined plane making an angle θ with the horizontal. Then its acceleration is

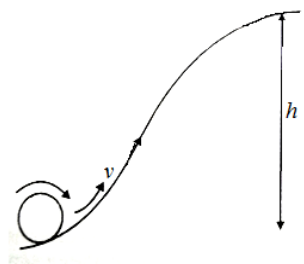
(a) $\frac{g\sin\theta}{1-MR^2/I}$

(b) $\frac{g\sin\theta}{1+I/MR^2}$

(c) $\frac{g\sin\theta}{1+MR^2/I}$

(d) $\frac{g\sin\theta}{1-I/MR^2}$

13) A solid sphere is rolling on a surface as shown in figure, with a translational velocity $v\,ms^{-1}$. If it is to climb the inclined surface continuing to roll without slipping, then minimum velocity for this to happen is



(a) $\sqrt{2gh}$

(b) $\sqrt{\frac{7}{5}gh}$

(c) $\sqrt{\frac{7}{2}gh}$

(d) $\sqrt{\frac{10}{7}gh}$

14) A thick – walled hollow sphere has outside radius R_0. It rolls down an incline without slipping and its speed at the bottom is v_0. Now the incline is waxed, so that it is practically frictionless and the sphere is observed to slide down (without any rolling). Its speed at the bottom is observed to be $5v_0/4$. The radius of gyration of the hollow sphere about an axis through its centre is

(a) $3R_0/2$

(b) $3R_0/4$

(c) $9R_0/16$

(d) $3R_0$

15) A tennis ball (treated as hollow spherical shell) starting from O rolls down a hill. At point A the ball becomes air borne leaving at an angle of 30° with the horizontal. The ball strikes the ground at B. What is the value of the distance AB?

(Moment of inertia of a spherical shell of mass m and radius R about its diameter = $\frac{2}{3}$ mR^2)

(a) 1.87m

(b) 2.08m

(c) 1.57m

(d) 1.77m

16) A loop of radius r and mass m rotating with an angular velocity ω_0 is placed on a rough horizontal surface. The initial velocity of the centre of the hoop is zero. What will be the velocity of the centre of the hoop when it ceases to slip?

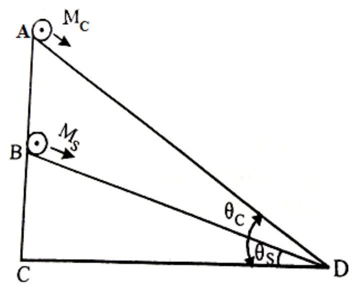
(a) $\frac{r\omega_0}{4}$

(b) $\frac{r\omega_0}{3}$

(c) $\frac{r\omega_0}{2}$

(d) $r\omega_0$

17) A cylinder of mass M_C and sphere of mass M_S are placed at points A and B of two inclines, respectively (See Figure). If they roll on the incline without slipping such that their accelerations are the same, then the ratio $\frac{\sin\theta_C}{\sin\theta_S}$ is:



(a) $\sqrt{\frac{8}{7}}$

(b) $\sqrt{\frac{15}{14}}$

(c) $\frac{8}{7}$

(d) $\frac{15}{14}$

18) A uniform solid cylindrical roller of mass 'm' is being pulled on a horizontal surface with force F parallel to the surface and applied at its centre. If the acceleration of the cylinder is 'a' and it is rolling without slipping then the value of 'F' is:

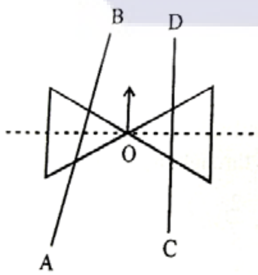
(a) ma

(b) $\frac{5}{3}$ ma

(c) $\frac{3}{2}$ ma

(d) 2ma

19) A roller is made by joining together two cones at their vertices O. It is kept on two rails AB and CD, which are placed asymmetrically (see figure), with its axis perpendicular to CD and its centre O at the centre line joining AB and CD (see figure). It is given a light push so that it starts rolling with its centre O moving parallel to CD in the direction shown. As it moves, the roller will tend to:



(a) go straight

(b) turn left and right alternatively

(c) turn left

(d) turn right

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
d	a	a	c	b	b	b	d	c	a
11	12	13	14	15	16	17	18	19	
b	b	d	b	b	c	d	c	c	

Topic 25: Kepler's Law of Planetary Motion

1) The largest and the shortest distance of the earth from the sun r_1 and r_2. Its distance from the sun when it is at perpendicular to the major axis of the orbit drawn from the sun is

(a) $\frac{r_1+r_2}{4}$

(b) $\frac{r_1+r_2}{r_1-r_2}$

(c) $\frac{2r_1r_2}{r_1+r_2}$

(d) $\frac{r_1+r_2}{3}$

2) The distance of two planets from the sun are 10^{13} and 10^{12} metres respectively. The ratio of time periods of these two planets is

(a) $\frac{1}{\sqrt{10}}$

(b) 100

(c) $10\sqrt{10}$

(d) $\sqrt{10}$

3) A satellite A of mass m is at a distance of r from the surface of the earth. Another satellite B of mass 2m is at distance of 2r from the earth's centre. Their time periods are in the ratio of

(a) 1 : 2

(b) 1 : 16

(c) 1 : 32

(d) $1 : 2\sqrt{2}$

4) The distance of Neptune and Saturn from the sun is nearly 10^{13} and 10^{12} meter respectively. Assuming that they move in circular orbits, their periodic times will be in the ratio

(a) 10

(b) 100

(c) $10\sqrt{10}$

(d) 1000

5) The period of revolution of planet A around the Sun is 8 times that of B. The distance of A from the Sun is how many times greater than that of B from the sun?

(a) 2

(b) 3

(c) 4

(d) 5

6) The figure shows elliptical orbit of a planet m about the sun S. The shaded area SCD is twice the shaded area SAB. If t_1 is the time for the planet to move from C to D and t_2 is the time to move from A to B then:

(a) $t_1 = 4t_2$

(b) $t_1 = 2t_2$

(c) $t_1 = t_2$

(d) $t_1 > t_2$

7) Kepler's third law states that square of period of revolution (T) of a planet around the sun is proportional to third power of average distance r between sun and planet i.e. $T^2 = Kr^3$ here K is constant. If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is $F = \frac{GMm}{r^2}$, here G is gravitational constant. The relation between G and K is described as

(a) $GMK = 4\pi^2$

(b) $K = G$

(c) $K = \frac{1}{G}$

(d) $GK = 4\pi^2$

8) The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to 4 times the previous value, the new time period will become

(a) 10 hours

(b) 80 hours

(c) 40 hours

(d) 20 hours

9) India's Mangalyan was sent to the Mars by launching it into a transfer orbit EOM around the sun. It leaves the earth at E and meets Mars at M. If the semi - major axis of Earth's orbit is $a_e = 1.5 \times 10^{11}$ m, that of Mars orbit $a_m = 2.28 \times 10^{11}$ m, taken Kepler's laws give the estimate of time for Mangalyan to reach Mars from Earth to be close to :

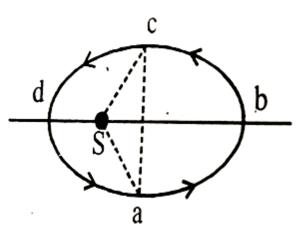
(a) 500 days

(b) 320 days

(c) 260 days

(d) 220 days

10) Figure shows elliptical path abcd of a planet around the sun S such that the area of triangle csa is $\frac{1}{4}$ the are of the ellipse. (See figure) With db as the semiamjor axis, and ca as the semiminor axis. If t_1 is the time taken for planet to go over path abc and t_2 for path taken over cda then:



(a) $t_1 = 4t_2$

(b) $t_1 = 2t_2$

(c) $t_1 = 3t_2$

(d) $t_1 = t_2$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	c	d	c	a	b	a	c	b	c

Topic 26: Newton's Universal Law of Gravitation

1) What will be the formula of the mass in terms of g, R and G (R = radius of earth)

(a) $g^2 \frac{R}{G}$

(b) $G \frac{R^2}{g}$

(c) $G \frac{R}{g}$

(d) $g \frac{R^2}{G}$

2) Two spheres of masses m and M are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be

(a) $\frac{F}{9}$

(b) 3F

(c) F

(d) $\frac{F}{3}$

3) A spherical planet has a mass M_P and diameter D_P.A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity equal to:

(a) $4GM_P/D_P^2$

(b) GM_Pm/D_P^2

(c) GM_P/D_P^2

(d) $4GM_Pm/D_P^2$

4) Two spherical bodies of mass M and 5M and radii R and 2R released in free space with initial separation between their centres equal to 12 R. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is

(a) 4.5 R

(b) 7.5 R

(c) 1.5 R

(d) 2.5 R

5) Two astronauts are floating in gravitation free space after having lost contact with their spaceship. The two will

(a) move towards each other

(b) move away from each other

(c) become stationary

(d) keep floating at the same distance between them

6) Two spherical bodies of mass M and 5M & radii R & 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

(a) 2.5 R

(b) 4.5 R

(c) 7.5 R

(d) 1.5 R

7) Two particles of equal mass 'm' go around a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle with respect to their centre of mass is

(a) $\sqrt{\frac{Gm}{4R}}$ (b) $\sqrt{\frac{Gm}{3R}}$

(c) $\sqrt{\frac{Gm}{2R}}$ (d) $\sqrt{\frac{Gm}{R}}$

8) From a sphere of mass M and radius R, a smaller sphere of radius $\frac{R}{2}$ is carved out such that the cavity made in the original sphere is between its centre and the periphery (See figure). For the configuration in the figure where the distance between the centre of the original sphere and the removed sphere is 3R, the gravitational force between the two sphere is:

(a) $\frac{41\ GM^2}{3600\ R^2}$ (b) $\frac{41\ GM^2}{450\ R^2}$

(c) $\frac{59\ GM^2}{450\ R^2}$ (d) $\frac{GM^2}{225\ R^2}$

9) Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is:

(a) $\sqrt{\frac{Gm}{R}}$ (b) $\sqrt{2\sqrt{2}\frac{GM}{R}}$

(c) $\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$ (d) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$

ANSWER KEY								
1	2	3	4	5	6	7	8	9
d	c	a	b	a	c	a	a	d

Topic 27: Acceleration Due to Gravity

1) In a rocket a seconds pendulum is mounted. Its period of oscillation decreases when the rocket

(a) comes down with uniform acceleration

(b) moves round the earth in a geostationary orbit

(c) moves up with a uniform velocity

(d) moves up with uniform acceleration

2) A body weighs 72 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface?

(a) 32 N
(b) 28 N
(c) 16 N
(d) 72 N

3) Assuming earth to be a sphere of uniform density, what is the value of ‘g’ in the mine 100 km below the earth’s surface? (Given, R = 6400 km)

(a) 9.65 m/s^2
(b) 7.65 m/s^2
(c) 5.06 m/s^2
(d) 3.10 m/s^2

4) The acceleration due to gravity on the planet A is 9 times the acceleration due to gravity on planet B. A man jumps to a height of 2m on the surface of A. What is the height of jump by the same person on the planet B?

(a) $\frac{2}{3}$ m
(b) $\frac{2}{9}$ m
(c) 18m
(d) 6m

5) The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

(a) ½ R
(b) 2 R
(c) 4 R
(d) 1/4 R

6) Imagine a new planet having the same density as that of earth but it is 3 times bigger than the earth in size. If the acceleration due to gravity on the surface of earth is g and that on the surface of the new planet is g', then

(a) g' = $g/9$
(b) g' = 27g
(c) g' = 9g
(d) g' = 3g

7) A roller coaster is designed such that riders experience “weightlessness” as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between:

(a) 14m/s and 15m/s

(b) 15m/s and 16m/s

(c) 16m/s and 17m/s

(d) 13m/s and 14m/s

8) The height at which the weight of a body becomes 1/16th, its weight on the surface of earth (radius R), is

(a) 5R

(b) 15R

(c) 3R

(d) 4R

9) The acceleration due to gravity at a height 1km above the earth is the same as at a depth d below the surface of earth. Then

(a) d = 1km

(b) d = $\frac{3}{2}$ km

(c) d = 2km

(d) d = $\frac{1}{2}$ km

10) Average density of the earth

(a) is a complete function of g

(b) does not depend on g

(c) is inversely proportional to g

(d) is directly proportional to g

11) The change in 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 earth. When both 'd' and 'h' are much smaller than the radius of earth, then which one of the following is correct ?

(a) d = $\frac{3h}{2}$

(b) d = $\frac{h}{2}$

(c) d = h

(d) d = 2h

12) The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth, is

(a) $\frac{R}{\sqrt{2}}$

(b) R/2

(c) $\sqrt{2}\,R$

(d) 2 R

13) Assuming the earth to be a sphere of uniform density, the acceleration due to gravity inside the earth at a distance of r from the centre is proportional to

(a) r

(b) r^{-1}

(c) r^2

(d) r^{-2}

14) The change in the value of acceleration of earth towards sun, when the moon comes from the position of solar eclipse to the position on the other side of earth in line with sun is : (mass of the moon = 7.36×10^{22} kg, radius of the moon's orbit = 3.8 ×n 10^8 m).

(a) 6.73×10^{-5} m/s^2

(b) 6.73×10^{-3} m/s^2

(c) 6.73×10^{-2} m/s^2

(d) 6.73×10^{-4} m/s^2

15) If the Earth has no rotational motion, the weight of a person on the equator is W. Determine the speed with which the earth would have to rotate about its axis so that the person at the equator will weight $\frac{3}{4}$ W. Radius of the Earth is 6400 km and g = 10m/s^2.

(a) 1.1×10^{-3} rad/s

(b) 0.83×10^{-3} rad/s

(c) 0.63×10^{-3} rad/s

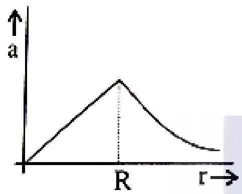
(d) 0.28×10^{-3} rad/s

16) The mass density of a spherical body is given by $\rho(r) = \frac{k}{r}$ for $r \le R$ and $\rho(r) = 0$ for $r > R$,

where r is the distance from the centre.

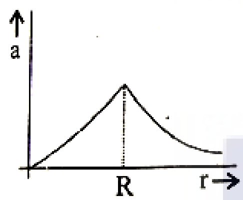
The correct graph that describes qualitatively the acceleration, a, of a test particle as a function of r is:

(a)

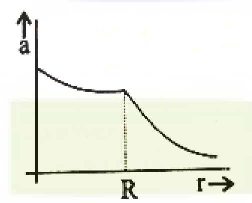


(b)

(c)

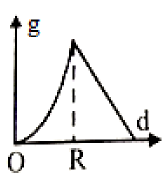


(d)



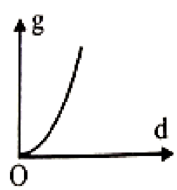
17) The variation of acceleration due to gravity g with distance d from centre of the earth is best represented by (R = Earth's radius):

(a)



(b)

(c)



(d)

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
d	a	a	c	a	d	a	c	c	d
11	12	13	14	15	16	17			
d	d	a	a	c	b	b			

Topic 28: Gravitation Field, Potential and Energy

1) With what velocity should a particle be projected so that its height becomes equal to radius of earth?

(a) $\left(\frac{GM}{R}\right)^{1/2}$

(b) $\left(\frac{8GM}{R}\right)^{1/2}$

(c) $\left(\frac{2GM}{R}\right)^{1/2}$

(d) $\left(\frac{4GM}{R}\right)^{1/2}$

2) The potential energy of a satellite, having mass m and rotating at a height of 6.4×10^6 m from the earth surface, is

(a) $-mgR_e$

(b) $-0.67mgR_e$

(c) $-0.5\ mgR_e$

(d) $-0.33\ mgR_e$

3) Assuming the radius of the earth as R, the change in gravitational potential energy of a body of mass m, when is taken from the earth's surface to a height 3R above its surface, is

(a) 3 mg R

(b) $\frac{3}{4}$ mg R

(c) 1 mg R

(d) $\frac{3}{2}$ mg R

4) The Earth is assumed to be sphere of radius R. A platform is arranged at a height R from the surface of the Earth. The velocity of a body from this platform is *fv*, where *v* is its velocity from the surface of the earth. The value of *f* is

(a) $\frac{1}{\sqrt{2}}$

(b) $\frac{1}{3}$

(c) $\frac{1}{2}$

(d) $\sqrt{2}$

5) A particle of mass M is situated at the centre of a spherical shell of same mass and radius a. The gravitational potential at a point situated at $\frac{a}{2}$ distance from the centre, will be:

(a) $-\frac{3GM}{a}$

(b) $-\frac{2GM}{a}$

(c) $-\frac{GM}{a}$

(d) $-\frac{4GM}{a}$

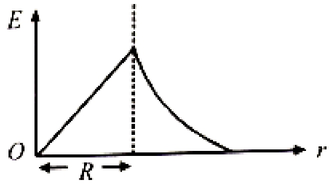
6) A particle of mass M is situated at the centre of spherical shell of mass M and radius a. The magnitude of the gravitational potential at a point situated at a/2 distance from the centre, will be

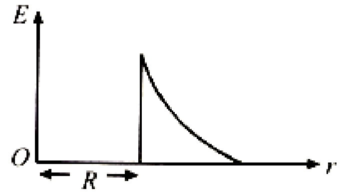
(a) $\frac{2\text{GM}}{\text{a}}$

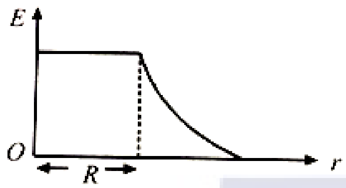
(b) $\frac{3\text{GM}}{\text{a}}$

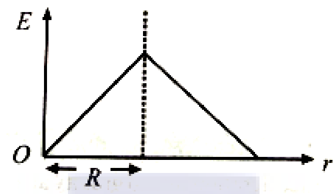
(c) $\frac{4GM}{a}$ (d) $\frac{GM}{a}$

7) Which one of the following plots represents the variation of gravitational field on a particle with distance r due to a thin spherical shell of radius R? (r is measured from the centre of the spherical shell)

(a)


(b)


(c)


(d)


8) Infinite number of bodies each of mass 2 kg are situated on x - axis at distances 1m, 2m, 4m, 8m,…..respectively, from the origin. The resulting gravitational potential due to this system at the origin will be

(a) $-\frac{8}{3}G$ (b) $-\frac{4}{3}G$

(c) -4 G (d) –G

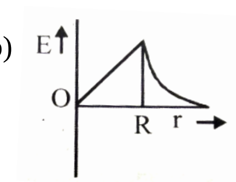
9) A body of mass ‘m’ is taken from the earth’s surface to the height equal to twice the radius (R) of the earth. The change in potential energy of body will be

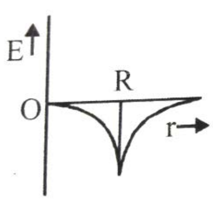
(a) $\frac{2}{3}$ mgR (b) 3 mgR

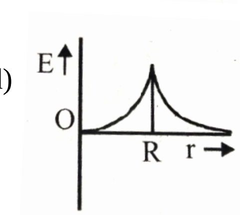
(c) $\frac{1}{3}$ mgR (d) mg2R

10) Dependence of intensity of gravitational field (E) of earth with distance (r) from centre of earth is correctly represented by:

(a)

(b)


(c)


(d)


11) At what height from the surface of earth the gravitational potential and the value of g are -5.4×10^{7} J kg^{-1} and 6.0 ms^{-2} respectively?

Take the radius of earth as 6400 km:

(a) 2600 km
(b) 1600 km
(c) 1400 km
(d) 2000 km

12) Energy required to move a body of mass m from an orbit of radius 2R to 3R is

(a) $GMm/12R^2$
(b) $GMm/3R^2$
(c) GMm/8R
(d) GMm/6R

13) 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

(a) $\frac{1}{4}$ mgR
(b) $\frac{1}{2}$ mgR
(c) 2mgR
(d) mgR

14) A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10cm. Find the work to be done against the gravitational force between them to take the particle far away from the sphere (you may take G = 6.67×10^{-11} Nm^2/kg^2)

(a) 3.33×10^{-10} J
(b) 13.34×10^{-10} J
(c) 6.67×10^{-10}J
(d) 6.67×10^{-9} J

15) This question contains Statement -1 and Statement - 2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement – 1: For a mass M kept at the centre of a cube of side 'a', the flux of gravitational field passing through its side 4π GM. and

Statement – 2: If the direction of a field due to 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.

(a) Statement – 1 is false, Statement – 2 is true

(b) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement -1

(c) Statement – 1 is true, Statement – 2 is true; Statement – 2 is not a correct explanation for Statement -1

(d) Statement – 1 is true, Statement – 2 is false

16) Two bodies of masses m and 4m are placed at a distance r. The gravitational potential at a point on the line joining them where the gravitational field is zero is:

(a) $-\frac{4Gm}{r}$
(b) $-\frac{6Gm}{r}$
(c) $-\frac{9Gm}{r}$
(d) zero

17) A point particle is held on the axis of a ring of mass m and radius r at a distance r from its centre C. When released, it reaches C under the gravitational attraction of the ring. Its speed at C will be

(a) $\sqrt{\frac{2Gm}{r}\left(\sqrt{2}-1\right)}$

(b) $\sqrt{\frac{Gm}{r}}$

(c) $\sqrt{\frac{2Gm}{r}\left(1-\frac{1}{\sqrt{2}}\right)}$

(d) $\sqrt{\frac{2Gm}{r}}$

18) The mass of a spaceship is 1000 kg. It is to be launched from the earth's surface out into free space. The value of g and R (radius of earth) are $10 m/s^2$ and 6400 km respectively. The required energy for this work will be

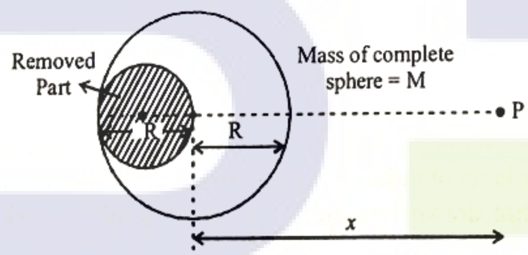
(a) 6.4×10^{11} Joules

(b) 6.4×10^{8} Joules

(c) 6.4×10^{9} Joules

(d) 6.4×10^{10} Joules

19) The gravitational field, due to the 'left over part' of a uniform sphere (from which a part as shown, has been 'removed out'), at a very far off point P, located as shown, would be (nearly):



(a) $\frac{5}{6}\frac{GM}{x^2}$

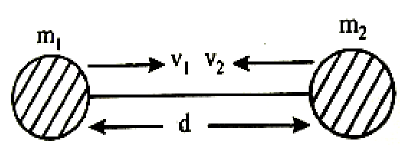
(b) $\frac{8}{9}\frac{GM}{x^2}$

(c) $\frac{7}{8}\frac{GM}{x^2}$

(d) $\frac{6}{7}\frac{GM}{x^2}$

20) Two hypothetical planets of masses m_1 and m_2 are at rest when they are infinite distance apart. Because of the gravitational force they move towards each other along the line joining their centres. What is their speed when their separation is 'd'?

(Speed of m_1 is v_1 and that of m_2 is v_2)



(a) $v_1 = v_2$

(b) $v_1 = m_2\sqrt{\frac{2G}{d(m_1+m_2)}}$ $\quad v_2 = m_1\sqrt{\frac{2G}{d(m_1+m_2)}}$

(c) $v_1 = m_1\sqrt{\frac{2G}{d(m_1+m_2)}}$ $\quad v_2 = m_2\sqrt{\frac{2G}{d(m_1+m_2)}}$

(d) $v_1 = m_2\sqrt{\frac{2G}{m_1}}$ $\qquad$ $v_2 = m_2\sqrt{\frac{2G}{m_2}}$

21) The gravitational field in a region is given by $\vec{g} = 5N/kg\hat{\imath} + 12N/kg\hat{\jmath}$. The change in the gravitational potential energy of a particle of mass 1 kg when it is taken from the origin to a point (7m,−3m) is:

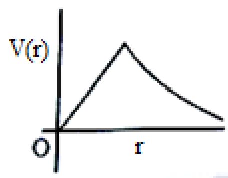
(a) 71 J

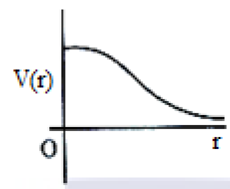
(b) $13\sqrt{58}$ J

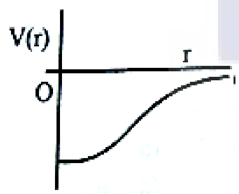
(c) −71 J

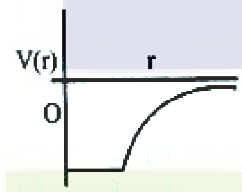
(d) 1 J

22) Which of the following most closely depicts the correct variation of the gravitational potential V(r) due to a large planet of radius R and uniform mass density? (Figures are not drawn to scale)

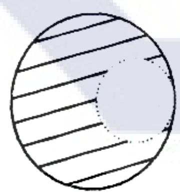
(a) 

(b) 

(c) 

(d) 

23) From a solid sphere of mass M and radius R, a spherical portion of radius R/2 is removed, as shown in the figure. Taking gravitational potential V = 0 at r = ∞, the potential at the centre of the cavity thus formed is: (G = gravitational constant)



(a) $\frac{-2GM}{3R}$

(b) $\frac{-2GM}{R}$

(c) $\frac{-GM}{2R}$

(d) $\frac{-GM}{R}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	c	b	a	a	b	b	c	a	d
11	12	13	14	15	16	17	18	19	20
a	d	b	c	b	c	c	d	c	b
21	22	23							
d	c	d							

Topic 29: Motion of Satellites, Escape Speed and Orbital Velocity

1) 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 will be

(a) 11 km/s

(b) $11\sqrt{3}$ km/s

(c) $\frac{11}{\sqrt{3}}$ km/s

(d) 33 km/s

2) If the gravitational force between two objects were proportional to 1/R (and not as $1/R^2$) where R is separation between them, then a particle in circular orbit under such a force would have its orbital speed *v* proportional to

(a) $1/R^2$

(b) R^0

(c) R^1

(d) 1/R

3) A planet is moving in an elliptical orbit around the sun. If T, V, E and L stand respectively for its kinetic energy, gravitational potential energy, total energy and magnitude of angular momentum about the centre of force, which of the following is correct?

(a) T is conserved

(b) V is always positive

(c) E is always negative

(d) L is conserved but direction of vector L changes continuously

4) A satellite of mass *m* is orbiting around the earth in a circular orbit with a velocity *v*. What will be its total energy?

(a) $(3/4)mv^2$

(b) $(1/2)\ mv^2$

(c) mv^2

(d) $-(1/2)\ mv^2$

5) The mean radius of earth is R, its angular speed on its own axis is ω and the acceleration due to gravity at earth's surface is g. What will be the radius of the orbit of a geostationary satellite?

(a) $(R^2g/\omega^2)^{1/3}$

(b) $(Rg/\omega^2)^{1/3}$

(c) $(R^2\omega^2/g)^{1/3}$

(d) $(R^2g/\omega)^{1/3}$

6) The escape velocity from earth is 11.2 km/s. If a body is to be projected in a direction making an angle 45°to the vertical, then the escape velocity is

(a) 11.2×2 km/s

(b) 11.2 km/s

(c) $11.2\ /\sqrt{2}$ km/s

(d) $11.2\sqrt{2}$ km/s

7) A satellite in force free space sweeps stationary interplanetary dust at a rate dM/dt = αv where M is the mass and v is the velocity of the satellite and α is a constant. What is the deceleration of the satellite?

(a) $-\alpha v^2$

(b) $-\alpha v^2/2M$

(c) $-\alpha v^2/M$

(d) $-2\alpha v^2/M$

8) The escape velocity from the surface of the earth is v_e. The escape velocity from the surface of a planet whose mass and radius are three times those of the earth, will be

(a) v_e

(b) $3v_e$

(c) $9v_e$

(d) $1/3v_e$

9) A ball is dropped from a satellite revolving around the earth at a height of 120 km. The ball will

(a) continue to move with same speed along a straight line tangentially to the satellite at that time

(b) continue to move with the same speed along the original orbit of satellite

(c) fall down to earth gradually

(d) go far away in space

10) The escape velocity of a body on the surface of the earth is 11.2 km/s. If the earth's mass increases to twice its present value and the radius of the earth becomes half, the escape velocity would become

(a) 44.8 km/s

(b) 22.4 km/s

(c) 11.2 km/s (remains unchanged)

(d) 5.6 km/s

11) The escape velocity of a sphere of mass m is given by (G = Universal gravitational constant; M = Mass of the earth and R_e= Radius of the earth)

(a) $\sqrt{\frac{GM}{R_e}}$

(b) $\sqrt{\frac{2GM}{R_e}}$

(c) $\sqrt{\frac{2GMm}{R_e}}$

(d) $\sqrt{\frac{2GM+R_e}{R_e}}$

12) The escape velocity on the surface of earth is 11.2 km/s. What would be the escape velocity on the surface of another planet of the same mass but 1/4 times the radius of the earth?

(a) 22.4 km/s

(b) 44.8 km/s

(c) 5.6 km/s

(d) 11.2 km/s

13) For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is

(a) $\frac{1}{2}$

(b) $\frac{1}{\sqrt{2}}$

(c) 2

(d) $\sqrt{2}$

14) Two satellites of earth, S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2. Which one of the following statements is true?

(a) The potential energies of earth satellites in the two cases are equal.

(b) S_1 and S_2 are moving with the same speed.

(c)The kinetic energies of the two satellites are equal

(d) The time periods of S_1 is four times that of S_2.

15) The radii of circular orbits of two satellites A and B of the earth, are 4R and R, respectively. If the speed of satellite A is 3V, then speed of satellite B will be:

(a) 3V/4
(b) 6V
(c) 12V
(d) 3V/2

16) A particle of mass m is thrown upwards from the surface of the earth, with a velocity u. The mass and the radius of the earth are, respectively, M and R. G is gravitational constant and g is acceleration due to gravity on the surface of the earth. The minimum value of u so that the particle does not return back to earth, is

(a) $\sqrt{\frac{2GM}{R}}$
(b) $\sqrt{\frac{2GM}{R^2}}$
(c) $\sqrt{2gR^2}$
(d) $\sqrt{\frac{2GM}{R}}$

17) A planet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance of r_2. If v_1 and v_2 are the linear velocities at these points respectively, then the ratio $\frac{v_1}{v_2}$ is

(a) $(r_1/ r_2)^2$
(b) r_2/ r_1
(c) $(r_2/ r_1)^2$
(d) r_1/ r_2

18) If v_e is escape velocity and v_0 is orbital velocity of a satellite for orbit close to the earth's surface, then these are related by:

(a) $v_0 = \sqrt{2}v_e$
(b) $v_0 = v_e$
(c) $v_0 = \sqrt{2v_0}$
(d) $v_e = \sqrt{2}v_0$

19) A geostationary satellite is orbiting the earth at a height of 5R above that surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of 2R from the surface of the earth is:

(a) 5
(b) 10
(c) $6\sqrt{2}$
(d) $\frac{6}{\sqrt{2}}$

20) A particle of mass '*m*' is kept at rest at a height 3R from the surface of earth, where 'R' is radius of earth and 'M' is mass of earth. The minimum speed with which it should be projected, so that it does not return back, is (g is acceleration due to gravity on the surface of earth)

(a) $\left(\frac{GM}{R}\right)^{\frac{1}{2}}$
(b) $\left(\frac{GM}{2R}\right)^{\frac{1}{2}}$

(c) $\left(\frac{gR}{4}\right)^{\frac{1}{2}}$

(d) $\left(\frac{2g}{4}\right)^{\frac{1}{2}}$

21) The radius of a planet is twice the radius of earth. Both have almost equal average mass densities. If V_P and V_E are escape velocities of the planet and the earth, respectively, then

(a) $V_E = 1.5\ V_P$

(b) $V_P = 1.5\ V_E$

(c) $V_P = 2\ V_E$

(d) $V_E = 3\ V_P$

22) A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass = 5.98×10^{24} kg) have to be compressed to be a black hole?

(a) 10^{-9} m

(b) 10^{-6} m

(c) 10^{-2} m

(d) 100 m

23) A remote - sensing satellite of earth revolves in a circular orbit at a height of 0.25×10^6 m above the surface of earth. If earth's radius is 6.38×10^6 m and g = $9.8 ms^{-2}$, then the orbital speed of the satellite is:

(a) $8.56\ kms^{-1}$

(b) $9.13\ kms^{-1}$

(c) $6.67\ kms^{-1}$

(d) $7.76\ kms^{-1}$

24) A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then,

(a) the total mechanical energy of S varies periodically with time.

(b) the linear momentum of S remains constant in magnitude.

(c) the acceleration of S is always directed towards the centre of the earth.

(d) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.

25) The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is:

(a) 1 : 2

(b) 1 : $2\sqrt{2}$

(c) 1 : 4

(d) 1 : 3

26) The escape velocity of a body depends upon mass as

(a) m^0

(b) m^1

(c) m^2

(d) m^3

27) If suddenly the gravitational force of attraction between Earth and a satellite revolving around it becomes zero, then the satellite will

(a) continue to move in its orbit with same velocity

(b) move tangentially to the original orbit in the same velocity

(c) become stationary in its orbit

(d) move towards the earth

28) The kinetic energy needed to project a body of mass m from the earth surface (radius R) to infinity is

(a) mgR/2
(b) 2mgR
(c) mgR
(d) mgR/4

29) 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° with the vertical, the escape velocity will be

(a) $11\sqrt{2}$ km/s
(b) 22 km/s
(c) 11 km/s
(d) $\frac{11}{\sqrt{2}}$ km/s

30) 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

(a) $\frac{gR^2}{R+x}$
(b) $\frac{gR}{R-x}$
(c) gx
(d) $\left(\frac{gR^2}{R+x}\right)^{1/2}$

31) The time period of an earth satellite in circular orbit is independent of

(a) both the mass and radius of the orbit

(b) radius of its orbit

(c) the mass of the satellite

(d) neither the mass of the satellite not the radius of its orbit.

32) Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to

(a) R^n
(b) $R^{\left(\frac{n-1}{2}\right)}$
(c) $R^{\left(\frac{n+1}{2}\right)}$
(d) $R^{\left(\frac{n-2}{2}\right)}$

33) A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth is 11km s^{-1}, the escape velocity from the surface of the planet would be

(a) 1.1 km s^{-1}
(b) 11 km s^{-1}
(c) 110 km s^{-1}
(d) 0.11 km s^{-1}

34) What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an amplitude of 2R?

(a) $\frac{5GmM}{6R}$
(b) $\frac{2GmM}{3R}$

(c) $\frac{GmM}{2R}$

(d) $\frac{GmM}{2R}$

35) A very long (length L) cylindrical galaxy is made of uniformly distributed mass and has radius R (R ≪ L). A star outside the galaxy is orbiting the galaxy in a plane perpendicular to the galaxy and passing through its centre. If the time period is T and its distance from the galaxy's axis is r, then:

(a) $T \propto r$

(b) $T \propto \sqrt{r}$

(c) $T \propto r^2$

(d) $T \propto r^3$

36) An astronaut of mass m is working on a satellite orbiting the earth at a distance h from the earth's surface. The radius of the earth is R, while its mass is M. The gravitational pull F_G on the astronaut is:

(a) Zero since astronaut feels weightless

(b) $\frac{GMm}{(R+h)^2} < F_G < \frac{GMm}{R^2}$

(c) $F_G = \frac{GMm}{(R+h)^2}$

(d) $0 < F_G < \frac{GMm}{R^2}$

37) A satellite is revolving in a circular orbit at a height 'h' from the earth's surface (radius of earth R; h ≪ R). The minimum increase in its orbital velocity required, so that the satellite could escape from the earth's gravitational field, is close to: (Neglect the effect of atmosphere).

(a) $\sqrt{gR/2}$

(b) $\sqrt{gR}\,(\sqrt{2}-1)$

(c) $\sqrt{2gR}$

(d) $\sqrt{gR}$

ANSWER KEY

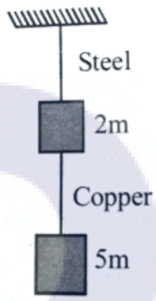
1	2	3	4	5	6	7	8	9	10
a	b	c	d	a	b	c	a	b	b
11	12	13	14	15	16	17	18	19	20
d	a	a	b	b	a	b	d	c	b
21	22	23	24	25	26	27	28	29	30
c	c	d	c	b	a	c	c	c	d
31	32	33	34	35	36	37			
c	c	c	a	a	c	b			

Topic 30: Hooke’s Law & Young’s Modulus of Elasticity

1) Two wires A and B are of same material. Their lengths are in the ratio 1 : 2 and the diameter are in the ratio 2 : 1. If they are pulled by the same force, then increase in length will be in the ratio

(a) 2 : 1
(b) 1 : 4
(c) 1 : 8
(d) 8 : 1

2) If the ratio of diameters, lengths and Young’s Modulus of steel and copper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be



(a) $\frac{7q}{(5sp)}$
(b) $\frac{5q}{(7sp^2)}$
(c) $\frac{7q}{(5sp^2)}$
(d) $\frac{2q}{(5sp)}$

3) The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied?

(a) Length = 100cm, diameter = 1mm
(b) Length = 200cm, diameter = 2mm
(c) Length = 300cm, diameter = 3mm
(d) Length = 50cm, diameter = 0.5mm

4) Copper of fixed volume ‘V; is drawn into wire of length ‘l’. When this wire is subjected to a constant force ‘F’, the extension produced in the wire is ‘Δl’. Which of the following graphs is a straight line?

(a) Δl versus $\frac{1}{l}$
(b) Δl versus l^2
(c) Δl versus $\frac{1}{l^2}$
(d) Δl versus l

5) The Young’s modulus of steel is twice that of brass. Two wires of same length and of same area cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of:

(a) 2 : 1
(b) 4 : 1

(c) 1 : 1 (d) 1 : 2

6) A wire elongates by *l* mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be (in mm)

(a) *l* (b) 2*l*

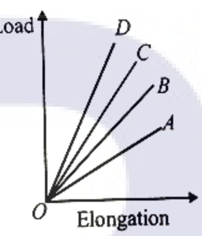
(c) zero (d) *l*/2

7) Two wires are made of the same material and have the same volume. However wire 1 has cross – sectional area 3A. If the length of wire 1 increases by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?

(a) 4F (b) 6F

(c) 9F (d) F

8) The load versus elongation graphs for four wires of same length and made of the same material are shown in the figure. The thinnest wire is represented by the line



(a) OA (b) OC

(c) OD (d) OB

9) A structural steel rod has a radius of 10mm and length of 1.0m. A 100kN force stretches it along its length. Young's modulus of structural steel is $2 \times 10^{11} Nm^{-2}$. The percentage strain is about

(a) 0.16% (b) 0.32%

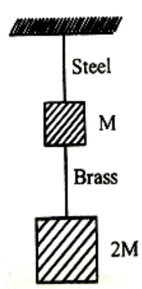
(c) 0.08% (d) 0.24%

10) A steel wire can sustain 100kg weight without breaking. If the wire is cut into two equal parts, each part can sustain a weight of

(a) 50kg (b) 400kg

(c) 100kg (d) 200kg

11) If the ratio of lengths, radii and Young's moduli of steel and brass wires in the figure are a, b and c respectively, then the corresponding ratio of increase in their length is:



(a) $\frac{3c}{2ab^2}$ (b) $\frac{2a^2c}{b}$

(c) $\frac{3a}{2b^2c}$ (d) $\frac{2ac}{b^2}$

12) A uniform wire (Young's modulus $2 \times 10^{11}Nm^{-2}$) is subjected to longitudinal tensile stress of 5×10^7 Nm^{-2}. If the overall volume change in the wire is 0.02%, the fractional decrease in the radius of the wire is close to:

(a) 1.0×10^{-4} (b) 1.5×10^{-4}

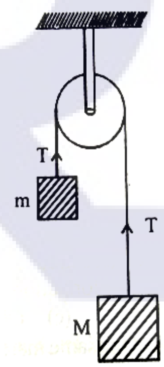
(c) 0.25×10^{-4} (d) 5×10^{-4}

13) A copper wire of length 1.0m and a steel wire of length 0.5m having equal cross – sectional areas are joined end to end. The composite wire is stretched by a certain load which stretches the copper wire by 1mm. If the Young's modulii of copper and steel are respectively $1.0 \times 10^{11}Nm^{-2}$ and $2.0 \times 10^{11}Nm^{-2}$, the total extension of the composite wire is:

(a) 1.75mm (b) 2.0mm

(c) 1.50mm (d) 1.25mm

14) Two blocks of masses m and M are connected by means of a metal wire of cross – sectional area A passing over a frictionless fixed pulley as shown in the figure. The system is then released. If M = 2m, then the stress produced in the wire is:



(a) $\frac{2mg}{3A}$ (b) $\frac{4mg}{3A}$

(c) $\frac{mg}{A}$ (d) $\frac{3mg}{4A}$

15) The pressure that has to be applied to the ends of a steel wire of length 10cm to keep its length constant when its temperature is raised by 100°C is:

(For steel Young's modulus is $2 \times 10^{11}Nm^{-2}$ and coefficient of thermal expansion is $1.1 \times 10^{-5}K^{-1}$)

(a) 2.2×10^8Pa (b) 2.2×10^9Pa

(c) 2.2×10^7Pa (d) 2.2×10^6Pa

16) A uniformly tapering conical wire is made from a material of Young's modulus Y and has a normal, unexpected length L. The radii, at the upper and lower ends of this conical wire, have values R and 3R,

respectively. The upper end of the wire is fixed to a rigid support and a mass M is suspended from its lower end. The equilibrium extended length, of this wire, would equal:

(a) $L\left(1+\frac{2}{9}.\frac{Mg}{\pi YR^{2}}\right)$ (b) $L\left(1+\frac{1}{9}.\frac{Mg}{\pi YR^{2}}\right)$

(c) $L\left(1+\frac{1}{3}.\frac{Mg}{\pi YR^{2}}\right)$ (d) $L\left(1+\frac{2}{3}.\frac{Mg}{\pi YR^{2}}\right)$

17) A thin 1m long rod has a radius of 5mm. A force of 50πkN is applied at one end to determine its Young's modulus. Assume that the force is exactly known. If the least count in the measurement of all lengths is 0.01mm, which of the following statements is false?

(a) The maximum value of Y that can be determined is 2×10^{14} N/m^2.

(b) $\frac{\Delta Y}{Y}$ gets minimum contribution from the uncertainty in the length

(c) $\frac{\Delta Y}{Y}$ gets its maximum contribution from the uncertainty in strain

(d) The figure of merit is the largest for the length of the rod.

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	c	d	b	a	a	c	a	a	c
11	12	13	14	15	16	17			
c	c	d	b	a	c	a			

Topic 31: Bulk and Rigidity Modulus & Work Done in Stretching a Wire

1) When an elastic material with Young's modulus Y is subjected to stretching stress S, elastic energy stored per unit volume of the material is

(a) YS/2 (b) $S^2Y/2$

(c) $S^2/2Y$ (d) S/2Y

2) The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p', the fractional decrease in radius is

(a) $\frac{B}{3p}$ (b) $\frac{3p}{B}$

(c) $\frac{p}{3B}$ (d) $\frac{p}{B}$

3) A wire fixed at the upper end stretches by length *l* by applying a force F. The work done in stretching is

(a) $2Fl$ (b) Fl

(c) $\frac{F}{2l}$ (d) $\frac{Fl}{2}$

4) If 'S' is stress and 'Y' is young's modulus of material of a wire, the energy stored in the wire per unit volume is

(a) $\frac{S^2}{2Y}$ (b) $2S^2Y$

(c) $\frac{S}{2Y}$ (d) $\frac{2Y}{S^2}$

5) In materials like aluminium and copper, the correct order of magnitude of various elastic modulus is:

(a) Young's modulus < shear modulus < bulk modulus.

(b) Bulk modulus < shear modulus < Young's modulus.

(c) Shear modulus < Young's modulus < bulk modulus.

(d) Bulk modulus < Young's modulus < shear modulus.

6) The bulk moduli of ethanol, mercury and water are given as 0.9, 25 and 2.2 respectively in units of $10^9 Nm^{-2}$. For a given value of pressure, the fractional compression in volume is $\frac{\Delta V}{V}$. Which of the following statements about $\frac{\Delta V}{V}$ for these three liquids is correct?

(a) Ethanol > Water > Mercury (b) Water > Ethanol > Mercury

(c) Mercury > Ethanol > Water

(d) Ethanol > Mercury > Water

7) Steel ruptures when a shear of $3.5 \times 10^8 Nm^{-2}$ is applied. The force needed to punch a 1cm diameter hole in a steel sheet 0.3cm thick is nearly:

(a) $1.4 \times 10^4 N$

(b) $2.7 \times 10^4 N$

(c) $3.3 \times 10^4 N$

(d) $1.1 \times 10^4 N$

8) A bottle has an opening of radius a and length b. A cork of length b and radius (a + Δa) where (Δa << a) is compressed to fit into the opening completely (see figure). If the bulk modulus of cork is B and friction coefficient between the bottle and cork is μ then the force needed to push the cork into the bottle is:

(a) (πμBb)a

(b) (2πμBb)Δa

(c) (πμBb) Δa

(d) (4πμBb) Δa

ANSWER KEY							
1	2	3	4	5	6	7	8
c	c	d	a	c	a	c	d

Topic 32: Pressure, Density Pascal's Law & Archimedes Principle

1) The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of $100 cm^3$ of water under a pressure of 100 atmosphere will be

(a) $0.4 cm^3$

(b) $4 \times 10^{-5} cm^3$

(c) $0.025 cm^3$

(d) $0.004 cm^3$

2) In rising from the bottom of a lake, to the top, the temperature of an air bubble remains unchanged, but its diameter gets doubled. If h is the barometric height (expressed in m of mercury of relative density ρ) at the surface of the lake, the depth of the lake is

(a) 8 ρh m

(b) 7 ρh m

(c) 9 ρh m

(d) 12 ρh m

3) The approximate depth of an ocean is 2700m. The compressibility of water is $45.4 \times 10^{-11} Pa^{-1}$ and density of water is $10^3 kg/m^3$. What fractional compression of water will be obtained at the bottom of the ocean?

(a) 1.0×10^{-2}

(b) 1.2×10^{-2}

(c) 1.4×10^{-2}

(d) 0.8×10^{-2}

4) Two non – mixing liquids of densities ρ and nρ (n > 1) are put in a container. The height of each liquid is h. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length pL (p < 1) in the denser liquid. The density d is equal to:

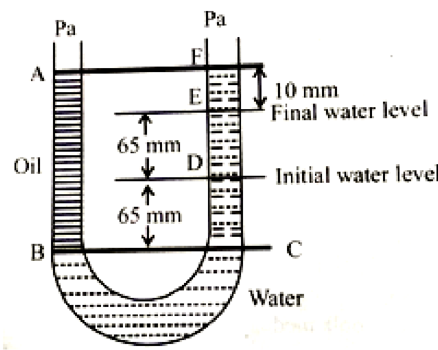
(a) {1 + (n +1) p}ρ

(b) {2 + (n +1) p}ρ

(c) {2 + (n −1) p}ρ

(d) {1 + (n −1) p}ρ

5) A U tube with both ends open to the atmosphere, is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10mm above the water level on the other side. Meanwhile the water rises by 65mm from its original level (see diagram). The density of the oil is



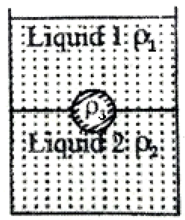
(a) $425 kg m^{-3}$

(b) $800 kg m^{-3}$

(c) 928 kg m^{-3}

(d) 650 kg m^{-3}

6) A jar is filled with two non – mixing liquids 1 and 2 having densities ρ_1 and ρ_2 respectively. A solid ball, made of a material of density ρ_3, is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for ρ_1, ρ_2 and ρ_3?



(a) $\rho_3 < \rho_1 < \rho_2$

(b) $\rho_1 > \rho_3 > \rho_2$

(c) $\rho_1 < \rho_2 < \rho_3$

(d) $\rho_1 < \rho_3 < \rho_2$

7) Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 0.8g cm^{-3}, the angle remains the same. If density of the material of the sphere is 1.6g cm^{-3}, the dielectric constant of the liquid is

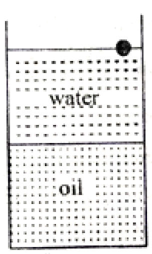
(a) 4

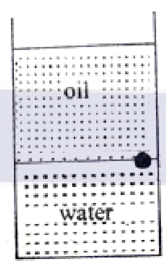
(b) 3

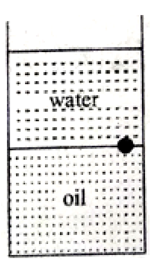
(c) 2

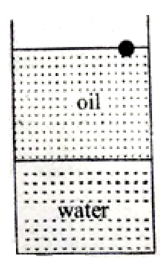
(d) 1

8) A ball is made of a material of density ρ where $\rho_{oil} < \rho < \rho_{water}$ with ρ_{oil} and ρ_{water} representing the densities of oil and water, respectively. The oil and water are immiscible. If the above ball is in equilibrium in a mixture of this oil and water, which of the following pictures represents its equilibrium position?

(a)


(b)


(c)


(d)


9) A uniform cylinder of length L and mass M having cross – sectional area A is suspended, with its length vertical, from a fixed point by a massless spring such that it is half submerged in a liquid of density σ at equilibrium position. The extension x_0 of the spring when it is in equilibrium is:

(a) $\frac{Mg}{k}$

(b) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{M}\right)$

(c) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{2M}\right)$

(d) $\frac{Mg}{k}\left(1+\frac{LA\sigma}{M}\right)$

10) There is a circular tube in a vertical plane. Two liquids which do not mix and of densities d_1 and d_2 are filled in the tube. Each liquid subtends 90° angle at centre. Radius joining their interface makes an angle α with vertical. Ratio $\frac{d_1}{d_2}$ is:

(a) $\frac{1+\sin\alpha}{1-\sin\alpha}$

(b) $\frac{1+\cos\alpha}{1-\cos\alpha}$

(c) $\frac{1+\tan\alpha}{1-\tan\alpha}$

(d) $\frac{1+\sin\alpha}{1-\cos\alpha}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	b	b	d	c	d	c	b	c	c

Topic 33: Fluid Flow, Reynolds Number & Bernoulli's Principle

1) A fluid is in streamline flow across a horizontal pipe of variable area of cross section. For this which of the following statements is correct?

(a) The velocity is minimum at the narrowest part of the pipe and the pressure is minimum at the widest part of the pipe

(b) The velocity is maximum at the narrowest part of the pipe and the pressure is maximum at the widest part of the pipe

(c) Velocity and pressure both are maximum at the narrowest part of the pipe

(d) Velocity and pressure both are maximum at the widest part of the pipe

2) The cylindrical tube of a spray pump has radius, R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is:

(a) $\frac{VR^2}{nr^2}$

(b) $\frac{VR^2}{n^3r^2}$

(c) $\frac{V^2R}{nr}$

(d) $\frac{VR^2}{n^2r^2}$

3) A wind with speed 40m/s blows parallel to the roof of a house. The area of the roof is $250m^2$. Assuming that the pressure inside the house is atmosphere pressure, the force exerted by the wind on the roof and the direction of the force will be ($\rho_{air} = 1.2kg/m^3$)

(a) 4.8×10^5N, upwards

(b) 2.4×10^5N, upwards

(c) 2.4×10^5N, downwards

(d) 4.8×10^5N, downwards

4) A cylinder of height 20m is completely filled with water. The velocity of efflux of water (in ms^{-1}) through a small hole on the side wall of the cylinder near its bottom is

(a) 10

(b) 20

(c) 25.5

(d) 5

5) Water is flowing continuously from a tap having an internal diameter 8×10^{-3}m. The water velocity as it leaves the tap is $0.4ms^{-1}$. The diameter of the water stream at a distance 2×10^{-1}m below the tap is close to:

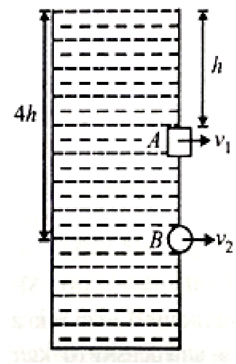
(a) 7.5×10^{-3}m

(b) 9.6×10^{-3}m

(c) 3.6×10^{-3}m

(d) 5.0×10^{-3}m

6) A square hole of side length *l* is made at a depth of h and a circular hole of radius r is made at a depth of 4h from the surface of water in a water tank kept on a horizontal surface. If *l* << h, r << h and the rate of water flow from the holes is the same, then r is equal to



(a) $\frac{l}{\sqrt{2\pi}}$

(b) $\frac{l}{\sqrt{3\pi}}$

(c) $\frac{l}{3\pi}$

(d) $\frac{l}{2\pi}$

7) Water is flowing through a horizontal tube having cross sectional areas of its two ends being A and A' such that the ratio A/A' is 5. If the pressure difference of water between the two ends is $3 \times 10^5 Nm^{-2}$, the velocity of water with which it enters the tube will be (neglect gravity effect)

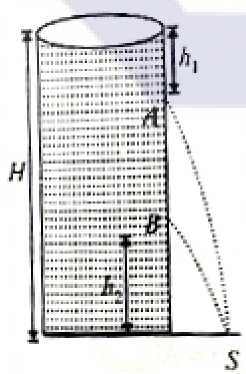
(a) $5ms^{-1}$

(b) $10ms^{-1}$

(c) $25ms^{-1}$

(d) $50\sqrt{10}ms^{-1}$

8) In a cylindrical water tank, there are two small holes A and B on the wall at a depth of h_1, from the surface of water and at a height of h_2 from the bottom of water tank. Surface of water is at height of h_2 from the bottom of water tank. Surface of water is at height H from the bottom of water tank. Water coming out from both holes strikes the ground at the same point S. Find the ratio of h_1 and h_2



(a) Depends on H

(b) 1 : 1

(c) 2 : 2

(d) 1 : 2

9) Air of density $1.2kgm^{-3}$ is blowing across the horizontal wings of an aeroplane in such a way that its speeds above and below the wings are $150ms^{-1}$ and $100ms^{-1}$, respectively. The pressure difference between the upper and lower sides of the wings, is:

(a) $60Nm^{-2}$

(b) $180Nm^{-2}$

(c) $7500Nm^{-2}$

(d) $12500Nm^{-2}$

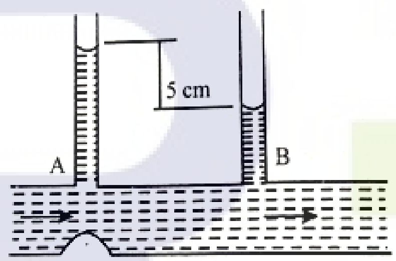
10) Water is flowing at a speed of $1.5ms^{-1}$ through horizontal tube of cross – sectional area $10^{-2}m^2$ and you are trying to stop the flow by your palm. Assuming that the water stops immediately after hitting the palm, the minimum force that you must exert should be (density of water = 10^3kgm^{-3})

(a) 15N
(b) 22.5N
(c) 33.7N
(d) 45N

11) A cylindrical vessel of cross – section A contains water to a height h. There is a hole in the bottom of radius 'a'. The time in which it will be emptied is:

(a) $\frac{2A}{\pi a^2}\sqrt{\frac{h}{g}}$
(b) $\frac{\sqrt{2}A}{\pi a^2}\sqrt{\frac{h}{g}}$
(c) $\frac{2\sqrt{2}A}{\pi a^2}\sqrt{\frac{h}{g}}$
(d) $\frac{A}{\sqrt{2}\pi a^2}\sqrt{\frac{h}{g}}$

12) In the diagram shown, the difference in the two tubes of the manometer is 5cm, the cross section of the tube at A and B is $6mm^2$ and $10mm^2$ respectively. The rate at which water flows through the tube is ($g = 10ms^{-2}$)



(a) 7.5cc/s
(b) 8.0cc/s
(c) 10.0cc/s
(d) 12.5cc/s

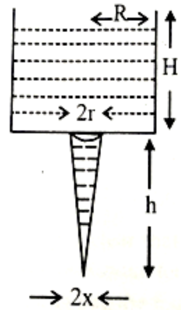
13) An open glass tube is immersed in mercury in such a way that a length of 8cm extends above the mercury level. The open end of the tube is then closed and sealed and the tube is raised vertically up by additional 46cm. What will be length of the air column above mercury in the tube now? (Atmospheric pressure = 76cm of Hg)

(a) 16cm
(b) 22cm
(c) 38cm
(d) 6cm

14) If it takes 5 minutes to fill a 15 liter bucket from a water tap of diameter $\frac{2}{\sqrt{\pi}}$ cm then the Reynolds number for the flow is (density of water = $10^3kg/m^3$) and viscosity of water = 10^{-3}P.a.s) close to:

(a) 1100
(b) 11,000
(c) 550
(d) 5500

15) Consider a water jar of radius R that has water filled up to height H and is kept on a stand of height h (see figure). Through a hole of radius (r << R) at its bottom, the water leaks out and the stream of water coming down towards the ground has a shape like a funnel as shown in the figure. If the radius of the cross – section of water stream when it hits the ground is x. Then:



(a) $x = r\left(\frac{H}{H+h}\right)^{\frac{1}{4}}$

(b) $x = r\left(\frac{H}{H+h}\right)$

(c) $x = r\left(\frac{H}{H+h}\right)^{2}$

(d) $x = r\left(\frac{H}{H+h}\right)^{\frac{1}{2}}$

16) Two tubes of radii r_1 and r_2, and lengths l_1 and l_2, respectively, are connected in series and a liquid flows through each of them in streamline conditions. P_1 and P_2 are pressure differences across the two tubes. If P_2 is $4P_1$ and l_2 is $\frac{l_1}{4}$, then the radius r_2 will be equal to:

(a) r_1

(b) $2r_1$

(c) $4r_1$

(d) $\frac{r_1}{2}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	a	b	b	c	a	a	a	c	a
11	12	13	14	15	16				
b	a	a	d	a	d				

Topic 34: Viscosity & Terminal Velocity

1) The terminal velocity v_r of a small steel ball of radius r falling under gravity through a column of a viscous liquid of coefficient of viscosity η depends on mass of the ball m, acceleration due to gravity g, coefficient of viscosity η and radius r. Which of the following relations is dimensionally correct?

(a) $v_r \propto \frac{mgr}{\eta}$

(b) $v_r \propto mg\eta r$

(c) $v_r \propto \frac{mg}{r\eta}$

(d) $v_r \propto \frac{\eta mg}{r}$

2) Spherical balls of radius 'R' are falling in a viscous fluid of viscosity 'η' with a velocity 'v'. The retarding viscous force acting on the spherical ball is

(a) inversely proportional to both radius 'R' and velocity 'v'

(b) directly proportional to both radius 'R' and velocity 'v'

(c) directly proportional to 'R' but inversely proportional to 'v'

(d) inversely proportional to 'R' but directly proportional to velocity 'v'

3) If the terminal speed of a sphere of gold (density = $19.5 kg/m^3$) is 0.2m/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) 0.4m/s

(b) 0.133m/s

(c) 0.1m/s

(d) 0.2m/s

4) A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density ρ_1 ($\rho_2 < \rho_1$). Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed v, i.e., $F_{viscous} = -kv^2$ ($k > 0$). The terminal speed of the ball is

(a) $\sqrt{\frac{Vg(\rho_1-\rho_2)}{k}}$

(b) $\frac{Vg\rho_1}{k}$

(c) $\sqrt{\frac{Vg\rho_1}{k}}$

(d) $\frac{Vg(\rho_1-\rho_2)}{k}$

5) If a ball of steel (density $\rho = 7.8 gcm^{-3}$) attains a terminal velocity of $10 cms^{-1}$ when falling in water (Coefficient of viscosity $\eta_{water} = 8.5 \times 10^{-4}$ Pa.s), then, its terminal velocity in glycerine ($\rho = 1.2 gcm^{-3}$, η = 13.2Pa.s) would be, nearly

(a) $6.25 \times 10^{-4} cms^{-1}$

(b) $6.45 \times 10^{-4} cms^{-1}$

(c) $1.5 \times 10^{-5} cms^{-1}$

(d) $1.6 \times 10^{-5} cms^{-1}$

6) The terminal velocity of a small sphere of radius a in a viscous liquid is proportional to

(a) a^2

(b) a^3

(c) a

(d) a^{-1}

7) In an experiment, a small steel ball falls through a liquid at a constant speed of 10m/s. If the steel ball is pulled upward with a force equal to twice its effective weight, how fast will it move upward?

(a) 5cm/s

(b) Zero

(c) 10cm/s

(d) 20cm/s

8) A tank with a small hole at the bottom has been filled with water and kerosene (specific gravity 0.8). The height of water is 3m and that of kerosene 2m. When the hole is opened the velocity of fluid coming out from it is nearly: (take g = $10ms^{-2}$ and density of water = $10^3 kgm^{-3}$)

(a) $10.7ms^{-1}$

(b) $9.6ms^{-1}$

(c) $8.5ms^{-1}$

(d) $7.6ms^{-1}$

9) The average mass of rain drops is 3.0×10^{-5}kg and their average terminal velocity is 9m/s. Calculate the energy transferred by rain to each square metre of the surface at a place which receives 100cm of rain a year.

(a) 3.5×10^5J

(b) 4.05×10^4J

(c) 3.0×10^5J

(d) 9.0×10^4J

10) The velocity of water in a river is 18km/hr near the surface. If the river is 5m deep, find the shearing stress between the horizontal layers of water. The co – efficient of viscosity of water = 10^{-2}poise.

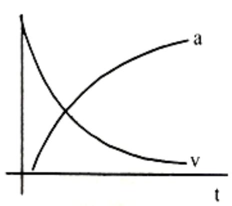
(a) $10^{-1}N/m^2$

(b) $10^{-2}N/m^2$

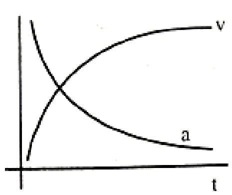
(c) $10^{-3}N/m^2$

(d) $10^{-4}N/m^2$

11) Which of the following option correctly describes the variation of the speed v and acceleration ‘a’ of a point mass falling vertically in a viscous medium that applies a force F = −kv, where ‘k’ is a constant, on the body? (Graphs are schematic and not drawn to scale)

(a)


(b)

(c)


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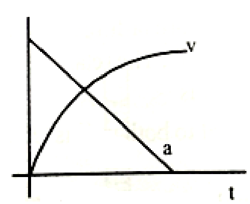


ANSWER KEY										
1	2	3	4	5	6	7	8	9	10	11
c	b	c	a	a	a	c	b	b	b	c

Topic 35: Surface Tension, Surface Energy & Capillarity

1) The angle of contact between pure water and pure glass, is

(a) 0° (b) 45°

(c) 90° (d) 135°

2) The wetability of a surface by a liquid depends primarily on

(a) surface tension

(b) density

(c) angle of contact between the surface and the liquid

(d) viscosity

3) A certain number of spherical drops of a liquid of radius 'r' coalesce to form a single drop of radius 'R' and volume 'V'. If 'T' is the surface tension of the liquid, then:

(a) energy = $4VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released

(b) energy = $3VT\left(\frac{1}{r}+\frac{1}{R}\right)$ is released

(c) energy = $3VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released

(d) energy is neither released nor absorbed

4) Water rises to a height 'h' in a capillary tube. If the length of capillary tube above the surface of water is made less than 'h' then:

(a) water rises upto the top of capillary tube and stays there without overflowing

(b) water rises upto a point a little below the top and stays there

(c) water does not rise at all

(d) Water rises upto the tip of capillary tube and then starts overflowing like fountain.

5) If two soap bubbles of different radii are connected by a tube

(a) air flows from the smaller bubble to the bigger

(b) air flows from the bigger bubble to the smaller bubble till the sizes are interchanged

(c) air flows from the bigger bubble to the smaller bubble till the sizes becomes equal

(d) there is no flow of air.

6) A 20cm long capillary tube is dipped in water. The water rises up to 8cm. If the entire arrangement is put in a freely falling elevator the length of water column in the capillary tube will be

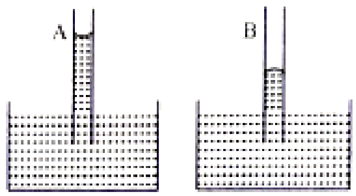
(a) 10cm

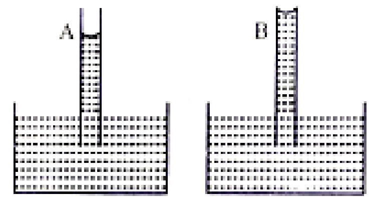
(b) 8cm

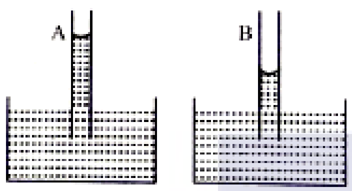
(c) 20cm

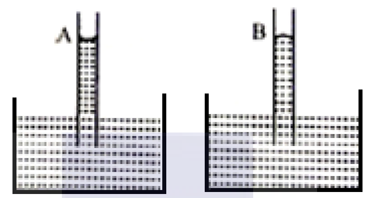
(d) 4cm

7) A capillary tube (A) is dipped in water. Another identical tube (B) is dipped in a soap – water solution. Which of the following shows the relative nature of the liquid columns in the two tubes?

(a) 

(b) 

(c) 

(d) 

8) Two mercury drops (each of radius ‘r’) merge to form bigger drop. The surface energy of the bigger drop, if T is the surface tension, is:

(a) $4\pi r^2 T$

(b) $2\pi r^2 T$

(c) $2^{8/3}\pi r^2 T$

(d) $2^{5/3}\pi r^2 T$

9) Work done in increasing the size of a soap bubble from a radius of 3cm to 5cm is nearly (Surface tension of soap solution = $0.03 Nm^{-1}$)

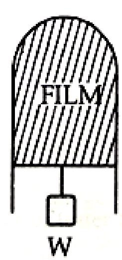
(a) $0.2\pi mJ$

(b) $2\pi mJ$

(c) $0.4\pi mJ$

(d) $4\pi mJ$

10) A thin liquid film formed between a U – shaped wire and a light slider supports a weight of 1.5×10^{-2} N (see figure). The length of the slider is 30cm and its weight is negligible. The surface tension of the liquid film is



(a) $0.0125 Nm^{-1}$

(b) $0.1 Nm^{-1}$

(c) $0.05 Nm^{-1}$

(d) $0.025 Nm^{-1}$

11) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: A capillary is dipped in a liquid and liquid rises to a height h in it. As the temperature of the liquid is raised, the height h increases (if the density of the liquid and the angle of contact remain the same).

Statement 2: Surface tension of a liquid decreases with the rise in its temperature.

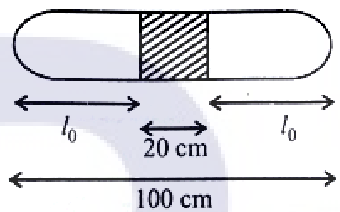
(a) Statement 1 is true, Statement 2 is true; Statement 2 is **not** the correct explanation of Statement 1.

(b) Statement 1 is false, Statement 2 is true.

(c) Statement 1 is true, Statement 2 is false.

(d) Statement 1 is true, Statement 2 is true; Statement 2 is the correct explanation of Statement 1.

12) A thin tube sealed at both ends is 100cm long. It lies horizontally, the middle 20cm containing mercury and two equal ends containing air at standard atmospheric pressure. If the tube is now turned to a vertical position, by what amount will the mercury be displaced?



(Given: cross – section of the tube can be assumed to be uniform)

(a) 2.95cm (b) 5.18cm

(c) 8.65cm (d) 0.0cm

13) Wax is coated on the inner wall of a capillary tube and the tube is then dipped in water. Then, compared to the unwaxed capillary, the angle of contact θ and the height h upto which water rises change. These changes are:

(a) θ increases and h also increases (b) θ decreases and h also decreases

(c) θ increases and h decreases (d) θ decreases and h increases

14) A capillary tube is immersed vertically in water and the height of the water column is x. When this arrangement is taken into a mine of depth d, the height of the water column is y. If R is the radius of earth, the ratio $\frac{x}{y}$ is:

(a) $\left(1-\frac{d}{R}\right)$ (b) $\left(1-\frac{2d}{R}\right)$

(c) $\left(\frac{R-d}{R+d}\right)$ (d) $\left(\frac{R+d}{R-d}\right)$

15) An air bubble of radius 0.1cm is in a liquid having surface tension 0.06N/m and density 10^3kg/m^3. The pressure inside the bubble is 1100Nm^{-2} greater than the atmospheric pressure. At what depth is the bubble below the surface of the liquid? (g = 9.8ms^{-2})

(a) 0.1m

(b) 0.15m

(c) 0.20m

(d) 0.25m

16) Two soap bubbles coalesce to form a single bubble. If V is the subsequent change in volume of contained air and S change in total surface area, T is the surface tension and P atmospheric pressure, then which of the following relation is correct?

(a) 4PV + 3ST = 0

(b) 3PV + 4ST = 0

(c) 2PV + 3ST = 0

(d) 3PV + 2ST = 0

17) A large number of liquid drops each of radius r coalesce to from a single drop of radius R. The energy released in the process is converted into kinetic energy of the big drop so formed. The speed of the big drop is (given, surface tension of liquid T, density ρ)

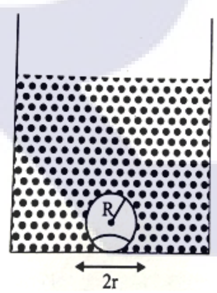
(a) $\sqrt{\frac{T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

(b) $\sqrt{\frac{2T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

(c) $\sqrt{\frac{4T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

(d) $\sqrt{\frac{6T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

18) On heating water, bubbles being formed at the bottom of the vessel detach and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of vessel. If r << R and the surface tension of water is T, value of r just before bubbles detach is: (density of water is ρ_w)



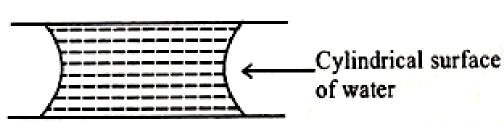
(a) $R^2\sqrt{\frac{2\rho_w g}{3T}}$

(b) $R^2\sqrt{\frac{\rho_w g}{6T}}$

(c) $R^2\sqrt{\frac{\rho_w g}{T}}$

(d) $R^2\sqrt{\frac{3\rho_w g}{T}}$

19) If two glass plates have water between them and are separated by very small distance (see figure), it is very difficult to pull them apart. It is because the water in between forms cylindrical surface on the side that gives rise to lower pressure in the water in comparison to atmosphere. If the radius of the cylindrical surface is R and surface tension of water is T then the pressure in water between the plates is lower by:



(a) $\frac{2T}{R}$

(b) $\frac{4T}{R}$

(c) $\frac{T}{4R}$

(d) $\frac{T}{R}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	c	c	a	a	c	c	c	c	d
11	12	13	14	15	16	17	18	19	
b	b	c	a	a	b	d	a	d	

Topic 36: Thermometry, Thermocouple & Thermal Expansion

1) A centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140°. What is the fall in temperature as registered by the Centigrade thermometer?

(a) 80°
(b) 60°
(c) 40°
(d) 30°

2) Mercury thermometer can be used to measure temperature upto

(a) 260°C
(b) 100°C
(c) 357°C
(d) 500°C

3) The temperature of inversion of thermocouple is 620°C and the neutral temperature is 300°C. What is the temperature of cold junction?

(a) 320°C
(b) 20°C
(c) −20°C
(d) 40°C

4) If the cold junction of a thermo – couple is kept at 0°C and the hot junction is kept at T°C then the relation between neutral temperature (T_n) and temperature of inversion (T_i) is

(a) $T_n = 2T_i$
(b) $T_n = T_i - T$
(c) $T_n = T_i + T$
(d) $T_n = T_i / 2$

5) On a new scale of temperature (which is linear) are called the W scale, the freezing and boiling points of water are 39° W and 239°W respectively. What will be the temperature on the new scale, corresponding to a temperature of 39°C on the Celsius scale?

(a) 78°W
(b) 117°W
(c) 200°W
(d) 139°W

6) The density of water 20°C is $998 kg/m^3$ and at 40°C $992 kg/m^3$. The coefficient of volume expansion of water is

(a) 10^{-4}/°C
(b) 3×10^{-4}/°C
(c) 2×10^{-4}/°C
(d) 6×10^{-4}/°C

7) The value of coefficient of volume expansion of glycerine is $5 \times 10^{-4} K^{-1}$. The fractional change in the density of glycerine for a rise of 40°C in its temperature, is

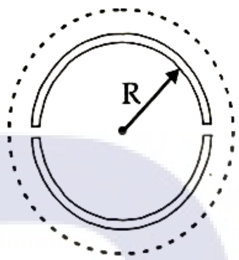
(a) 0.020
(b) 0.025
(c) 0.010
(d) 0.015

8) Coefficient of linear expansion of brass and steel rods are α_1 and α_2. Lengths of brass and steel rods are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations holds good?

(a) $\alpha_1 {l_2}_2 = \alpha_2 {l_1}_2$ (b) $\alpha_1 l_2 = \alpha_2 l_1$

(c) $\alpha_1 l_2 > \alpha_2 l_1$ (d) $\alpha_1 l_1 = \alpha_2 l_2$

9) A wooden wheel of radius R is made of two semicircular part (see figure). The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than 2πR. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the metal is α, and its Young's modulus is Y, the force that one part of the wheel applies on the other part is:



(a) 2πSYαΔT (b) SYαΔT

(c) πSYαΔT (d) 2SYαΔT

10) On a linear temperature scale Y, water freezes at −160°Y and boils at −50°Y. On this Y scale, a temperature of 340K would be read as: (water freezes at 273K and boils at 373K)

(a) −73.7°Y (b) −233.7°Y

(c) −86.3°Y (d) −106.3°Y

11) The ratio of the coefficient of volume expansion of a glass container to that of a viscous liquid kept inside the container is 1 : 4. What fraction of the inner volume of the container should the liquid occupy so that the volume of the remaining vacant space will be same at all temperatures?

(a) 2 : 5 (b) 1 : 4

(c) 1 : 64 (d) 1 : 8

12) A compressive force, F is applied at the two ends of a long thin steel rod. It is heated, simultaneously, such that its temperature increases by ΔT. The net change in its length is zero. Let l be the length of the rod, A its area of cross – section, Y its Young's modulus, and α its coefficient of linear expansion. Then, F is equal to:

(a) $l^2 Y\alpha\Delta T$ (b) $lAY\alpha\Delta T$

(c) $AY\alpha\Delta T$ (d) $\frac{AY}{\alpha\Delta T}$

13) A steel rail of length 5m and area of cross – section 40cm^2 is prevented from expanding along its length while the temperature rises by 10°C. If the coefficient of linear expansion and Young's modulus of steel are $1.2 \times 10^{-5} K^{-1}$ and $2 \times 10^{11} Nm^{-2}$ respectively, the force developed in the rail is approximately:

(a) 2×10^7N

(b) 1×10^5N

(c) 2×10^9N

(d) 3×10^{-5}N

14) An external pressure P is applied on a cube at 0°C so that it is equally compressed from all sides. K is the bulk modulus of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by:

(a) $\frac{3\alpha}{PK}$

(b) $3PK\alpha$

(c) $\frac{P}{3\alpha K}$

(d) $\frac{P}{\alpha K}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	c	c	d	b	b	a	d	d	c
11	12	13	14						
b	c	b	c						

Topic 37: Calorimetry & Heat Transfer

1) 10gm of ice cubes at 0°C are released in a tumbler (water equivalent 55g) at 40°C.Assuming that negligible heat is taken from the surroundings, the temperature of water in the tumbler becomes nearly (L = 80cal/g)

(a) 31°C (b) 22°C

(c) 19°C (d) 15°C

2) Thermal capacity of 40g of aluminium (s = 0.2cal/g K) is

(a) 168 joule/°C (b) 672 joule/°C

(c) 840 joule/°C (d) 33.6 joule/°C

3) If the temperature of the sun is doubled, the rate of energy received on earth will be increased by a factor of

(a) 2 (b) 4

(c) 8 (d) 16

4) A black body is at temperature of 500K. It emits energy at rate which is proportional to

(a) $(500)^4$ (b) $(500)^3$

(c) $(500)^2$ (d) 500

5) The radiant energy from the sun, incident normally at the surface of earth is 20 k cal/m^2 min. What would have been the radiant energy, incident normally on the earth, if the sun had a temperature, twice of the present one?

(a) 160 k cal/m^2 min (b) 40 k cal/m^2 min

(c) 320 k cal/m^2 min (d) 80 k cal/m^2 min

6) If 1g of steam is mixed with 1g of ice, then the resultant temperature of the mixture is

(a) 270°C (b) 230°C

(c) 100°C (d) 50°C

7) The presence of gravitational field is required for the heat transfer by

(a) conduction (b) stirring of liquids

(c) natural convection (d) radiation

8) A cylindrical rod having temperature T_1 and T_2 at its end. The rate of flow of heat is Q_1 cal/sec. If all the linear dimensions are doubled keeping temperature constant, then the rate of flow of heat Q_2 will be

(a) $4Q_1$ (b) $2Q_1$

(c) $Q_1/4$ (d) $Q_1/2$

9) A black body has maximum wavelength λ_m at temperature 2000K. Its corresponding wavelength at temperature 3000K will be

(a) $\frac{3}{2}\lambda_m$ (b) $\frac{2}{3}\lambda_m$

(c) $\frac{4}{9}\lambda_m$ (d) $\frac{9}{4}\lambda_m$

10) Two rods of thermal conductivities K_1 and K_2, cross – sections A_1 and A_2 and specific heats S_1 and S_2 are of equal lengths. The temperature of two ends of each rod are T_1 and T_2. The rate of flow of heat at the steady state will be equal if

(a) $\frac{K_1}{A_1S_1} = \frac{K_2}{A_2S_2}$ (b) $K_1A_1 = K_2A_2$

(c) $K_1S_1 = K_2S_2$ (d) $A_1S_1 = A_2S_2$

11) Radiation from which of the following sources, approximates black body radiation best?

(a) A tungsten lamp

(b) Sodium flame

(c) Hot lamp black

(d) A hole in a cavity, maintained at constant temperature

12) Wien's law is concerned with

(a) relation between emissivity and absorptivity of a radiating surface

(b) total radiation, emitted by a hot surface

(c) an expression for spectral distribution of energy of a radiation from any source

(d) a relation between the temperature of a black body and the wavelength at which there is maximum radiant energy per unit wavelength

13) Consider a compound slab consisting of two different materials having equal thickness and thermal conductivities K and 2K, respectively. The equivalent thermal conductivity of the slab is

(a) $\frac{4}{3}$ K (b) $\frac{2}{3}$ K

(c) $\sqrt{3}$ K (d) 3K

14) If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature TK is maximum, then

(a) $\lambda_m \propto T^{-1}$ (b) $\lambda_m \propto T^4$

(c) λ_m is independent to T (d) $\lambda_m \propto T$

15) Which of the following circular rods (given radius r and length l), each made of the same material and whose ends are maintained at the same temperature will conduct most heat?

(a) $r = r_0$; $l = l_0$ (b) $r = 2r_0$; $l = l_0$

(c) $r = r_0$; $l = 2l_0$

(d) $r = 2r_0$; $l = 2l_0$

16) A black body at 1227°C emits radiations with maximum intensity at a wavelength of 5000Å. If the temperature of the body is increased by 1000°C, the maximum intensity will be observed at

(a) 5000Å

(b) 6000Å

(c) 3000Å

(d) 4000Å

17) Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature t°C, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is

(a) $\frac{r^2\sigma(t+273)^4}{4\pi R^2}$

(b) $\frac{16\pi^2 r^2 \sigma\, t^4}{R^2}$

(c) $\frac{r^2\sigma(t+273)^4}{R^2}$

(d) $\frac{4\pi r^2 \sigma\, t^4}{R^2}$

18) A black body is 727°C. It emits energy at a rate which is proportional to

(a) $(1000)^4$

(b) $(1000)^2$

(c) $(727)^4$

(d) $(727)^2$

19) An electrical kettle takes 4A current at 220V. How much time will it take to boil 1kg of water from temperature 20°C? The temperature of boiling water is 100°C.

(a) 6.3 min

(b) 8.4 min

(c) 12.6 min

(d) 4.2 min

20) A black body at 227°C radiates heat at the rate of 7cals/cm^{2}s. At a temperature of 727°C, the rate of heat radiated in the same units will be:

(a) 50

(b) 112

(c) 80

(d) 60

21) The two ends of a rod of length L and a uniform cross – sectional area A are kept at two temperatures T_1 and T_2 ($T_1 > T_2$). The rate of heat transfer, $\frac{dQ}{dt}$ through the rod in a steady state is given by:

(a) $\frac{dQ}{dt} = \frac{k(T_1 - T_2)}{LA}$

(b) $\frac{dQ}{dt} = kLA\,(T_1 - T_2)$

(c) $\frac{dQ}{dt} = \frac{kA\,(T_1 - T_2)}{L}$

(d) $\frac{dQ}{dt} = \frac{kL\,(T_1 - T_2)}{A}$

22) The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r, whose outer surface radiates as a black body at a temperature T K is given by:

(a) $\frac{\sigma\, r^2 T^4}{R^2}$

(b) $\frac{\sigma\, r^2 T^4}{4\pi r^2}$

(c) $\frac{\sigma\ r^4T^4}{r^4}$

(d) $\frac{4\pi\sigma\ r^2T^4}{R^2}$

23) A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?

(a) $\frac{Q}{4}$

(b) $\frac{Q}{16}$

(c) 2Q

(d) $\frac{Q}{2}$

24) A slab of stone of area $0.36m^2$ and thickness 0.1m is exposed on the lower surface to steam at 100°C. A block of ice at 0°C rests on the upper surface of the slab. In one hour 4.8kg of ice is melted. The thermal conductivity of slab is: (Given latent heat of fusion of ice = $3.36 \times 10^5 Jkg^{-1}$):

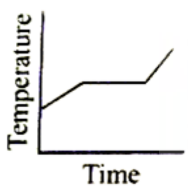
(a) 1.24 J/ms/°C

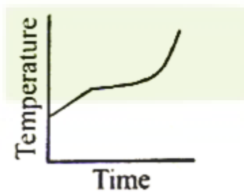
(b) 1.29 J/ms/°C

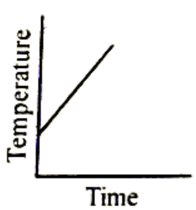
(c) 2.05 J/ms/°C

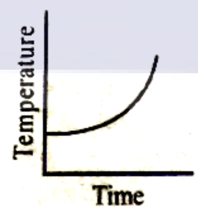
(d) 1.02 J/ms/°C

25) Liquid oxygen at 50K is heated to 300K at constant pressure of 1atm. The rate of heating is constant. Which one of the following graphs represents the variation of temperature with time?

(a)


(b)


(c)


(d)


26) If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q?

(a) $Q/4\pi R^2\sigma$

(b) $(Q/4\pi R^2\sigma)^{-1/2}$

(c) $(4\pi R^2 Q/\sigma)^{1/4}$

(d) $(Q/4\pi R^2\sigma)^{1/4}$

27) Two metal rods 1 and 2 of same lengths have same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 and cross sectional areas A_1 and A_2, respectively. If the rate of heat conduction in rod 1 is four times that in rod 2, then

(a) $K_1A_1 = K_2A_2$

(b) $K_1A_1 = 4K_2A_2$

(c) $K_1A_1 = 2K_2A_2$

(d) $4K_1A_1 = K_2A_2$

28) A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using

(a) Wien's displacement law
(b) Kirchhoff's law
(c) Newton's law of cooling
(d) Stefan's law

29) Steam at 100°C is passed into 20g of water at 10°C. When water acquires a temperature of 80°C, the mass of water present will be:

[Take specific heat of water = 1 cal g^{-1} $°C^{-1}$ and latent heat of steam = 540 cal g^{-1}]

(a) 24 g
(b) 31.5 g
(c) 42.5 g
(d) 22.5 g

30) The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0J/s. If the ends are maintained at temperatures 200°C and 210°C, the rate of heat flow will be

(a) 16.8 J/s
(b) 8.0 J/s
(c) 4.0 J/s
(d) 44.0 J/s

31) On observing light from three different stars P, Q and R, it was found that intensity of violet colour is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q. If T_P, T_Q and T_R are the respective absolute temperature of P, Q and R, then it can be concluded from the above observations that

(a) $T_P > T_R > T_Q$
(b) $T_P < T_R < T_Q$
(c) $T_P < T_Q < T_R$
(d) $T_P > T_Q > T_R$

32) A piece of ice falls from a height h so that it melts completely. Only one – quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is:

[Latent heat of ice is 3.4×10^5 J/kg and g = 10N/kg]

(a) 34km
(b) 544km
(c) 136km
(d) 68km

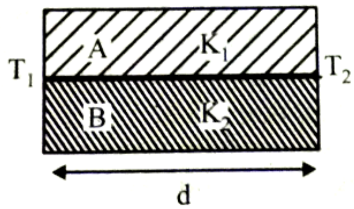
33) A black body is at a temperature of 5760K. The energy of radiation emitted by the body at wavelength 250nm is U_1, at wavelength 500nm is U_2 and that at 1000nm is U_3. Wien's constant, b = 2.88 $\times 10^6$ nmK. Which of the following is correct?

(a) $U_1 = 0$
(b) $U_3 = 0$
(c) $U_1 > U_2$
(d) $U_2 > U_1$

34) A spherical black body with a radius of 12cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be:

(a) 450
(b) 1000
(c) 1800
(d) 225

35) Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be:



(a) $\frac{3(K_1+K_2)}{2}$ (b) $K_1 + K_2$

(c) $2(K_1 + K_2)$ (d) $\frac{K_1+K_2}{2}$

36) Two spheres of the same material have radii 1m and 4m and temperatures 4000K and 2000K respectively. The ratio of the energy radiated per second by the first sphere to that by the second is

(a) 1 : 1 (b) 16 : 1

(c) 4 : 1 (d) 1 : 9

37) If mass – energy equivalence is taken into account, when water is cooled to form ice, the mass of water should

(a) increase (b) remain unchanged

(c) decrease (d) first increase then decrease

38) Which of the following is more close to a black body?

(a) black board paint (b) green leaves

(c) black holes (d) red roses

39) Infrared radiation is detected by

(a) spectrometer (b) pyrometer

(c) nanometer (d) photometer

40) Heat given to a body which raises its temperature by 1°C is

(a) water equivalent (b) thermal capacity

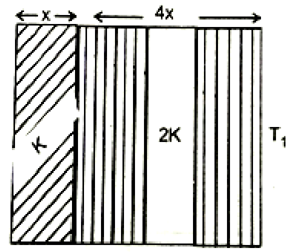
(c) specific heat (d) temperature gradient

41) The earth radiates in the infra – red region of the spectrum. The spectrum is correctly given by

(a) Rayleigh Jeans law (b) Planck's law of radiation

(c) Stefan's law of radiation (d) Wien's law

42) The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and 2K and thickness x and 4x, respectively, are T_2 and T_1 ($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2-T_1)K}{x}\right) f$, with f equal to



(a) $\frac{2}{3}$

(b) $\frac{1}{2}$

(c) 1

(d) $\frac{1}{3}$

43) If the temperature of the sun were to increase from T to 2T and its radius from R to 2R, then the ratio of the radiant energy received on earth to what it was previously will be

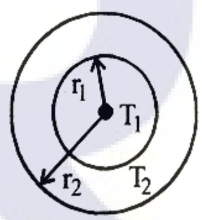
(a) 32

(b) 16

(c) 4

(d) 64

44) The figure shows a system of two concentric spheres of radii r_1 and r_2 are kept at temperatures T_1 and T_2, respectively. The radial rate of flow of heat in a substance between the two concentric spheres is proportional to



(a) $ln\left(\frac{r_2}{r_1}\right)$

(b) $\frac{(r_1-r_2)}{(r_1r_2)}$

(c) $(r_2 - r_1)$

(d) $\frac{r_1r_2}{(r_2-r_1)}$

45) Two rigid boxes containing different ideal gases are placed on a table. Box A contains one mole of nitrogen at temperature T_0, while Box contains one mole of helium at temperature $\left(\frac{7}{3}\right)T_0$. The boxes are then put into thermal contact with each other, and heat flows between them until the gases reach a common final temperature (ignore the heat capacity of boxes). Then, the final temperature of the gases, T_f in terms of T_0 is

(a) $T_f = \frac{3}{7} T_0$

(b) $T_f = \frac{7}{3} T_0$

(c) $T_f = \frac{3}{2} T_0$

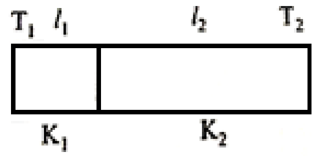
(d) $T_f = \frac{5}{3} T_0$

46) Assuming the Sun to be a spherical body of radius R at a temperature of TK, evaluate the total radiant powered incident of Earth at a distance r from the Sun

(a) $4\pi r_0^2 R^2 \sigma \frac{T^4}{r^2}$ (b) $\pi r_0^2 R^2 \sigma \frac{T^4}{r^2}$

(c) $r_0^2 R^2 \sigma \frac{T^4}{4\pi r^2}$ (d) $R^2 \sigma \frac{T^4}{r^2}$

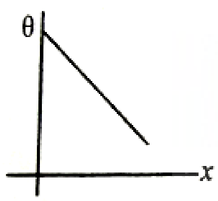
47) One end of a thermally insulated rod is kept at a temperature T_1 and the other at T_2. The rod is composed of two sections of length l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two section is

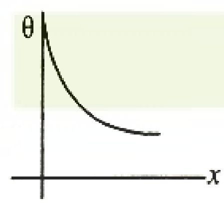


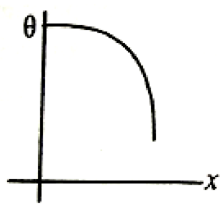
(a) $\frac{(K_1 l_1 T_1 + K_2 l_2 T_2)}{(K_1 l_1 + K_2 l_2)}$ (b) $\frac{(K_2 l_2 T_1 + K_1 l_1 T_2)}{(K_1 l_1 + K_2 l_2)}$

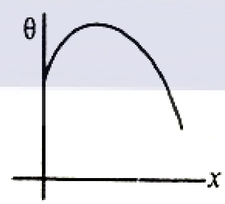
(c) $\frac{(K_2 l_1 T_1 + K_1 l_2 T_2)}{(K_2 l_1 + K_1 l_2)}$ (d) $\frac{(K_1 l_2 T_1 + K_2 l_1 T_2)}{(K_1 l_2 + K_2 l_1)}$

48) A long metallic bar is carrying heat from one of its ends to the other end under steady – state. The variation of temperature θ along the length x of the bar from its hot end is best described by which of the following figures?

(a)


(b)


(c)


(d)


49) The specific heat capacity of a metal at low temperature (T) is given as

$$C_P\,(kJK^{-1}kg^{-1}) = 32\left(\frac{T}{400}\right)^3$$

A 100gram vessel of this metal is to be cooled from 20°K to 4°K by a special refrigerator operating at room temperature (27°C). The amount of work required to cool the vessel is

(a) greater than 0.148kJ (b) between 0.148kJ and 0.028kJ

(c) less than 0.028kJ (d) equal to 0.002kJ

50) 100g of water is heated from 30°C to 50°C. Ignoring the slight expansion of the water, the change in its internal energy is (specific heat of water is 4184J/kg/K):

(a) 8.4kJ (b) 84kJ

(c) 2.1kJ
(d) 4.2kJ

51) The heat radiated per unit area in 1 hour by a furnace whose temperature is 3000K is ($\sigma = 5.7 \times 10^{-8}$ $Wm^{-2}K^{-4}$)

(a) 1.7×10^{10}J
(b) 1.1×10^{12}J
(c) 2.8×10^{8}J
(d) 4.6×10^{6}J

52) A large cylindrical rod of length L is made by joining two identical rods of copper and steel of length $\left(\frac{L}{2}\right)$ each. The rods are completely insulated from the surroundings. If the free end of copper rod is maintained at 100°C and that of steel at 0°C then the temperature of junction is (Thermal conductivity of copper is 9 times that of steel)

(a) 90°C
(b) 50°C
(c) 10°C
(d) 67°C

53) Given that 1g of water in liquid phase has volume $1cm^3$ and in vapour phase $1671cm^3$ at atmospheric pressure and the latent heat of vaporization of water is 2256J/g; the change in the internal energy in joules for 1g of water at 373K when it changes from liquid phase to vapour phase at the same temperature is:

(a) 2256
(b) 167
(c) 2089
(d) 1

54) 500g of water and 100g of ice at 0°C are in a calorimeter whose water equivalent is 40g. 10g of steam at 100°C is added to it. Then water in the calorimeter is: (Latent heat of ice = 80cal/g, Latent heat of steam = 540cal/g)

(a) 580g
(b) 590g
(c) 600g
(d) 610g

55) A mass of 50g of water in a closed vessel, with surroundings at a constant temperature takes 2 minutes to cool from 30°C to 25°C. A mass of 100g of another liquid in an identical vessel with identical surroundings takes same time to cool from 30°C to 25°C. The specific heat of the liquid is: (The water equivalent of the vessel is 30g).

(a) 2.0 kcal/kg
(b) 7 kcal/kg
(c) 3 kcal/kg
(d) 0.5 kcal/kg

56) Assume that a drop of liquid evaporates by decrease in its surface energy, so that its temperature remains unchanged. What should be the minimum radius of the drop for this to be possible? The surface tension is T, density of liquid is ρ and L is its latent heat of vaporization.

(a) $\rho L/T$
(b) $\sqrt{T/\rho L}$
(c) $T/\rho L$
(d) $2T/\rho L$

57) Water of volume 2L in a closed container is heated with a coil of 1kW. While water is heated, the container loses energy at a rate of 160J/s. In how much time will the temperature of water rise from 27°C to 77°C? (Specific heat of water is 4.2 kJ/kg and that of the container is negligible).

(a) 8 min 20 s

(b) 6 min 2 s

(c) 7 min

(d) 14 min

58) A black coloured solid sphere of radius R and mass M is inside a cavity with vacuum inside. The walls of the cavity are maintained at temperature T_0. The initial temperature of the sphere is $3T_0$. If the specific heat of the material of the sphere varies as αT^3 per unit mass with the temperature T of the sphere, where α is a constant, then the time taken for the sphere to cool down to temperature $2T_0$ will be (σ is Stefan Boltzmann constant)

(a) $\frac{M\alpha}{4\pi R^2\sigma} \ln\left(\frac{3}{2}\right)$

(b) $\frac{M\alpha}{4\pi R^2\sigma} \ln\left(\frac{16}{3}\right)$

(c) $\frac{M\alpha}{16\pi R^2\sigma} \ln\left(\frac{16}{3}\right)$

(d) $\frac{M\alpha}{16\pi R^2\sigma} \ln\left(\frac{3}{2}\right)$

59) Three rods of Copper, Brass and Steel are welded together to form a Y shaped structure. Area of cross – section of each rod = $4cm^2$. End of copper rod is maintained at 100°C where as ends of brass and steel are kept at 0°C. Lengths of the copper, brass and steel rods are 46, 13 and 12 cms respectively. The rods are thermally insulated from surroundings excepts at ends. Thermal conductivities of copper, brass and steel are 0.92, 0.26 and 0.12 CGS units respectively. Rate of heat flow through copper rod is:

(a) 1.2 cal/s

(b) 2.4 cal/s

(c) 4.8 cal/s

(d) 6.0 cal/s

60) An experiment takes 10 minutes to raise the temperature of water in a container from 0°C to 100°C and another 55 minutes to convert it totally into steam by a heater supplying heat at a uniform rate. Neglecting the specific heat of the container and taking specific heat of water to be 1cal/g °C, the heat of vaporization according to this experiment will come out to be:

(a) 560 cal/g

(b) 550 cal/g

(c) 540 cal/g

(d) 530 cal/g

61) In an experiment a sphere of aluminium of mass 0.20kg is heated upto 150°C. Immediately, it is put into water of volume 150 cc at 27°C kept in a calorimeter of water equivalent to 0.025kg. Final temperature of the system is 40°C. The specific heat of aluminium is:

(a) 378 J/kg −°C

(b) 315 J/kg −°C

(c) 476 J/kg −°C

(d) 434 J/kg −°C

62) A copper ball of mass 100gm is at a temperature T. It is dropped in a copper calorimeter of mass 100gm, filled with 170gm of water at room temperature. Subsequently, the temperature of the system is found to be 75°C. T is given by (Given: room temperature = 30°C, specific heat of copper = 0.1cal/gm °C

(a) 1250°C

(b) 825°C

(c) 800°C

(d) 885°C

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	d	d	a	c	c	c	b	b	b
11	12	13	14	15	16	17	18	19	20
d	d	a	a	b	c	c	a	a	b
21	22	23	24	25	26	27	28	29	30
c	a	b	a	a	d	b	a	d	c
31	32	33	34	35	36	37	38	39	40
a	c	d	c	d	a	c	a	b	b
41	42	43	44	45	46	47	48	49	50
d	d	d	d	c	b	d	a	d	a
51	52	53	54	55	56	57	58	59	60
a	a	c	b	d	d	a	c	c	b
61	62								
d	d								

Topic 38: Newton’s Law of Cooling

1) A body cools from 50.0°C to 48°C in 5s. How long will it take to cool from 40.0°C to 39°C? Assume the temperature of surroundings to be 30.0°C and Newton’s law of cooling to be valid.

(a) 2.5s
(b) 10 s
(c) 20 s
(d) 5 s

2) A beaker full of hot water is kept in a room. If it cools from 80°C to 75°C in t_1 minutes, from 75°C to 70°C in t_2 minutes and from 70°C to 65°C in t_3 minutes, then

(a) $t_1 = t_2 = t_3$
(b) $t_1 < t_2 = t_3$
(c) $t_1 < t_2 < t_3$
(d) $t_1 > t_2 > t_3$

3) Certain quantity of water cools from 70°C to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is:

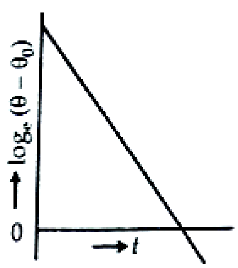
(a) 45°C
(b) 20°C
(c) 42°C
(d) 10°C

4) According to Newton’s law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperature of the body and the surroundings, and n is equal to

(a) two
(b) three
(c) four
(d) one

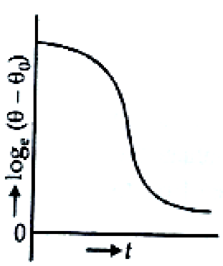
5) A liquid in a beaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton’s law of cooling the correct graph between $\log_e(\theta - \theta_0)$ and t is:

(a)

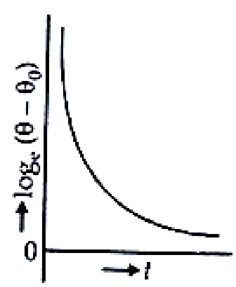


(b)

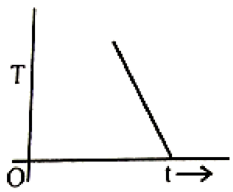
(c)

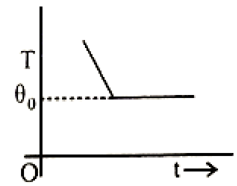


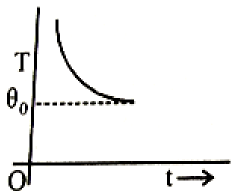
(d)

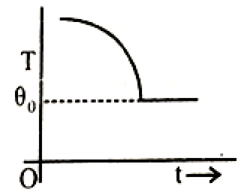


6) If a piece of metal is heated to temperature θ and then allowed to cool in a room which is at temperature θ_0, the graph between the temperature T of the metal and time t will be closest to

(a) 

(b) 

(c) 

(d) 

7) A hot body, obeying Newton's law of cooling is cooling down from its peak value 80°C to an ambient temperature of 30°C. It takes 5 minutes in cooling down from 80°C to 40°C. How much time will it take to cool down from 62°C to 32°C? (Given In 2 = 0.693, In 5 = 1.609)

(a) 3.75 minutes

(b) 8.6 minutes

(c) 9.6 minutes

(d) 6.5 minutes

8) Hot water cools from 60°C to 50°C in the first 10 minutes and to 42°C in the next 10 minutes. The temperature of the surroundings is:

(a) 25°C

(b) 10°C

(c) 15°C

(d) 20°C

ANSWER KEY							
1	2	3	4	5	6	7	8
b	c	a	d	a	c	b	b

Topic 39: First law of Thermodynamics

1) First law of thermodynamics is consequence of conservation of

(a) work
(b) energy
(c) heat
(d) all of these

2) Which of the following is not thermodynamical function?

(a) Enthalpy
(b) Work done
(c) Gibb's energy
(d) Internal energy

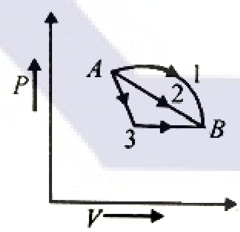
3) 110 joules of heat is added to a gaseous system whose internal energy is 40J. Then the amount of external work done is

(a) 150J
(b) 70J
(c) 110J
(d) 40J

4) The internal energy change in a system that has absorbed 2 kcals of heat and done 500J of work is:

(a) 6400J
(b) 5400J
(c) 7900J
(d) 8900J

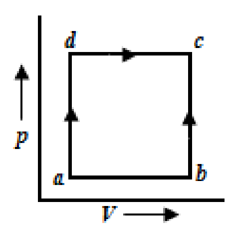
5) An ideal gas goes from state A to state B via three different processes as indicated in the P – V diagram:



If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and ΔU_1, ΔU_2, ΔU_3 indicate the change in internal energy along the three processes respectively, then

(a) $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
(b) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
(c) $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
(d) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

6) A system is taken from state a to state c by two paths adc and abc as shown in the figure. The internal energy at a is U_a = 10J. Along the path adc the amount of heat absorbed δQ_1 = 50J and the work done δW_1 = 20J whereas along the path abc the heat absorbed δQ_2 = 36J. The amount of work done along the path abc is



(a) 6J
(b) 10J
(c) 12J
(d) 36J

7) Which of the following is incorrect regarding the first law of thermodynamics?

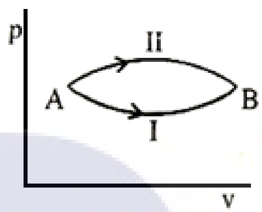
(a) It is a restatement of the principle of conservation of energy

(b) It is not applicable to any cyclic process

(c) It does not introduces the concept of the entropy

(d) It introduces the concept of the internal energy

8) A system goes from A to B via two processes I and II as shown in figure. If ΔU_1 and ΔU_2 are the changes in internal energies in the processes I and II respectively, then



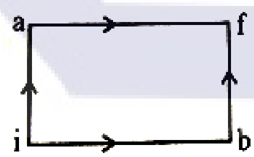
(a) relation between ΔU_1 and ΔU_2 cannot be determined

(b) $\Delta U_1 = \Delta U_2$

(c) $\Delta U_2 < \Delta U_1$

(d) $\Delta U_2 > \Delta U_1$

9) When a system is taken 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. W along the path ibf is



(a) 14 cal
(b) 6 cal
(c) 16 cal
(d) 66 cal

10) An insulated container of gas has two chambers separated by an insulating partition. One of the chambers has volume V_1 and contains ideal gas at pressure P_1 and temperature T_1. The other chamber has volume V_2 and contains ideal gas at pressure P_2 and temperature T_2. If the partition is removed without doing any work on the gas, the final equilibrium temperature of the gas in the container will be

(a) $\frac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_2+P_2V_2T_1}$
(b) $\frac{P_1V_1T_1+P_2V_2T_2}{P_1V_1+P_2V_2}$
(c) $\frac{P_1V_1T_2+P_2V_2T_1}{P_1V_1+P_2V_2}$
(d) $\frac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_1+P_2V_2T_2}$

11) A gas is compressed from a volume of $2m^3$ to a volume of $1m^3$ at a constant pressure of $100N/m^2$. Then it is heated at constant volume by supplying 150J of energy. As a result, the internal energy of the gas:

(a) increases by 250J
(b) decreases by 250J
(c) increases by 50J
(d) decreases by 50J

12) 200g water is heated from 40°C to 60°C. Ignoring the slight expansion of water, the change in its internal energy is close to (Given specific heat of water = 4184J/kgK):

(a) 167.4kJ
(b) 8.4kJ
(c) 4.2kJ
(d) 16.7kJ

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	b	b	c	a	a	b	b	b	a
11	12								
a	d								

Topic 40: Specific Heat Capacity & Thermodynamic Processes

1) At 27°C a gas is compressed suddenly such that its pressure becomes (1/8) of original pressure. Final temperature will be ($\gamma = 5/3$)

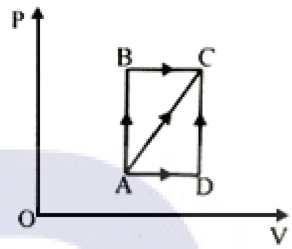
(a) 420K

(b) 300K

(c) –142°C

(d) 327°C

2) A thermodynamic process is shown in the figure. The pressures and volumes corresponding to some points in the figure are



$P_A = 3 \times 10^4 Pa$

$V_A = 2 \times 10^{-3} m^3$

$P_B = 8 \times 10^4 Pa$

$V_D = 5 \times 10^{-3} m^3$

In process AB, 600J of heat is added to the system and in process BC, 200J of heat is added to the system. The change in internal energy of the system in process AC would be

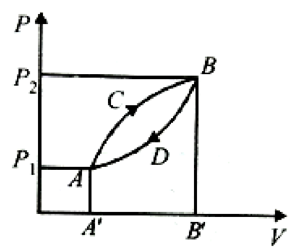
(a) 560J

(b) 800J

(c) 600J

(d) 640J

3) A thermodynamic system is taken from state A to B along ACB and is brought back to A along BDA as shown in the PV diagram. The net work done during the complete cycle is given by the area



(a) $P_1ACBP_2P_1$

(b) ACBB'A'A

(c) ACBDA

(d) ADBB'A'A

4) An ideal gas A and a real gas B have their volumes increased from V to 2V under isothermal conditions. The increase in internal energy

(a) will be same in both A and B

(b) will be zero in both the gases

(c) of B will be more than that of A

(d) of A will be more than that of B

5) A diatomic gas initially at 18°C is compressed adiabatically to one eighth of its original volume. The temperature after compression will be

(a) 18°C

(b) 668.4°K

(c) 395.4°C

(d) 144°C

6) An ideal gas undergoing adiabatic change has the following pressure – temperature relationship

(a) $P^{\gamma-1}T^{\gamma}$ = constant

(b) $P^{\gamma}T^{\gamma-1}$ = constant

(c) $P^{\gamma}T^{1-\gamma}$ = constant

(d) $P^{1-\gamma}T^{\gamma}$ = constant

7) A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest when the expansion is

(a) adiabatic

(b) isobaric

(c) isothermal

(d) equal in all cases

8) If the ratio of specific heat of as gas at constant pressure to that at constant volume is γ, the change in internal energy of a mass of gas, when the volume changes from V to 2V at constant pressure P, is

(a) $\frac{R}{(\gamma-1)}$

(b) PV

(c) $\frac{PV}{(\gamma-1)}$

(d) $\frac{\gamma\ PV}{(\gamma-1)}$

9) An ideal gas at 27°C is compressed adiabatically to $\frac{8}{27}$ of its original volume. The rise in temperature is $\left(\gamma = \frac{5}{3}\right)$

(a) 475°C

(b) 402°C

(c) 275°C

(d) 175°C

10) One mole of an ideal gas at an initial temperature of T K does 6R joules of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is 5/3, the final temperature of gas will be

(a) (T – 4) K

(b) (T + 2.4) K

(c) (T – 2.4) K

(d) (T + 4) K

11) If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then:

(a) W = 0

(b) Q = W = 0

(c) E = 0

(d) Q = 0

12) In thermodynamic processes which of the following statements is not true?

(a) In an isochoric process pressure remains constant

(b) In an isothermal process the temperature remains constant

(c) In an adiabatic process PV^{γ} = constant

(d) In an adiabatic process the system is insulated from the surroundings

13) If ΔU and ΔW represents the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true?

(a) $\Delta U = -\Delta W$, in an adiabatic process

(b) $\Delta U = \Delta W$, in an isothermal process

(c) $\Delta U = \Delta W$, in an adiabatic process

(d) $\Delta U = -\Delta W$, in an isothermal process

14) A mass of diatomic gas ($\gamma = 1.4$) at a pressure of 2 atmospheres is compressed adiabatically so that its temperature rises from 27°C to 927°C. The pressure of the gas in final state is

(a) 28 atm

(b) 68.7 atm

(c) 256 atm

(d) 8 atm

15) During an isothermal expansion, a confined ideal gas does –150J of work against its surroundings. This implies that

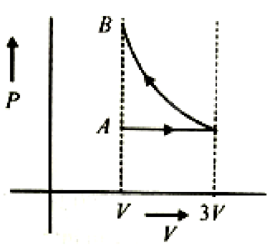
(a) 150J heat has been removed from the gas

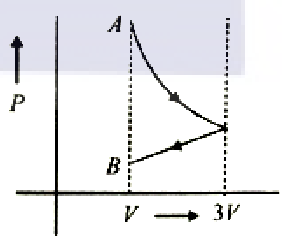
(b) 300J of heat has been added to the gas

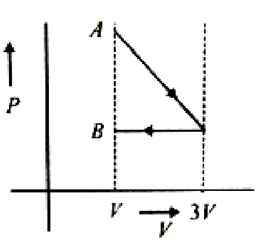
(c) no heat is transferred because the process is isothermal

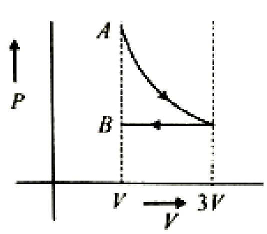
(d) 150J of heat has been added to the gas

16) One mole of an ideal gas goes from an initial state A to final state B via two processes: It first undergoes isothermal expansion from volume V to 3V and then its volume is reduced from 3V to V at constant pressure. The correct P – V diagram representing the two processes is:

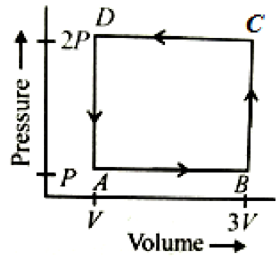
(a)


(b)


(c)


(d)


17) A thermodynamic system is taken through the cycle ABCD as shown in figure. Heat rejected by the gas during the cyclic process is:



(a) 2PV (b) 4PV

(c) $\frac{1}{2}$ PV (d) PV

18) Which of the following relations does not give the equation of an adiabatic process, where terms have their usual meaning?

(a) $P^{\gamma}T^{1-\gamma}$ = constant (b) $P^{1-\gamma}T^{\gamma}$ = constant

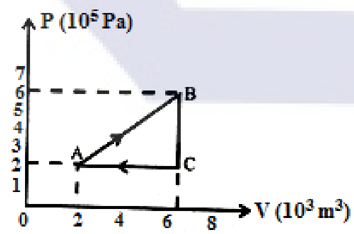
(c) PV^{γ} = constant (d) $TV^{\gamma-1}$ = constant

19) During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of $\frac{C_p}{C_v}$ for the gas is

(a) 2 (b) $\frac{5}{3}$

(c) $\frac{3}{2}$ (d) $\frac{4}{3}$

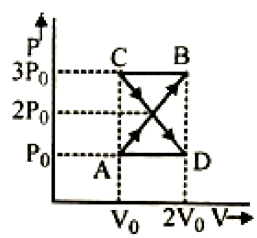
20) A gas is taken through the cycle A → B → C → A, as shown in figure. What is the net work done by the gas?



(a) 1000 J (b) zero

(c) –2000 J (d) 2000 J

21) A thermodynamic system undergoes cyclic process ABCDA as shown in figure. The work done by the system in the cycle is:



(a) P_0V_0 (b) $2P_0V_0$

(c) $\frac{P_0V_0}{2}$

(d) Zero

22) A monoatomic gas at a pressure P, having a volume V expands isothermally to a volume 2V and then adiabatically to a volume 16V. The final pressure of the gas is: $\left(\text{take } \gamma = \frac{5}{3}\right)$

(a) 64P

(b) 32P

(c) $\frac{P}{64}$

(d) 16P

23) An ideal gas is compressed to half its initial volume by means of several processes. Which of the process results in the maximum work done on the gas?

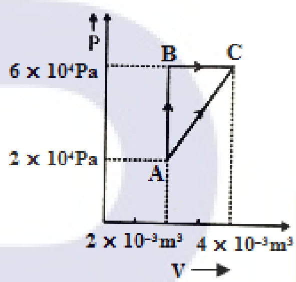
(a) Isobaric

(b) Isochoric

(c) Isothermal

(d) Adiabatic

24) Figure below shows two paths that may be taken by a gas to go from a state A to a state C.



In process AB, 400J of heat is added to the system and in process BC, 100J of heat is added to the system. The heat absorbed by the system in the process AC will be

(a) 500 J

(b) 460 J

(c) 300 J

(d) 380 J

25) A gas is compressed isothermally to half its initial volume. The same gas is compressed separately through an adiabatic process until its volume is again reduced to half. Then:

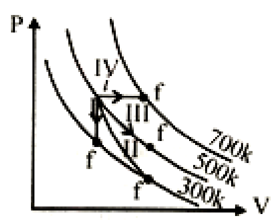
(a) Compressing the gas isothermally will require more work to be done.

(b) Compressing the gas through adiabatic process will require more work to be done.

(c) Compressing the gas isothermally or adiabatically will require the same amount of work.

(d) Which of the case (whether compression through isothermal or through adiabatic process) requires more work will depend upon the atomicity of the gas.

26) Thermodynamic processes are indicated in the following diagram:



Match the following

	Column – 1		Column – 2
P.	Process I	A.	Adiabatic
Q.	Process II	B.	Isobaric
R.	Process III	C.	Isochoric
S.	Process IV	D.	Isothermal

(a) P → C, Q → A, R → D, S → B

(b) P → C, Q → D, R → B, S → A

(c) P → D, Q → B, R → A, S → C

(d) P → A, Q → C, R → D, S → B

27) Which of the following parameter does not characterize the thermodynamic state of matter?

(a) Temperature

(b) Pressure

(c) Work

(d) Volume

28) The work of 146kJ is performed in order to compress one kilo mole of gas adiabatically and in this process the temperature of the gas increases by 7°C. The gas is ($R = 8.3 J\ mol^{-1} K^{-1}$)

(a) diatomic

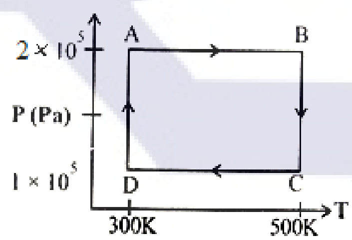
(b) triatomic

(c) a mixture of monoatomic and diatomic

(d) monoatomic

Directions for questions 29 to 31: Questions are based on the following paragraph.

Two moles of helium gas are taken over the cycle ABCDA, as shown in the P – T diagram.



29) The net work done on the gas in the cycle ABCDA is

(a) 279R

(b) 1076R

(c) 1904R

(d) zero

30) The work done on the gas in taking it from D to A is

(a) +414R

(b) −690R

(c) +690R

(d) −414R

31) Assuming the gas to be ideal the work done on the gas in taking it from A to B is

(a) 300R

(b) 400R

(c) 500R

(d) 200R

32) A container with insulating walls is divided into equal parts by a partition fitted with a valve. One part is filled with an ideal gas at a pressure P and temperature T, whereas the other part is completely evacuated. If the valve is suddenly opened, the pressure and temperature of the gas will be:

(a) $\frac{P}{2}, \frac{T}{2}$

(b) P, T

(c) P, $\frac{T}{2}$

(d) $\frac{P}{2}$, T

33) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: In an adiabatic process, change in internal energy of a gas is equal to work done on/by the gas in the process.

Statement 2: The temperature of a gas remains constant in an adiabatic process.

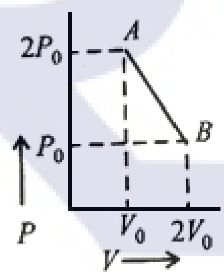
(a) Statement 1 is true, Statement 2 is true, Statement 2 is a correct explanation of Statement 1.

(b)Statement 1 is true, Statement 2 is false.

(c) Statement 1 is false, Statement 2 is true.

(d) Statement 1 is true, Statement 2 is true, Statement 2 is not a correct explanation of Statement 1.

34) n moles of an ideal gas undergo a process A → B as shown in the figure. Maximum temperature of the gas during the process is



(a) $\frac{9P_0V_0}{nR}$

(b) $\frac{3P_0V_0}{2nR}$

(c) $\frac{9P_0V_0}{2nR}$

(d) $\frac{9P_0V_0}{4nR}$

35) The pressure of an ideal gas varies with volume as P = αV, where α is a constant. One mole of the gas is allowed to undergo expansion such that its volume becomes 'm' times its initial volume. The work done by the gas in the process is

(a) $\frac{\alpha V}{2}$ $(m^2 – 1)$

(b) $\frac{\alpha^2 V^2}{2}$ $(m^2 – 1)$

(c) $\frac{\alpha}{2}$ $(m^2 – 1)$

(d) $\frac{\alpha V^2}{2}$ $(m^2 – 1)$

36) An ideal monatomic gas with pressure P, volume V and temperature T is expanded isothermally to a volume 2V and a final pressure P_i. If the same gas is expanded adiabatically to a volume 2V, the final pressure is P_a. The ratio $\frac{P_a}{P_i}$ is

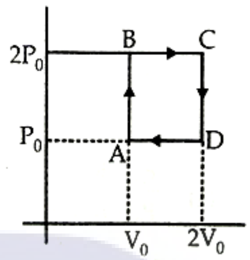
(a) $2^{-1/3}$

(b) $2^{1/3}$

(c) $2^{2/3}$

(d) $2^{-2/3}$

37) Helium gas goes through a cycle ABCDA (consisting of two isochoric and isobaric lines) as shown in figure. The efficiency of this cycle is nearly: (Assume the gas to be close to ideal gas)



(a) 15.4%

(b) 9.1%

(c) 10.5%

(d) 12.5%

38) An ideal gas at atmospheric pressure is adiabatically compressed so that its density 32 times of its initial value. If the final pressure of gas is 128 atmospheres, the value of 'γ' of the gas is:

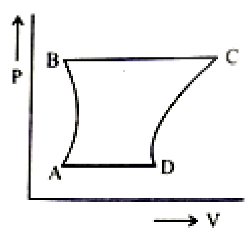
(a) 1.5

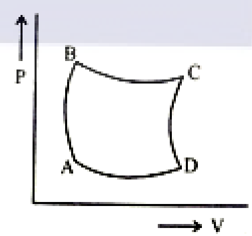
(b) 1.4

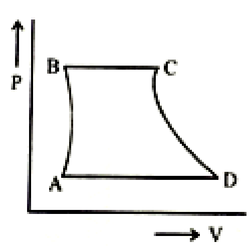
(c) 1.3

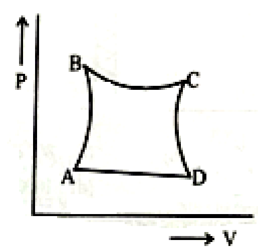
(d) 1.6

39) A certain amount of gas is taken through a cyclic process (A B C D A) that has two isobars, one isochore and one isothermal. The cycle can be represented on a P – V indicator diagram as:

(a)


(b)


(c)


(d)


40) The equation of state for a gas is given by PV = nRT + αV, where n is the number of moles and α is a positive constant. The initial temperature and pressure of one mole of the gas contained in a cylinder are T_0 and P_0 respectively. The work done by the gas when its temperature doubles isobarically will be:

(a) $\frac{P_0T_0R}{P_0-\alpha}$ (b) $\frac{P_0T_0R}{P_0+\alpha}$

(c) P_0T_0R In 2 (d) P_0T_0R

41) During an adiabatic compression, 830 J of work is done on 2 moles of a diatomic ideal gas to reduce its volume by 50%. The change in its temperature is nearly: (R = 8.3 JK^{-1} mol^{-1})

(a) 40K (b) 33K

(c) 20K (d) 14K

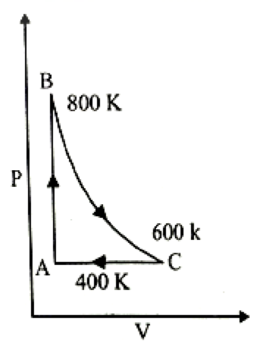
42) An ideal monoatomic gas is confined in a cylinder by a spring loaded piston of cross section 8.0×10^{-3} m^2. Initially the gas is at 300K and occupies a volume of $2.4 \times 10^{-3}m^3$ and the spring is in its relaxed state as shown in figure. The gas is heated by a small heater until the piston moves out slowly by 0.1m. The force constant of the spring is 8000N/m and the atmospheric pressure is $1.0 \times 10^5N/m^2$. The cylinder and the piston are thermally insulated. The piston and the spring are massless and there is no friction between the piston and the cylinder. The final temperature of the gas will be:

(Neglect the heat loss through the lead wires of the heater. The heat capacity of the heater coil is also negligible).

(a) 300K (b) 800K

(c) 500K (d) 1000K

43) One mole of a diatomic ideal gas undergoes a cyclic process ABC as shown in figure. The process BC is adiabatic. The temperatures at A, B and C are 400K, 800K and 600K respectively. Choose the correct statement:



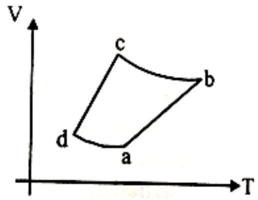
(a) The change in internal energy in whole cyclic process is 250R.

(b) The change in internal energy in the process CA is 700R.

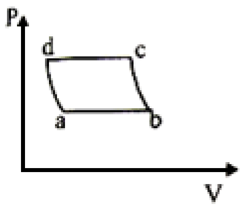
(c) The change in internal energy in the process AB is 350R.

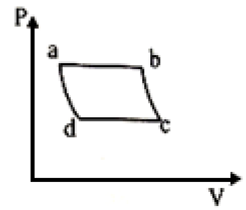
(d) The change in internal energy in the process BC is 500R.

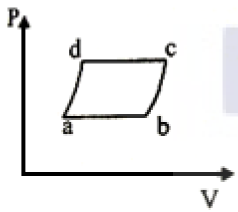
44) An ideal gas goes through a reversible cycle a → b → c → d has the V – T diagram shown below. Process d → a and b → c are adiabatic.

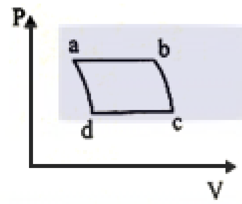


The corresponding P – V diagram for the process is (all figures are schematic and not drawn to scale):

(a) 

(b) 

(c) 

(d) 

45) Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u = \frac{U}{V} \propto T^4$ and the pressure $p = \frac{1}{3}\left(\frac{U}{V}\right)$. If the shell now undergoes an adiabatic expansion the relation between T and R is:

(a) $T \propto \frac{1}{R}$

(b) $T \propto \frac{1}{R^3}$

(c) $T \propto e^{-R}$

(d) $T \propto e^{-3R}$

46) Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increases as V^q, where V is the volume of the gas. The value of q is: $\left(\gamma = \frac{C_p}{C_v}\right)$

(a) $\frac{\gamma+1}{2}$

(b) $\frac{\gamma-1}{2}$

(c) $\frac{3\gamma+5}{6}$

(d) $\frac{3\gamma-5}{6}$

47) The ratio of work done by an ideal monoatomic gas to the heat supplied to it in an isobaric process is:

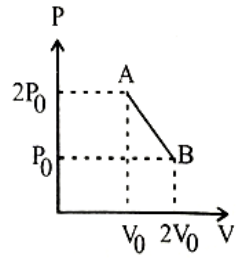
(a) $\frac{2}{5}$

(b) $\frac{3}{2}$

(c) $\frac{3}{5}$

(d) $\frac{2}{3}$

48) 'n' moles of an ideal gas undergoes a process A → B as shown in the figure. The maximum temperature of the gas during the process will be:



(a) $\frac{9P_0V_0}{2nR}$

(b) $\frac{9P_0V_0}{nR}$

(c) $\frac{9P_0V_0}{4nR}$

(d) $\frac{3P_0V_0}{2nR}$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	a	c	b	b	d	b	c	b	a
11	12	13	14	15	16	17	18	19	20
c	a	a	c	d	d	a	a	c	a
21	22	23	24	25	26	27	28	29	30
d	c	d	b	b	a	c	a	a	a
31	32	33	34	35	36	37	38	39	40
b	d	b	b	d	d	a	b	c	a
41	42	43	44	45	46	47	48		
c	c	d	b	a	a	a	c		

Topic 41: Carnot Engine, Refrigerator & Second Law of Thermodynamics

1) An ideal carnot engine, whose efficiency is 40% receives heat at 500K. If its efficiency is 50%, then the intake temperature for the same exhaust temperature is

(a) 600 K
(b) 700 K
(c) 800 K
(d) 900 K

2) The efficiency of a Carnot engine operating between the temperature of 100°C and –23°C will be

(a) $\frac{100+23}{100}$
(b) $\frac{100-23}{100}$
(c) $\frac{373+250}{373}$
(d) $\frac{373-250}{373}$

3) A reversible engine converts one – sixth of the heat input into work. When the temperature of the sink is reduced by 62°C, the efficiency of the engine is doubled. The temperatures of the source and sink are

(a) 99°C, 37°C
(b) 80°C, 37°C
(c) 95°C, 37°C
(d) 90°C, 37°C

4) The temperature of source and sink of a heat engine are 127°C and 27°C respectively. An inventor claims its efficiency to be 26%, then:

(a) it is impossible
(b) it is possible with high probability
(c) it is possible with low probability
(d) data are insufficient

5) An ideal gas heat engine operates in a Carnot cycle between 227°C and 127°C. It absorbs 6 kcal at the higher temperature. The amount of heat (in kcal) converted into work is equal to

(a) 1.2
(b) 4.8
(c) 3.5
(d) 1.6

6) A Carnot engine whose efficiency is 50% has an exhaust temperature of 500K. If the efficiency is to be 60% with the same intake temperature, the exhaust temperature must be (in K)

(a) 800
(b) 200
(c) 400
(d) 600

7) An ideal gas heat engine operates in Carnot cycle between 227°C and 127°C. It absorbs 6×10^4 cals of heat at higher temperature. Amount of heat converted to work is

(a) 4.8×10^4 cals
(b) 6×10^4 cals
(c) 2.4×10^4 cals
(d) 1.2×10^4 cals

8) Which of the following processes is reversible?

(a) Transfer of heat by conduction

(b) Transfer of heat by radiation

(c) Isothermal compression

(d) Electrical heating of a nichrome wire

9) A Carnot engine whose sink is at 300 K has an efficiency of 40%. By how much should the temperature of source be increased so as to increase, its efficiency by 50% of original efficiency?

(a) 325 K

(b) 250 K

(c) 380 K

(d) 275 K

10) An engine has an efficiency of 1/6. When the temperature of sink is reduced by 62°C, its efficiency is doubled. Temperature of the source is

(a) 37°C

(b) 62°C

(c) 99°C

(d) 124°C

11) When 1kg of ice at 0°C melts to water at 0°C, the resulting change in its entropy, taking latent heat of ice to be 80 cal/°C, is

(a) 273 cal/K

(b) 8 × 104 cal/K

(c) 80 cal/K

(d) 293 cal/K

12) Two Carnot engines A and B are operated in series. The engine A receives heat from the source at temperature T_1 and rejects the heat to the sink at temperature T. The second engine B receives the heat at temperature T and rejects to its sink at temperature T_2. For what value of T the efficiencies of the two engines are equal?

(a) $\frac{T_1+T_2}{2}$

(b) $\frac{T_1-T_2}{2}$

(c) T_1T_2

(d) $\sqrt{T_1T_2}$

13) The coefficient of performance of a refrigerator is 5. If the inside temperature of freezer is –20°C, then the temperature of the surroundings to which it rejects heat is

(a) 41°C

(b) 11°C

(c) 21°C

(d) 31°C

14) A refrigerator works between 4°C and 30°C. It is required to remove 600 calories of heat every second in order to keep the temperature of the refrigerated space constant. The power required is:
(Take 1 cal = 4.2 joules)

(a) 2.365 W

(b) 23.65 W

(c) 236.5 W

(d) 2365 W

15) A carnot engine having an efficiency of $\frac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10J, the amount of energy absorbed from the reservoir at lower temperature is:-

(a) 90 J

(b) 99 J

(c) 100 J

(d) 1 J

16) Even Carnot engine cannot give 100% efficiency because we cannot

(a) prevent radiation

(b) find ideal sources

(c) reach absolute zero temperature

(d) eliminate friction

17) Which statement is incorrect?

(a) All reversible cycles have same efficiency

(b) Reversible cycle has more efficiency than an irreversible one

(c) Carnot cycle is a reversible one

(d) Carnot cycle has the maximum efficiency in all cycles

18) A Carnot engine takes 3×10^6 cal of heat from a reservoir at 627°C, and gives it to a sink at 27°C. The work done by the engine is

(a) 4.2×10^6 J

(b) 8.4×10^6 J

(c) 16.8×10^6 J

(d) zero

19) "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement of consequence of

(a) second law of thermodynamics

(b) conservation of momentum

(c) conservation of mass

(d) first law of thermodynamics

20) Which of the following statements is **correct** for any thermodynamic system?

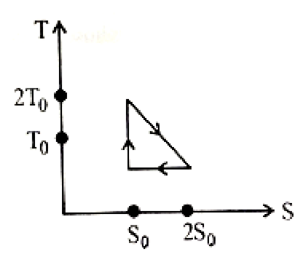
(a) The change in entropy can never be zero

(b) Internal energy and entropy are state functions

(c) The internal energy changes in all processes

(d) The work done in an adiabatic process is always zero.

21) The temperature – entropy diagram of a reversible engine cycle is given in the figure. Its efficiency is



(a) $\frac{1}{4}$

(b) $\frac{1}{2}$

(c) $\frac{2}{3}$

(d) $\frac{1}{3}$

22) A Carnot engine, having an efficiency of $\eta = 1/10$ as heat engine, is used as a refrigerator. If the work done on the system is 10J, the amount of energy absorbed from the reservoir at lower temperature is

(a) 100J

(b) 99J

(c) 90J

(d) 1J

23) A diatomic ideal gas is used in a Carnot engine as the working substance. If during the adiabatic expansion part of the cycle the volume of the gas increases from V to 32V, the efficiency of the engine is

(a) 0.5

(b) 0.75

(c) 0.99

(d) 0.25

24) A Carnot engine operating between temperatures T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62K its efficiency increases to $\frac{1}{3}$. Then T_1 and T_2 are, respectively:

(a) 372K and 310K

(b) 330K and 268K

(c) 310K and 248K

(d) 372K and 310K

25) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: An inventor claims to have constructed an engine that has an efficiency of 30% when operated between the boiling and freezing points of water. This is not possible.

Statement 2: The efficiency of a real engine is always less than the efficiency of a Carnot engine operating between the same two temperatures.

(a) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

(b)Statement 1 is true, Statement 2 is false.

(c) Statement 1 is false, Statement 2 is true.

(d) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

26) The door of a working refrigerator is left open in a well insulated room. The temperature of air in the room will

(a) decrease

(b) increase in winters and decrease in summers

(c) remain the same

(d) increase

27) A Carnot engine, whose efficiency is 40%, takes in heat from a source maintained at a temperature of 500K. It is desired to have an engine of efficiency 60%. Then, the intake temperature for the same exhaust (sink) temperature must be:

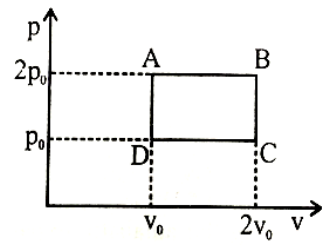
(a) efficiency of Carnot engine cannot be made larger than 50%

(b) 1200K

(c) 750K

(d) 600K

28)



The above p – v diagram represents the thermodynamic cycle of an engine, operating with an ideal monatomic gas. The amount of heat, extracted from the source in a single cycle is

(a) p_0v_0

(b) $\left(\frac{13}{2}\right)p_0v_0$

(c) $\left(\frac{11}{2}\right)p_0v_0$

(d) $4p_0v_0$

29) A Carnot engine absorbs 1000J of heat energy from a reservoir at 127°C and rejects 600J of heat energy during each cycle. The efficiency of engine and temperature of sink will be:

(a) 20% and −43°C

(b) 40% and −33°C

(c) 50% and −20°C

(d) 70% and −10°C

30) A solid body of constant heat capacity 1J/°C is being heated by keeping it in contact with reservoirs in two ways:

(i) Sequentially keeping in contact with 2 reservoirs such that each reservoir supplies same amount of heat.

(ii) Sequentially keeping in contact with 8 reservoirs such that each reservoir supplies same amount of heat.

In both the cases body is brought from initial temperature 100°C to final temperature 200°C. Entropy change of the body in the two cases respectively is:

(a) $ln2$, $2ln2$

(b) $2ln2$, $8ln2$

(c) $ln2$, $4ln2$

(d) $ln2$, $ln2$

31) A Carnot freezer takes heat from water at 0°C inside and rejects it to the room at a temperature of 27°C. The latent heat of ice is $336 \times 10^3 Jkg^{-1}$. If 5kg of water at 0°C is converted into ice at 0°C by the freezer, then the energy consumed by the freezer is close to:

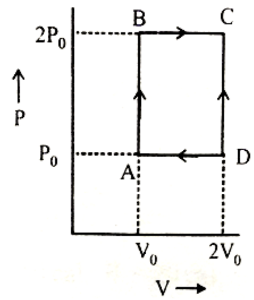
(a) 1.51×10^5J

(b) 1.68×10^6J

(c) 1.71×10^7J

(d) 1.67×10^5J

32) An engine operates by taking n moles of an ideal gas through the cycle ABCDA shown in figure. The thermal efficiency of the engine is: (Take $C_V = 1.5R$, where R is gas constant)



(a) 0.24

(b) 0.15

(c) 0.32

(d) 0.08

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	d	a	a	a	c	d	c	b	c
11	12	13	14	15	16	17	18	19	20
d	d	d	c	a	c	a	b	a	b
21	22	23	24	25	26	27	28	29	30
d	c	b	d	d	d	c	b	b	d
31	32								
d	b								

Topic 42: Kinetic Theory of an Ideal Gas & Gas Laws

1) At constant volume, temperature is increased then

(a) collision on walls will be less

(b) number of collisions per unit time will increase

(c) collisions will be in straight lines

(d) collisions will not change

2) According to kinetic theory of gases, at absolute zero temperature

(a) water freezes

(b) liquid helium freezes

(c) molecular motion freezes

(d) liquid hydrogen freezes

3) The equation of state, corresponding to 8g of O_2 is

(a) PV = 8 RT

(b) PV = RT/4

(c) PV = RT

(d) PV = RT/2

4) A gas at 27°C temperature and 30 atmospheric pressure is allowed to expand to the atmospheric pressure. If the volume becomes 10 times its initial volume, then the final temperature becomes

(a) 100°C

(b) 173°C

(c) 273°C

(d) −173°C

5) The equation of state for 5g of oxygen at a pressure P and temperature T, when occupying a volume V, will be

(a) PV = (5/16) RT

(b) PV = (5/32) RT

(c) PV = 5 RT

(d) PV = (5/2) RT

6) When volume of system is increased twice and temperature is decreased half of its initial temperature, then pressure becomes

(a) 2 times

(b) 4 times

(c) $\frac{1}{2}$ times

(d) $\frac{1}{4}$ times

7) At 10°C the value of the density of a fixed mass of an ideal gas divided by its pressure is x. At 110°C this ratio is:

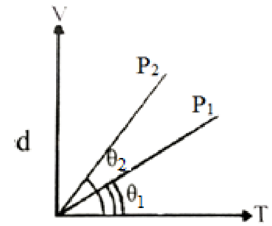
(a) x

(b) $\frac{383}{283}$ x

(c) $\frac{10}{110}$ x

(d) $\frac{283}{383}$ x

8) In the given (V – T) diagram, what is the relation between pressure P_1 and P_2?



(a) $P_2 > P_1$

(b) $P_2 < P_1$

(c) Cannot be predicted

(d) $P_2 = P_1$

9) Two vessels separately contain two ideal gases A and B at the same temperature. The pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weight of A and B is:

(a) $\frac{3}{4}$

(b) 2

(c) $\frac{1}{2}$

(d) $\frac{2}{3}$

10) Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will

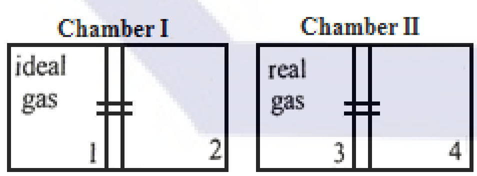
(a) increase

(b) decrease

(c) remain same

(d) decrease for some, while increase for others

11)



There are two identical chambers, completely thermally insulated from surroundings. Both chambers have a partition wall dividing the chambers in two compartments. Compartment 1 is filled with an ideal gas and Compartment 3 is filled with a real gas. Compartments 2 and 4 are vacuum. A small hole (orifice) is made in the partition walls and the gases are allowed to expand in vacuum.

Statement – 1: No change in the temperature of the gas takes place when ideal gas expands in vacuum. However, the temperature of real gas goes down (cooling) when it expands in vacuum.

Statement – 2: The internal energy of an ideal gas is only kinetic. The internal energy of a real gas is kinetic as well as potential.

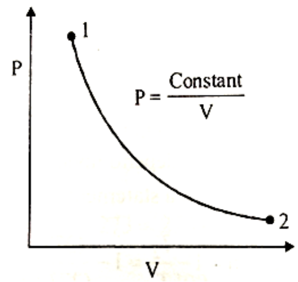
(a) Statement – 1 is false and Statement – 2 is true.

(b) Statement –1 and Statement –2 both are true. Statement –2 is the correct explanation of Statement – 1.

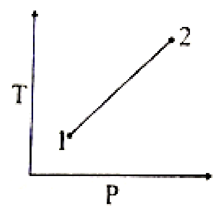
(c) Statement – 1 is true and Statement – 2 is false.

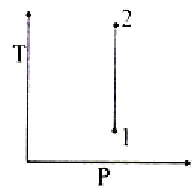
(d) Statement –1 and Statement –2 both are true. Statement –2 is **not** correct explanation of Statement – 1.

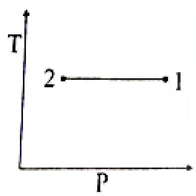
12) For the P – V diagram given for an ideal gas,

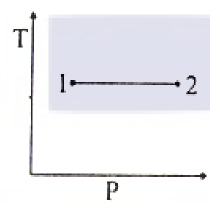


out of the following which one correctly represents the T – P diagram?

(a) 

(b) 

(c) 

(d) 

13) The temperature of an open room of volume $30 m^3$ increases from 17°C to 27°C due to sunshine. The atmospheric pressure in the room remains $1 \times 10^5 Pa$. If n_i and n_f are the number of molecules in the room before and after heating, then $n_f - n_i$ will be:

(a) 2.5×10^{25}

(b) -2.5×10^{25}

(c) -1.61×10^{23}

(d) 1.38×10^{23}

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	c	b	d	b	d	d	b	a	c
11	12	13							
a	c	b							

Topic 43: Speeds of Gas, Pressure & Kinetic Energy

1) Two containers A and B are partly filled with water and closed. The volume of A is twice that of B and it contains half the amount of water in B. If both are at the same temperature, the water vapour in the containers will have pressure in the ratio of

(a) 1 : 2
(b) 1 : 1
(c) 2 : 1
(d) 4 : 1

2) N molecules each of mass m of a gas A and 2N molecules each of mass 2m of gas B are contained in the same vessel which is maintained at temperature T. The mean square velocity of molecule of B type is v^2 and the mean square rectangular component of the velocity of A type is denoted by ω^2. Then ω^2/v^2

(a) 2
(b) 1
(c) 1/3
(d) 2/3

3) Three containers of the same volume contain three different gases. The masses of the molecules are m_1, m_2, and m_3 and the number of molecules in their respective containers are N_1, N_2 and N_3. The gas pressure in the containers are P_1, P_2 and P_3 respectively. All the gases are now mixed and put in one of these containers. The pressure P of the mixture will be

(a) $P < (P_1 + P_2 + P_3)$
(b) $P = \frac{P_1+P_2+P_3}{3}$
(c) $P = P_1 + P_2 + P_3$
(d) $P > (P_1 + P_2 + P_3)$

4) Relation between pressure (P) and energy (E) of a gas is

(a) $P = \frac{2}{3} E$
(b) $P = \frac{1}{3} E$
(c) $P = \frac{1}{2} E$
(d) $P = 3E$

5) If C_S be the velocity of sound in air and C be the r.m.s velocity, then

(a) $C_S < C$
(b) $C_S = C$
(c) $C_S = C (\gamma/3)^{1/2}$
(d) none of these

6) The pressure of a gas is raised from 27°C to 927°C. The root mean square speed is

(a) $\sqrt{(927/27)}$ times the earlier value
(b) remain the same
(c) gets halved
(d) get doubled

7) At 0 K, which of the following properties of a gas will be zero?

(a) Kinetic energy
(b) Potential energy
(c) Density
(d) Mass

8) In a vessel, the gas is at a pressure P. If the mass of all molecules is halved and their speed is doubled, then the resultant pressure will be

(a) 4P
(b) 2P
(c) P
(d) P/2

9) The molecules of a given mass of gas have r.m.s velocity of $200 ms^{-1}$ at 27°C and 1.0×10^5 Nm^{-2} pressure. When the temperature and pressure of the gas are respectively, 127°C and 0.05×10^5 Nm^{-2}, the r.m.s velocity of its molecules in ms^{-1} is:

(a) $100\sqrt{2}$
(b) $\frac{400}{\sqrt{3}}$
(c) $\frac{100\sqrt{2}}{3}$
(d) $\frac{100}{3}$

10) At what temperature is the r.m.s velocity of a hydrogen molecule equal to that of an oxygen molecule at 47°C?

(a) 80K
(b) −73K
(c) 3K
(d) 20K

11) 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)

(a) $1421 ms^{-1}$
(b) $500 ms^{-1}$
(c) $650 ms^{-1}$
(d) $330 ms^{-1}$

12) One kg of a diatomic gas is at a pressure of $8 \times 10^4 N/m^2$. The density of the gas is $4 kg/m^3$.What is the energy of the gas due to its thermal motion?

(a) $5 \times 10^4 J$
(b) $6 \times 10^4 J$
(c) $7 \times 10^4 J$
(d) $3 \times 10^4 J$

13) Three perfect gases at absolute temperatures T_1, T_2 and T_3 are mixed. The masses of molecules are m_1, m_2 and m_3 and the number of molecules are n_1, n_2 and n_3 respectively. Assuming no loss of energy, the final temperature of the mixture is:

(a) $\frac{n_1T_1+n_2T_2+n_3T_3}{n_1+n_2+n_3}$
(b) $\frac{n_1T_1^2+n_2T_2^2+n_3T_3^2}{n_1T_1+n_2T_2+n_3T_3}$
(c) $\frac{n_1^2T_1^2+n_2^2T_2^2+n_3^2T_3^2}{n_1T_1+n_2T_2+n_3T_3}$
(d) $\frac{(T_1+T_2+T_3)}{3}$

14) A thermally insulated vessel contains an ideal gas of molecular mass M and ratio of specific heats γ. It is moving with speed v and it’s suddenly brought to rest. Assuming no heat is lost to the surroundings, its temperature increases by:

(a) $\frac{(\gamma-1)}{2\gamma R} Mv^2 K$
(b) $\frac{\gamma M^2 v}{2R} K$

(c) $\frac{(\gamma-1)}{2R}$ Mv^{2}K

(d) $\frac{(\gamma-1)}{2(\gamma+1)R}$ Mv^{2}K

15) A perfect gas at 27°C is heated at constant pressure so as to double its volume. The final temperature of the gas will be, close to

(a) 327°C

(b) 200°C

(c) 54°C

(d) 300°C

16) In the isothermal expansion of 10g of gas from volume V to 2V the work done by the gas is 575J. What is the root mean square speed of the molecules of the gas at that temperature?

(a) 398m/s

(b) 520m/s

(c) 499m/s

(d) 532m/s

17) At room temperature a diatomic gas is found to have an r.m.s. speed of 1930ms^{-1}. The gate is:

(a) H_2

(b) Cl_2

(c) O_2

(d) F_2

18) A gas molecule of mass M at the surface of the Earth has kinetic energy equivalent to 0°C. If it were to go up straight without colliding with any other molecules, how high it would rise? Assume that the height attained is much less than the radius of the earth. (k_B is Boltzmann constant).

(a) 0

(b) $\frac{273k_B}{2Mg}$

(c) $\frac{546k_B}{3Mg}$

(d) $\frac{819k_B}{2Mg}$

19) In an ideal gas at temperature T, the average force that a molecule applies on the walls of a closed container depends on T as T^q. A good estimate for q is:

(a) $\frac{1}{2}$

(b) 2

(c) 1

(d) $\frac{1}{4}$

20) N moles of a diatomic gas in a cylinder are at a temperature T. Heat is supplied to the cylinder such that the temperature remains constant but n moles of the diatomic gas get converted into monatomic gas. What is the change in the total kinetic energy of the gas?

(a) $\frac{1}{2}$ nRT

(b) 0

(c) $\frac{3}{2}$ nRT

(d) $\frac{5}{2}$ Nrt

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	d	c	a	c	d	a	b	b	d
11	12	13	14	15	16	17	18	19	20
a	a	a	c	a	c	a	d	c	a

Topic 44: Degree of Freedom, Specific Heat Capacity & Mean Free Path

1) A polyatomic gas with n degrees of freedom has a mean energy per molecule given by

(a) $\frac{nkT}{N}$

(b) $\frac{nkT}{2N}$

(c) $\frac{nkT}{2}$

(d) $\frac{3kT}{2}$

2) One mole of an ideal monoatomic gas requires 207 J heat to raise the temperature by 10K when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by the same 10K, the heat required is

[Given the gas constant R = 8.3J/mol. K]

(a) 198.7 J

(b) 29 J

(c) 215.3 J

(d) 124 J

3) For a certain gas the ratio of specific heats is given to be $\gamma = 1.5$. For this gas

(a) $C_V = 3R/J$

(b) $C_P = 3R/J$

(c) $C_P = 5R/J$

(d) $C_V = 5R/J$

4) For hydrogen gas, $C_P - C_V = a$ and for oxygen gas, $C_P - C_V = b$, so the relation between a and b is given by

(a) a = 16 b

(b) 16 b = a

(c) a = 4 b

(b) a = b

5) If for a gas, $\frac{R}{C_V} = 0.67$, the gas is made up of molecules which are

(a) diatomic

(b) mixture of diatomic and polyatomic molecules

(c) monoatomic

(d) polyatomic

6) The number of translational degrees of freedom for a diatomic gas is

(a) 2

(b) 3

(c) 5

(d) 6

7) The degree of freedom of a molecule of a triatomic gas is

(a) 2

(b) 4

(c) 6

(d) 8

8) If γ be the ratio of specific heats of a perfect gas, the number of degrees of freedom of a molecule of the gas is

(a) $\frac{25}{2}(\gamma - 1)$

(b) $\frac{3\gamma-1}{2\gamma-1}$

(c) $\frac{2}{\gamma-1}$

(d) $\frac{9}{2}(\gamma - 1)$

9) The molar specific heat at constant pressure of an ideal gas is (7/2) R. The ratio of specific heat at constant pressure to that at constant volume is

(a) 8/7

(b) 5/7

(c) 9/7

(d) 7/5

10) The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_P and C_V, respectively. If $\gamma = \frac{C_P}{C_V}$ and R is the universal gas constant, then C_V is equal to

(a) $\frac{R}{(\gamma-1)}$

(b) $\frac{(\gamma-1)}{R}$

(c) γR

(d) $\frac{1+\gamma}{1-\gamma}$

11) The amount of heat energy required to raise the temperature of 1g of Helium at NTP, from T_1K to T_2K is

(a) $\frac{3}{2} N_a k_B (T_2 - T_1)$

(b) $\frac{3}{4} N_a k_B (T_2 - T_1)$

(c) $\frac{3}{4} N_a k_B \frac{T_2}{T_1}$

(d) $\frac{3}{8} N_a k_B (T_2 - T_1)$

12) The mean free path of molecules of a gas, (radius ‘r’) is inversely proportional to:

(a) r^3

(b) r^2

(c) r

(d) $\sqrt{r}$

13) 4.0g of a gas occupies 22.4 litres at NTP. The specific heat capacity of the gas at constant volume is $5.0 JK^{-1}$. If the speed of sound in this gas at NTP is $952 ms^{-1}$, then the heat capacity at constant pressure is (Take gas constant $R = 8.3 JK^{-1}mol^{-1}$)

(a) $7.5\ JK^{-1}mol^{-1}$

(b) $7.0\ JK^{-1}mol^{-1}$

(c) $8.5\ JK^{-1}mol^{-1}$

(d) $8.0\ JK^{-1}mol^{-1}$

14) The ratio of the specific heats $\frac{C_p}{C_v} = \gamma$ in terms of degrees of freedom (n) is given by

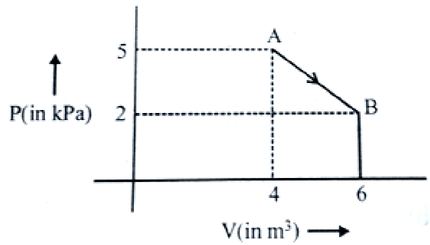
(a) $\left(1 + \frac{n}{3}\right)$

(b) $\left(1 + \frac{2}{n}\right)$

(c) $\left(1+\frac{n}{2}\right)$

(d) $\left(1+\frac{1}{n}\right)$

15) One mole of an ideal diatomic gas undergoes a transition from A to B along a path AB as shown in the figure.



The change in internal energy of the gas during the transition is:

(a) -20kJ

(b) 20 J

(c) -12kJ

(d) 20kJ

16) A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T. Neglecting all vibrational modes, the total internal energy of the system is:-

(a) 15 RT

(b) 9 RT

(c) 11RT

(d) 4 RT

17) During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio C_p/C_V for the gas is

(a) $\frac{4}{3}$

(b) 2

(c) $\frac{5}{3}$

(d) $\frac{3}{2}$

18) One mole of ideal monatomic gas ($\gamma = 5/3$) is mixed with one mole of diatomic gas (= 7/5). What is γ for the mixture? γ Denotes the ratio of specific heat at constant pressure, to that at constant volume

(a) 35/23

(b) 23/15

(c) 3/2

(d) 4/3

19) A gaseous mixture consists of 16g of helium and 16g of oxygen. The ratio $\frac{C_p}{C_v}$ of the mixture is

(a) 1.62

(b) 1.59

(c) 1.54

(d) 1.4

20) If C_p and C_V denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then

(a) $C_p - C_V = 28R$

(b) $C_p - C_V = R/28$

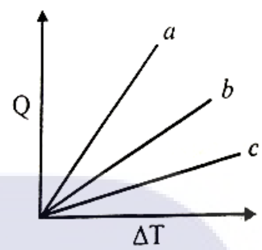
(c) $C_p - C_V = R/14$

(d) $C_p - C_V = R$

21) A given ideal gas with $\gamma = \frac{C_p}{C_v} = 1.5$ at a temperature T. If the gas is compressed adiabatically to one – fourth of its initial volume, the final temperature will be

(a) $2\sqrt{2}$ T
(b) 4 T
(c) 2 T
(d) 8 T

22) Figure shows the variation in temperature (ΔT) with the amount of heat supplied (Q) in an isobaric process corresponding to a monatomic (M), diatomic (D) and a polyatomic (P) gas. The initial state of all the gases are the same and the scales for the two axes coincide. Ignoring vibrational degrees of freedom, the lines a, b and c respectively correspond to:



(a) P, M and D
(b) M, D and P
(c) P, D and M
(d) D, M and P

23) Modern vacuum pumps can evacuate a vessel down to a pressure of 4.0×10^{-15} atm. at room temperature (300K). Taking $R = 8.0 JK^{-1} mole^{-1}$, $1 atm = 10^5 Pa$ and $N_{Avogadro} = 6 \times 10^{23} mole^{-1}$, the mean distance between molecules of gas in an evacuated vessel will be of the order of:

(a) 0.2μm
(b) 0.2mm
(c) 0.2cm
(d) 0.2nm

24) Using equipartition of energy, the specific heat (in $Jkg^{-1}K^{-1}$) of aluminium at room temperature can be estimated to be (atomic weight of aluminium = 27)

(a) 410
(b) 25
(c) 1850
(d) 925

25) An ideal gas undergoes a quasi static, reversible process in which its molar heat capacity C remains constant. If during this process the relation of pressure P and volume V is given be PV^n = constant, then n given by (Here C_p and C_v are molar specific heat at constant pressure and constant volume, respectively):

(a) $n = \frac{C_p - C}{C - C_v}$
(b) $n = \frac{C - C_v}{C - C_p}$
(c) $n = \frac{C_p}{C_v}$
(d) $n = \frac{C - C_p}{C - C_v}$

26) An ideal gas has molecules with 5 degrees of freedom. The ratio of specific heats at constant pressure (C_p) and at constant volume (C_v) is:

(a) 6

(b) $\frac{7}{2}$

(c) $\frac{5}{2}$

(d) $\frac{7}{5}$

27) C_p and C_v are specific heat at constant pressure and constant volume respectively. It is observed that

$C_p - C_v = a$ for hydrogen gas

$C_p - C_v = b$ for nitrogen gas

The correct relation between a and b is:

(a) a = 14b

(b) a = 28b

(c) $a = \frac{1}{14} b$

(d) a = b

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	d	b	d	c	b	c	c	d	a
11	12	13	14	15	16	17	18	19	20
d	b	d	b	a	c	d	c	a	b
21	22	23	24	25	26	27			
c	b	b	d	d	d	a			

Topic 45: Displacement, Phase, Velocity & Acceleration of SHM

1) A particle moving along the X – axis, executes simple harmonic motion then force acting on it is given by

(a) $-A\,kx$

(b) $A\cos(kx)$

(c) $A\exp(-kx)$

(d) $A\,kx$

where, A and k are positive constants.

2) The composition of two simple harmonic motions of equal periods at right angle to each other and with a phase difference of π results in the displacement of the particle along

(a) circle

(b) figures of eight

(c) straight line

(d) ellipse

3) A particle is subjected to two mutually perpendicular simple harmonic motions such that its x and y coordinates are given by

$$x = 2\sin\omega t; \qquad y = 2\sin\left(\omega t + \frac{\pi}{4}\right)$$

The path of the particle will be

(a) a straight line

(b) a circle

(c) an ellipse

(d) a parabola

4) Which one of the following is a simple harmonic motion?

(a) Ball bouncing between two rigid vertical walls

(b) Particles moving in a circle with uniform speed

(c) Wave moving through a string fixed at both ends

(d) Earth spinning about its own axis

5) A particle starts simple harmonic motion from the mean position. Its amplitude is A and time period is T. What is its displacement when its speed is half of its maximum speed

(a) $\frac{\sqrt{2}}{3}A$

(b) $\frac{\sqrt{3}}{2}A$

(c) $\frac{2}{\sqrt{3}}A$

(d) $\frac{A}{\sqrt{2}}$

6) Two simple harmonic motions with the same frequency act on a particle at right angles i.e., along x and y axis. If the two amplitudes are equal and the phase difference is π/2, the resultant motion will be

(a) a circle

(b) an ellipse with the major axis along y – axis

(c) an ellipse with the major axis along x – axis

(d) a straight line inclined at 45° to the x – axis

7) A particle executing S.H.M has amplitude 0.01m and frequency 60Hz. The maximum acceleration of the particle is

(a) $144\pi^2 m/s^2$

(b) $120\ \pi^2 m/s^2$

(c) $80\ \pi^2 m/s^2$

(d) $60\ \pi^2 m/s^2$

8) Two simple harmonic motions act on a particle. These harmonic motions are x = A cos (ωt + δ), y = A cos (ωt + α) when $\delta = \alpha + \frac{\pi}{2}$, the resulting motion is

(a) a circle and the actual motion is clockwise

(b) an ellipse and the actual motion is counterclockwise

(c) an ellipse and the actual motion is clockwise

(d) a circle and the actual motion is counter clockwise

9) Which one of the following statements is true for the speed v and the acceleration a of a particle executing simple harmonic motion?

(a) When v is maximum, a is zero

(b) When v is maximum, a is maximum

(c) Value of a is zero, whatever may be the value of v

(d) When v is zero, a is zero

10) A particle executing simple harmonic motion of amplitude 5cm has maximum speed of 3.14 cm/s. Its oscillation per second

(a) 4

(b) 3

(c) 2

(d) 1

11) The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is

(a) π

(b) 0.707 π

(c) zero

(d) 0.5 π

12) Two simple harmonic motions of angular frequency 100 and 1000 rad s^{-1} have the same displacement amplitude. The ratio of their maximum acceleration is:

(a) 1 : 10

(b) $1 : 10^2$

(c) $1 : 10^3$

(d) $1 : 10^4$

13) Which one of the following equations of motion represents simple harmonic motion?

(a) Acceleration = −k (x + a)

(b) Acceleration = k (x + a)

(c) Acceleration = kx

(d) Acceleration = $-k_0x + k_1x^2$

14) The displacement of a particle along the x – axis is given by x = a $\sin^2 \omega t$. The motion of the particle corresponds to:

(a) simple harmonic motion of frequency ω/π

(b) simple harmonic motion of frequency 3ω/2π

(c) non simple harmonic motion

(d) simple harmonic motion of frequency ω/2π

15) Two particles are oscillating along two close parallel straight lines side by side, with the same frequency and amplitudes. They pass each other, moving in opposite directions when their displacement is half of the amplitude. The mean positions of the two particles lie on a straight line perpendicular to the paths of the two particles. The phase difference is

(a) 0

(b) 2π/3

(c) π

(d) π/6

16) Out of the following functions, representing motion of a particle, which represents SHM?

(A) y = sin ωt – cos ωt

(B) y = $\sin^3 \omega t$

(C) y = 5 cos $\left(\frac{3\pi}{4} - 3\omega t\right)$

(D) y = 1 + ωt + $\omega^2 t^2$

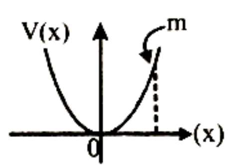
(a) only (A)

(b) Only (D) does not represent SHM

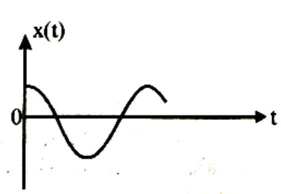
(c) Only (A) and (C)

(d) Only (A) and (B)

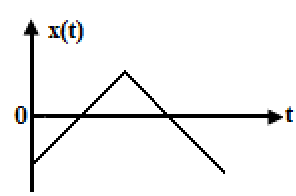
17) A particle of mass m is released from rest and follows a parabolic path as shown. Assuming that the displacement of the mass from the origin is small, which graph correctly depicts the position of the particle as a function of time



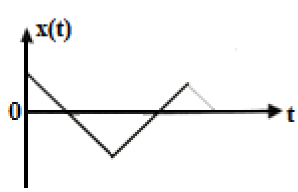
(a)



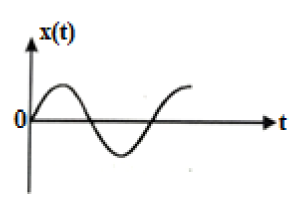
(b)



(c)



(d)



18) The equation of a simple harmonic wave is given by

$$y = 3 \sin \frac{\pi}{2} (50t - x)$$

Where x and y are in meters and t is seconds. The ratio of maximum particle velocity to the wave velocity is

(a) 2π

(b) $\frac{3}{2}\pi$

(c) 3π

(d) $\frac{2}{3}\pi$

19) A particle of mass m oscillates along x – axis according to equation x = a sin ωt. The nature of the graph between momentum and displacement of the particle is

(a) straight line passing through origin

(b) circle

(c) hyperbola

(d) ellipse

20) The oscillation of a body on a smooth horizontal surface is represented by the equation,

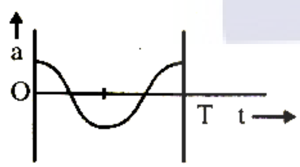
X = A cos (ωt)

Where X = displacement at time t

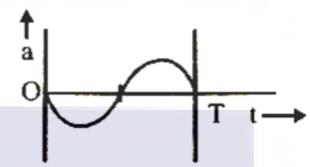
ω = frequency of oscillation

Which one of the following graphs shows correctly the variation of ‘a’ with ‘t’?

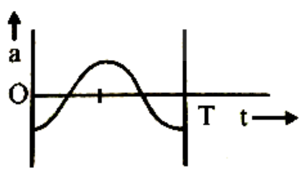
(a)



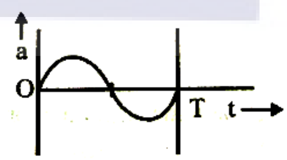
(b)



(c)



(d)



21) When two displacements represented by $y_1 = a \sin(\omega t)$ and $y_2 = b \cos(\omega t)$ are superimposed the motion is:

(a) simple harmonic with amplitude $\frac{a}{b}$

(b) simple harmonic with amplitude $\sqrt{a^2 + b^2}$

(c) simple harmonic with amplitude $\frac{(a+b)}{2}$

(d) not a simple harmonic

22) The displacement of a particle varies according to the relation x = 4(cos πt + sin πt). The amplitude of the particle is

(a) -4

(b) 4

(c) $4\sqrt{2}$

(d) 8

23) Two particles A and B of equal masses are suspended from two massless springs of spring constant k_1 and k_2, respectively. If the maximum velocities, during oscillation, are equal, the ratio of amplitude of A and B is

(a) $\sqrt{\frac{k_1}{k_2}}$

(b) $\frac{k_2}{k_1}$

(c) $\sqrt{\frac{k_2}{k_1}}$

(d) $\frac{k_1}{k_2}$

24) Two simple harmonic motions are represented by the equations $y_1 = 0.1\sin\left(100\pi + \frac{\pi}{3}\right)$ and $y_2 = 0.1\cos \pi t$. The phase difference of the velocity of particle 1 with respect to the velocity of particle 2 is

(a) $\frac{\pi}{3}$

(b) $\frac{-\pi}{6}$

(c) $\frac{\pi}{6}$

(d) $\frac{-\pi}{3}$

25) The function $\sin^2(\omega t)$ represents

(a) a periodic, but not simple harmonic motion with a period $\frac{\pi}{\omega}$

(b) a periodic, but not simple harmonic motion with a period $\frac{2\pi}{\omega}$

(c) a simple harmonic motion with a period $\frac{\pi}{\omega}$

(d) a simple harmonic motion with a period $\frac{2\pi}{\omega}$

26) The maximum velocity of a particle, executing simple harmonic motion with an amplitude 7mm, is 4.4m/s. The period of oscillation is

(a) 0.01s

(b) 10s

(c) 0.1s

(d) 100s

27) A coin is placed on a horizontal platform which undergoes vertical simple harmonic motion of angular frequency ω. The amplitude of oscillation is gradually increased. The coin will leave contact with the platform for the first time

(a) at the mean position of the platform

(b) for an amplitude of $\frac{g}{\omega^2}$

(c) for an amplitude of $\frac{g^2}{\omega^2}$

(d) at the highest position of the platform

28) A point mass oscillates along the x – axis according to the law $x = x_0\cos(\omega t - \pi/4)$. If the acceleration of the particle is written as $a = A \cos(\omega t + \delta)$, then

(a) $A = x_0\omega^2$, $\delta = 3\pi/4$

(b) $A = x_0$, $\delta = -\pi/4$

(c) $A = x_0\omega^2$, $\delta = \pi/4$

(d) $A = x_0\omega^2$, $\delta = -\pi/4$

29) A mass M, attached to a horizontal spring, executes S.H.M. with amplitude A_1. When the mass M passes through its mean position then a smaller mass m is placed over it and both of them move together with amplitude A_2. The ratio of $\left(\frac{A_1}{A_2}\right)$ is:

(a) $\frac{M+m}{M}$

(b) $\left(\frac{M}{M+m}\right)^{\frac{1}{2}}$

(c) $\left(\frac{M+m}{M}\right)^{\frac{1}{2}}$

(d) $\frac{M}{M+m}$

30) Two particles are executing simple harmonic motion of the same amplitude A and frequency ω along the x – axis. Their mean position is separated by distance X_0($X_0 > A$). If the maximum separation between them is ($X_0 + A$), the phase difference between their motion is:

(a) $\frac{\pi}{3}$

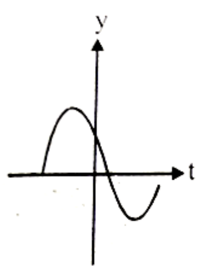
(b) $\frac{\pi}{4}$

(c) $\frac{\pi}{6}$

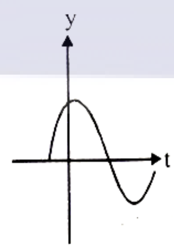
(d) $\frac{\pi}{2}$

31) The displacement $y(t) = A\sin(\omega t + \phi)$ of a pendulum for $\phi = \frac{2\pi}{3}$ is correctly represented by

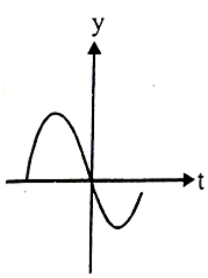
(a)



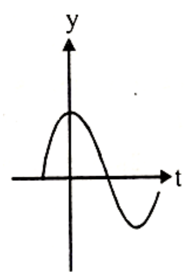
(b)



(c)

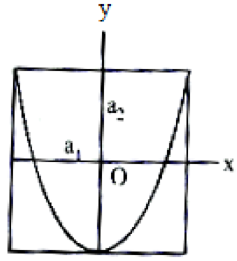


(d)

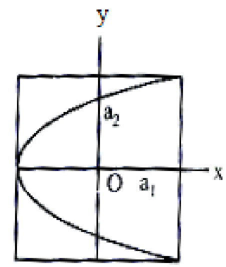


32) A particle which is simultaneously subjected to two perpendicular simple harmonic motions represented by; $x = a_1 \cos \omega t$ and $y = a_2 \cos 2\omega t$ traces a curve given by:

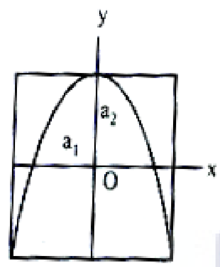
(a)



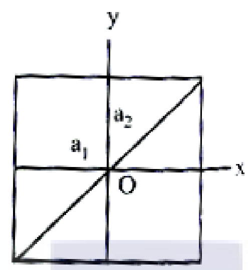
(b)



(c)



(d)



33) Which of the following expressions corresponds to simple harmonic motion along a straight line, where x is the displacement and a, b, c are positive constants?

(a) $a + bx - cx^2$

(b) bx^2

(c) $a - bx + cx^2$

(d) $-bx$

34) A body is in simple harmonic motion with time period half second (T = 0.5s) and amplitude one cm (A = 1cm). Find the average velocity in the interval in which it moves form equilibrium position to half of its amplitude.

(a) 4 cm/s

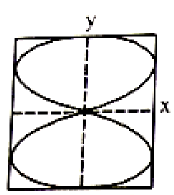
(b) 6 cm/s

(c) 12 cm/s

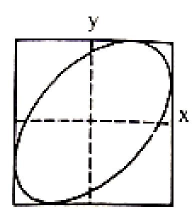
(d) 16 cm/s

35) x and y displacements of a particle are given as $x(t) = a \sin \omega t$ and $y(t) = a \sin 2\omega t$. Its trajectory will look like:

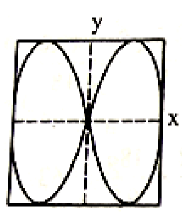
(a)



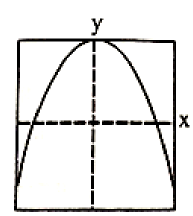
(b)



(c)



(d)



36) A simple harmonic oscillator of angular frequency 2 rad s^{-1} is acted upon by an external force F = sin t N. If the oscillator is at rest in its equilibrium position at t = 0, its position at later times is proportional to:

(a) $\sin t + \frac{1}{2}\cos 2t$

(b) $\cos t - \frac{1}{2}\sin 2t$

(c) $\sin t - \frac{1}{2}\sin 2t$

(d) $\sin t + \frac{1}{2}\sin 2t$

37) Two particles are performing simple harmonic motion in a straight line about the same equilibrium point. The amplitude and time period for both particles are same and equal to A and T, respectively. At time t = 0 one particle has displacement A while the other one has displacement $\frac{-A}{2}$ and they are moving towards each other. If they cross each other at time t, then t is:

(a) $\frac{5T}{6}$

(b) $\frac{T}{3}$

(c) $\frac{T}{4}$

(d) $\frac{T}{6}$

38) A particle perform simple harmonic motion with amplitude A. Its speed is trebled at the instant that it is at a distance $\frac{2A}{3}$ from equilibrium position. The new amplitude of the motion is:

(a) $A\sqrt{3}$

(b) $\frac{7A}{3}$

(c) $\frac{A}{3}\sqrt{41}$

(d) 3A

39) The ratio of maximum acceleration to maximum velocity in a simple harmonic motion is $10s^{-1}$. At t = 0 the displacement is 5m. What is the maximum acceleration? The initial phase is $\frac{\pi}{4}$

(a) $500 m/s^2$

(b) $500\sqrt{2}\ m/s^2$

(c) $750\ m/s^2$

(d) $750\sqrt{2}\ m/s^2$

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
a	c	c	c	b	a	a	d	a	d
11	12	13	14	15	16	17	18	19	20
d	b	a	a	b	c	a	b	d	c
21	22	23	24	25	26	27	28	29	30
b	c	c	b	c	a	b	a	c	a
31	32	33	34	35	36	37	38	39	
a	b	d	c	c	c	d	b	b	

Topic 46: Energy in Simple Harmonic Motion

1) The angular velocity and the amplitude of a simple pendulum is ω and a respectively. At a displacement x from the mean position if its kinetic energy is T and potential energy is V, then the ratio of T to V is

(a) $\frac{(a^2-x^2\omega^2)}{x^2\omega^2}$

(b) $\frac{x^2\omega^2}{(a^2-x^2\omega^2)}$

(c) $\frac{(a^2-x^2)}{x^2}$

(d) $\frac{x^2}{(a^2-x^2)}$

2) A body executes S.H.M with an amplitude A. At what displacement from the mean position is the potential energy of the body is one fourth of its total energy?

(a) A/4

(b) A/2

(c) 3A/4

(d) Some other fraction of A

3) A linear harmonic oscillator of force constant 2×10^6 N/m and amplitude 0.01 m has a total mechanical energy of 160 J. Its

(a) potential energy is 160 J

(b) potential energy is 100 J

(c) potential energy is zero

(d) potential energy is 120 J

4) In a simple harmonic motion, when the displacement is one – half the amplitude, what fraction of the total energy is kinetic?

(a) 0

(b) $\frac{1}{4}$

(c) $\frac{1}{2}$

(d) $\frac{3}{4}$

5) There is a body having mass m and performing S.H.M with amplitude a. There is a restoring force $F = -kx$. The total energy of body depends upon

(a) k, x

(b) k, a

(c) k, a, x

(d) k, a, v

6) A particle is executing a simple harmonic motion of amplitude a. Its potential energy is maximum when the displacement from the position of the maximum kinetic energy is

(a) 0

(b) $\pm$ a

(c) $\pm$ a/2

(d) −a/2

7) The potential energy of a simple harmonic oscillator when the particle is half way to its end point is

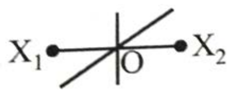
(a) $\frac{1}{2}$ E

(b) $\frac{2}{3}$ E

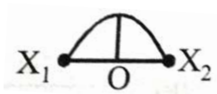
(c) $\frac{1}{8}$ E

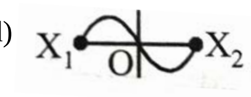
(d) $\frac{1}{4}$ E

8) A particle of mass m oscillates with simple harmonic motion between point x_1 and x_2, the equilibrium position being O. Its potential energy is plotted. It will be as given below in the graph.

(a) 

(b)

(c) 

(d) 

9) The potential energy of a long spring when stretched by 2cm is U. If the spring is stretched by 8cm, the potential energy stored in it is

(a) 8 U

(b) 16 U

(c) U/4

(d) 4 U

10) The particle executing simple harmonic motion has a kinetic energy $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the total energy are respectively

(a) $K_0/2$ and K_0

(b) K_0 and $2 K_0$

(c) K_0 and K_0

(d) 0 and $2 K_0$

11) In a simple harmonic oscillator, at the mean position

(a) kinetic energy is minimum, potential energy is maximum

(b) both kinetic and potential energies are maximum

(c) kinetic energy is maximum, potential energy is minimum

(d) both kinetic and potential energies are minimum

12) A body executes simple harmonic motion. The potential energy (P.E), the kinetic energy (K.E) and total energy (T.E) are measured as a function of displacement x. Which of the following statements is true?

(a) K.E. is maximum when $x = 0$

(b) T.E. is zero when $x = 0$

(c) K.E. is maximum when x is maximum

(d) P.E. is maximum when $x = 0$

13) The total energy of a particle, executing simple harmonic motion is

(a) independent of x

(b) $\propto x^2$

(c) $\propto x$

(d) $\propto x^{1/2}$

14) Starting from the origin a body oscillates simple harmonically with a period of 2s. After what time will its kinetic energy be 75% of the total energy?

(a) $\frac{1}{6}$ s

(b) $\frac{1}{4}$ s

(c) $\frac{1}{3}$ s

(d) $\frac{1}{12}$ s

15) A particle of mass m executes simple harmonic motion with amplitude a and frequency v. The average kinetic energy during its motion from the position of equilibrium to the end is

(a) $2\pi^2 ma^2v^2$

(b) $\pi^2 ma^2v^2$

(c) $\frac{1}{4} ma^2v^2$

(d) $4\pi^2 ma^2v^2$

16) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

If two springs S_1 and S_2 of force constants k_1 and k_2 respectively, are stretched by the same force, it is found that more work is done on spring S_1 than on spring S_2.

Statement 1: If stretched by the same amount of work done on S_1

Statement 2: $k_1 < k_2$

(a) Statement 1 is false, Statement 2 is true.

(b) Statement 1 is true, Statement 2 is false.

(c) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

(d) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

17) A pendulum with time period of 1s is losing energy. At certain time its energy is 45J. If after completing 15 oscillations, its energy has become 15J, its damping constant (in s^{-1}) is:

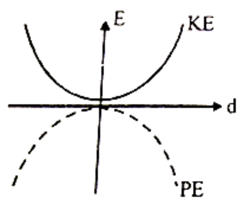
(a) $\frac{1}{2}$

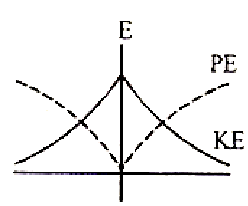
(b) $\frac{1}{30}$ ln3

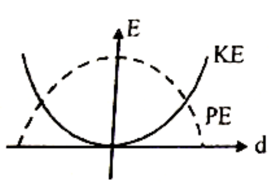
(c) 2

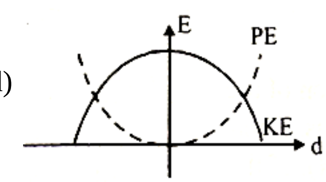
(d) $\frac{1}{15}$ ln3

18) For a simple pendulum, a graph is plotted between its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly? (*graphs are schematic and not drawn to scale*)

(a)


(b)


(c)


(d)


19) A block of mass 0.1kg is connected to an elastic spring of spring constant $640Nm^{-1}$ and oscillates in a medium of constant 10^{-2} kg s^{-1}. The system dissipates its energy gradually. The time taken for its mechanical energy of vibration to drop to half of its initial value, is closest to:

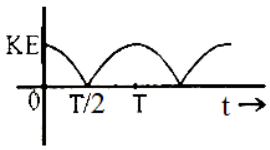
(a) 2s

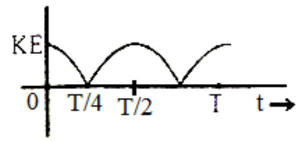
(b) 3.5s

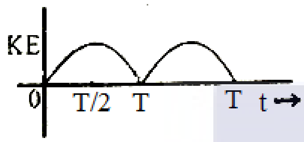
(c) 5s

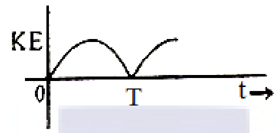
(d) 7s

20) A particle is executing simple harmonic motion with a time period T. At time t = 0, it is at its position of equilibrium. The kinetic energy – time graph of the particle will look like:

(a)


(b)


(c)


(d)


ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	b	b	d	b	b	d	b	b	c
11	12	13	14	15	16	17	18	19	20
c	a	a	a	b	b	d	d	b	b

Topic 47: Time Period, Frequency, Simple Pendulum & Spring Pendulum

1) A mass m is suspended from a two coupled springs, connected in series. The force constant for springs are k_1 and k_2. The time period of the suspended mass will be

(a) $T = 2\pi\sqrt{\frac{m}{k_1 - k_2}}$

(b) $T = 2\pi\sqrt{\frac{mk_1k_2}{k_1 + k_2}}$

(c) $T = 2\pi\sqrt{\frac{m}{k_1 + k_2}}$

(d) $T = 2\pi\sqrt{\frac{m(k_1 + k_2)}{k_1k_2}}$

2) A simple pendulum is suspended from the roof of a trolley which moves in a horizontal direction with an acceleration a, then the time period is given by $T = 2\pi\sqrt{(l/g)}$, where g is equal to

(a) g

(b) g – a

(c) g + a

(d) $\sqrt{(g^2 + a^2)}$

3) A body is executing S.H.M. When the displacement from the mean position are 4cm and 5cm, the corresponding velocities of the body are 10cm per sec and 8 cm per sec. Then the time period of the body is

(a) 2π sec

(b) π/2 sec

(c) π sec

(d) (3π/2) sec

4) A simple harmonic oscillator has an amplitude A and time period T. The time required by it to travel from x = A to x = A/2 is

(a) T/6

(b) T/4

(c) T/3

(d) T/2

5) If a simple harmonic oscillator has got a displacement of 0.02m and acceleration equal to $2.0 m/s^2$ at any time, the angular frequency of the oscillator is equal to

(a) 10 rad/s

(b) 0.1 rad/s

(c) 100 rad/s

(d) 1 rad/s

6) A hollow sphere is filled with water. It is hung by a long thread. As the water out of a hole at the bottom, the period of oscillation will

(a) first increase and then decrease

(b) first decrease and then increase

(c) go on increasing

(d) go on decreasing

7) If the length of a simple pendulum is increased by 2%, then the time period

(a) increases by 2%

(b) decreases by 2%

(c) increases by 1%

(d) decreases by 1%

8) A mass m is vertically suspended from a spring of negligible mass; the system oscillates with a frequency n. What will be the frequency of the system, if a mass 4m is suspended from the same spring?

(a) $\frac{n}{4}$

(b) 4n

(c) $\frac{n}{2}$

(d) 2n

9) Two simple pendulums of length 5m and 20m respectively are given small linear displacement in one direction at the same time. They will again be in the phase when the pendulum of shorter length has completed…….oscillations

(a) 5

(b) 1

(c) 2

(d) 3

10) The time period of a simple pendulum is 2 seconds. If its length is increased by 4 – times, then its time period becomes

(a) 16 s

(b) 12 s

(c) 8 s

(d) 4 s

11) Masses M_A and M_B hanging from the ends of strings of lengths L_A and L_B are executing simple harmonic motions. If their frequencies are $f_A = 2f_B$, then

(a) $L_A = 2L_B$ and $M_A = M_B/2$

(b) $L_A = 4L_B$ regardless of masses

(c) $L_A = L_B/4$ regardless of masses

(d) $L_A = 2L_B$ and $M_A = 2M_B$

12) A simple pendulum has a metal bob, which is negatively charged. If it is allowed to oscillate above a positively charged metallic plate, then its time period will

(a) increase

(b) decrease

(c) become zero

(d) remain the same

13) The amplitude of a pendulum executing simple harmonic motion falls to 1/3 the original value after 100 oscillations. The amplitude falls to S times the original value after 200 oscillations, where S is

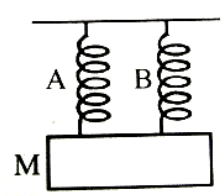
(a) 1/9

(b) 1/2

(c) 2/3

(d) 1/6

14) A body of mass M, executes vertical SHM with periods t_1 and t_2, when separately attached to spring A and spring B respectively. The period of SHM, when the body executes SHM, as shown in the figure is t_0. Then



(a) $t_0^{-1} = t_1^{-1} + t_2^{-1}$

(b) $t_0 = t_1 + t_2$

(c) $t_0^2 = t_1^2 + t_2^2$

(d) $t_0^{-2} = t_1^{-2} + t_2^{-2}$

15) The time period of a mass suspended from a spring is T. If the spring is cut into four equal parts and the same mass is suspended from one of the parts, then the new time period will be

(a) 2T

(b) $\frac{T}{4}$

(c) 2

(d) $\frac{T}{2}$

16) Two springs of spring constants k_1 and k_2 are joined in series. The effective spring constant of the combination is given by

(a) $k_1k_2 / (k_1 + k_2)$

(b) k_1k_2

(c) $(k_1 + k_2)/2$

(d) $k_1 + k_2$

17) A particle executes simple harmonic oscillation with an amplitude a. The period of oscillation is T. The minimum time taken by the particle to travel half of the amplitude from the equilibrium position is

(a) T/8

(b) T/12

(c) T/2

(d) T/4

18) A mass of 2.0kg is put on a flat pan attached to a vertical spring fixed on the ground as shown in the figure. The mass of the spring and the pan is negligible. When pressed slightly and released the mass executes a simple harmonic motion. The spring constant is 200N/m. What should be the minimum amplitude of the motion so that the mass gets detached from the pan (take $g = 10m/s^2$) ?

(a) 10.0 cm

(b) any value less than 12.0 cm

(c) 4.0 cm

(d) 8.0 cm

19) A point performs simple harmonic oscillation of period T and the equation of motion is given by $x = a \sin(\omega t + \pi/6)$. After the elapse of what fraction of the time period the velocity of the point will be equal to half of its maximum velocity?

(a) T/8

(b) T/6

(c) T/3

(d) T/12

20) A block of mass M is attached to the lower end of a vertical spring. The spring is hung from a ceiling and has force constant value k. The mass is released from rest with the spring initially unstretched. The maximum extension initially unstretched. The maximum extension produced in the length of the spring will be:

(a) 2 Mg/k

(b) 4 Mg/k

(c) Mg/2k

(d) Mg/k

21) A simple pendulum performs simple harmonic motion about x = 0 with an amplitude a and time period T. The speed of the pendulum at $x = \frac{a}{2}$ will be:

(a) $\frac{\pi a}{T}$

(b) $\frac{3\pi^2 a}{T}$

(c) $\frac{\pi a\sqrt{3}}{T}$

(d) $\frac{\pi a\sqrt{3}}{2T}$

22) The period of oscillation of a mass M suspended from a spring of negligible mass is T. If along with it another mass M is also suspended, the period of oscillation will now be

(a) T

(b) $T/\sqrt{2}$

(c) 2T

(d) $\sqrt{2}$ T

23) A particle is executing a simple harmonic motion. Its maximum acceleration is a and maximum velocity is b. Then its time period of vibration will be:

(a) $\frac{\alpha}{\beta}$

(b) $\frac{\beta^2}{\alpha}$

(c) $\frac{2\pi\beta}{\alpha}$

(d) $\frac{\beta^2}{\alpha^2}$

24) A particle is executing SHM along a straight line. Its velocity at distances x_1 and x_2 from the mean position are V_1 and V_2, respectively. Its time period is

(a) $2\pi\sqrt{\frac{x_2^2-x_1^2}{V_1^2-V_2^2}}$

(b) $2\pi\sqrt{\frac{V_1^2+V_2^2}{x_1^2+x_2^2}}$

(c) $2\pi\sqrt{\frac{V_1^2-V_2^2}{x_1^2-x_2^2}}$

(d) $2\pi\sqrt{\frac{x_1^2-x_2^2}{V_1^2-V_2^2}}$

25) A spring of force constant k is cut into lengths of ratio 1: 2 : 3. They are connected in series and the new force constant k'. Then they are connected in parallel and force constant is k''. Then k': k'' is

(a) 1: 9

(b) 1: 11

(c) 1: 14

(d) 1: 6

26) A particle executes linear simple harmonic motion with an amplitude of 3cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is

(a) $\frac{\sqrt{5}}{2\pi}$

(b) $\frac{4\pi}{\sqrt{5}}$

(c) $\frac{2\pi}{\sqrt{3}}$

(d) $\frac{\sqrt{5}}{\pi}$

27) A child swinging on a swing in sitting position, stands up, then the time period if the swing will

(a) increase

(b) decrease

(c) remains same

(d) increases if the child is long and decreases if the child is short

28) If a spring has time period T, and is cut into *n* equal parts then the time period of each part will be

(a) $T\sqrt{n}$

(b) $T/\sqrt{n}$

(c) nT

(d) T

29) The length of a simple pendulum executing simple harmonic motion is increased by 21%. The percentage increase in the time period of the pendulum of increased length is

(a) 11%

(b) 21%

(c) 42%

(d) 10%

30) A mass M is suspended from a spring of negligible mass. The spring is pulled a little and then released so that the mass executes SHM of time period T. If the mass is increased by m, the time period becomes $\frac{5T}{3}$. Then the ratio of $\frac{m}{M}$ is

(a) $\frac{3}{5}$

(b) $\frac{25}{9}$

(c) $\frac{16}{9}$

(d) $\frac{5}{3}$

31) A particle at the end of a spring executes S.H.M. 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) $T^{-1} = t_1^{-1} + t_2^{-1}$

(b) $T^2 = t_1^2 + t_2^2$

(c) $T = t_1 + t_2$

(d) $T^{-2} = t_1^{-2} + t_2^{-2}$

32) The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglecting frictional force of water and given that the density of the bob is $(4/3) \times 1000 kg/m^3$. Which relationship between t and t_0 is true?

(a) $t = 2t_0$

(b) $t = t_0/2$

(c) $t = t_0$

(d) $t = 4t_0$

33) If a simple harmonic motion is represented by $\frac{d^2x}{dt^2} + \alpha x = 0$, its time period is

(a) $\frac{2\pi}{\sqrt{\alpha}}$

(b) $\frac{2\pi}{\alpha}$

(c) $2\pi\sqrt{\alpha}$

(d) $2\pi\alpha$

34) The bob of a simple pendulum is a spherical hollow ball fitted with water. A plugged hole near the bottom of the oscillating bob gets suddenly unplugged. During observation, till water is coming out, the time period of oscillation would

(a) first decrease and then increase to the original value

(b) first increase and then decrease to the original value

(c) increase towards a saturation value

(d) remain unchanged

35) The displacement of an object attached to a spring and executing simple harmonic motion is given by $x = 2 \times 10^{-2} \cos \pi t$ metre. The time at which the maximum speed first occurs is

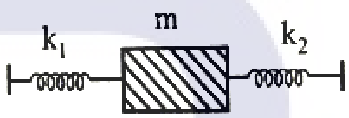
(a) 0.25s

(b) 0.5s

(c) 0.75s

(d) 0.125s

36) Two springs, of force constants k_1 and k_2 are connected to a mass m as shown. The frequency of oscillation of the mass is f. If both k_1 and k_2 are made four times their original values, the frequency of oscillation becomes



(a) $2f$

(b) $f/2$

(c) $f/4$

(d) $4f$

37) If x, v and a denote the displacement , the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time?

(a) aT/x

(b) aT/2πv

(c) aT/v

(d) $a^2T^2 + 4\pi^2v^2$

38) A wooden cube (density of wood 'd') of side 'l' floats in a liquid of density 'ρ' with its upper and lower surfaces horizontal. If the cube is pushed slightly down and released, it performs simple harmonic motion of period 'T'

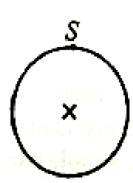
(a) $2\pi\sqrt{\frac{ld}{\rho g}}$

(b) $2\pi\sqrt{\frac{l\rho}{dg}}$

(c) $2\pi\sqrt{\frac{ld}{(\rho - d)g}}$

(d) $2\pi\sqrt{\frac{l\rho}{(\rho - d)g}}$

39) A ring is suspended from a point S on its rim as shown in the figure. When displaced from equilibrium, it oscillates with time period of 1 second. The radius of the ring is (take $g = \pi^2$)



(a) 0.15m

(b) 1.5m

(c) 1.0m

(d) 0.5m

40) If a simple pendulum has significant amplitude (up to a factor of 1/e of original) only in the period between t = 0s to t = τs, then τ may be called the average life of the pendulum suffers a retardation (due to viscous drag) proportionally to its velocity with b as the constant of proportionally, the average life time of the pendulum in second is (assuming damping is small)

(a) $\frac{0.693}{b}$

(b) b

(c) $\frac{1}{b}$

(d) $\frac{2}{b}$

41) Two simple pendulums of length 1m and 4m respectively are both given small displacement in the same direction at the same instant. They will be again in phase after the shorter pendulum has completed number of oscillations equal to:

(a) 2

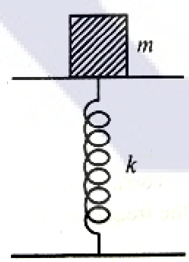
(b) 7

(c) 5

(d) 3

42) A mass *m* = 1.0kg is put on a flat pan attached to a vertical spring fixed on the ground. The mass of the spring and the pan is negligible. When pressed slightly and released, the mass executes simple harmonic motion. The spring constant is 500N/m. What is the amplitude A of motion, so that the mass m tends to get detached from the pan? (Take g = 10m/s^2).

The spring is stiff enough so that it does not get distorted during the motion.



(a) A > 2.0cm

(b) A = 2.0cm

(c) A < 2.0cm

(d) A = 1.5cm

43) An ideal gas enclosed in a vertical cylindrical container supports a freely moving piston of mass M. The piston and the cylinder have equal cross sectional area A. When the piston is in equilibrium, the volume of the gas is V_0 and its pressure is P_0. The piston is slightly displaced from the equilibrium position and released. Assuming that the system is completely isolated from its surrounding, the piston executes a simple harmonic motion with frequency

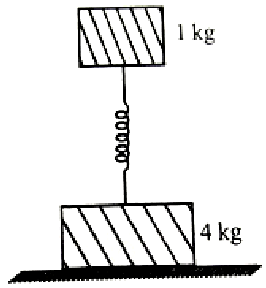
(a) $\frac{1}{2\pi}\frac{A\gamma P_0}{V_0 M}$

(b) $\frac{1}{2\pi}\frac{V_0 M P_0}{A^2\gamma}$

(c) $\frac{1}{2\pi}\sqrt{\frac{A^2\gamma P_0}{M V_0}}$

(d) $\frac{1}{2\pi}\sqrt{\frac{M V_0}{A\gamma P_0}}$

44) Two bodies of mass 1kg and 4kg are connected to a vertical spring, as shown in the figure. The smaller mass executes simple harmonic motion of angular frequency 25 rad/s, and amplitude 1.6cm while the bigger mass remains stationary on the ground. The maximum force exerted by the system on the floor is (take g = $10ms^{-2}$)



(a) 20N

(b) 10N

(c) 60N

(d) 40N

45) The amplitude of a simple pendulum, oscillating in air with a small spherical bob, decreases from 10cm to 8cm in 40 seconds. Assuming that Stokes law is valid, and ratio of the coefficient of viscosity of air to that of carbon dioxide is 1.3. The time in which amplitude of this pendulum will reduce from 10cm to 5cm in carbon dioxide will be close to (In 5 = 1.601, In 2 = 0.693).

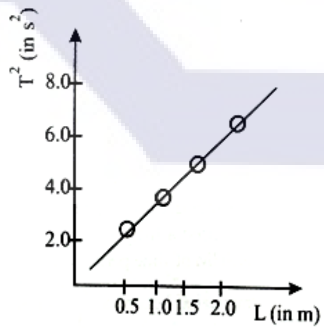
(a) 231s

(b) 208s

(c) 161s

(d) 142s

46) In an experiment for determining the gravitational acceleration g of a place with the help of a simple pendulum, the measured time period square is plotted against the string length of the pendulum in the figure.



What is the value of g at the place?

(a) $9.81m/s^2$

(b) $9.87m/s^2$

(c) $9.91m/s^2$

(d) $10.0m/s^2$

47) A particle moves with simple harmonic motion in a straight line. In first τs, after starting from rest it travels a distance a, and in next τs it travels 2a, in same direction, then:

(a) amplitude of motion is 3a

(b) time period of oscillation is 8τ

(c) amplitude of motion is 4a

(d) time period of oscillation is 6τ

48) A pendulum made of a uniform wire of cross sectional area A has time period T. When an additional mass M is added to its bob, the time period changes to T_M. If the Young's modulus of the material of the wire is Y then $\frac{1}{Y}$ is equal to: (g = *gravitational acceleration*)

(a) $\left[1-\left(\frac{T_M}{T}\right)^2\right]\frac{A}{Mg}$

(b) $\left[1-\left(\frac{T}{T_M}\right)^2\right]\frac{A}{Mg}$

(c) $\left[\left(\frac{T}{T_M}\right)^2-1\right]\frac{A}{Mg}$

(d) $\left[\left(\frac{T_M}{T}\right)^2-1\right]\frac{Mg}{A}$

49) In a engine the piston undergoes vertical simple harmonic motion with amplitude 7cm. A washer rests on top of the piston and moves with it. The motor speed is slowly increased. The frequency of the piston at which the washer no longer stays in contact with the piston, is close to:

(a) 0.7Hz

(b) 1.9Hz

(c) 1.2Hz

(d) 0.1Hz

50) A pendulum clock loses 12s a day if the temperature is 40°C and gains 4s a day if the temperature is 20°C. The temperature at which the clock will show correct time, and the co – efficient of linear expansion (α) of the metal of the pendulum shaft are respectively:

(a) 30°C; $\alpha = 1.85 \times 10^{-3}$/°C

(b) 55°C; $\alpha = 1.85 \times 10^{-2}$/°C

(c) 25°C; $\alpha = 1.85 \times 10^{-5}$/°C

(d) 60°C; $\alpha = 1.85 \times 10^{-4}$/°C

51) A 1kg block attached to a spring vibrates with a frequency of 1Hz on a frictionless horizontal table. Two springs identical to the original spring are attached in parallel to an 8kg block placed on the same table. So, the frequency of vibration of the 8kg block is:

(a) $\frac{1}{4}$ Hz

(b) $\frac{1}{2\sqrt{2}}$ Hz

(c) $\frac{1}{2}$ Hz

(d) 2 Hz

52) In a experiment to determine the period of a simple pendulum of length 1m, it is attached to different spherical bobs of radii r_1 and r_2. The two spherical bobs have uniform mass distribution. If the relative difference in the periods, is found to be 5×10^{-4}s, the difference in radii, $|r_1 - r_2|$ is best given by:

(a) 1cm

(b) 0.1cm

(c) 0.5cm

(d) 0.01cm

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
d	d	c	a	a	a	c	c	c	d
11	12	13	14	15	16	17	18	19	20
c	b	a	d	d	a	b	a	d	d
21	22	23	24	25	26	27	28	29	30
c	d	c	a	b	b	b	b	d	c
31	32	33	34	35	36	37	38	39	40
b	a	a	b	b	a	a	a	a	d
41	42	43	44	45	46	47	48	49	50
a	c	c	c	d	b	d	c	b	c
51	52								
c	b								

Topic 48: Damped SHM, Forced Oscillations & Resonance

1) A particle, with restoring force proportional to displacement and resistive force proportional to velocity is subjected to a force F sin ω_0. If the amplitude of the particle is maximum for $\omega = \omega_1$ and the energy of the particle is maximum for $\omega = \omega_2$, then

(a) $\omega_1 = \omega_0$ and $\omega_2 \neq \omega_0$

(b) $\omega_1 = \omega_0$ and $\omega_2 = \omega_0$

(c) $\omega_1 \neq \omega_0$ and $\omega_2 = \omega_0$

(d) $\omega_1 \neq \omega_0$ and $\omega_2 \neq \omega_0$

2) Resonance is an example of

(a) tuning fork

(b) forced vibration

(c) free vibration

(d) damped vibration

3) In case of a forced vibration, the resonance wave becomes very sharp when the

(a) quality factor is small

(b) damping force is small

(c) resorting force is small

(d) applied periodic force is small

4) The damping force on an oscillator is directly proportional to the velocity. The unit of the constant of proportionality is:

(a) $kgms^{-1}$

(b) $kgms^{-2}$

(c) kgs^{-1}

(d) kgs

5) A particle of mass m is attached to a spring (of spring constant k) and has a natural angular frequency ω_0. An external F(t) proportional to cos ωt ($\omega \neq \omega_0$) is applied to the oscillator. The displacement of the oscillator will be proportional to

(a) $\frac{1}{m(\omega_0^2+\omega^2)}$

(b) $\frac{1}{m(\omega_0^2-\omega^2)}$

(c) $\frac{m}{\omega_0^2-\omega^2}$

(d) $\frac{m}{(\omega_0^2+\omega^2)}$

6) In forced oscillation of a particle the amplitude is maximum for a frequency ω_1 of the force while the energy is maximum for a frequency ω_2 of the force; then

(a) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large

(b) $\omega_1 > \omega_2$

(c) $\omega_1 = \omega_2$

(d) $\omega_1 < \omega_2$

7) Bob of a simple pendulum of length l is made of iron. The pendulum is oscillating over a horizontal coil carrying direct current. If the time period of the pendulum is T then:

(a) $T < 2\pi\sqrt{\frac{l}{g}}$ and damping is smaller than in air alone.

(b) $T = 2\pi\sqrt{\frac{l}{g}}$ and damping is larger than in air alone.

(c) $T > 2\pi\sqrt{\frac{l}{g}}$ and damping is smaller than in air alone.

(d) $T < 2\pi\sqrt{\frac{l}{g}}$ and damping is larger than in air alone.

8) A uniform cylinder of length L and mass M having cross – sectional area A is suspended, with its length vertical, from a fixed point by a massless spring, such that it is half submerged in a liquid of density σ at equilibrium position. When the cylinder is given a downward push and released, it starts oscillating vertically with a small amplitude. The time period T of the oscillations of the cylinder will be:

(a) Smaller than $2\pi\left[\frac{M}{(k+A\sigma g)}\right]^{1/2}$

(b) $2\pi\sqrt{\frac{M}{k}}$

(c) Larger than $2\pi\left[\frac{M}{(k+A\sigma g)}\right]^{1/2}$

(d) $2\pi\left[\frac{M}{(k+A\sigma g)}\right]^{1/2}$

9) The amplitude of a damped oscillator decreases to 0.9 times its original magnitude in 5s. In another 10s it will decrease to α times its original magnitude, where α equals

(a) 0.7

(b) 0.81

(c) 0.729

(d) 0.6

10) The angular frequency of the damped oscillator is given by, $\omega = \sqrt{\left(\frac{k}{m} - \frac{r^2}{4m^2}\right)}$ where k is the spring constant, m is the mass of the oscillator and r is the damping constant. If the ratio $\frac{r^2}{mk}$ is 8%, the change in time period compared to the undamped oscillator is approximately as follows:

(a) increases by 1%

(b) increases by 8%

(c) decreases by 1%

(d) decreases by 8%

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	b	b	c	b	c	d	a	c	b

Topic 49: Basic of Mechanical Waves, Progressive & Stationary Waves

1) The velocity of sound in any gas depends upon

(a) wavelength of sound only
(b) density and elasticity of gas
(c) intensity of sound waves only
(d) amplitude and frequency of sound

2) Equation of a progressive wave is given by

$$y = 4\sin\left[\pi\left(\frac{t}{5} - \frac{x}{9}\right) + \frac{\pi}{6}\right]$$

Then which of the following is correct?

(a) v = 5cm
(b) λ = 18cm
(c) a = 0.04cm
(d) f = 50Hz

3) When sound waves travel from air to water, which of the following remains constant?

(a) Velocity
(b) Wavelength
(c) Frequency
(d) All of the above

4) The transverse wave represented by the equation $y = 4\sin\left(\frac{\pi}{6}\right)\sin(3x - 15t)$ has

(a) amplitude = 4
(b) wavelength = $4\frac{\pi}{3}$
(c) speed of propagation = 5
(d) period = $\frac{\pi}{15}$

5) Velocity of sound waves in air is 330m/s. For a particular sound wave in air, a path difference of 40cm is equivalent to phase difference of 1.6π. The frequency of this wave is

(a) 165Hz
(b) 150Hz
(c) 660Hz
(d) 330Hz

6) The frequency of sinusoidal wave n = 0.40 cos [2000t + 0.80] would be

(a) 1000 π Hz
(b) 2000 Hz
(c) 20 Hz
(d) $\frac{1000}{\pi}$ Hz

7) With the propagation of a longitudinal wave through a material medium, the quantities transmitted in the propagation direction are

(a) Energy, momentum and mass
(b) Energy
(c) Energy and mass
(d) Energy and linear momentum

8) The temperature at which the speed of sound becomes double as was at 27°C is

(a) 273°C (b) 0°C

(c) 927°C (d) 1027°C

9) A wave of frequency 100Hz is sent along a string towards a fixed end. When this wave travels back after reflection, a node is formed at a distance of 10cm from the fixed end of the string. The speeds of incident (and reflected) waves are

(a) 5 m/s (b) 10 m/s

(c) 20 m/s (d) 40 m/s

10) Which of the following equations represent a wave?

(a) $y = A \sin \omega t$ (b) $y = A \cos kx$

(c) $y = A \sin (at - bx + c)$ (d) $y = A (\omega t - kx)$

11) A standing wave is represented by $y = A \sin (100t) \cos (0.01x)$, where y and A in millimeter, t in seconds and x in the meter. Velocity of wave is

(a) 10^4 m/s (b) 1 m/s

(c) 10^{-4} m/s (d) not derivable from above data

12) A hospital uses an ultrasonic scanner to locate tumours in a tissue. The operating frequency of the scanner is 4.2 MHz. The speed of sound in a tissue is 1.7km/s. The wavelength of sound in tissue is close to

(a) 4×10^{-4} m (b) 8×10^{-4} m

(c) 4×10^{-3} m (d) 8×10^{-3} m

13) The speed of a wave in a medium is 760m/s. If 3600 waves are passing through a point in the medium in 2 min, then their wavelength is

(a) 13.8 m (b) 25.3 m

(c) 41.5 m (d) 57.2 m

14) Two waves are approaching each other with a velocity of 20m/s and frequency n. The distance between two consecutive nodes is

(a) $\frac{20}{n}$ (b) $\frac{10}{n}$

(c) $\frac{5}{n}$ (d) $\frac{n}{10}$

15) From a wave equation: $y = 0.5\sin \frac{2\pi}{3.2} (64t - x)$, the frequency of the wave is

(a) 5Hz (b) 15Hz

(c) 20Hz (d) 25Hz

16) The equation of a sound wave is given as: $y = 0.0015\sin(62.4x + 316t)$. The wavelength of this wave is

(a) 0.4 unit (b) 0.3 unit

(c) 0.2 unit (d) 0.1 unit

17) What is the effect of humidity on sound waves when humidity increases?

(a) speed of sound waves is more (b) speed of sound waves is less

(c) speed of sound waves remains same (d) speed of sound waves becomes zero

18) Two sound waves having a phase difference of 60° have path difference of

(a) 2λ (b) $\frac{\lambda}{2}$

(c) $\frac{\lambda}{3}$ (d) $\frac{\lambda}{6}$

19) The equation of a travelling wave is

$$y = 60\cos(180t - 6x)$$

where y is in microns, t in second and x in metres. The ratio of maximum particle velocity to velocity of wave propagation is

(a) 3.6 (b) 3.6×10^{-4}

(c) 3.6×10^{-6} (d) 3.6×10^{-11}

20) The speed of a wave in a medium is 960 m/s. If 3600 waves are passing through a point in the medium in 1 min., then the wavelength of the wave is

(a) 8m (b) 12m

(c) 16m (d) 20m

21) In a sinusoidal wave, the time required for a particular point to move from maximum displacement to zero displacement is 0.170 sec. The frequency of the wave is

(a) 1.47 Hz (b) 0.36 Hz

(c) 0.73 Hz (d) 2.94 Hz

22) A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21Å between them. The wavelength of the standing wave is

(a) 1.21Å (b) 2.42Å

(c) 6.05Å (d) 3.63Å

23) A transverse wave is represented by the equation $y = y_0 \sin\frac{2\pi}{\lambda}(vt - x)$

For what value of λ is the maximum particle velocity equal to two times the wave velocity?

(a) $\lambda = 2\pi y_0$

(b) $\lambda = \frac{\pi y_0}{3}$

(c) $\lambda = \frac{\pi y_0}{2}$

(d) $\lambda = \pi y_0$

24) The equation of a wave is represented by: $y = 10^{-4} \sin\left[100t - \frac{x}{10}\right]$. The velocity of the wave will be

(a) 100 m/s

(b) 250 m/s

(c) 750 m/s

(d) 1000 m/s

25) The equation for a transverse wave travelling along the positive x – axis with amplitude 0.2m, velocity $v = 360 ms^{-1}$ and wavelength $\lambda = 60$ m can be written as

(a) $y = 0.2 \sin\left[2\pi\left(6t - \frac{x}{60}\right)\right]$

(b) $y = 0.2 \sin\left[\pi\left(6t + \frac{x}{60}\right)\right]$

(c) $y = 0.2 \sin\left[\pi\left(6t - \frac{x}{60}\right)\right]$

(d) $y = 0.2 \sin\left[2\pi\left(6t + \frac{x}{60}\right)\right]$

26) The phase difference between two waves, represented by

$y_1 = 10^{-6}\sin\{100t + (x/50) + 0.5\}$ m

$y_2 = 10^{-6}\cos\{100t + (x/50)\}$ m

where x is expressed in metres and t is expressed in seconds, is approximately

(a) 1.5 radians

(b) 1.07 radians

(c) 2.07 radians

(d) 0.5 radians

27) A point source emits sound equally in all directions in a non – absorbing medium. Two points P and Q are at distances of 2m and 3m respectively from source. The ratio of the intensities of the waves at P and Q is

(a) 3 : 2

(b) 2 : 3

(c) 9 : 4

(d) 4 : 9

28) The time of reverberation of a room A is one second. What will be the time (in seconds) of reverberation of a room, having all the dimensions double of these of room A?

(a) 4

(b) $\frac{1}{2}$

(c) 1

(d) 2

29) A transverse wave propagating along x – axis is represented by $y(x, t) = 8.0 \sin\left(0.5\pi x - 4\pi t - \frac{\pi}{4}\right)$ where x is in metres and t is in seconds. The speed of the wave is

(a) $0.5\ \pi$m/s

(b) $\frac{\pi}{4}$ m/s

(c) 8 m/s

(d) $4\ \pi$m/s

30) Which one of the following statements is true?

(a) The sound waves in air are longitudinal while the light waves are transverse

(b) Both light and sound waves in air are longitudinal

(c) Both light and sound wave can travel in vacuum

(d) Both light sound waves in air are transverse

31) The wave described by $y = 0.25 \sin(10\pi x - 2\pi t)$, where x and y are in metres and t in seconds, is a wave travelling along the:

(a) – ve x direction with frequency 1Hz.

(b) +ve x direction with frequency π Hz and wavelength $\lambda = 0.2$m

(c) +ve x direction with frequency 1Hz and wavelength $\lambda = 0.2$m

(d) – ve x direction with amplitude 0.25m and wavelength $\lambda = 0.2$m

32) A wave in a string has an amplitude of 2cm. The wave travels in the +ve direction of x axis with a speed of 128m/sec and it is noted that 5 complete waves fit in 4m length of the string. The equation describing the wave is

(a) $y = (0.02)\text{m} \sin(15.7x - 2010t)$

(b) $y = (0.02)\text{m} \sin(15.7x + 2010t)$

(c) $y = (0.02)\text{m} \sin(7.85x - 1005t)$

(d) $y = (0.02)\text{m} \sin(7.85x + 1005t)$

33) A transverse wave is represented by $y = A \sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity?

(a) $\frac{\pi A}{2}$

(b) πA

(c) $2\pi A$

(d) A

34) Sound waves travel at 350m/s through a warm air and at 3500 m/s through brass. The wavelength of a 700Hz acoustic wave as it enters brass from warm air

(a) decreases by a factor 10

(b) increases by a factor 20

(c) increases by a factor 10

(d) decreases by a factor 20

35) Two waves are represented by the equations $y_1 = a \sin(\omega t + kx + 0.57)$m and $y_2 = a \cos(\omega t + kx)$m, where x is in meter and t in sec. The phase difference between them is

(a) 1.0 radian

(b) 1.25 radian

(c) 1.57 radian

(d) 0.57 radian

36) A wavelength in the +ve x – direction having displacement along y – direction as 1m, wavelength 2πm and frequency $\frac{1}{\pi}$ Hz is represented by

(a) $y = \sin(2\pi x - 2\pi t)$

(b) $y = \sin(10\pi x - 20\pi t)$

(c) $y = \sin(2\pi x + 2\pi t)$

(d) $y = \sin(x - 2t)$

37) When temperature increases, the frequency of a tuning fork

(a) increases

(b) decreases

(c) remains same

(d) increases or decreases depending on the material

38) The displacement y of a wave travelling in the x – direction is given by y = $10^{-4}\sin\left(600 - 2x + \frac{\pi}{3}\right)$ metres where x is expressed in meters and t in seconds. The speed of the wave – motion, in ms^{-1}, is

(a) 300
(b) 600
(c) 1200
(d) 200

39) The displacement y of a particle in a medium can be expressed as, y = $10^{-6}\sin\left(100t + 20x + \frac{\pi}{4}\right)$ m where t is in second and x in meter. The speed of the wave is

(a) 20m/s
(b) 5m/s
(c) 2000m/s
(d) 5πm/s

40) A sound absorber attenuates the sound level by 20dB. The intensity decreases by a factor of

(a) 100
(b) 1000
(c) 10000
(d) 10

41) A wave travelling along the x – axis is described by the equation y(x, t) = 0.005 cos (αx – βt). If the wavelength and the time period of the wave are 0.08m and 2.0s, respectively, then α and β in appropriate units are

(a) α = 25.00π, β = π
(b) $\alpha = \frac{0.08}{\pi}$, $\beta = \frac{2.0}{\pi}$
(c) $\alpha = \frac{0.04}{\pi}$, $\beta = \frac{1.0}{\pi}$
(d) α = 12.50π, $\beta = \frac{\pi}{2.0}$

42) The transverse displacement y(x, t) of a wave is given by y(x, t) = $e^{-\left((ax^2+bt^2+2\sqrt{ab})xt\right)}$

This represents a:

(a) wave moving in – x direction with speed $\sqrt{\frac{b}{a}}$

(b) standing wave of frequency $\sqrt{b}$

(c) standing wave of frequency $\frac{1}{\sqrt{b}}$

(d) wave moving in +x direction with speed $\sqrt{\frac{a}{b}}$

43) The disturbance y(x, t) of a wave propagating in the positive x – direction is given by $y = \frac{1}{1+x^2}$ at time t = 0 and by $y = \frac{1}{[1+(x-1)^2]}$ at t = 2s, where x and y are in meters. The shape of the wave disturbance does not change during the propagation. The velocity of wave in m/s is

(a) 2.0
(b) 4.0
(c) 0.5
(d) 1.0

44) When two sound waves travel in the same direction in a medium, the displacements of a particle located at 'x' at time 't' is given by:

$y_1 = 0.05\cos(0.50\pi x - 100\pi t)$

$y_2 = 0.05\cos(0.46\pi x - 92\pi t)$

where y_1, y_2 and x are in meters and t in seconds. The speed of sound in the medium is:

(a) 92m/s
(b) 200m/s
(c) 100m/s
(d) 332m/s

45) In a transverse wave the distance between a crest and neighbouring trough at the same instant is 4.0cm and the distance between a crest and trough at the same place is 1.0cm. The next crest appears at the same place after a time interval of 0.4s. The maximum speed of the vibrating particles in the medium is:

(a) $\frac{3\pi}{2}$ cm/s
(b) $\frac{5\pi}{2}$ cm/s
(c) $\frac{\pi}{2}$ cm/s
(d) 2π cm/s

46) A transverse wave is represented by

$$y = \frac{10}{\pi}\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right)$$

For what value of the wavelength the wave velocity is twice the maximum particle velocity?

(a) 40cm
(b) 20cm
(c) 10cm
(d) 60cm

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
b	b	c	c	c	d	b	c	c	c
11	12	13	14	15	16	17	18	19	20
a	a	b	b	c	d	a	d	b	c
21	22	23	24	25	26	27	28	29	30
a	a	d	d	a	b	c	d	c	a
31	32	33	34	35	36	37	38	39	40
c	c	c	c	a	d	b	a	b	a
41	42	43	44	45	46				
a	a	c	b	b	a				

Topic 50: Vibration of String & Organ Pipe

1) A closed organ pipe (closed at one end) is excited to support the third overtone. It is found that air in the pipe has

(a) three nodes and three antinodes
(b) three nodes and four antinodes
(c) four nodes and three antinodes
(d) four nodes and four antinodes

2) A stretched string resonates with tuning fork frequency 512 Hz when length of the string is 0.5m. The length of the string required to vibrate resonantly with a tuning fork of frequency 256 Hz would be

(a) 0.25m
(b) 0.5m
(c) 1m
(d) 2m

3) 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

(a) 2f
(b) 3f/2
(c) f
(d) f/2

4) An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2, open at both ends vibrating in its third overtone are in resonance with a given tuning fork. The ratio of lengths of P_1 and P_2 respectively are given by

(a) 1 : 2
(b) 1 : 3
(c) 3 : 8
(d) 3 : 4

5) A string of 7m length has a mass of 0.035kg. If tension in the string is 60.5 N, then speed of a wave on the string is

(a) 77 m/s
(b) 102 m/s
(c) 110 m/s
(d) 165 m/s

6) Each of the two strings of length 51.6 cm and 49.1cm are tensioned separated by 20N force. Mass per unit length of both the strings is same and equal to 1 g/m. When both the strings vibrate simultaneously the number of beats is

(a) 7
(b) 8
(c) 3
(d) 5

7) The length of the wire between two ends of a sonometer is 100cm. What should be the positions of two bridges below the wire so that the three segments of the wire have their fundamental frequencies in the ratio of 1 : 3 : 5?

(a) $\frac{1500}{23}$ cm, $\frac{2000}{23}$ cm
(b) $\frac{1500}{23}$ cm, $\frac{500}{23}$ cm
(c) $\frac{1500}{23}$ cm, $\frac{300}{23}$ cm
(d) $\frac{300}{23}$ cm, $\frac{1500}{23}$ cm

8) If we study the vibration of a pipe open at both ends, then which of the following statements is not true?

(a) Odd harmonics of the fundamental frequency will be generated

(b) All harmonics of the fundamental frequency will be generated

(c) Pressure change will be maximum at both ends

(d) Antinode will be at open end

9) The number of possible natural oscillation of air column in a pipe closed at one end of length 85cm whose frequencies lie below 1250Hz are: (velocity of sound = 340 ms^{-1})

(a) 4 (b) 5

(c) 7 (d) 6

10) 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 is given by:

(a) $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$ (b) $\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{n_1}} + \frac{1}{\sqrt{n_2}} + \frac{1}{\sqrt{n_3}}$

(c) $\sqrt{n} = \sqrt{n_1} + \sqrt{n_2} + \sqrt{n_3}$ (d) $n = n_1 + n_2 + n_3$

11) A string is stretched between two fixed points separated by 75.0cm. It is observed to have resonant frequencies of 420Hz and 315Hz. There are no other resonant frequencies between these two. The lowest resonant frequency for this string is:

(a) 205Hz (b) 10.5Hz

(c) 105Hz (d) 155Hz

12) The fundamental frequency of a closed organ pipe of 20cm is equal to the second overtone of an organ pipe open at both ends. The length of organ pipe open at both the ends is

(a) 100cm (b) 120cm

(c) 140cm (d) 80cm

13) A uniform rope of length L and mass m_1 hangs vertically from a rigid support. A block of mass m_2 is attached to the free end of the rope. A transverse pulse of wavelength λ_1 is produced at the lower end of the rope. The wavelength of the pulse when it reaches the top of the rope is λ_2 the ratio λ_2 / λ_1 is

(a) $\sqrt{\frac{m_1}{m_2}}$ (b) $\sqrt{\frac{m_1+m_2}{m_2}}$

(c) $\sqrt{\frac{m_2}{m_1}}$ (d) $\sqrt{\frac{m_1+m_2}{m_1}}$

14) An air column, closed at one end and open at the other, resonates with a tuning fork when the smallest length of the column is 50cm. The next larger length of the column resonating with the same tuning fork is:

(a) 66.7cm (b) 100cm

(c) 150cm (d) 200cm

15) The two nearest harmonics of a tube closed at one end and open at other end are 220 Hz and 260 Hz. What is the fundamental frequency of the system?

(a) 20 Hz (b) 30 Hz

(c) 40 Hz (d) 10 Hz

16) A wave y = a sin(ωt – kx) on a string meets with another wave producing a node at x = 0. Then the equation of the unknown wave is

(a) y = a sin(ωt + kx) (b) y = −a sin(ωt + kx)

(c) y = a sin(ωt – kx) (d) y = −a sin(ωt −kx)

17) Tube A has both ends open while tube B has one end closed, otherwise they are identical. The ratio of fundamental frequency of tube A and B is

(a) 1 : 2 (b) 1 : 4

(c) 2 : 1 (d) 4 : 1

18) A string is stretched between fixed points separated by 75.0cm. It is observed to have resonant frequencies of 420Hz and 315Hz. There are no other resonant frequencies between these two. Then, the lowest resonant frequency for this string is

(a) 105Hz (b) 1.05Hz

(c) 1050Hz (d) 10.5Hz

19) While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18cm during winter. Repeating the same experiment during summer, she measures the column length to be x cm for the second resonance. Then

(a) 18 > x (b) x > 54

(c) 54 > x > 36 (d) 36 > x > 18

20) The equation of a wave on a string of linear mass density 0.04kgm^{-1} is given by

$$y = 0.02(\text{m}) \sin\left[2\pi\left(\frac{t}{0.04(\text{s})} - \frac{x}{0.50(\text{m})}\right)\right]$$

The tension in the string is

(a) 4.0N (b) 12.5N

(c) 0.5N (d) 6.25N

21) A uniform tube of length 60.5cm is held vertically with its lower end dipped in water. A sound source of frequency 500Hz sends waves into the tube. When the length of tube above water is 16cm and again when it is 50cm, the tube resonates with the source of sound. Two lowest frequencies (in Hz), to which tube will resonate when it is taken out of water, are (approximately).

(a) 281, 562 (b) 281, 843

(c) 276, 552 (d) 272, 544

22) An air column in a pipe, which is closed at one end, will be in resonance with a vibrating tuning fork of frequency 264Hz if the length of the column in cm is (velocity of sound = 330m/s)

(a) 125.00 (b) 93.75

(c) 62.50 (d) 187.50

23) A cylindrical tube, open at both ends, has a fundamental frequency f in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air – column is now:

(a) f (b) $f/2$

(c) $3f/4$ (d) $2f$

24) A sonometer wire of length 114cm is fixed at both the ends. Where should the two bridges be placed so as to divide the wire into three segments whose fundamental frequencies are in the ratio 1 : 3 : 4?

(a) At 36cm and 84cm from one end (b) At 24cm and 72cm from one end

(c) At 48cm and 96cm from one end (d) At 72cm and 96cm from one end

25) A sonometer wire of length 1.5m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are $7.7 \times 10^3 kg/m^3$ and $2.2 \times 10^{11} N/m^2$ respectively?

(a) 188.5Hz (b) 178.2Hz

(c) 200.5Hz (d) 770Hz

26) The total length of a sonometer wire between fixed ends is 110 cm. Two bridges are placed to divide the length of wire of ratio 6 : 3 : 2. The tension in the wire is 400N and the mass per unit length is 0.01kg/m. What is the minimum common frequency with which three parts can vibrate?

(a) 1100Hz (b) 1000Hz

(c) 166Hz (d) 100Hz

27) A pipe of length 85cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250Hz. The velocity of sound in air 340m/s.

(a) 12 (b) 8

(c) 6 (d) 4

28) A pipe open at both ends has a fundamental frequency f in air. The pipe is dipped vertically in water so that half of it is in water. The fundamental frequency of the air column is now:

(a) 2f (b) f

(c) $\frac{f}{2}$ (d) $\frac{3f}{4}$

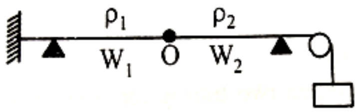
29) A uniform string of length 20m is suspended from a rigid support. A short wave pulse is introduced at its lowest end. It starts moving up the string. The time taken to reach the supports is: (take $g = 10ms^{-2}$)

(a) $2\sqrt{2}s$ (b) $\sqrt{2}s$

(c) $2\pi\sqrt{2}s$

(d) 2s

30) Two wires W_1 and W_2 have the same radius r and respective densities ρ_1 and ρ_2 such that $\rho_2 = 4\rho_1$. They are joined together at the point O, as shown in the figure. The combination is used as a sonometer wire and kept under tension T. The point O is midway between the two bridges. When a stationary waves is set up in the composite wire, the joint is found to be a node. The ratio of the number of antinodes formed in W_1 to W_2 is:



(a) 1 : 1

(b) 1 : 2

(c) 1 : 3

(d) 4 : 1

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
d	d	c	c	c	a	a	c	d	a
11	12	13	14	15	16	17	18	19	20
c	b	b	c	a	b	c	a	b	d
21	22	23	24	25	26	27	28	29	30
d	b	a	d	b	b	c	b	a	b

Topic 51: Beats, Interference & Superposition of Waves

1) If the amplitude of sound is doubled and the frequency is reduced to one fourth, the intensity of sound at the same point will be

(a) increasing by a factor of 2

(b) decreasing by a factor of 2

(c) decreasing by a factor of 4

(d) unchanged

2) A wave has S.H.M whose period is 4 seconds while another wave which also possess SHM has its period 3 seconds. If both are combined, then the resultant wave will have the period equal to

(a) 4 seconds

(b) 5 seconds

(c) 12 seconds

(d) 3 seconds

3) For production of beats the two sources must have

(a) different frequencies and same amplitude

(b) different frequencies

(c) different frequencies, same amplitude and same phase

(d) different frequencies and same phase

4) A source of sound gives 5 beats per second, when sounded with another source of frequency 100/sec. The second harmonic of the source, together with a source of frequency 205/sec gives 5 beats per second. What is the frequency of the source?

(a) 95 sec^{-1}

(b) 100 sec^{-1}

(c) 105 sec^{-1}

(d) 205 sec^{-1}

5) Two waves of the same frequency and intensity superimpose each other in opposite phases. After the superposition, the intensity and frequency of waves will

(a) increase

(b) decrease

(c) remain constant

(d) become zero

6) Two waves of lengths 50cm and 51cm produce 12 beats per sec. The velocity of sound is

(a) 306 m/s

(b) 331 m/s

(c) 340 m/s

(d) 360 m/s

7) Two sound sources emitting sound each of wavelength λ are fixed at a given distance apart. A listener moves with a velocity u along the line joining the two sources. The number of beats heard by him per second is

(a) $\frac{u}{2\lambda}$

(b) $\frac{2u}{\lambda}$

(c) $\frac{u}{\lambda}$

(d) $\frac{u}{3\lambda}$

8) Two vibrating tuning forks produce progressive waves given by $y_1 = 4 \sin 500 \pi t$ and $y_2 = 2 \sin 506 \pi t$. Number of beats produced per minute is

(a) 360

(b) 180

(c) 60

(d) 3

9) Two sound waves with wavelengths 5.0m and 5.5m respectively, each propagate in a gas with velocity 330m/s. We expect the following number of beats per second

(a) 0

(b) 1

(c) 6

(d) 12

10) A tuning fork of frequency 512 Hz makes 4 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per sec when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was

(a) 510 Hz

(b) 514 Hz

(c) 516 Hz

(d) 508 Hz

11) Two identical piano wires kept under the same tension T have a fundamental frequency of 600 Hz. The fractional increase in the tension of one of the wires which will lead to occurrence of 6 beats/s when both the wires oscillate together would be

(a) 0.02

(b) 0.03

(c) 0.04

(d) 0.01

12) Two sources of sound placed close to each other are emitting progressive wave given by $y_1 = 4 \sin 600 \pi t$ and $y_2 = 5 \sin 608 \pi t$. An observer located near these two sources of sound will hear:

(a) 4 beats per second with intensity ratio 25 : 16 between waxing and waning

(b) 8 beats per second with intensity ratio 25 : 16 between waxing and waning

(c) 8 beats per second with intensity ratio 81 : 1 between waxing and waning

(d) 4 beats per second with intensity ratio 81 : 1 between waxing and waning

13) Two sources P and Q produce notes of frequency 660Hz each. A listener moves from P to Q with a speed of 1 ms^{-1}. If the speed of sound is 330 m/s, then the number of beats heard by the listener per second will be

(a) zero

(b) 4

(c) 8

(d) 2

14) A source of unknown frequency gives 4 beats/s, when sounded with a source of known frequency 250Hz. The second harmonic of the source of unknown frequency gives five beats per second, when sounded with a source of frequency 513Hz. The unknown frequency is

(a) 246 Hz

(b) 240 Hz

(c) 260 Hz

(d) 254 Hz

15) A tuning fork arrangement (pair) produces 4 beats/sec with one fork of frequency 288cps. A little wax is placed on the unknown fork and it then produces 2 beats/sec. The frequency of the unknown fork is

(a) 286cps

(b) 292cps

(c) 294cps

(d) 288cps

16) A tuning fork of known frequency 256Hz makes 5 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per second when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was

(a) (256 + 2)Hz

(b) (256 – 2)Hz

(c) (256 – 5)Hz

(d) (256 + 5)Hz

17) When two tuning forks (fork 1 and fork 2) are sounded simultaneously, 4 beats per second are heard. Now, some tape is attached on the prong of the fork 2. When the tuning forks are sounded again, 6 beats per second are heard. If the frequency of fork 1 is 200Hz, then what was the original frequency of fork 2?

(a) 202Hz

(b) 200Hz

(c) 204Hz

(d) 196Hz

18) Three sound waves of equal amplitude have frequencies (v – 1), v, (v + 1). They superpose to give beats. The number of beats produced per second will be:

(a) 3

(b) 2

(c) 1

(d) 4

19) **Statement – 1:** Two longitudinal waves given by equations:

$y_1(x, t) = 2a \sin(\omega t - kx)$ and $y_2(x, t) = a \sin(2\omega t - 2kx)$ will have equal intensity.

Statement – 2: Intensity of waves of given frequency in same medium is proportional to square of amplitude only.

(a) Statement – 1 is true, statement – 2 is false.

(b) Statement – 1 is true, statement – 2 is true, statement – 2 is the correct explanation of statement – 1

(c) Statement – 1 is true, statement – 2 is true, statement – 2 is not the correct explanation of statement – 1

(d) Statement – 1 is false, statement – 2 is true.

20) 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 result is

(a) A wave travelling along +x direction

(b) A wave travelling along −x direction

(c) A standing wave having nodes at

$x = \frac{n\lambda}{2}$, n = 0, 1, 2…..

(d) A standing wave having nodes at

$$x = \left(n + \frac{1}{2}\right)\frac{\lambda}{2},\ n = 0, 1, 2.....$$

21) Following are expressions for four plane simple harmonic waves

(i) $y_1 = A \cos 2\pi\left(n_1 t + \frac{x}{\lambda_1}\right)$

(ii) $y_2 = A \cos 2\pi\left(n_1 t + \frac{x}{\lambda_1} + \pi\right)$

(iii) $y_3 = A \cos 2\pi\left(n_2 t + \frac{x}{\lambda_2}\right)$

(iv) $y_4 = A \cos 2\pi\left(n_2 t + \frac{x}{\lambda_2}\right)$

The pairs of waves which will produce destructive interference and stationary waves respectively in a medium, are

(a) (iii, iv), (i, ii)

(b) (i, iii), (ii, iv)

(c) (i, iv), (ii, iii)

(d) (i, ii), (iii, iv)

22) A wave represented by the equation $y_1 = a \cos (kx - \omega t)$ is superimposed with another wave to form a stationary wave such that the point x – 0 is node. The equation for the other wave is

(a) $a \cos (kx - \omega t + \pi)$

(b) $a \cos (kx + \omega t + \pi)$

(c) $a \cos (kx + \omega t + \frac{\pi}{2})$

(d) $a \cos (kx - \omega t + \frac{\pi}{2})$

23) A standing wave is formed by the superposition of two waves travelling in opposite directions. The transverse displacement is given by

$$y(x, t) = 0.5\sin\left(\frac{5\pi}{4}x\right)\cos(200\pi t)$$

What is the speed of the travelling wave moving in the positive x direction?

(x and t are in meter and second, respectively.)

(a) 160m/s

(b) 90m/s

(c) 180m/s

(d) 120m/s

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	c	b	c	c	a	b	b	c	d
11	12	13	14	15	16	17	18	19	20
a	d	b	d	b	c	d	b	a	d
21	22	23							
d	b	a							

Topic 52: Musical Sound & Doppler's Effect

1) Two trains move towards each other with the same speed. The speed of sound is 340m/s. If the height of the tone of the whistle of one of them heard on the other changes 9/8 times, then the speed of each train should be

(a) 20 m/s

(b) 2 m/s

(c) 200 m/s

(d) 2000 m/s

2) A star, which is emitting radiation at a wavelength of 5000Å, is approaching the earth with velocity of 1.50×10^6m/s. The change in wavelength of the radiation as received on the earth is

(a) 0.25 Å

(b) 2.5 Å

(c) 25 Å

(d) 250 Å

3) A vehicle, with a horn of frequency n is moving with a velocity of 30m/s in a direction perpendicular to the straight line joining the observer and the vehicle. The observer perceives the sound to have a frequency $n + n_1$. Then (if the sound velocity in air is 300m/s)

(a) $n_1 = 10n$

(b) $n_1 = 0$

(c) $n_1 = 0.1n$

(d) $n_1 = -0.1n$

4) A source and an observer move away from each other, with a velocity of 10m/s with respect to ground. If the observer finds the frequency of sound coming from the source as 1950 Hz, then original frequency of source is (velocity of sound in air = 340m/s)

(a) 1950 Hz

(b) 2068 Hz

(c) 2132 Hz

(d) 2486 Hz

5) A whistle of frequency 385 Hz rotates in a horizontal circle of radius 50cm at an angular speed of 20 radians s^{-1}. The lowest frequency heard by a listener a long distance away at rest with respect to the centre of the circle, given velocity of sound equal to $340ms^{-1}$, is

(a) 396 Hz

(b) 363 Hz

(c) 374 Hz

(d) 385 Hz

6) An observer moves towards a stationary source of sound with a speed $1/5^{th}$ of the speed of sound. The wavelength and frequency of the sound emitted are λ and f respectively. The apparent frequency and wavelength recorded by the observer are respectively.

(a) 0.8f, 0.8λ

(b) 1.2f, 1.2λ

(c) 1.2f, λ

(d) f, 1.2λ

7) A car is moving towards a high cliff. The car driver sounds a horn of frequency f. The reflected sound heard by the driver has frequency 2f. If v be the velocity of sound, then the velocity of the car, in the same velocity units, will be

(a) v/2
(b) v/$\sqrt{2}$

(c) v/3
(d) v/4

8) The driver of a car travelling with speed 30m/sec towards a hill sounds a horn of frequency 600Hz. If the velocity of sound in air is 330m/s, the frequency of reflected sound as heard by driver is

(a) 555.5Hz
(b) 720Hz

(c) 500Hz
(d) 550Hz

9) A train moving a speed of 220ms^{-1} towards a stationary object, emits a sound of frequency 1000Hz. Some of the sound reaching the object gets reflected back to the train as echo. The frequency of the echo as detected by the driver of the train is: (speed of sound in air is 330ms^{-1})

(a) 3500Hz
(b) 4000Hz

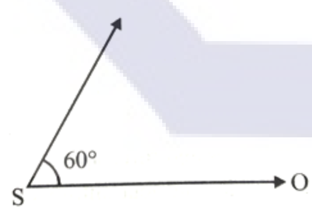
(c) 5000Hz
(d) 3000Hz

10) A speeding motor cyclist sees traffic jam ahead of him. He slows down to 36km/hour. He finds that traffic has eased and a car moving ahead of him at 18km/hour is honking at a frequency of 1392Hz. If the speed of sound is 343 m/s, the frequency of the honk as heard by him will be:

(a) 1332Hz
(b) 1372Hz

(c) 1412Hz
(d) 1464Hz

11) A source of sound S emitting waves of frequency 100Hz and an observer O are located at some distance from each other. The source is moving with a speed of 19.4 ms^{-1} at an angle of 60° with the source observer line as shown in the figure. The observer is at rest. The apparent frequency observed by the observer is (velocity of sound in air 330ms^{-1})



(a) 103Hz
(b) 106Hz

(c) 97Hz
(d) 100Hz

12) A siren emitting a sound of frequency 800Hz moves away from an observer towards a cliff at speed of 15ms^{-1}. Then, the frequency of sound that the observer hears in the echo reflected from the cliff is: (Take velocity of sound in air = 330ms^{-1})

(a) 765Hz
(b) 800Hz

(c) 838Hz
(d) 885Hz

13) Two cars moving in opposite directions approach each other with speed of 22m/s and 16.5m/s respectively. The driver of the first car blows a horn having a frequency 400Hz. The frequency heard by the driver of the second car is [velocity of sound 340m/s]:-

(a) 361Hz
(b) 411Hz

(c) 448Hz (d) 350Hz

14) An observer moves towards a stationary source of sound, with a velocity one – fifth of the velocity of sound. What is the percentage increase in the apparent frequency?

(a) 0.5% (b) zero

(c) 20% (d) 5%

15) A whistle producing sound waves of frequencies 9500Hz and above is approaching a stationary person with speed vms^{-1}. The velocity of sound in air is $300ms^{-1}$. If the person can hear frequencies upto a maximum of 10,000Hz, the maximum value of v upto which he can hear whistle is

(a) $15\sqrt{2}ms^{-1}$ (b) $\frac{15}{\sqrt{2}}$ ms^{-1}

(c) 15 ms^{-1} (d) 30 ms^{-1}

16) A motor cycle starts from rest and accelerates along a straight path at $2m/s^2$. At the starting point of 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})

(a) 98m (b) 147m

(c) 196m (d) 49m

17) This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement 1: Bats emitting ultrasonic waves can detect the location of a prey by hearing the waves reflected from it.

Statement 2: When the source and the detector are moving, the frequency of reflected waves is changed.

(a) Statement 1 is false and Statement 2 is true.

(b) Statement 1 is true and Statement 2 is false.

(c) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

(d) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

18) An engine approaches a hill with a constant speed. When it is at a distance of 0.9km, it blows a whistle whose echo is heard by the driver after 5 seconds. If the speed of sound in air is 330m/s, then the speed of the engine is:

(a) 32m/s (b) 27.5m/s

(c) 60m/s (d) 30m/s

19) A and B are two sources generating sound waves. A listener is situated at C. The frequency of the source at A is 500Hz. A, now moves towards C with speed 4m/s. The number of beats heard at C is 6. When A moves away from C with speed 4m/s, the number of beats heard at C is 18. The speed of sound is 340m/s. The frequency of the source at B is:

(a) 500Hz (b) 506Hz

(c) 512Hz (d) 494Hz

20) Two factories are sounding their sirens at 800Hz. A man goes from one factory to other at a speed of 2m/s. The velocity of sound is 320m/s. The number of beats heard by the person in one second will be:

(a) 2 (b) 4

(c) 8 (d) 10

21) A source of sound A emitting waves of frequency 1800Hz is falling towards ground with a terminal speed v. The observer B on the ground directly beneath the source receives waves of frequency 2150Hz. The source A receives waves, reflected from ground of frequency nearly: (Speed of sound = 343m/s)

(a) 2150Hz (b) 2500Hz

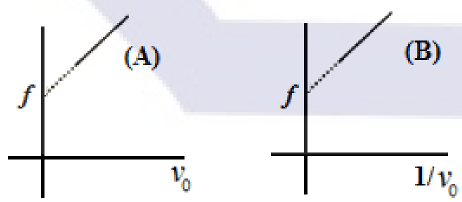
(c) 1800Hz (d) 2400Hz

22) A bat moving at $10ms^{-1}$ towards a wall sends a sound signal of 8000Hz towards it. On reflection it hears a sound of frequency *f*. The value of *f* in Hz is close to (speed of sound = $320ms^{-1}$)

(a) 8516 (b) 8258

(c) 8424 (d) 8000

23) A source of sound emits sound waves at frequency f_0. It is moving towards an observer with fixed speed v_S ($v_S < v$, where v is the speed of sound in air). If the observer were to move towards the source with speed v_0, one of the following two graphs (A and B) will given the correct variation of the frequency f heard by the observer as v_0 is changed.



The variation of f with v_0 is given correctly by:

(a) graph A with slope = $\frac{f_0}{(v+v_S)}$ (b) graph B with slope = $\frac{f_0}{(v-v_S)}$

(c) graph A with slope = $\frac{f_0}{(v-v_S)}$ (d) graph B with slope = $\frac{f_0}{(v+v_S)}$

24) A train is moving on a straight track with speed $20ms^{-1}$. It is blowing its whistle at the frequency of 1000Hz. The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound = $320ms^{-1}$) close to:

(a) 18% (b) 24%

(c) 6% (d) 12%

25) Two engines pass each other moving in opposite directions with uniform speed of 30m/s. One of them is blowing a whistle of frequency 540Hz. Calculate the frequency heard by driver of second engine before they pass each other. Speed of sound is 330m/sec:

(a) 450Hz
(b) 540Hz
(c) 270Hz
(d) 648Hz

26) A toy – car, blowing its horn, is moving with a steady speed of 5m/s, away from a wall. An observer, towards whom the toy car is moving, is able to hear 5 beats per second. If the velocity of sound in air is 340m/s, the frequency of the horn of the toy car is close to:

(a) 680Hz
(b) 510Hz
(c) 340Hz
(d) 170Hz

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
a	c	b	b	c	c	c	b	c	c
11	12	13	14	15	16	17	18	19	20
a	c	c	c	c	a	c	d	c	d
21	22	23	24	25	26				
b	a	c	d	d	d				