PHYSICS - CET 2025 - VERSION CODE - D1
KEYS

1. At 27°C temperature, the mean kinetic energy of the atoms of an ideal gas is E_1. If the temperature is increased to 327 °C, then the mean kinetic energy of the atoms will be

(1) $\frac{E_1}{2}$ (2) $\frac{E_1}{\sqrt{2}}$ (3) $\sqrt{2}E_1$ (4) 2 E_1

Ans (4)

$E_{avg} = \frac{3}{2}kT$

$\frac{E_2}{E_1} = \frac{T_2}{T_1} = \frac{600}{300}$

$E_2 = 2E_1$

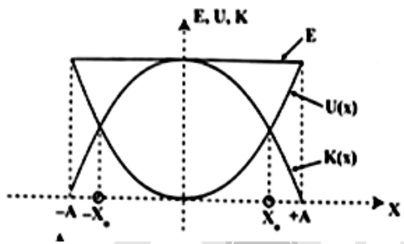
2. The variations of kinetic energy K(x), potential energy U(x) and total energy as a function of displacement of a particle in SHM is as shown in the figure. The value | x_0 | is

(1) $\frac{A}{2}$

(2) 2 A

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

(4) $\sqrt{2}$ A



Ans (3)

KE = PE

$\frac{1}{2}K\left(A^2 - x^2\right) = \frac{1}{2}Kx_0^2$

$A^2 - x_0^2 = x_0^2$

$x_0^2 = \frac{A^2}{2}$

$x_0 = \frac{A}{\sqrt{2}}$

3. The angle between the particle velocity and wave velocity in a transverse wave is [except when the particle passes through the mean position]

(1) Zero radian (2) $\frac{\pi}{4}$ radian (3) $\frac{\pi}{2}$ radian (4) π radian

Ans (3)

In transverse wave, particle velocity and wave velocity are perpendicular.

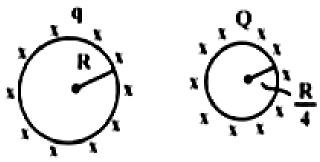
4. A metallic sphere of radius R carrying a charge q is kept at certain distance from another metallic sphere of radius $\frac{R}{4}$ carrying a charge Q. What is the electric flux at any point inside the metallic sphere of radius R due to the sphere of radius $\frac{R}{4}$?

(1) $\frac{Q}{\varepsilon_0}$

(2) $\frac{Q}{\varepsilon_0} - \frac{q}{\varepsilon_0}$

(3) Zero

(4) $\frac{q}{\varepsilon_0} - \frac{Q}{\varepsilon_0}$



Ans (3)

Conceptual

No charge is enclosed inside the sphere.

Hence, $\phi = 0$

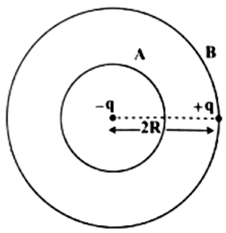
5. You are given a dipole of charge +q and −q separated by a distance 2R. A sphere 'A' of radius 'R' passes through the centre of the dipole as shown below and another sphere 'B' of radius '2R' passes through the charge +q. Then the electric flux through the sphere A is

(1) $-\frac{q}{\varepsilon_0}$

(2) $\frac{q}{\varepsilon_0}$

(3) Zero

(4) $\frac{2q}{\varepsilon_0}$



Ans (1)

$$\phi_A = \frac{1}{\varepsilon_0}(q_A) = \frac{1}{\varepsilon_0}(-q) = -\frac{q}{\varepsilon_0}$$

6. A potential at a point A is −3 V and that at another point B is 5 V. What is the work done in carrying a charge of 5 m C from B to A?

(1) − 40 J (2) − 0.04 J (3) − 0.4 J (4) − 4 J

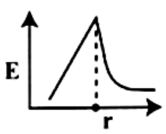
Ans (2)

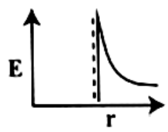
$W = q(V_A - V_B)$

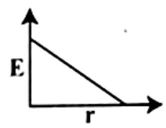
$W = 5 \times 10^{-3} [-3 - 5] = -40 \times 10^{-3}$

$= -0.04$ J

7. Charges are uniformly spread on the surface of a conducting sphere. The electric field from the centre of sphere to a point outside the sphere varies with distance r from the centre as

(1) 

(2) 

(3) 

(4) 

Ans (2)

8. Match Column-I with Column-II related to an electric dipole of dipole moment $\vec{p}$ that is placed in a uniform electric field $\vec{E}$.

Column - I Angle between $\vec{p}$ and $\vec{E}$		Column - II Potential energy of the dipole	
(a)	180°	(i)	$-$ pE
(b)	120°	(ii)	pE
(c)	90°	(iii)	$\frac{1}{2}$pE
		(iv)	Zero

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

Ans (1)

$U = -\, pE\cos\theta$

9. Which of the following statements is not true?

(1) Electric field is always perpendicular to an equipotential surface.
(2) Work done to move a charge on an equipotential surface is not zero.
(3) Equipotential surfaces are the surfaces where the potential is constant.
(4) Equipotential surfaces for a uniform electric field are parallel and equidistant from each other.

Ans (2)

$W = q_{moved}\,(\Delta V)$ (for equipotential surface, V is constant)

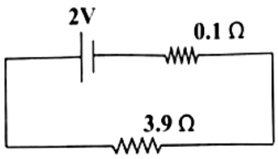
$W = 0$

10. Which of the following is a correct statement?

(1) Gauss's law is true for any closed surface
(2) Gauss's law is true for any open surface
(3) Gauss's law is not applicable when charges are not symmetrically distributed over a closed surface
(4) Gauss's law does not hold good for a charge situated outside the Gaussian surface.

Ans (1)

11. In the following circuit, the terminal voltage across the cell is



(1) 0.52 V
(2) 1.68 V
(3) 1.95 V
(4) 2.71 V

Ans (3)

$I = \frac{E}{R + r}$

$I = \frac{2}{3.9 + 0.1}$

$I = \frac{2}{4}$, $I = 0.5$ A

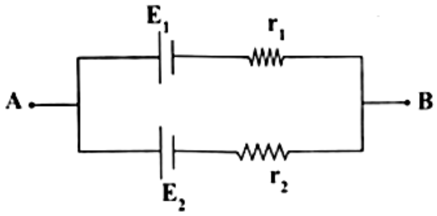
Terminal voltage V = E − Ir

$$V = 2 - \frac{1}{2}(0.1)$$

$$V = 2 - 0.05$$

$$V = 1.95\ V$$

12. Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 ($E_2 > E_1$ and $r_2 > r_1$) respectively, are connected in parallel as shown in figure. The equivalent emf of the combination is E_{eq}. Then



(1) $E_1 < E_{eq} < E_2$ and E_{eq} is nearer E_1
(2) $E_1 < E_{eq} < E_2$ and E_{eq} is nearer E_2
(3) $E_{eq} > E_2$
(4) $E_{eq} < E_1$

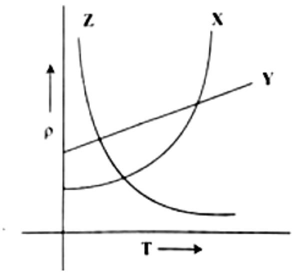
Ans (1)

$$E_{eq} = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$$

$$r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$$

As $E_2 > E_1 \Rightarrow E_1 < E_{eq} < E_2$ [for all values of r_1 and r_2]

13. The variations of resistivity ρ with absolute temperature T for three different materials X, Y and Z are shown in the graph below. Identify the materials X, Y and Z.



(1) X-copper, Y-nichrome, Z-semiconductor
(2) X-copper, Y-semiconductor, Z-nichrome
(3) X-semiconductor, Y-nichrome, Z-copper
(4) X-nichrome, Y-copper, Z-semiconductor

Ans (1)
Conceptual
Temperature dependence of resistivity.

14. Given, a current carrying wire of non-uniform cross-section, which of the following is constant throughout the length of wire?

(1) Current, electric field and drift speed
(2) Drift speed
(3) Current and drift speed
(4) Current only

Ans (4)

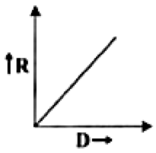
$I = neAv_d$ (I is constant)

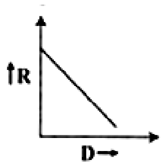
$$v_d = \frac{I}{neA} \Rightarrow v_d \propto \frac{1}{A}$$

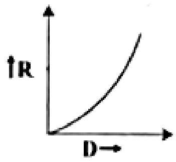
$$E = \frac{j}{\sigma} = \frac{I}{\sigma A} \Rightarrow E \propto \frac{1}{A}$$

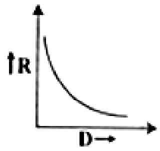
Hence, current remains constant.

15. The graph between variation of resistance of a metal wire as a function of its diameter keeping other parameters like length and temperature constant is

(1) 

(2) 

(3) 

(4) 

Ans (4)

$R \propto \frac{1}{A} \propto \frac{1}{D^2}$

16. Two thin long parallel wires separated by a distance 'r' from each other in vacuum carry a current of 1 ampere in opposite directions. Then, they will

(1) Attract each other with a force per unit length of $\frac{\mu_0 I^2}{2\pi r^2}$

(2) Attract each other with a force per unit length of $\frac{\mu_0 I^2}{2\pi r}$

(3) Repel each other with a force per unit length of $\frac{\mu_0 I^2}{2\pi r}$

(4) Repel each other with a force per unit length of $\frac{\mu_0 I^2}{2\pi r^2}$

Ans (3)

Force acting per unit length between two parallel conductors $F = \frac{\mu_0 I_1 I_2}{2\pi r}$

If $I_1 = I_2 = I$

$F = \frac{\mu_0 I^2}{2\pi r}$

If currents are opposite, conductors repel each other.

17. A solenoid is 1 m long and 4 cm in diameter. It has five layers of windings of 1000 turns each and carries a current of 7A. The magnetic field at the centre of the solenoid is

(1) 439.6 T
(2) 0.4396×10^{-5} T
(3) 4.396×10^{-2} T
(4) 43.96×10^{-2} T

Ans (3)

$B = \mu_0 nI \qquad n = \frac{N}{l}$

$= \frac{\mu_0 NI}{l}$

$B = 4\pi \times 10^{-7} \times \frac{5000}{1} \times 7$

$B = 4.39 \times 10^{-2}$ T

18. Two similar galvanometers are converted into an ammeter and a milliammeter. The shunt resistance of ammeter as compared to the shunt resistance of milliammeter will be

(1) Equal
(2) Zero
(3) More
(4) Less

Ans (4)

$$S = \frac{I_g G}{I - I_g}$$

$$\Rightarrow S \propto \frac{1}{I - I_g}$$

$\therefore\ S_A < S_{mA}$

19. Which of the following statements is true in respect of diamagnetic substances?

(1) Susceptibility is small and negative

(2) They are feebly attracted by magnets

(3) Permeability is greater than 1000

(4) Susceptibility decreases with temperature

Ans (1)

Conceptual

20. Identify the correct statement

(1) The magnetic field inside a solenoid is non-uniform.

(2) A current carrying conductor produces an electric field around it.

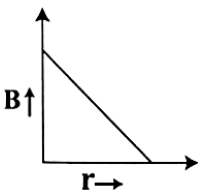
(3) A straight current carrying conductor has circular magnetic field lines around it.

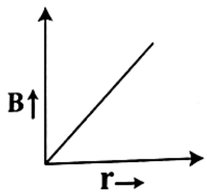
(4) The direction of magnetic field due to a current element is given by Flemings Left Hand Rule

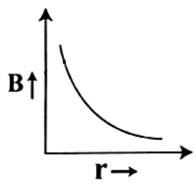
Ans (3)

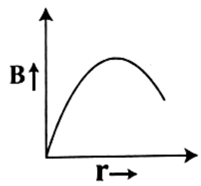
Conceptual

21. Which of the following graphs represents the variation of magnetic field B with perpendicular distance 'r' from an infinitely long, straight conductor carrying current?

(1) 

(2) 

(3) 

(4) 

Ans (3)

$$B = \frac{\mu_0}{4\pi}\frac{2I}{r}$$

$$B \propto \frac{1}{r}$$

22. If we consider an electron and a photon of same de-Broglie wavelength, then they will have same

(1) Momentum (2) Angular momentum (3) Energy (4) Velocity

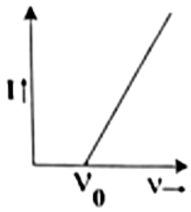
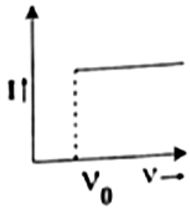
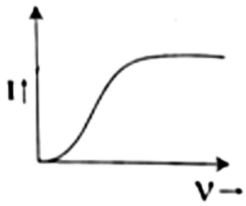
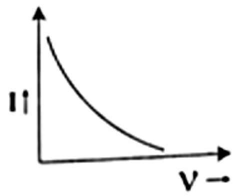
Ans (1)

$$\lambda = \frac{h}{p}$$

λ is constant

$\therefore\ p = \text{constant}$

23. The anode voltage of a photocell is kept fixed. The frequency of the light falling on the cathode is gradually increased. Then the correct graph which shows the variation of photo current I with the frequency ν of incident light is

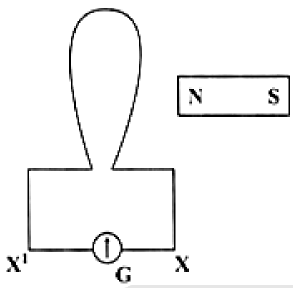
(1) 
(2) 
(3) 
(4) 

Ans (2)

Photoelectric current is independent of frequency of incident radiation

24. When a bar magnet is pushed towards the coil, along its axis, as shown in the figure, the galvanometer pointer deflects towards X. When this magnet is pulled away from the coil, the galvanometer pointer

(1) deflects towards X
(2) deflects towards X^1
(3) does not deflect
(4) oscillates



Ans (2)

Lenz's law

25. A square loop of side 2m lies in the Y-Z plane in a region having a magnetic field $\vec{B} = (5\hat{i} + 3\hat{j} - 4\hat{k})$T. The magnitude of magnetic flux through the square loop is

(1) 10 Wb (2) 20 Wb (3) 12 Wb (4) 16 Wb

Ans (2)

$\phi = \vec{B} \cdot \vec{A}$

$\phi = (5\hat{i} + 3\hat{j} - 4\hat{k}) \cdot 4\hat{i}$

$\phi = 20$ Wb

26. In domestic electric mains supply, the voltage and the current are

(1) AC voltage and AC current (2) AC voltage and DC current
(3) DC voltage and DC current (4) DC voltage and AC current

Ans (1)

Conceptual

27. A sinusoidal voltage produced by an AC generator at any instant t is given by an equation V = 311 sin 314 t. The rms value of voltage and frequency are respectively

(1) 200 V, 100 Hz (2) 200 V, 50 Hz (3) 220 V, 100 Hz (4) 220 V, 50 Hz

Ans (4)

$V_0 = 311$ V

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{311}{1.414} = 220 \text{ V}$$

$\omega = 314$

$2\pi f = 314$

$f = 50$ Hz.

28. A series LCR circuit containing an AC source of 100 V has an inductor and a capacitor of reactances 24 Ω and 16 Ω respectively. If a resistance of 6 Ω is connected in series, then the potential difference across the series combination of inductor and capacitor only is

(1) 40 V (2) 80 V (3) 400 V (4) 8 V

Ans (2)

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{36 + 64} = 10\,\Omega$

$I = \frac{V}{Z} = \frac{100}{10} = 10\text{ A}$

$V_L = IX_L = 10 \times 24 = 240\text{ V}$

$V_C = IX_C = 10 \times 16 = 160\text{ V}$

$V_L - V_C = 240 - 160 = 80\text{ V}$

29. Match the following types of waves with their wavelength ranges.

Waves		Wavelength ranges	
(i)	Microwave	(a)	700 nm to 400 nm
(ii)	Visible light	(b)	1 nm to 10^{-3} nm
(iii)	Ultraviolet	(c)	0.1 m to 1 mm
(iv)	X-rays	(d)	400 nm to 1 nm

(1) (i) – (a); (ii) – (d); (iii) – (b); (iv) – (c)
(2) (i) – (c); (ii) – (a); (iii) – (d); (iv) – (b)
(3) (i) – (d); (ii) – (b); (iii) – (c); (iv) – (a)
(4) (i) – (b); (ii) – (c); (iii) – (a); (iv) – (d)

Ans (2)

Conceptual

30. A ray of light passes from vacuum into a medium of refractive index n. If the angle of incidence is twice the angle of refraction, then the angle of incidence in terms of refractive index is

(1) $\text{Cos}^{-1}\left(\frac{n}{2}\right)$ (2) $\text{Sin}^{-1}\left(\frac{n}{2}\right)$ (3) $2\text{Cos}^{-1}\left(\frac{n}{2}\right)$ (4) $2\text{Sin}^{-1}\left(\frac{n}{2}\right)$

Ans (3)

$n = \frac{\sin i}{\sin r}$

$n = \frac{\sin 2r}{\sin r}$

$n = \frac{2\sin r\cos r}{\sin r}$

$\cos r = \frac{n}{2}$

$r = \cos^{-1}\left(\frac{n}{2}\right)$

$\frac{i}{2} = \cos^{-1}\left(\frac{n}{2}\right)$ $i = 2\cos^{-1}\left(\frac{n}{2}\right)$

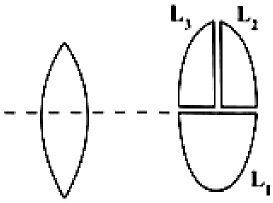
31. A convex lens has power P. It is cut into two halves along its principal axis. Further one piece (out of two halves) is cut into two halves perpendicular to the principal axis as shown in figure. Choose the incorrect option for the reported lens pieces

(1) Power of L_1 is $\frac{P}{2}$

(2) Power of L_2 is $\frac{P}{2}$

(3) Power of L_3 is $\frac{P}{2}$

(4) Power of L_1 is P



Ans (1)

Focal length of L_1 is f and hence power, $P_1 = \frac{1}{f} = P$

Focal length of L_2 and L_3 is 2f and hence power, $P = \frac{1}{2f} = \frac{P}{2}$.

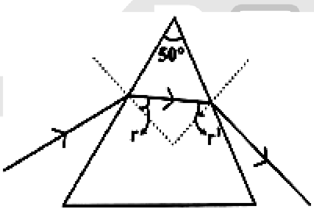
32. The image formed by an objective lens of a compound microscope is

(1) Virtual and diminished
(2) Real and diminished
(3) Real and enlarged
(4) Virtual and enlarged

Ans (3)

33. If r and r^1 denote the angles inside the prism having angle of prism 50° considering that during the interval of time from t = 0 to t = t, r varies with time as $r = 10° + t^2$. During this time r^1 will vary with time is

(1) $40° - t^2$
(2) $40° + t^2$
(3) $50° - t^2$
(4) $50° + t^2$



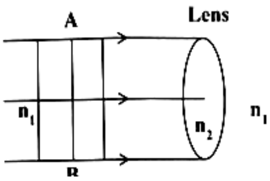
Ans (1)

$A = r + r^1 \Rightarrow r^1 = A - r$

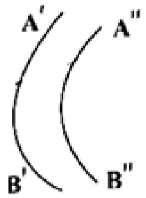
$= 50° - (10° + t^2)$

$= 40° - t^2$

34. If AB is incident plane wave front then refracted wave front is ($n_2 > n_1$)



(1)


(2)


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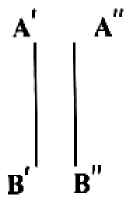

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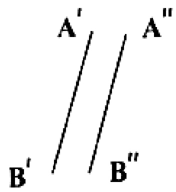


Ans (2)

When parallel beam passes through convex lens converging beam is obtained.

35. The total energy carried by the light wave when it travels from a rarer to a non-reflecting and non-absorbing medium

(1) decreases

(2) remains same

(3) increases

(4) either increases or decreases depending upon angle of incidence

Ans (2)

36. If the radius of first Bohr orbit is r, then the radius of the second Bohr orbit will be

(1) 2r (2) 8r (3) 4r (4) $2\sqrt{2}\,r$

Ans (3)

$r_n = n^2 r_1$

$r_2 = 2^2 r_1 = 4r$

37. Match the following types of nuceli with examples shown.

Column I		Column II	
(A)	Isotopes	(i)	${}_3Li^7$, ${}_4Be^7$
(B)	Isobars	(ii)	${}_8O^{18}$, ${}_9F^{19}$
(C)	Isotones	(iii)	${}_1H^1$, ${}_1H^2$

(1) (A) – (iii), (B) – (i), (C) – (ii) (2) (A) – (ii), (B) – (iii), (C) – (i)

(3) (A) – (i), (B) – (iii), (C) – (ii) (4) (A) – (iii), (B) – (ii), (C) – (i)

Ans (1)

Isotopes – ${}_1H^1$, ${}_1H^2$

Isobars – ${}_3Li^7$, ${}_4Be^7$

Isomers – ${}_8O^{16}$, ${}_9F^{19}$

38. Which of the following statements is incorrect with reference to 'Nuclear force'?

(1) Potential energy is minimum, if the separation between the nucleons is 0.8 fm

(2) Nuclear force becomes attractive for nucleon distances larger than 0.8 fm

(3) Nuclear force becomes repulsive for nucleon distances less than 0.8 fm

(4) Nuclear force is always attractive

Ans (4)

Nucleus force is always attractive is a wrong statement, it can be repulsive when the distance between the nucleon is larger than 0.8 fm.

39. The range of electric conductivity (σ) and resistivity (ρ) for metals, among the following is

(1) $\rho \to 10^{-2} - 10^{-8}\ \Omega m$, $\sigma \to 10^{2} - 10^{8}\ Sm^{-1}$

(2) $\rho \to 10^{-5} - 10^{6}\ \Omega m$, $\sigma \to 10^{5} - 10^{-6}\ Sm^{-1}$

(3) $\rho \to 10^{11} - 10^{19}\ \Omega m$, $\sigma \to 10^{-11} - 10^{-19}\ Sm^{-1}$

(4) $\rho \to 10^{2} - 10^{8}\ \Omega m$, $\sigma \to 10^{-2} - 10^{-8}\ Sm^{-1}$

Ans (1)

40. Which of the following statements is correct for an n-type semiconductor?

(1) The donor energy level lies just below the bottom of the conduction band

(2) The donor energy level lies closely above the top of the valence band

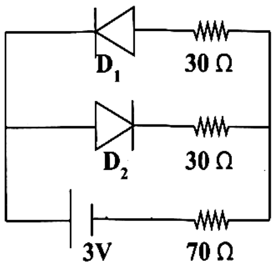
(3) The donor energy level lies at the half way mark for forbidden energy gap

(4) The donor energy level does not exist

Ans (1)

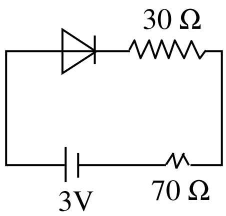
The donor energy level lies just below the bottom of the conduction band

41. The circuit shown in the figure contains two ideal diodes D_1 and D_2. If a cell of emf 3 V and negligible internal resistance is connected as shown, then the current through 70 Ω resistance (in ampere) is



(1) 0
(2) 0.01
(3) 0.02
(4) 0.03

Ans (4)



$R_{eff} = 30 + 70 = 100\ \Omega$

$$I = \frac{E}{R_{eff} + r} = \frac{3}{100+0}$$

I = 0.03 A

42. In determining the refractive index of a glass slab using a travelling microscope, the following readings are tabulated.

(a) Reading of travelling microscope for ink mark = 5.123 cm

(b) Reading of travelling microscope for ink mark through glass slab = 6.123 cm

(c) Reading of travelling microscope for chalk dust on glass slab = 8.123 cm

From the data, the refractive index of a glass slab is

(1) 1.390 (2) 1.500 (3) 1.601 (4) 1.399

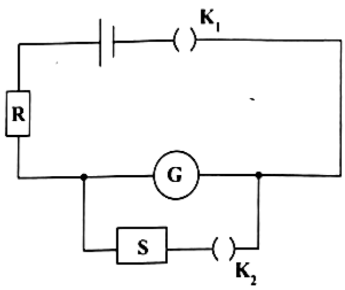
Ans (2)

$R_1 = 5.123$ cm, $R_2 = 6.123$ cm, $R_3 = 8.123$ cm

$$n = \frac{R_3 - R_1}{R_3 - R_2} = \frac{8.123 - 5.123}{8.123 - 6.123} = \frac{3}{2}$$

n = 1.5

43. In an experiment to determine the figure of merit of a galvanometer by half deflection method, a student constructed the following circuit.



He Unplugged a resistance of 5200 Ω in R. When K_1 is closed and K_2 is open, the deflection observed in the galvanometer is 26 div. When K_2 is also closed a resistance of 90 Ω is removed in S, the deflection becomes 13 div. The resistance of galvanometer is nearly

(1) 116.0 Ω (2) 45.0 Ω (3) 103.0 Ω (4) 91.6 Ω

Ans (4)

Resistance of the galvanometer, $G = \frac{RS}{R-S}$

$= \frac{5200 \times 90}{5200 - 90}$

$G = 91.6\ \Omega$

44. While determining the coefficient of viscosity of the given liquid, a spherical steel ball sinks by a distance h = 0.9 m. The radius of the ball is r = $\sqrt{3} \times 10^{-3}$ m. The time taken by the ball to sink in tree three trials are tabulated as follows:

Trial No.	**Time take by the ball to fall by h (in second)**
1.	2.75
2.	2.65
3.	2.70

The difference between the densities of the steel ball and the liquid is 7000 kg m^{-3}. If g = 10.0 ms^{-2}, then the co-efficient of viscosity of the given liquid at room temperature is

(1) 0.28 Pa.s (2) 0.14 Pa.s (3) 0.14×10^{-3} Pa.s (4) 14 Pa.s

Ans (2)

$v = \frac{2}{9}\frac{r^2(\rho - \sigma)g}{\eta}$ $v = \frac{s}{t} = \frac{0.9}{2.7} = 0.333\ m\ s^{-1}$

$\eta = \frac{2}{9}\frac{r^2(\rho - \sigma)g}{v}$

$= \frac{2}{9} \times \frac{3 \times 10^{-6}(7000)10}{0.333}$

$\eta = 0.14$ Pa.s

45. Which of the following expression can be deduced on the basis of dimensional analysis? (All symbols have their usual meanings)

(1) $s = ut + \frac{1}{2}at^2$ (2) x = A cos ωt (3) $N = N_0 e^{-\lambda t}$ (4) F = 6 πηrv

Ans (4)

Expression involving trigonometric functions, exponents, sum or difference cannot be deduced using dimensional analysis.

46. Two stones begin to fall from rest from the same height, with the second stone starting to fall 'Δt' seconds after the first falls from rest. The distance of separation between the two stones becomes 'H', 't_0' seconds after the first stone starts its motion. Then t_0 is equal to

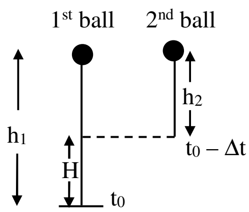
(1) $\frac{H}{g\Delta t}$ (2) $\frac{H}{\Delta t} + \frac{\Delta t}{2g}$ (3) $\frac{H}{g\Delta t} - \frac{\Delta t}{2}$ (4) $\frac{H}{g\Delta t} + \frac{\Delta t}{2}$

Ans (4)

$H = h_1 - h_2$

$H = \frac{1}{2}gt_0^2 - \frac{1}{2}g(t_0 - \Delta t)^2$

$H = \frac{1}{2}gt_0^2 - \frac{1}{2}gt_0^2 - \frac{g\Delta t^2}{2} + gt_0\Delta t$



$$H = -\frac{g\Delta t^2}{2} + gt_0\Delta t$$

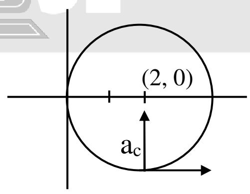
$$H + \frac{g\Delta t^2}{2} = gt_0\Delta t$$

$$\frac{H}{g\Delta t} + \frac{g\Delta t^2}{2g\Delta t} = t_0$$

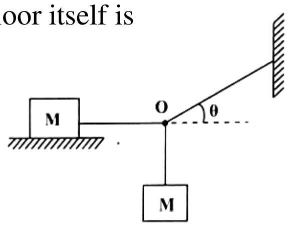
$$t_0 = \frac{H}{g\Delta t} + \frac{\Delta t}{2}$$

47. In the projectile motion of a particle on a level ground, which of the following remains constant with reference to time and position?
(1) Vertical component of the velocity of the projectile
(2) Average velocity between any two points on the path
(3) Horizontal component of velocity
(4) Angle between the instantaneous velocity with the horizontal
Ans (3)
Through out the projectile motion the horizontal component of velocity remains constant.

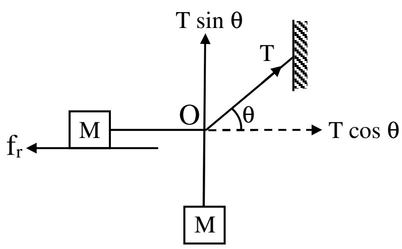
48. A particle is in uniform circular motion. The equation of its trajectory is given by $(x - 2)^2 + y^2 = 25$, where x and y are in meter. The speed of the particle is 2 ms^{-1}. When the particle attains the lowest 'y' co-ordinate, the acceleration of the particle is (in ms^{-2})
(1) $0.4\,\hat{i}$ (2) $0.4\,\hat{j}$ (3) $0.8\,\hat{i}$ (4) $0.8\,\hat{j}$
Ans (4)
Comparing it with the standard equation
$(x - h)^2 + (y - k)^2 = r^2$
$(x - 2)^2 + y^2 = 25$
$\Rightarrow r = 5$ m $\quad v = 2\ ms^{-1}$
$\therefore\ a = \frac{v^2}{r} = \frac{4}{5} = 0.8\,\hat{j}\ ms^{-2}$



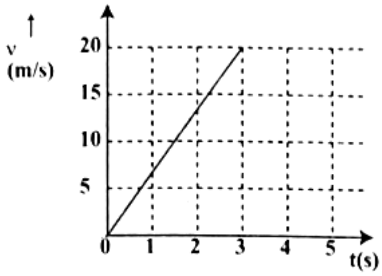
49. A wooden block of mass M lies on a rough floor. Another wooden block of the same mass is hanging from the point O through strings as shown in the figure. To achieve equilibrium, the co-efficient of static friction between the block on the floor with the floor itself is
(1) $\mu = \cos\theta$
(2) $\mu = \cot\theta$
(3) $\mu = \sin\theta$
(4) $\mu = \tan\theta$



Ans (2)
At equilibrium, $T\cos\theta = f_r = \mu Mg$ …(1)
$T\sin\theta = Mg$ ...(2)
Dividing (1) and (2),
$\mu = \cot\theta$



50. A block of certain mass is placed on a rough floor. The coefficients of static and kinetic friction between the block and the floor are 0.4 and 0.25 respectively. A constant horizontal force F = 20 N acts on it so that the velocity of the block varies with time according to the following graph. The mass of the block is nearly (Take $g \simeq 10\ ms^{-2}$)



(1) 2.2 kg
(2) 4.4 kg
(3) 1.2 kg
(4) 1.0 kg

Ans (1)

From gram, $a = \frac{\Delta v}{\Delta t} = \frac{20}{3} ms^{-1}$

$F_{net} = F - f_r$

$m_a = 20 - \mu mg$

$m(a + \mu g) = 20$

$$m = \frac{20}{a + \mu g} = \frac{20}{\frac{20}{3} + 2.5} = \frac{60}{27.5} = \frac{120}{55} = 2.2 \text{ kg}$$

51. A body of mass 0.25 kg travels along a straight line from x = 0 to x = 2 m with a speed $\upsilon = k\,x^{3/2}$ where k = 2 SI units. The work done by the net force during this displacement is

(1) 4 J (2) 8 J (3) 16 J (4) 32 J

Ans (1)

m = 0.25 kg

$v = k\,x^{3/2}$ at $x = 0 \Rightarrow v_1 = 0$

$x = 2 \Rightarrow v_2 = 2(2)^{3/2} = = 4\sqrt{2}\ ms^{-1}$

$$W = \frac{1}{2} m \left(v_2^2 - v_1^2\right)$$

$$= \frac{1}{2} \times \frac{1}{4} \times 16 \times 2 = 4\,J$$

52. During an elastic collision between two bodies, which of the following statements are correct?

I. The initial kinetic energy is equal to the final kinetic energy of the system.

II. The linear momentum is conserved.

III. The kinetic energy during Δt (the collision time) is not conserved.

(1) I and II only (2) II and III only (3) I and III only (4) I, II and III

Ans (4)

I, II and III are correct.

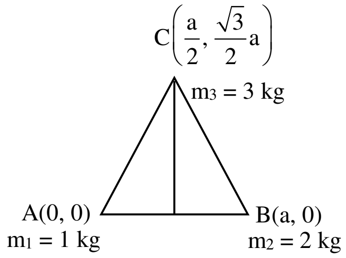
53. Three particles of mass 1 kg, 2 kg and 3 kg are placed at the vertices A, B and C respectively of an equilateral triangle ABC of side 1 m. The centre of mass of the system from vertex A (located at origin) is

(1) (0, 0) (2) $\left(\frac{7}{12}, \frac{3\sqrt{3}}{12}\right)$ (3) $\left(\frac{9}{12}, \frac{3\sqrt{3}}{12}\right)$ (4) $\left(\frac{7}{12}, \frac{6+3\sqrt{3}}{12}\right)$

Ans (2)

$$X_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} = \frac{7}{12}$$

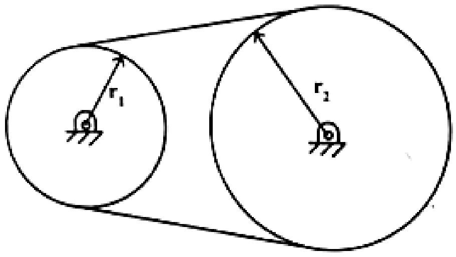
$$Y_{CM} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{3\sqrt{3}}{12}$$



54. Two fly wheels are connected by a non-slipping belt as shown in the figure. $I_1 = 4$ kg m^2, $r_1 = 20$ cm, $I_2 = 20$ kg m^2 and $r_2 = 30$ cm. A torque of 10 Nm is **applied** on the smaller wheel. Then match the entries column I with appropriate entries of column II.

I	**Quantities**	**II**	**Their numerical values (in SI units)**
(a)	Angular acceleration of smaller wheel	(i)	$\frac{5}{3}$
(b)	Torque on the larger wheel	(ii)	$\frac{100}{3}$
(c)	Angular acceleration of larger wheel	(iii)	$\frac{5}{2}$

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



Ans None of the answer matches

$\tau - T r_1 = \tau_1$

$$\tau - \frac{I_2\alpha_2}{r_2}(r_1) = I_1\alpha_1$$

Since a = r α = constant

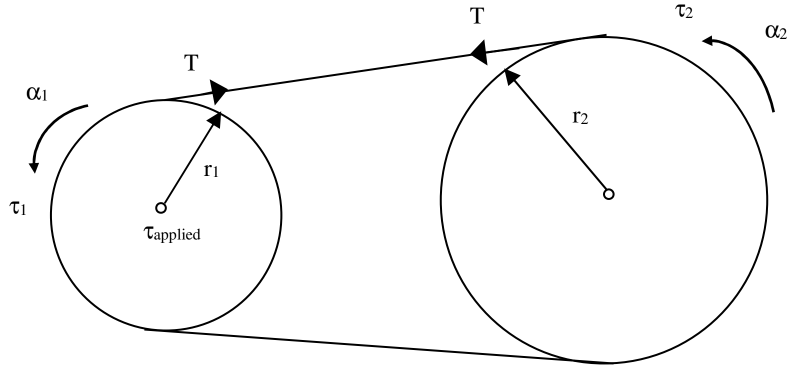
$r_1\alpha_1 = r_2\alpha_2$

$$\therefore\ \alpha_2 = \frac{r_1}{r_2}\alpha_1$$

$$\therefore\ \tau - I_2\alpha_1\left(\frac{r_1}{r_2}\right)^2 = I_1\alpha_1$$

$$10 - 20\alpha_1\left(\frac{2}{3}\right)^2 = 4\alpha_1$$

$$10 = \left(4 + \frac{80}{9}\right)\alpha_1$$



$$\alpha_1 = \frac{90}{116} \simeq \frac{10}{13} \text{rad s}^{-2}$$

$$\alpha_2 = \frac{r_1\alpha_1}{r_2} = \frac{2}{3} \times \frac{10}{13} = \frac{20}{39} \approx 0.5 \text{rad s}^{-2}$$

$\tau_2 = I_2\, \alpha_2$

$\approx 20 \times 0.51$

≈ 10.3 Nm

- If torque of 10 Nm is **acting** on the smaller wheel

$\tau_1 = I_1\alpha_1$

$\alpha_1 = \frac{\tau_1}{I_1}$

$\alpha_1 = \frac{10}{4}$

$\alpha_1 = \frac{5}{2}$

$a_1 = a_2$

$r_1\alpha_1 = r_2\alpha_2$

$\alpha_2 = \left(\frac{r_1}{r_2}\right)\alpha_1 \quad = \left(\frac{20}{30}\right)\frac{5}{2}$

$\alpha_2 = \frac{5}{3} \text{rad s}^{-2}$

$\tau_2 = I_2\alpha_2$

$\tau_2 = 20 \times \frac{5}{3}$

$\tau_2 = \frac{100}{3}$ Nm

Then the correct option is (1)

55. If r_p, v_p, L_p and r_a, v_a, L_a are radii, velocities and angular momenta of a planet at perihelion and aphelion of its elliptical orbit around the Sun respectively, then

(1) $r_p < r_a$, $v_p < v_a$, $L_a < L_p$ (2) $r_p > r_a$, $v_p > v_a$, $L_a > L_p$

(3) $r_p < r_a$, $v_p > v_a$, $L_a = L_p$ (4) $r_p > r_a$, $v_p < v_a$, $L_a = L_p$

Ans (3)

$L_a = L_p$ (conservation of angular momentum)

$r_a v_a = r_p v_p$

$\frac{r_a}{r_p} = \frac{v_p}{v_a}$

$r_p < r_a$ (radius of orbit of earth at perihelion is smaller than radius of orbit of Earth at aphelion)

$\therefore$ $v_p > v_a$. (velocity of Earth at perihelion is greater than that at aphelion)

56. The total energy of a satellite in a circular orbit at a distance (R + h) from the center of the Earth varies as [R is the radius of the Earth and h is the height of the orbit from Earth's surface]

(1) $\frac{1}{(R+h)}$ (2) $-\frac{1}{(R+h)}$ (3) $\frac{1}{(R+h)^2}$ (4) $-\frac{1}{(R+h)^2}$

Ans (2)

Total energy of satellite = kinetic energy + potential energy

$E = K + U \quad = -\frac{GMm}{2r}$

$E = -\frac{GMm}{(R+h)}$

57. Two wires A and B are made of same material. Their diameters are in the ratio of 1 : 2 and lengths are in the ratio of 1 : 3. If they are stretched by the same force, then increase in their lengths will be in the ratio of

(1) 4 : 3 (2) 3 : 4 (3) 2 : 3 (4) 3 : 2

Ans (1)

Young's modulus is same for both the wires

$\frac{d_A}{d_B} = \frac{1}{2}$ and $\frac{L_A}{L_B} = \frac{1}{3}$

Force is same

$Y_A = Y_B$

$$\left(\frac{FL}{A\Delta l}\right)_A = \left(\frac{FL}{A\Delta l}\right)_B$$

$$\frac{L_A}{\left(\frac{\pi d_A^2}{4}\right)\Delta l_A} = \frac{L_B}{\left(\frac{\pi d_B^2}{4}\right)\Delta l_B}$$

$$\frac{\Delta l_A}{\Delta l_B} = \frac{L_A}{L_B}\left(\frac{d_B}{d_A}\right)^2$$

$$= \left(\frac{1}{3}\right)\left(\frac{2}{1}\right)^2 = \frac{4}{3}$$

58. A horizontal pipe carries water in a streamlined flow. At a point along the pipe, where the cross-sectional area is 10 cm^2, the velocity of water is 1 ms^{-1} and the pressure is 2000 Pa. What is the pressure of water at another point where the cross-sectional area is 5 cm^2?

[Density of water = 1000 kgm^{-3}]

(1) 200 Pa (2) 300 Pa (3) 400 Pa (4) 500 Pa

Ans (4)

Using equation of continuity

$A_1 v_1 = A_2 v_2$

$10(1) = 5(v_2)$

$$v_2 = \frac{1}{5}\times 10 = 2\ m s^{-1}$$

Using Bernoulli's principle for Horizontal pipe

$$P_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$$

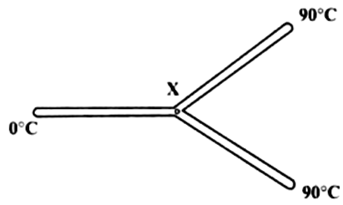
$$2000 + \frac{1}{2}(10^3)(1)^2 = P_2 + \frac{1}{2}(10^3)(2)^2$$

$P_2 = (2000 + 500) - 2000$

$P_2 = 500$ Pa

59. Three metal rods of the same material and identical in all respects are joined as shown in the figure. The temperatures at the ends of these rods are maintained as indicated. Assuming no heat energy loss occurs through the curved surfaces of the rods, the temperature at the junction x is

(1) 45°C
(2) 60°C
(3) 30°C
(4) 20°C



Ans (2)

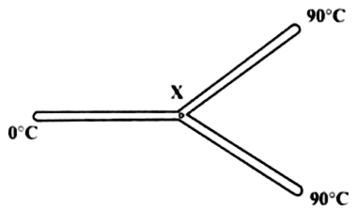
The sum of rate of heat flow at the junction X should be zero

$\therefore \frac{dQ}{dt} = \frac{KA.dT}{l}$

$\therefore \frac{kA}{l}\left((0-X)+(90-X)+(90-X)\right)=0$

$\Rightarrow 180 - 3X = 0$

$X = \frac{180}{3} = 60°C$



60. A gas is taken from state A to state B along two different paths 1 and 2. The heat absorbed and work done by the system along these two paths are Q_1 and Q_2 and W_1 and W_2 respectively. Then

(1) $Q_1 = Q_2$
(2) $W_1 = W_2$
(3) $Q_1 - W_1 = Q_2 - W_2$
(4) $Q_1 + W_1 = Q_2 + W_2$

Ans (3)

Since initial and final states are same for both the paths, change in internal is same

$\therefore$ Using 1st law of thermodynamics

For Path 1, $Q_1 = \Delta U + W_1$ … (1)

For Path 2, $Q_2 = \Delta U + W_2$ … (2)

$\Rightarrow Q_1 - W_1 = \Delta U$

$\Rightarrow Q_2 - W_2 = \Delta U$

$\therefore Q_1 - W_1 = Q_2 - W_2$

* * *