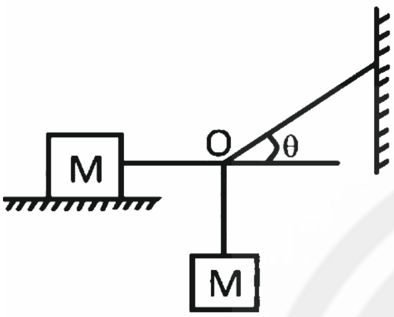
KCET PYQ 2025

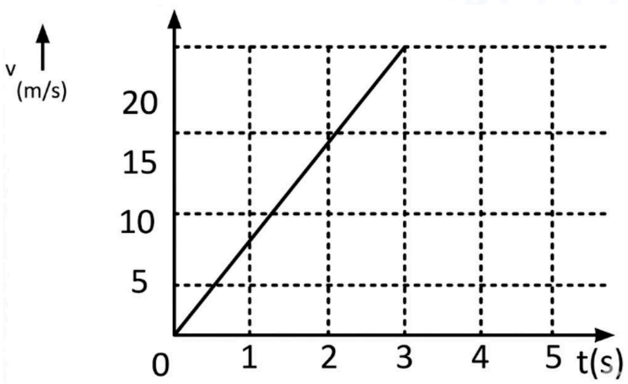
PHYSICS

Q1 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



(A) $\mu = \cot\theta$
(B) $\mu = \sin\theta$
(C) $\mu = \tan\theta$
(D) $\mu = \cos\theta$

Q2 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 $g \simeq 10ms^{-2}$)



(A) 4.4 kg (B) 1.2 kg
(C) 1.0 kg (D) 2.2 kg

Q3 A body of mass 0.25 kg travels along a straight line from x = 0 to x = 2m with a speed $v = kx^{3/2}$ where k = 2SI units. The work done by the net during this displacement is

(A) 8 J (B) 16 J
(C) 32 J (D) 4 J

Q4 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.

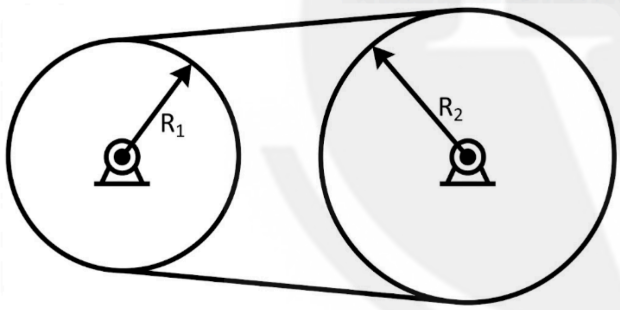
(A) II and III only
(B) I and III only
(C) I, II and III
(D) I and II only

Q5 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

(A) $\left(\frac{7}{12}, \frac{3\sqrt{3}}{12}\right)$ (B) $\left(\frac{9}{12}, \frac{3\sqrt{3}}{12}\right)$
(C) $\left(\frac{7}{12}, \frac{6+3\sqrt{3}}{12}\right)$ (D) (0,0)

Q6 Two fly wheels are connected by a non-slipping belt as shown in the figure. $I_1 = 4kg\ m^2, r_1 = 20cm\ , r_2 = 30cm\ I_2.$ A $= 20\ kg\ m^2$
torque of 10 Nm is applied on the smaller wheel. Then match the entries of column I with appropriate entries of column II.

I	Quantities	II	Their numerical Values (in SI units)
(a)	Angular acceleration of smaller wheel	(i)	5/3
(b)	Torque on the larger wheel	(ii)	100/3
(c)	Angular acceleration of larger wheel	(iii)	5/2



(A) a – ii, b – iii, c – i
(B) a – iii, b – i, c – ii
(C) a – ii, b – i, c – iii
(D) a – iii, b – ii, c – i

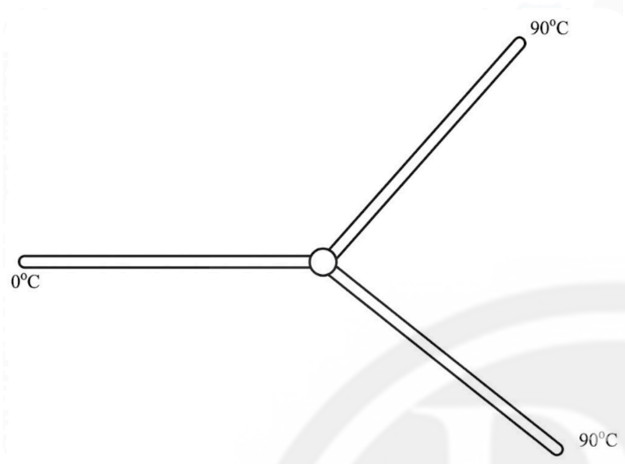
Q7 If r_p, v_p, L_p and r_a, v_a, L_a are radii, velocities and angular momenta of a planet at perihelion and aphelion of its elliptical orbit around the Sun respectively, then
(A) $r_p > r_a, v_p > v_a L_a > L_P$
(B) $r_p < r_a, v_p > v_a L_a = L_P$
(C) $r_p < r_a, v_p < v_a L_a = L_P$
(D) $r_p < r_a, v_p < v_a L_a < L_P$

Q8 The total energy of a satellite in a circular orbit at a distance $(R+h)$ from the centre of the Earth varies as [R is the radius of the Earth and *h* is the height of the oribit from Earth's surface]
(A) $-\frac{1}{(R+h)}$ (B) $\frac{1}{(R+h)^2}$
(C) $-\frac{1}{(R+h)^2}$ (D) $\frac{1}{(R+h)}$

Q9 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
(A) 3 : 4 (B) 2 : 3
(C) 3 : 2 (D) 4 : 3

Q10 A horizontal pipe carries water in a streamlined flow. At a point along the pipe, where the cross-sectional area is $10cm^{-2}$, the velocity of water is $1cm^{-2}$ 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 $= 1000kgm^{-3}$] [KCET 2025]
(A) 300 Pa (B) 400 Pa
(C) 500 Pa (D) 200 Pa

Q11 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



(A) 60°C
(B) 30°C
(C) 20°C
(D) 45°C

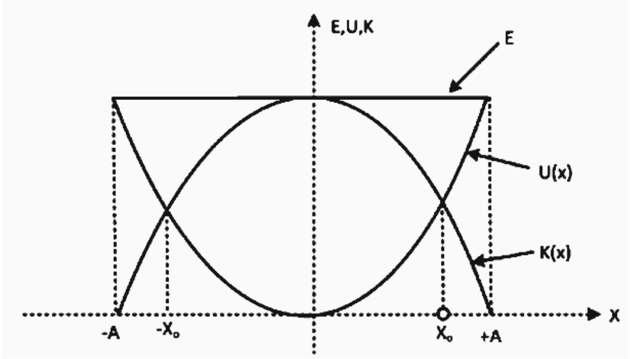
Q12 A gas is taken from state A to state B along two different paths 1 and 2. The heat absorbed and work done by the system along these two paths are Q_1 and Q_2 and W_1 and W_2 respectively. Then

(A) $W_1 = W_2$
(B) $Q_1 - W_1 = Q_2 - W_2$
(C) $Q_1 + W_1 = Q_2 + W_2$
(D) $Q_1 = Q_2$

Q13 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

(A) $\frac{E_1}{\sqrt{2}}$
(B) $\sqrt{2E_1}$
(C) $2E_1$
(D) $\frac{E_1}{2}$

Q14 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 of $|x_o|$ is

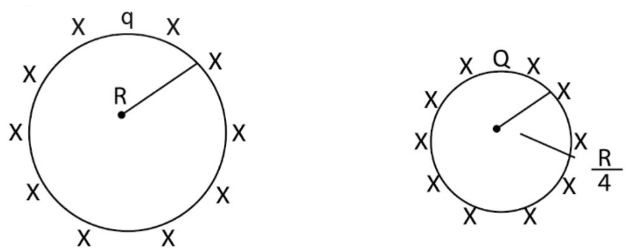


(A) 2 A
(B) $\frac{A}{\sqrt{2}}$
(C) $\sqrt{2}A$
(D) $\frac{A}{2}$

Q15 The angle between the particle velocity and wave velocity in a transverse wave is [except when the particle passes through the mean position]

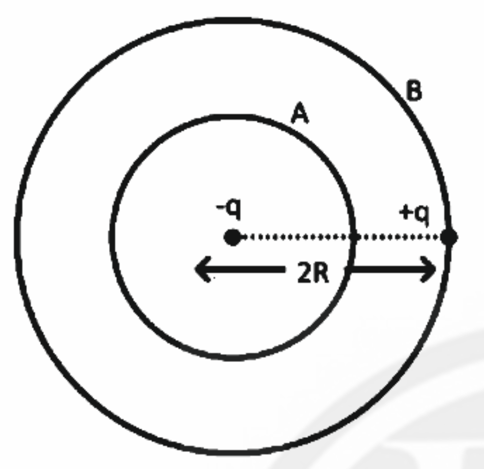
(A) $\frac{\pi}{4} radian$
(B) $\frac{\pi}{2} radian$
(C) $\pi\, radian$
(D) Zero radian

Q16 A metallic sphere of radius *R* carrying a charge *q* is kept at certain distance from another metallic sphere of radius 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 R/4 ?



(A) $\frac{Q}{\varepsilon_o} - \frac{q}{\varepsilon_o}$
(B) Zero
(C) $\frac{q}{\varepsilon_o} - \frac{Q}{\varepsilon_o}$
(D) $\frac{Q}{\varepsilon_o}$

Q17 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

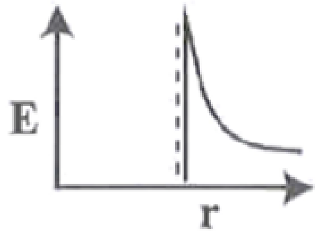


(A) q/ε_0
(B) Zero
(C) $2q/\varepsilon_0$
(D) $-q/\varepsilon_0$

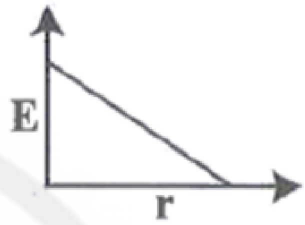
Q18 A potential at a point A is -3 V and that at another point B is 5 V . What is the work done in carrying a charge of 5 m C from B to A ?

(A) –0.04 J (B) –0.4 J
(C) –4 J (D) –40 J

Q19 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



(A)



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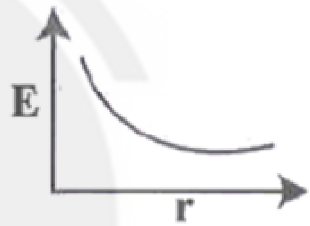

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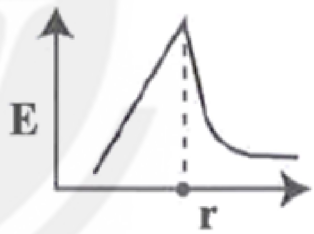


(D)

Q20 Match Column-I with Column - II related to an electric dipole of dipole moment $\vec{p}$ that is placed in a uniform electric field $\vec{E}$.

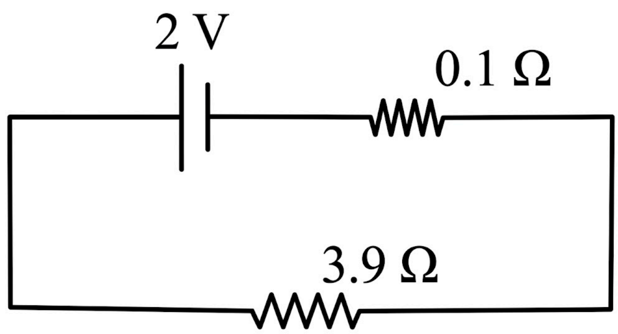
Column - I Angle between $\vec{p}$ and $\vec{E}$	Column - II Potential energy of the dipole
a) 180°	i) –pE
b) 120°	ii) pE
c) 90°	iii) 1/2 pE
	iV) Zero

(A) $a-i, b-ii, c-iii$
(B) $a-ii, b-iii, c-i$
(C) $a-ii, b-i, c-iv$
(D) $a-ii, b-iii, c-iv$

Q21 Which of the following statements is not true?
(A) Work done to move a charge on an equipotential surface is not zero
(B) Equipotential surfaces are the surfaces where the potential is constant
(C) Equipotential surfaces for a uniform electric field are parallel and equidistant from each other
(D) Electric field is always perpendicular to an equipotential surfaces

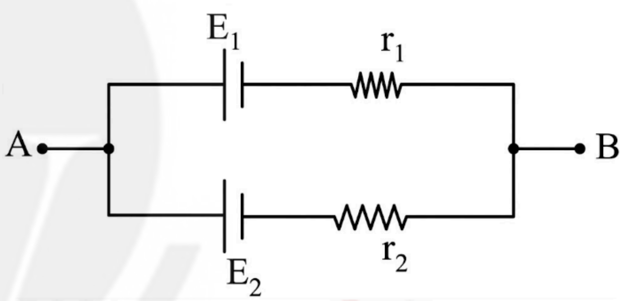
Q22 Which of the following is a correct statement? [KCET 2025]
(A) Gauss's law is true for any open surface
(B) Gauss's law is not applicable when charges are not symmetrically distributed over a closed surface.
(C) Gauss's law does not hold good for a charge situated outside the Gaussian surface.
(D) Gauss's law is true for any closed surface

Q23 In the following circuit, the terminal voltage across the cell is



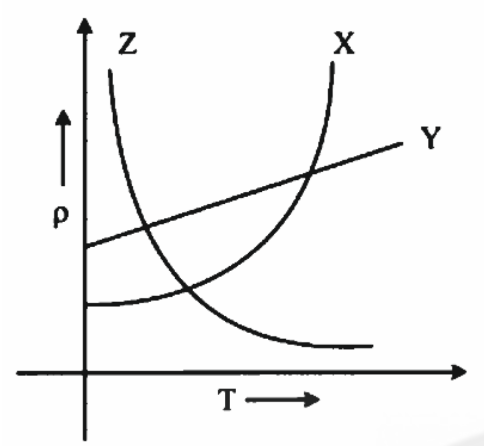
(A) 1.68 V (B) 1.95 V
(C) 2.71 V (D) 0.52 V

Q24 Two cells of emfs E_1 and E_2 and internal resistances r_1 and r_2 and $\left(E_2 < E_1 \text{ and } r_2 > r_1\right)$ respectively, are connected in parallel as shown in figure. The equivalent emf of the combination is E_{eq}. Then



(A) $E_1 < E_{eq} < E_2$ *and* E_{eq} *and* E_{eq} *is* nearer
(B) $E_{eq} > E_2$
(C) $E_{eq} < E_1$
(D) $E_1 < E_{eq} < E_2$ *and* E_{eq} is nearer E_1

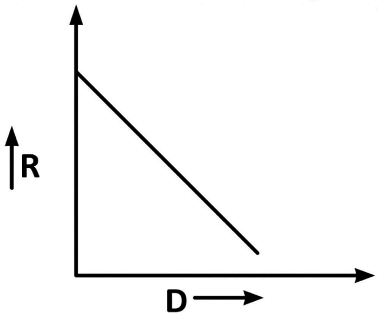
Q25 The variations of resistivity ρ with absolute temperature T for three different materials X, Y and Z are shown in the graph below. Identify the materials X, Y $and\ Z$.

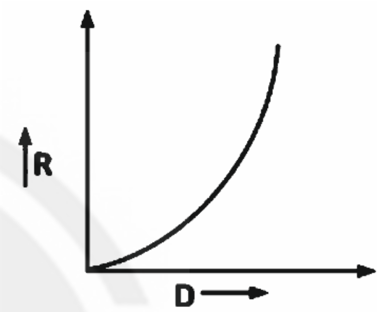


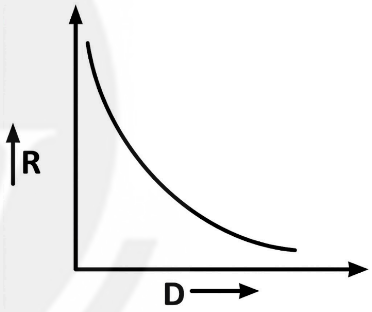
(A) X-copper, Y-semiconductor, Z - nichrome
(B) X-semiconductor, Y - nichrome, Z - copper
(C) X-nichrome, Y-copper, Z-semiconductor
(D) X-copper, Y-nichrome, Z - semiconductor

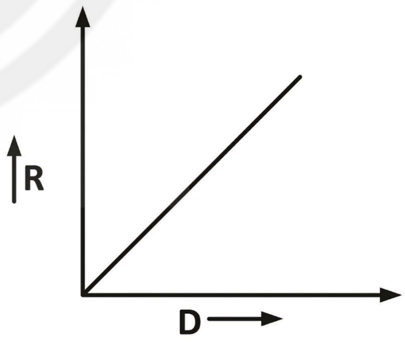
Q26 Given, a current carrying wire of non-uniform cross-section, which of the following is constant throughout the length of wire?
(A) Drift speed
(B) Current and drift speed
(C) Current only
(D) electric field and drift speed

Q27 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 [KCET 2025]

(A)


(B)


(C)


(D)


Q28 Two thin long parallel wires separated by a distance 'r' from each other in vacuum carry a current of I ampere in opposite directions. Then, they will

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

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

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

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

Q29 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

(A) 0.4396×10^{-5} T

(B) 4.396×10^{-2} T

(C) 43.96×10^{-2} T

(D) 439.6 T

Q30 Two similar galvanometers are covered into an ammeter and a milliammeter. The shunt resistance of ammeter as compared to the shunt resistance of milliammeter will be [KCET 2025]

(A) Zero (B) More

(C) Less (D) Equal

Q31 Which of the following statements is true in respect of diamagnetic susbtances? [KCET 2025]

(A) They are feebly attracted by magnets

(B) Permeability is greater than 1000

(C) Susceptibility decreases with temperature.

(D) Susceptibility is small and negative

Q32 Identify the correct statement [KCET 2025]

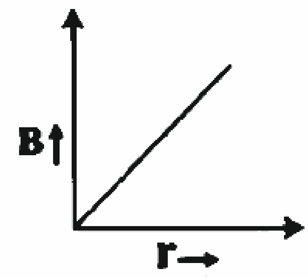
(A) A current carrying conductor produces an electric field around it.

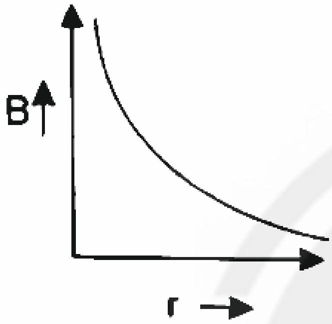
(B) A straight current carrying conductor has circular magnetic field lines around it.

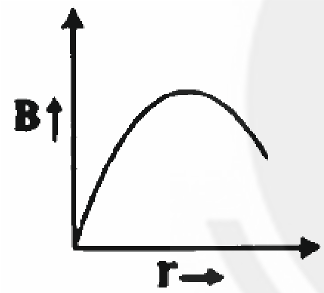
(C) The direction of magnetic field due to a current element is given by Flemings Left Hand Rule

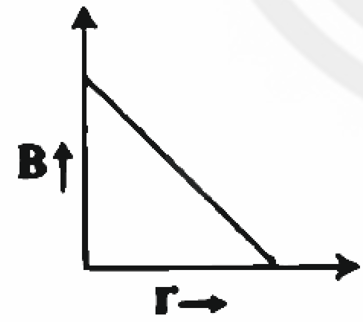
(D) The magnetic field inside a solenoid is non-uniform

Q33 Which of the following graphs represents the variation of magnetic field B with perpendicular distance ' r ' from an infinitely long, straight conductor carrying current? [KET 2025]

(A) 

(B) 

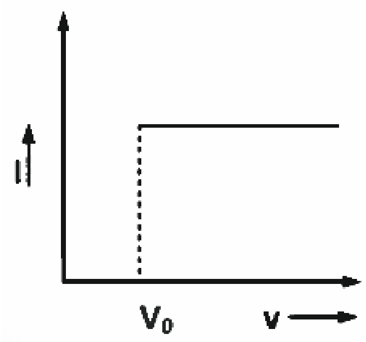
(C) 

(D) 

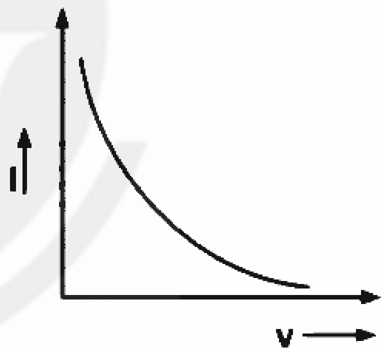
Q34 If we consider an electron and a photon of same de-Broglie wavelength, then they will have same [KCET 2025]

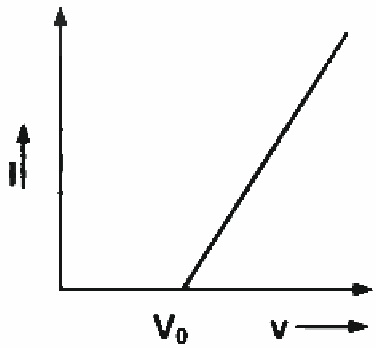
(A) Amgular momentum
(B) Energy
(C) Velocity
(D) Momentum

Q35 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 v of incident light is [KCET 2025]

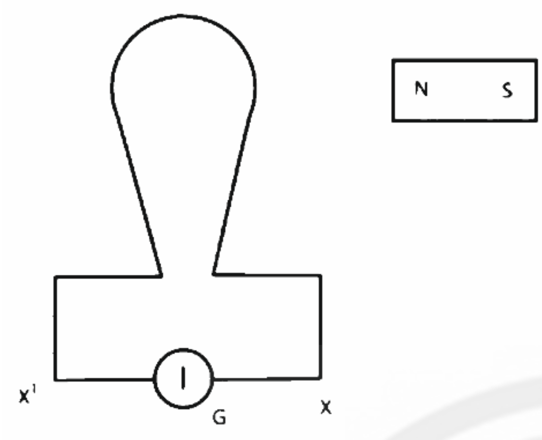
(A) 

(B) 

(C) 

(D) 

Q36 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



(A) Deflects towards X_1

(B) Does not deflect

(C) Osillates

(D) Deflects towards X

Q37 A square loop of side 2 m 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 [KCET 2025]

(A) 20 Wb (B) 12 Wb

(C) 16 Wb (D) 10 Wb

Q38 In domestic electric mains supply, the voltage and the current are [KCET 2025]

(A) AC voltage and DC current

(B) DC Voltage and DC Current

(C) DC voltage and AC Current

(D) AC voltage and AC current

Q39 A sinusoidal voltage produced by an AC generator at any instant t is given by an equation $V = 311 \sin 314t$. The rms value of voltage and frequency are respectively

(A) 200V, 50 Hz (B) 200V, 100 Hz

(C) 220V, 50 Hz (D) 200V, 100 Hz

Q40 A series LCR circuit containing an AC source of 100 V has an inductor and a capacitor of reactances 24Ω and 16Ω respectively. If a resistance of 6Ω is connected in series, then the potential difference across the series combination of inductor and capacitor only is

(A) 80 V (B) 400 V

(C) 8 V (D) 40 V

Q41 Match the following types of waves with their wavelength ranges [KCET 2025]

Waves	Wavelenght ranges
i. Microwave	a. 700 nm to 400 nm
ii. visiable 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

(A) i-c, ii-a,iii-d, iv-b

(B) i-d, ii-b, iii-c, iv-a

(C) i-b, ii-c, iii-a, iv-d

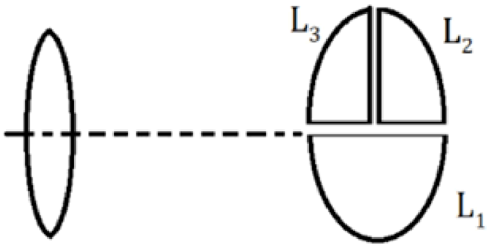
(D) i-a, ii-d, iii-b, iv-c

Q42 A ray of light passes from vaccum 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 [KCET 2025]

(A) $\sin^{-1}\left(\frac{n}{2}\right)$ (B) $2\cos^{-1}\left(\frac{n}{2}\right)$

(C) $2\sin^{-1}\left(\frac{n}{2}\right)$ (D) $\cos^{-1}\left(\frac{n}{2}\right)$

Q43 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 [KCET 2025]



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

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

(C) Power of L_1 is P

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

Q44 The image formed by an objective lens of a compound microscope is [KCET 2025]

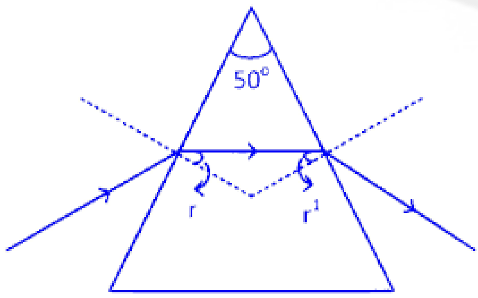
(A) Real and diminished

(B) Real and enalrged

(C) Cirtual and enlarged

(D) Vitrual and diminished

Q45 If r and r^1 denotes the angles inside the prism having angle of prism 50° considering that during interval of time from t = 0 to t = t, r varies with time as r = 10° + t^2 During the time r^1 will vary with time as [KCET 2025]



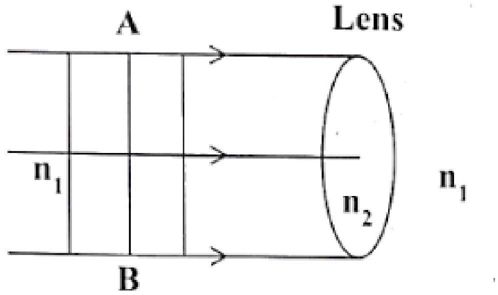
(A) 40° + t^2

(B) 50° – t^2

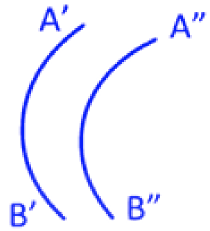
(C) 50° + t^2

(D) 40° – t^2

Q46 If AB is incident plane wave front then refracted wave front in $(n_2 > n_1)$



(A)



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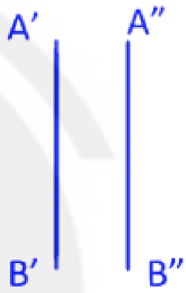

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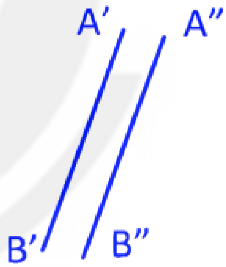
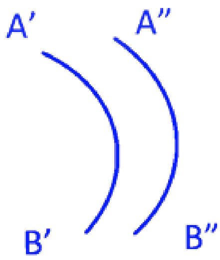


(D)



Q47 The total energy carried by the light wave when it travels from a rarer to a non-reflecting and nonabsorbing medium [KCET 2025]

(A) Remains same

(B) Increases

(C) Either increases or decreases depending upon angle of incidence

(D) Decreases

Q48 If the radius of first Bohr orbit is *r*, then the radius of the second Bohr orbit will be [KCET 2025]

(A) 8 r (B) 4 r

(C) $2\sqrt{2}r$ (D) 2 r

Q49 Match the following types of nuclei with examples shown [KCET 2025]

Column-I	Column-II
A. Isotopes	i. Li^7, Be^7
B. Isobars	ii. $_8O^{18}$, $_9F^{19}$
C. Isotones	iii. $_1H^1$, $^1{}_1H^2$

(A) A-ii, B-iii, C-i

(B) A-i, B-iii, C-ii

(C) A-iii, B-ii, C-i

(D) A-iii, B-i, C-ii

Q50 Which of the following statements is incorrect with reference of 'Nuclear force'? [KCET 2025]

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

(B) Nuclear force becomes repulsive for nucleon distances less then 0.8 fm

(C) Nuclear force is always attractive

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

Q51 The range of electrical conductivity (σ) and resistivity (ρ) for metals, among the following, is [KCET 2025]

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

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

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

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

Q52 Which of the following statements is correct for an n-type semiconductor? [KCET 2025]

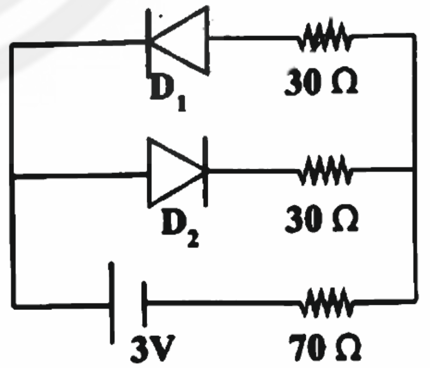
(A) The donor energy level lies closely above the top of the valance band

(B) The donor energy level lies at the half way mark of forbidden energy gap

(C) The donor energy level does not exist

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

Q53 The circuit shown in figure contains two ideal diodes D_1 and D_2. If a cell of emf 3V and negligible internal resistance is connected as shown, then the current through 70Ω resistance, (in ampere) is [KCET 2025]



(A) 0.01 (B) 0.02

(C) 0.03 (D) 0

Q54 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

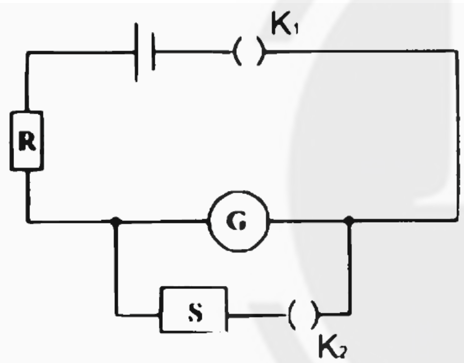
(c) Reading of travelling microscope for chalk dust on glass slab = 8.123 cm

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

(A) 1.500 (B) 1.601

(C) 1.399 (D) 1.390

Q55 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 52000 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 and a resistance of 900 is removed in S, the deflection between 13 div. The resistance of galvanometer is nearly

(A) 45.0 Ω

(B) 103.0Ω

(C) 91.6Ω

(D) 116.0Ω

Q56 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 $r = \sqrt{3} \times 10^{-3} m.$

Trail No	Time Taken 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 ms^{-2}, then the coefficient of viscosity of the given liquid at room temperature is

(A) 0.14 Pa.s

(B) 0.14×10^{-3} Pa.s

(C) 14 Pa.s

(D) 0.28 Pa.s

Q57 Which of the following expression can be deduced on the basis of dimensional analysis? (All symbols have their usual meanings) [KCET 2025]

(A) $X = A\cos\omega t$

(B) $N = N_0 e^{-\lambda t}$

(C) $F = 6\pi\eta r v$

(D) $S = ut + \frac{1}{2}at^2$

Q58 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_o ' seconds after the first stone starts its motion. Then to is equal to [KCET 2025]

(A) $\frac{H}{\Delta t} + \frac{\Delta t}{2g}$

(B) $\frac{H}{g\Delta t} - \frac{\Delta t}{2}$

(C) $\frac{H}{g\Delta t} + \frac{\Delta t}{2}$

(D) $\frac{H}{g\Delta t}$

Q59 In the projectile motion of a particle on a level ground, which of the following remains constant with reference to time and position? [KCET 2025]

(A) Average velocity between any two points on the path

(B) Horizontal component of velocity

(C) Angle between the instantaneous velocity with the horizontal

(D) Vertical component of the velocity of the projectile

Q60 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})

(A) $0.4\hat{j}$
(B) $0.8\hat{i}$
(C) $0.8\hat{j}$
(D) $0.4\hat{i}$

Vernacular

Answer Key

Q1	A
Q2	D
Q3	D
Q4	C
Q5	A
Q6	D
Q7	B
Q8	A
Q9	D
Q10	C
Q11	A
Q12	B
Q13	C
Q14	B
Q15	B
Q16	B
Q17	D
Q18	A
Q19	A
Q20	D
Q21	A
Q22	D
Q23	B
Q24	D
Q25	D
Q26	C
Q27	C
Q28	B
Q29	B
Q30	C
Q31	D
Q32	B
Q33	B
Q34	D
Q35	A
Q36	A
Q37	A
Q38	D
Q39	C
Q40	A
Q41	A
Q42	B
Q43	D
Q44	B
Q45	D
Q46	A
Q47	A
Q48	B
Q49	D
Q50	C
Q51	D
Q52	D
Q53	C
Q54	A
Q55	C
Q56	A
Q57	C
Q58	C
Q59	B
Q60	C

Vernacular

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

A wooden block of mass M rests on a rough floor, while another block of the same mass is suspended from a point O by strings. To maintain equilibrium, we need to determine the coefficient of static friction between the block on the floor and the floor itself.

From the figure and given conditions, we can use the following equations for equilibrium:

The vertical component of tension:

$T\sin\theta = Mg \quad \ldots(i)$

This equation accounts for the vertical force balance, where T is the tension in the string, and θ is the angle made by the string with the vertical.

The horizontal component of tension:

$T\cos\theta = \mu Mg \quad \ldots(ii)$

Here, μ represents the coefficient of static friction.

To find μ, divide equation (ii) by equation (i):

$\frac{T\cos\theta}{T\sin\theta} = \frac{\mu Mg}{Mg}$

$\cot\theta = \mu$

Therefore, the coefficient of static friction is:

$\mu = \cot\theta$

Q2 Text Solution:

To determine the mass of the block, consider the following analysis using the given data:

Friction: Since the block is moving, we deal with kinetic friction in this scenario.

Acceleration Calculation:

$a = \frac{v-u}{t} = \frac{20-0}{3} = \frac{20}{3}$ m/s^2

Here, v is the final velocity, u is the initial velocity, and t is the time.

Net Force Calculation:

The net force acting on the block can be expressed as:

$F - f_k = m \times a$

where F = 20 N is the applied force and f_k is the force due to kinetic friction.

Kinetic Friction Force:

$f_k =$ coefficient of kinetic friction$\times$ normal force$= 0.25 \times m \times g$

Using the Net Force Equation:

Substitute the values into the equation:

$20 - 0.25 \times m \times 10 = m \times \frac{20}{3}$

Solving for m:

$20 - 2.5m = \frac{20}{3}m$

Rearranging the terms gives:

$20 = \frac{20}{3}m + 2.5m$

Combine the terms:

$20 = \left(\frac{20+7.5}{3}\right)m$

$20 = \frac{27.5}{3}m$

Simplifying the equation:

$m = \frac{20\times 3}{27.5}$

Therefore,

$m \approx 2.2$ kg

Thus, the mass of the block is approximately 2.2 kg.

Q3 Text Solution:

To determine the work done by the net force during the displacement of the body, we need to evaluate the change in kinetic energy (ΔKE) as the object moves from to x = 2 m.

The initial velocity u when x = 0 is zero because $v = kx^{3/2}$ and substituting x = 0 gives v = 0.

The final kinetic energy at x = 2m can be found by calculating the velocity at this point:

$v = k \cdot (2)^{3/2}$

Given k = 2 SI units, the velocity at x = 2 is:

$v = 2 \cdot 2^{3/2}$

The change in kinetic energy is:

$\Delta\text{KE} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Substituting m = 0.25 kgand u = 0:

$\Delta\text{KE} = \frac{1}{2} \times 0.25 \times (2 \times 2^{3/2})^2 - 0$

Calculate $\left(2\times 2^{3/2}\right)^2$:
$= (2^1 \times (2^{3/2}))^2 = 2^2 \times (2^3) = 2^5 = 32$

So the change in kinetic energy is:
$\Delta KE = \frac{1}{2} \times 0.25 \times 32$

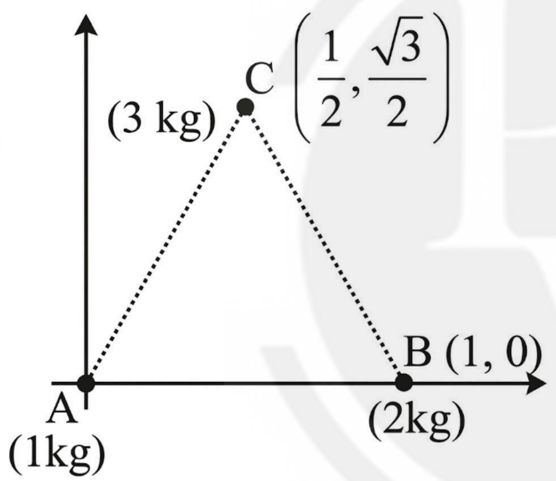
Finally, solving gives:
$= 4$ J

Hence, the work done by the net force during the displacement is 4 Joules.

Q4 Text Solution:

I. Final total kinetic energy equals initial
II. Linear momentum is always conserved
III. During collision kinetic energy gets parthy converted to potential energy
∴All statements are correct

Q5 Text Solution:



$$x_{cm} = \frac{\sum mixi}{\sum mi}$$
$$= \frac{1\times0+2\times1+3\times\frac{1}{2}}{6} = \frac{7}{12}$$
$$y_{cm} = \frac{\sum miyi}{\sum mi} = \frac{1\times0+2\times0+3\times\frac{\sqrt{3}}{2}}{6} = \frac{3\sqrt{3}}{12}$$

Q6 Text Solution:

The relationship between the torque, moment of inertia, and angular acceleration for each wheel can be established with the following equations:
For the smaller wheel:
$T_1 = I_1\alpha_1$
where T_1 is the torque applied to the smaller wheel, $I_1 = 4kg.m^2$ is its moment of inertia, and α_1 is the angular acceleration.

The angular acceleration ratio between the two wheels is given by:
$\alpha_2 r_2 = \alpha_1 r_1$
where α_2 is the angular acceleration of the larger wheel, $r_1 = 0.2\ m\ and\ r_2 = 0.3\ m$
Given that a torque of 10 Nm is applied to the smaller wheel:
$10 = \alpha_1 \times 4$
Solving for α_1:
$\alpha_1 = \frac{10}{4} = \frac{5}{2}$ rad/s^2
Using the relation for the angular accelerations:
$\alpha_2 \times 0.3 = \left(\frac{5}{2}\right) \times 0.2$
$\alpha_2 = \frac{5}{3}$ rad/s^2
Finally, for the larger wheel, the torque T_2 is given by:
$T_2 = I_2\alpha_2$
where $I_2 = 20kg.m^2$. Plugging in the values:
$T_2 = 20 \times \frac{5}{3} = \frac{100}{3}$ Nm
Thus, the angular accelerations and the torque can be summarized as follows:
Angular acceleration of the smaller wheel $\alpha_1 = \frac{5}{2} rad/s^2$
Angular acceleration of the larger wheel $\alpha_2 = \frac{5}{3} rad/s^2$
Torque on the larger wheel $T_2 = \frac{100}{3} Nm$

Q7 Text Solution:

Angular momentum is conserved in an elliptical orbit, meaning:
$L_p = L_a$
where L_p is the angular momentum at perihelion and L_a is the angular momentum at aphelion.
The perihelion is the point in the orbit where the planet is closest to the Sun. Therefore, the radius at perihelion (r_p) is less than the radius at aphelion (r_a):
$r_p < r_a$
Because angular momentum is conserved, we have:

$mv_p r_p = mv_a r_a$

From this, it follows that the velocity at perihelion (v_p) is greater than the velocity at aphelion (v_a):

$v_p > v_a$

Q8 Text Solution:

The total (mechanical) energy E of a satellite in a circular orbit of radius $r = R + h$ is the sum of its kinetic and potential energies. You can show that

Gravitational potential energy:

$U = -\frac{GMm}{r}$

Kinetic energy (for a circular orbit):

$K = \frac{1}{2}\frac{GMm}{r}$

Total energy:

$E = K + U = \frac{1}{2}\frac{GMm}{r} - \frac{GMm}{r} = -\frac{1}{2}\frac{GMm}{r}$

Since G, M and *m* are constants, *E* varies as

$E \propto -\frac{1}{r} = -\frac{1}{R+h}$.

Answer Option: $-\frac{1}{R+h}$

Q9 Text Solution:

The problem involves two wires, A and B, made from the same material. The ratio of their diameters is 1 : 2, and the ratio of their lengths is 1 : 3. When the same force is applied to both wires, we need to determine the ratio of their length increases.

Here's how we can solve it:

The formula for the increase in length $(\Delta\ell)$ when a wire is stretched by a force *F* is given by:

$\Delta\ell = \frac{F\ell}{AY} = \frac{F\ell}{\pi r^2 Y}$

Where:

ℓ is the original length,

A is the cross-sectional area of the wire,

Y is Young's modulus,

r is the radius of the wire.

To find the ratio of the increase in lengths of wires A and B, we calculate:

$\frac{\Delta\ell_1}{\Delta\ell_2} = \left(\frac{\ell_1}{\ell_2}\right) \times \left(\frac{r_2}{r_1}\right)^2$

For wires A and B:

The length ratio $\ell_1 : \ell_2$ is $1 : 3$

The diameter ratio (⇒ radius ratio) is $1 : 2$, so $\frac{r_2}{r_1} = \frac{2}{1}$.

Substitute these values into the equation:

$\frac{\Delta\ell_1}{\Delta\ell_2} = \frac{1}{3} \times \left(\frac{2}{1}\right)^2 = \frac{1}{3} \times 4 = \frac{4}{3}$

Therefore, the ratio of the increase in their lengths is $4 : 3$.

Q10 Text Solution:

The continuity equation for fluid flow states that the product of the cross-sectional area of the pipe and the fluid velocity must remain constant:

$A_1V_1 = A_2V_2$

Given:

$A_1 = 10\,\text{cm}^2 = 10 \times 10^{-4}\,\text{m}^2$

$V_1 = 1\,\text{m/s}$

$A_2 = 5\,\text{cm}^2 = 5 \times 10^{-4}\,\text{m}^2$

Solving for V_2:

$V_2 = \frac{A_1V_1}{A_2} = \frac{10\times10^{-4}\times1}{5\times10^{-4}} = 2\,\text{m/s}$

Applying Bernoulli's Equation:

Bernoulli's equation for steady, incompressible flow along a streamline is:

$P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$

Where:

$P_1 = 2000\,\text{Pa}$

$\rho = 1000 kg/m^3$ (density of water)

Rearranging to find P_2

Substituting the known values:

$P_2 = P_1 + \frac{1}{2}\rho(V_1^2 - V_2^2)$

$P_2 = 2000 + \frac{1}{2} \times 1000 \times (1^2 - 2^2)$

$P_2 = 2000 + \frac{1}{2} \times 1000 \times (1 - 4)$

$P_2 = 2000 + 500 \times (-3) = 2000 - 1500 = 500\,\text{Pa}$

Thus, the pressure of the water at the second point in the pipe is 500 Pa

Q11 Text Solution:

To determine the temperature at the junction *x* of three identical metal rods, follow this analysis:

Assuming No Heat Loss: The rods are made of the same material and are identical, ensuring consistent heat flow throughout.

Thermal Resistance: Let the thermal resistance of each rod be *R*. The temperature at the junction is T_x.

Heat Flow Equilibrium: Since the system reaches a steady state, the heat flowing into the junction from each side should equal the heat flowing out:

$$H = H_1 + H_2$$

Where:

H is the heat flowing into the junction from both ends.

H_1 and H_2 are the heat flows from the sides of the junction.

Application: Set up the heat balance equation:

$$\frac{T_x - 0}{R} = \frac{90 - T_x}{R} + \frac{90 - T_x}{R}$$

Simplifying: Substitute and solve:

$$T_x = \frac{180}{3} = 60^{\circ}\text{C}$$

Therefore, the temperature at the junction *x* is 60°C. This calculation assumes perfect thermal conduction and no heat loss outside the system.

Q12 Text Solution:

According to the first law of thermodynamics, the change in internal energy (ΔU) of a system can be expressed as:

$$\Delta U = Q - W$$

Where *Q* is the heat absorbed by the system and *W* is the work done by the system.

For paths 1 and 2 from state A to state B, the change in internal energy is the same, regardless of the path taken:

$$\Delta U_1 = \Delta U_2$$

Therefore, the heat absorbed and work done along the different paths follows the relationship:

$$Q_1 - W_1 = Q_2 - W_2$$

This equation signifies that the net change in energy (considering both heat and work) is equal for both paths due to the same change in internal energy from state A to state B.

Q13 Text Solution:

The mean kinetic energy of the atoms in an ideal gas is directly proportional to the temperature measured in Kelvin. At an initial temperature of 27°C, the mean kinetic energy is E_1. When the temperature is increased to 327°C, we can determine the new mean kinetic energy E_2 using the relationship:

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

To find E_2, we can rearrange this equation:

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

Converting the given temperatures from Celsius to Kelvin:

Initial temperature,

$$T_1 = 27^{\circ}C + 273 = 300K$$

Final temperature,

$$T_2 = 327^{\circ}C + 273 = 600K$$

Substituting these values into the equation:

$$E_2 = E_1 \left(\frac{600}{300}\right) = E_1 \times 2 = 2E_1$$

Therefore, when the temperature increases to 327°C, the mean kinetic energy of the atoms will be $2E_1$

Q14 Text Solution:

To understand the displacement x_0 where kinetic energy (KE) equals potential energy (PE) in simple harmonic motion (SHM), consider the following explanation:

At the position x_0, the kinetic energy is equal to the potential energy. Mathematically, this is represented by:

$$\frac{1}{2}m\omega^2(A^2 - x^2) = \frac{1}{2}m\omega^2 x^2$$

Here, the left side of the equation represents the kinetic energy, and the right side represents the potential energy. Simplifying the equation:

$$A^2 - x^2 = x^2$$

Rearranging terms, we get:

$$A^2 = 2x^2$$

Solving for x:

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

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

Thus, the value of $|x_0|$ is $\frac{A}{\sqrt{2}}$.

Q15 Text Solution:

In a transverse wave, particles oscillate in a direction perpendicular to the wave's direction of propagation. Therefore, the angle between the particle velocity and wave velocity is $\frac{\pi}{2}$ radians, except when the particle crosses the mean position.

Q16 Text Solution:

Since spheres are electrostatically shielded from each other, $\phi = 0$.

Q17 Text Solution:

To determine the electric flux through sphere 'A', we can apply Gauss's Law, which states that the electric flux ϕ through a closed surface is equal to the charge Q_{enc} enclosed by that surface divided by the permittivity of free space ε_o

For sphere 'A', which passes through the center of the dipole, the enclosed charge is only the negative charge --*q*, since the positive charge +*q* lies outside of sphere 'A'.

Thus, the electric flux through sphere 'A' is calculated as:

$\phi_{\text{sphere}A} = \frac{-q}{\varepsilon_0}$

This result indicates that sphere 'A' encloses a net negative charge, contributing to a negative flux value.

Q18 Text Solution:

To determine the work done in moving a charge from point B to point A, we use the formula:

$W_{ext} = q\Delta V$

Where:

q is the charge being moved, given as 5 mC or $5 \times 10^{-3} C$.

ΔV is the change in electric potential between the two points: $V_f - V_i$

Given:

Potential at point A, $V_A = -3V$

Potential at point B, $V_B = 5V$

Substitute these values into the formula:

$W_{ext} = 5 \times 10^{-3} (V_A - V_B)$

$= 5 \times 10^{-3}(-3 - 5)$

$= 5 \times 10^{-3} \times (-8)$

$= -40 \times 10^{-3}$ J

$= -0.04$ J

Thus, the work done in carrying the charge from point B to point A is –0.04 J

Q19 Text Solution:

For a conducting sphere with uniform surface charge distribution:$(r \geq R)$

Inside the sphere $(r < R)$: The electric field *E*= 0. This is because the electric field within a conductor in electrostatic equilibrium is zero.

Outside the sphere $(r \geq R)$: The electric field behaves like that of a point charge. It can be represented by the equation $E = \frac{kQ}{r^2}$, where *k* is Coulomb's constant, *Q* is the total charge on the sphere, and *r* is the distance from the center of the sphere.

Thus, the graph depicting the electric field as a function of distance *r* should show a flat line at $E = 0$ for $r < R$ and then a curve following the inverse square law $E = \frac{kQ}{r^2}\ for\ r \geq R$

Q20 Text Solution:

The potential energy (PE) of an electric dipole in a uniform electric field is given by the formula:

$\text{PE} = -\vec{p} \cdot \vec{E} = -pE\cos\theta$

Let's evaluate the potential energy for different angles:

(a) $\theta = 180°$

$\text{PE} = -pE\cos 180° = pE$

This corresponds to option (ii) in Column-II.

(b) $\theta = 120°$

$$\mathrm{PE} = -pE\cos 120^\circ = -pE\left(\frac{-1}{2}\right) = \frac{pE}{2}$$

This corresponds to option (iii) in Column-II.

(c) $\theta = 90^\circ$

$$\mathrm{PE} = -pE\cos 90^\circ = 0$$

This corresponds to option (iv) in Column-II.

Thus, the correct matching is:

$a \rightarrow$ (ii)

$b \rightarrow$ (iii)

$c \rightarrow$ (iv)

Q21 Text Solution:

The false statement is Option A.

Reasoning:

By definition, on an equipotential surface the potential *V* is the same everywhere, so any two points have

$\Delta V = 0.$

The work done in moving a charge q through a potential difference ΔV is

$W = q\,\Delta V = q \times 0 = 0.$

Hence it's incorrect to say the work is "not zero."

The other options are all true:

B: Equipotentials are surfaces of constant V.

C: In a uniform field, equipotentials are equally spaced parallel planes.

D: *E* is always perpendicular to equipotential surfaces.

Q22 Text Solution:

The only correct statement is Option D.

Reasoning:

Gauss's law in integral form reads

$\Phi_E = \oint_S \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{\text{enclosed}}}{\varepsilon_0},$

where the surface integral is taken over a **closed** surface *S*.

It holds **for any** closed surface, regardless of its shape or how the enclosed charge is distributed.

Open surfaces (Option A) aren't allowed because the "enclosed" concept only makes sense for closed surfaces.

Symmetry is not required for the **validity** of Gauss's law—it only makes field calculations easier (so Option B is false).

Charges outside the surface contribute zero net flux, but Gauss's law itself still applies (so Option C is false).

Hence:

Option D is correct.

Q23 Text Solution:

To determine the terminal voltage across the cell in the given circuit, we start by calculating the current (i) flowing through the circuit. The formula for the current is:

$i = \frac{\text{Voltage}}{\text{Resistance}} = \frac{2}{4} = \frac{1}{2}$ A

Next, we calculate the terminal voltage using the formula for terminal voltage, which accounts for the internal resistance of the cell:

Terminal voltage$=$ emf $- i \times r$

where:

emf is the electromotive force of the cell (2 V in this case),

i is the current calculated above (1/2 A),

r is the internal resistance of the cell (0.1 Ω).

Substituting these values into the formula:

Terminal voltage$= 2 - \left(\frac{1}{2} \times 0.1\right) = 2 - 0.05 = 1.95$ V

Therefore, the terminal voltage across the cell is 1.95 *V*.

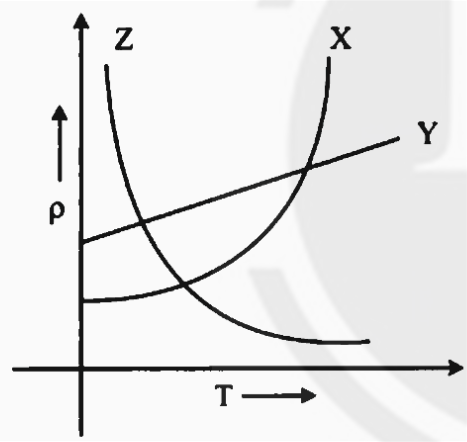
Q24 Text Solution:

To find the equivalent electromotive force (emf) of the two cells connected in parallel, we use the formula for the equivalent emf, E_{eq}, which is given by:

This result represents the combined effect of the two cells' emfs and their internal resistances. The equivalent emf E_1 will lie between E_1 and E_2. Given that $E_2 > E_1$ *and* $r_2 > r_1$, the equivalent emf E_{eq} will be closer to E_2 rather than E_1 because the cell with the larger emf and larger internal resistance will have a more significant influence on the total emf value. Therefore, it can be concluded that $E_1 < E_{eq} < E_2$, and E_{eq} is nearer to E_2.

Q25 Text Solution:

X-copper, Y-nichrome, Z - semiconductor



Q26 Text Solution:

In a steady state circuit the charge per second crossing any section must be the same, so the current *I* is constant. However, for a non-uniform wire:

Drift speed

$v_d = \frac{I}{nqA}$

depends on the local cross-sectional area A, so v_d varies.

Electric field

$E = \rho J = \rho \frac{I}{A}$

also varies with *A*.

Therefore only the current remains the same throughout.

Answer: Option C (Current only).

Q27 Text Solution:

To understand how the resistance of a metal wire varies with its diameter, while keeping other factors like length and temperature constant, we use the formula for resistance:

$R = \frac{\rho\ell}{A} = \frac{\rho\ell}{\pi r^2}$

Where:

R is the resistance.

ρ is the resistivity of the material.

ℓ is the length of the wire.

A is the cross-sectional area of the wire.

r is the radius of the wire.

Since $A = \pi r^2$, the resistance *R* is inversely proportional to the square of the radius:

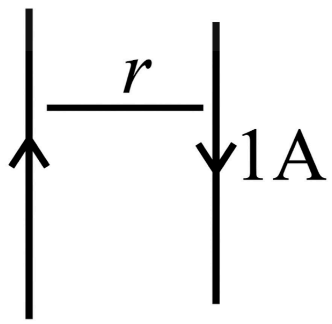
$R \propto \frac{1}{r^2}$

When considering the diameter *d* of the wire, which is twice the radius $(d = 2r)$, the relation can be rewritten in terms of the diameter:

$R \propto \frac{1}{(d/2)^2} = \frac{4}{d^2}$

This indicates that as the diameter of the wire increases, the resistance decreases quadratically. The relationship between resistance *R* and diameter *d* is a hyperbolic function, as resistance is inversely proportional to the square of the diameter.

Q28 Text Solution:

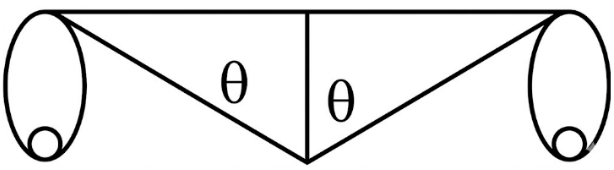


$\frac{f}{\ell} = \frac{\mu_0 i^2}{2\pi r}$

If they carry opposite currently they repeat each other

Q29 Text Solution:

$\ell = 1\text{m}; \text{r} = 2\,\text{cm}; \text{N} = 5000; \text{t} = 7\text{A}; \sin\theta \approx 1$

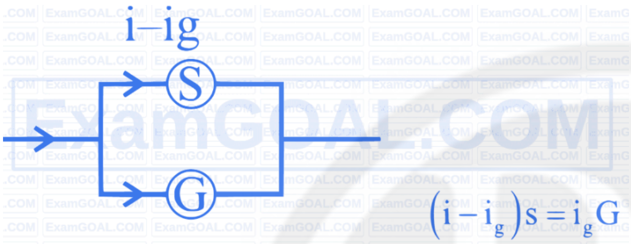


$\text{B} = \frac{\mu_0\,\text{Ni}}{\ell}\sin\theta$

$B = \frac{4\pi\times10^{-7}\times5000\times7\times1}{1}$

$B = 4.396\times10^{-2}\text{T}$

Q30 Text Solution:



$i = i_g\left(\frac{G}{s}+1\right)$

More '*S*', less *i*

So milliammeter will have more shunt resistance.

Q31 Text Solution:

The correct choice is Option D.

Diamagnetic materials develop an induced magnetic moment opposite to an applied field, so their volume susceptibility is small and negative (χ < 0).

They're actually repelled (not attracted) by a magnet.

Their permeability μ is just below 1 (not as high as 1000).

And unlike paramagnets, their susceptibility is essentially independent of temperature.

Q32 Text Solution:

The correct statement is Option B:

Option B

A straight current-carrying conductor has circular magnetic field lines around it.

Why the others are incorrect:

Option A

A neutral, current-carrying wire does not produce an electric field around it (externally it remains electrically neutral).

Option C

Fleming's Left-Hand Rule gives the direction of force on a current in an external magnetic field, not the field created by the current itself. The field around a straight conductor follows the Right-Hand Thumb Rule.

Option D

Inside a long, closely wound solenoid the magnetic field is essentially uniform along its length.

Q33 Text Solution:

The magnetic field *B* around an infinitely long, straight conductor carrying a steady current can be described using the equation:

$B = \frac{\mu_0 i}{2\pi r}$

where:

B is the magnetic field,

μ_0 is the permeability of free space,

i is the current through the conductor, and

r is the perpendicular distance from the conductor.

From this equation, we can see that B is inversely proportional to *r*, which implies:

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

This relationship is characteristic of a rectangular hyperbola, meaning the graph of magnetic field *B* versus distance *r* will form a hyperbolic shape.

Q34 Text Solution:

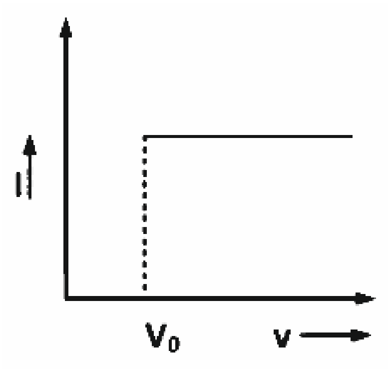
They'll have the same momentum.

Reasoning (from de Broglie's relation):

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

If an electron and a photon share the same λ, they share the same p.

Q35 Text Solution:



Q36 Text Solution:

According to Lenz's Law, a changing magnetic flux through a coil induces an electromotive force (EMF) that opposes the change in flux. When a bar magnet is pushed towards the coil, the change in magnetic flux through the coil causes the galvanometer pointer to deflect in one direction (towards X, in this case). Conversely, when the bar magnet is pulled away from the coil, the change in magnetic flux is in the opposite direction. Thus, the galvanometer pointer will deflect in the opposite direction, which is towards X^1 This occurs as the system attempts to oppose the change in magnetic flux by inducing a current that produces a magnetic field opposing the original direction.

Q37 Text Solution:

To find the magnetic flux through a square loop of side 2 meters that lies in the Y-Z plane, given the magnetic field $\vec{B} = \left(5\hat{i} + 3\hat{j} - 4\hat{k}\right)T$, we proceed as follows:

Determine the area vector:

Since the loop is in the Y-Z plane, its area vector $\overline{A}$ is perpendicular to this plane and points along the X-axis. The magnitude of the area vector is given by the area of the square, which is $2 \times 2 = 4$ square meters. The area vector is thus $\overline{A} = 4\hat{i}$

Calculate the magnetic flux:

The magnetic flux ϕ through the loop is given by the dot product of the magnetic field $\overline{\mathrm{B}}$ and the area vector $\overline{\mathrm{A}}$:

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

Performing the dot product, we have:

$\phi = (5 \times 4) + (3 \times 0) + (-4 \times 0) = 20\,\mathrm{Wb}$

Thus, the magnitude of the magnetic flux through the square loop is $20\,\mathrm{Wb}$.

Q38 Text Solution:

Domestic mains use alternating voltage and thus also alternating current. That matches: Option D: AC voltage and AC current.

Q39 Text Solution:

The sinusoidal voltage from an AC generator at any instant is represented by the equation $V = 311 \ \sin\ 314t$

To determine the root mean square (rms) value of the voltage, we use the formula for the rms value of a sinusoidal voltage:

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

Here, $V_o = 311V$ is the peak voltage.

To find the frequency, we use the relationship between angular frequency (ω) and frequency (f):

$\omega = 2\pi f$

Given $\omega = 314$, we set:

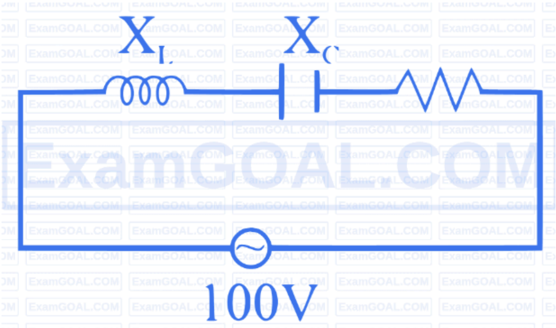
$314 = 2\pi f$

Solving for f, we find:

$f = \frac{314}{2\pi} \approx 50\,\text{Hz}$

Thus, the rms value of the voltage is 220 V, and the frequency is 50 Hz.

Q40 Text Solution:



$X_C = 24\Omega$

$X_L = 16\Omega$

$R = 6\Omega$

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

$= \sqrt{6^2 + 8^2}$

$= \sqrt{100} = 10\Omega$

$\mathrm{i} = \frac{\mathrm{V}}{\mathrm{Z}} = \frac{100}{10} = 10\mathrm{A}$

Net voltage across capacitor and inductor

$= \mathrm{i}\left(\mathrm{X_L} - \mathrm{X_C}\right)$

$= 10(24 - 16)$

$= 10(8)$

$= 80\mathrm{V}$

Q41 Text Solution:

The correct matching is

i. Microwave c. 0.1 m to 1 mm

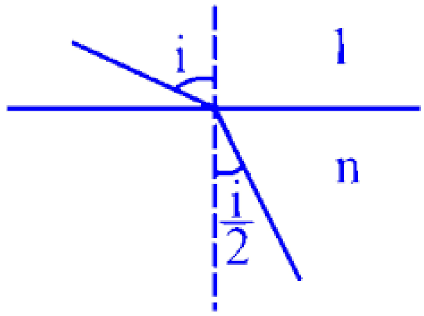
ii. Visible light a. 700 nm to 400 nm

iii. Ultraviolet d. 400 nm to 1 nm

iv. X rays b. 1 nm to 10^{3} nm

That corresponds to **Option A**.

Q42 Text Solution:



$1 \times \sin i = n \sin \frac{i}{2}$

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

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

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

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

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

Q43 Text Solution:

$P_2 \frac{1}{F} = (\mu - 1) \frac{2}{R}$

Power of L1∇ $\rightarrow \mathrm{P}_{L_1} = (\mu - 1) \frac{2}{R} = \mathrm{P}$

Q44 Text Solution:

The objective lens of a compound microscope produces a real, inverted and magnified image of the object.

So the correct choice is:

Option B: Real and enlarged

Q45 Text Solution:

In this problem, we are given two angles, *r* and r^1, inside a prism with an angle of 50°. The angle changes with time according to the equation $r = 10° + t^2$

To find out how r^1 changes with time, we follow these steps:

Since the sum of angles *r* and r^1 inside the prism must equal the prism's angle, we write:

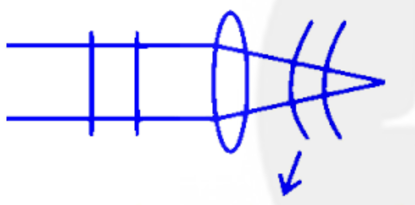
$r + r^1 = 50°$

Substitute the expression for r into the equation:

$(10° + t^2) + r^1 = 50°$ Solve for r^1: $r^1 = 50° - 10° - t^2 = 40° - t^2$

Therefore, during the time interval considered, the angle r^1 varies with time as $40° - t^2$.

Q46 Text Solution:



Refracted wave front

Q47 Text Solution:

When light passes into a non-reflecting, non-absorbing medium, no energy is lost at the boundary. In particular:

Energy flux is given by the (time-averaged) Poynting vector

$\vec{S} = \vec{E} \times \vec{H}$.

For no reflection and no absorption, the tangential components of both fields are continuous across the interface:

$E_1 = E_2, \quad H_1 = H_2$.

Hence the incident and transmitted fluxes are equal:

$S_1 = E_1 H_1 = E_2 H_2 = S_2$.

Since all the energy that arrives is carried forward, the total energy carried by the wave remains the same.

Answer: Option A (remains same).

Q48 Text Solution:

In the Bohr model the radius of the n^{th} orbit is given by

$r_n = n^2 r_1$

where $r_1 = r$ is the radius of the first orbit.

For $n = 2$

$r_2 = 2^2 r_1 = 4r$

Answer: 4 r (Option B)

Q49 Text Solution:

Here's how the examples match up:

Isotopes (same Z, different A)

– ${}_1H^1$, ${}_1H^2$

group iii

Isobars (same A, different Z)

– ${}_3Li^7$, ${}_4Be^7$

group i

Isotones (same N, different Z)

– ${}_8O^{18}$, ${}_9F^{19}$

group ii

So the correct matching is

A–iii, B–i, C–ii Option D.

Q50 Text Solution:

The incorrect statement is Option C.

• At very short separations (r < 0.8 fm) the nuclear force is strongly repulsive (a "hard core").

• For distances r 0.8–3 fm it becomes attractive.

• The potential energy reaches its minimum (stable equilibrium) at roughly r = 0.8 fm.

Since the force is not always attractive (it's repulsive at r < 0.8 fm), saying "nuclear force is always attractive" is wrong.

Q51 Text Solution:

Explanation:

Metals have very low resistivity, on the order of

$\rho \approx 10^{-8}$–$10^{-6}\ \Omega \cdot m$

(for example, copper is about $1.7 \times 10^{-8}\,\Omega \cdot m$).

Their conductivity is the reciprocal,
$\sigma = \frac{1}{\rho} \approx 10^6 – 10^8 \; S/m$.

Option D's intervals
$\rho : 10^{-2} – 10^{-8} \, \Omega m, \quad \sigma : 10^2 – 10^8 \; S/m$

clearly include the true metallic range at the low-ρ/high-σ end.

Q52 Text Solution:

In an n-type semiconductor, donor impurities contribute electron energy levels high in the semiconductor band gap, allowing electrons to be easily excited into the conduction *b* and. This donar level is located closed to, and just below, the bottom of the conduction band.

Q53 Text Solution:

$D_1 \Rightarrow$ revere biased,act as open circuit

$D_2 \Rightarrow$ Forward biased

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

$I \Rightarrow \frac{V}{R_{eq}} = \frac{3}{100} = 0.03A$

Q54 Text Solution:

To determine the refractive index of a glass slab using a traveling microscope, we have recorded the following data:

Reading for the ink mark on the table surface: 5.123 cm

Reading for the ink mark viewed through the glass slab: 6.123 cm

Reading for chalk dust on top of the glass slab: 8.123 cm

Using these readings, we calculate the refractive index (n) of the glass slab as follows:

The real depth of the glass slab is the difference between the reading for chalk dust on the slab and the reading for the ink mark on the table:

Real depth 8.123 cm 5.123 cm 3 cm The apparent depth is the difference between the reading for chalk dust on the slab and the reading for the ink mark viewed through the glass slab:

Apparent depth = 8.123 cm 6.123 cm 2 cm

The refractive index (n) is calculated by dividing the real depth by the apparent depth:

$n = \frac{\text{Real depth}}{\text{Apparent}} = \frac{3cm}{2cm} = 1.5$

Therefore, the refractive index of the glass slab is 1.5.

Q55 Text Solution:

In an experiment to determine the figure of merit of a galvanometer using the half deflection method, a student set up a specific circuit. Here's a representation of that setup:

During the experiment, the student initially removed a resistance of 5200Ω at point R. When switch K_1 was closed and K_2 remained open, the galvanometer showed a deflection of 26 divisions. With both K_1 and K_2 closed and a resistance of 900 removed at S, the galvanometer's deflection adjusted to 13 divisions.

To find the resistance of the galvanometer (G), we use the formula:

$$G = \frac{S'}{\frac{Q_1}{Q_2} - 1}$$

Substituting the values into the formula:

This simplifies to:

$$G = 90\Omega \approx 91.6\Omega$$

Thus, the approximate resistance of the galvanometer is 91.6 Ω.

Q56 Text Solution:

To determine the coefficient of viscosity of a liquid, a spherical steel bal$0.14\,\text{Pa. s}$l sinks a distance of h = 0.9 m. The ball's radius is $r = \sqrt{3} \times 10^{-3} m$. The time taken by the ball to sink as measured in three trials is shown in the table below:

Trail No	Time Taken by the ball to fall by h (in second)
1.	2.75
2.	2.65
3.	2.70

The density difference between the steel ball and the liquid is 7000 kg/m^3, and the gravitational acceleration 9 = 10 m/s^2. We aim to calculate the coefficient of viscosity of the liquid at room temperature.

Average Time:

$$t_{avg} = \frac{2.75+2.65+2.70}{3} = 2.7 \text{ seconds}$$

$$\text{Terminal velocity} = \frac{h}{t_{avg}} = \frac{0.9}{2.7} = \frac{1}{3}\text{m/s}$$

Coefficient of Viscosity:

$$\eta = \frac{2}{9}\frac{\pi r^2 g\left(\rho_{\text{steel}} - \rho_{\text{iquid}}\right)}{v_t}$$

Substituting the values,

$$\eta = \frac{2}{9} \times \frac{\pi \times \left(1.732 \times 10^{-3}\right)^2 \times 10 \times 7000}{\frac{1}{3}}$$

Simplifying these terms, we find:

$$\eta = 0.14\,\text{Pa. s}$$

The coefficient of viscosity of the liquid is 0.14 Pa.s .

Q57 Text Solution:

Only the drag law (Option *C*) follows purely from matching dimensions. In fact, if you assume

F depends on the viscosity *n*, radius r and speed *v* as

$$F \propto \eta^a r^b v^c$$

then dimensional balance

$$\left[MLT^{-2}\right] = \left(ML^{-1}T^{-1}\right)^{a} \cdot L^{b} \cdot \left(LT^{-1}\right)^{c}$$

gives

So

$$F = K\eta r v$$

Where K is a dimensionless constant (in Stokes' solution K = 6π).

The other formulas (A, B, D) involve specific functional forms or numerical factors that dimensional analysis alone cannot fix.

Q58 Text Solution:

To solve this problem, we need to determine the time, denoted as t_0 at which the separation between two falling stones becomes *H*. The second stone starts falling Δt seconds after the first stone.

Distance Fallen by the First Stone (S_1) :

The first stone falls for t_0 seconds, so the distance it covers is given by:

$S_1 = \frac{1}{2}gt_0^2$

Distance Fallen by the Second Stone (S_2) :

The second stone starts falling Δt seconds after the first, so it falls for (t_0 – Δt) seconds.

Thus, the distance it covers is:

$S_2 = \frac{1}{2}g(t_0 - \Delta t)^2$

Distance of Separation (H):

The separation distance between the two stones is:

$H = S_1 - S_2 = \frac{1}{2}gt_0^2 - \frac{1}{2}g(t_0 - \Delta t)^2$

Simplifying the equation:

$$\mathrm{H} = \frac{1}{2}gt_0^2 - \frac{1}{2}g\left(t_0^2 - 2t_0\Delta t + (\Delta t)^2\right)$$
$$= \frac{1}{2}g \cdot \left(2t_0\Delta t - (\Delta t)^2\right)$$
$$= g \cdot \left(t_0\Delta t - \frac{1}{2}\Delta t^2\right)$$

Expression for t_0:

Solving the above equation for t_0, we have:

$$\mathrm{H} = g\left(t_0\Delta t - \frac{1}{2}\Delta t^2\right)$$
$$t_0\Delta t = \frac{H}{g} + \frac{1}{2}\Delta t^2$$
$$t_0 = \frac{H}{g\Delta t} + \frac{\Delta t}{2}$$

Therefore, the time t_0 at which the separation between the two stones becomes H is given by:

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

Q59 Text Solution:

The only quantity that stays unchanged (no acceleration in that direction) is the horizontal component of the velocity. In symbols:

If the launch speed is u at an angle θ above horizontal,

$v_x = u\cos\theta$

and since there's no horizontal acceleration, v_x remains the same at all times and positions.

So the correct choice is:

Option B: Horizontal component of velocity

Q60 Text Solution:

To determine the acceleration of a particle in uniform circular motion, we start with the equation of the circle:

$(x-2)^2 + y^2 = 25$

This equation represents a circle with its center at (2, 0) and a radius r of 5 meters, derived from:

$r^2 = 25 \Rightarrow r = 5$

In uniform circular motion, the centripetal acceleration a_c is given by the formula:

$a_c = \frac{v^2}{r}$

Substituting the given speed v = 2m / s and the radius r = 5 :

$a_c = \frac{2^2}{5} = \frac{4}{5} = 0.8m/s^2$

When the particle is at the lowest y-coordinate, it is at the point (2, -5), assuming downward is along the negative y-axis. At this point, the acceleration vector, which is directed towards the center of the circle, points horizontally to the right towards the center (2, 0). Therefore, the acceleration is entirely in the i direction:

$\vec{a}_e = 0.8\hat{i}m/s^2$