KCET PYQ 2023

PHYSICS

Q1 The Curie temperature of cobalt and iron are 1400 *K* and 1000 *K* respectively. At T = 1600 *K*,, the ratio of magnetic susceptibility of cobalt to that of iron is [KCET 2023]

(A) 1/3 (B) 3
(C) 7/5 (D) 5/7

Q2 The torque acting on a magnetic dipole placed in uniform magnetic field is zero, when the angle between the dipole axis and the magnetic field is ....[KCET 2023]

(A) Zero (B) 45°
(C) 60° (D) 90°

Q3 The horizontal component of Earth's magnetic field at a place is 3×10^{-5} *T*. If the dip at that place is 45°. the resultant magnetic field at that place is [KCET 2023]

(A) $3\times10^{-5}T$
(B) $\frac{3}{\sqrt{2}}\times10^{-5}T$
(C) $3/2\sqrt{3}\times10^{-5}T$
(D) $3\sqrt{2}\times10^{-5}T$

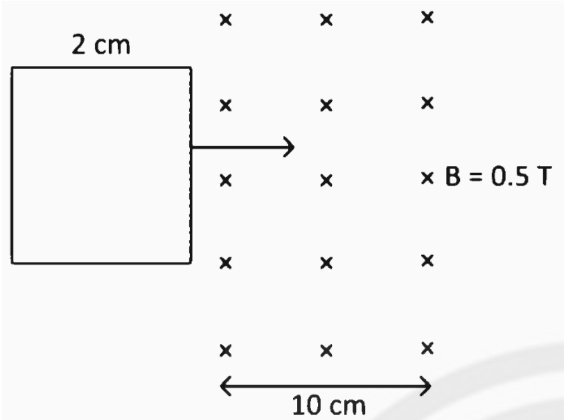
Q4 A proton and an alpha-particle moving with the same velocity enter a uniform magnetic field with their velocities perpendicular to the magnetic field. The ratio of radii of their circular paths is [KCET 2023]

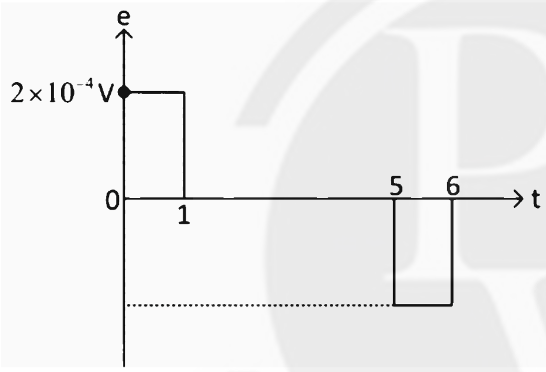
(A) 2 : 1 (B) 1 : 4
(C) 4 : 1 (D) 1 : 2

Q5 A moving coil galvanometer is converted into an ammeter of range 0 to 5 *mA*. The galvanometer resistance is 90Ω and the shunt resistance has a value of 10Ω. If there are 50 divisions in the galvanometer-turned-ammeter on either sides of zero, its current sensitivity is [KCET 2023]

(A) $2\times10^{4}\,div/A$
(B) $1\times10^{5}\,div/A$
(C) $2\times10^{4}\,div/A$
(D) $1\times10^{5}\,div/A$

Q6 A square loop of side 2 cm enters a magnetic field with a constant speed of 2 cm s^{-1} as shown. The front edge enters the field at t = 0 s. Which of the following graph correctly depicts the induced emf in the loop? (Take clockwise direction positive) [KCET 2023]



(A)


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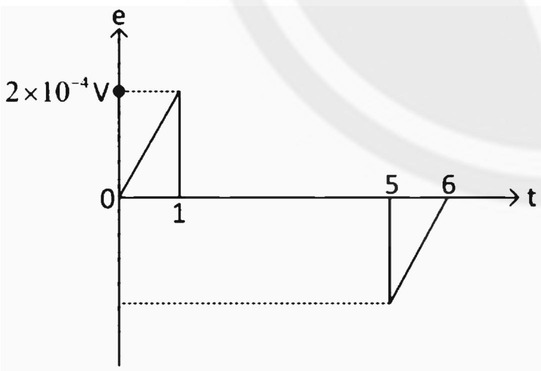

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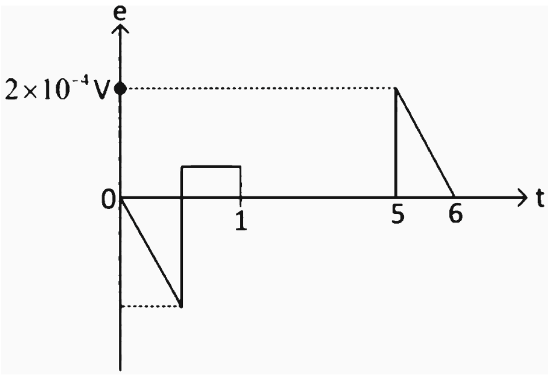
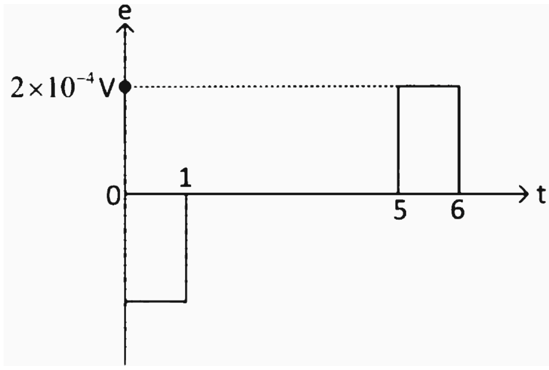


(D)


Q7 In series LCR circuit at resonance, the phase difference between voltage and current is [KCET 2023]

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

Q8 An ideal transformer has a turns ratio of 10. When the primary is connected to 220V, 50 Hz as source, the power output is

(A) 10 times the power input
(B) 1/10 in the power input
(C) equal to power input
(D) Zero

Q9 The current in a coil changes from 2A to 5A in 0.3 s. The magnitude of emf induced in the coil is1.0 V. The value of self-inductance of the coil is [KCET 2023]

(A) 1.0 mH (B) 100 mH
(C) 0.1 mH (D) 10 mH

Q10 A metallic rod of length 1 m held along east-west direction is allowed to fall down freely. Given horizontal component of earth's magnetic field $B_H = 3 \times 10^{-5}$ T the emf induced in the rod at an instant t = 2 s after it is released is (Take, g = 10 ms^{-2}) [KCET 2023]

(A) $6 \times 10^{-4} V$
(B) $3 \times 10^{-3} V$
(C) $3 \times 10^{-4} V$
(D) $6 \times 10^{-3} V$

Q11 For a point object, which of the following always produces virtual image in air? [KCET 2023]

(A) Cancave mirror

(B) Plano-convex lens

(C) Convex mirror

(D) Biconvex lens

Q12 For a given pair of transparent media, the critical angle for which colour is maximum? [KCEt 2023]

(A) Green (B) Red

(C) Blue (D) Voilet

Q13 An equiconvex lens made of glass of refractive index 3/2 has focal length f in air. It is completely immersed in water of refractive index 4/3. The percentage change in the focal length is [KCET 2023]

(A) 400 % increase

(B) 300 % decrease

(C) 400 % decrease

(D) 300% increase

Q14 A point object is moving at a constant speed of 1 ms^{-1} along the principal axis of a convex lens of focal length 10 cm. The speed of the image is also 1 ms^{-1}, when the object is at .... cm from the optical centre of the lens.

(A) 10 (B) 15

(C) 20 (D) 5

Q15 When light propagates through a given homogeneous medium, the velocities of [KCET 2023]

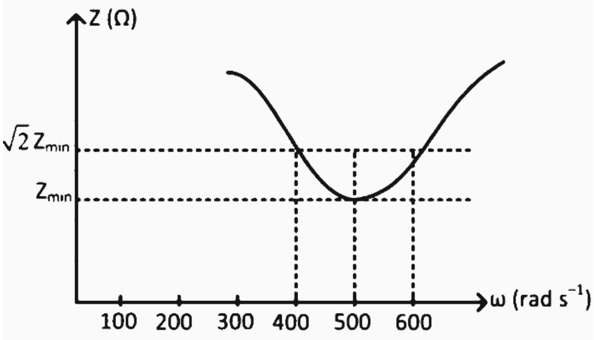
(A) Primary wavefront are larger than those of secondary wavelets.

(B) Primary wavefronts are lesser than those of secondary wavelets.

(C) Primary wavefronts are greater than or equal to those of secondary wavelets.

(D) Primary wavefront and wavelets are equal

Q16 Total impedance of a series *L-C-R* circuit varies with angular frequency of the AC source connected to it as shown in the graph. The quality factor *Q* of the series *L–C–R* circuit is



(A) 0.4 (B) 2.5

(C) 5 (D) 1

Q17 The ratio of the magnitudes of electric field to the magnetic field of an electromagnetic wave is of the order of [KCET 2023]

(A) $10^{-8}\,ms^{-1}$

(B) $10^{5}\,ms^{-1}$

(C) $10^{-5}\,ms^{-1}$

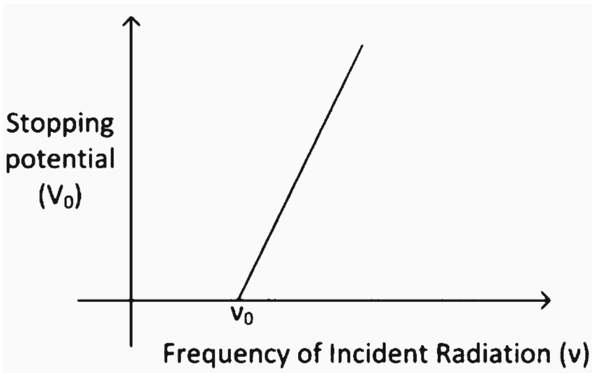
(D) 10^{8} ms^{-1}

Q18 A 60 W source emits monochromatic light of wavelength 662.5 nm. The number of photons emitted per second is [KCET 2023]

(A) 5×10^{17} (B) 2×10^{20}

(C) 5×10^{26} (D) 2×10^{29}

Q19 In an experiment to study photoelectric effect the observed variation of stopping potential with frequency of incident radiation is as shown in the figure. The slope and *Y*-intercept are respectively [KCET 2023]



(A) $\frac{h}{c}, -\frac{h\upsilon_0}{e}$ (B) $\frac{h\upsilon}{e}, \upsilon_o$

(C) $\frac{h\upsilon}{e}, -\frac{h}{e}$ (D) $h\upsilon_1 - h\upsilon_0$

Q20 In the Rutherford's alpha scattering experiment, as the impact parameter increases, the scattering angle of the alpha particle [KCET 2023]

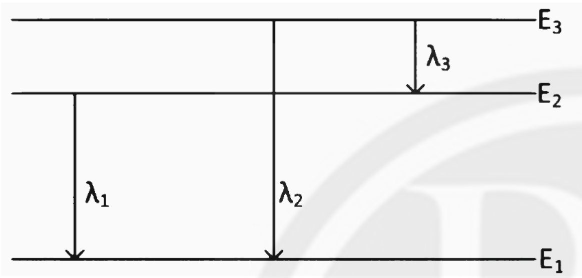
(A) Remains the same

(B) Is always 90°

(C) Decreases

(D) Increases

Q21 Three energy levels of hydrogen atom and the corresponding wavelength of the emitted radiation due to different electron transition are as shown. Then, [KCET 2023]



(A) $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1+\lambda_2}$

(B) $\lambda_1 = \frac{\lambda_2 \lambda_3}{\lambda_2+\lambda_3}$

(C) $\lambda_2 = \lambda_1 + \lambda_3$

(D) $\lambda_2 = \frac{\lambda_1 \lambda_3}{\lambda_1+\lambda_3}$

Q22 An unpolarised light of intensity *I* is passed through two polaroids kept one after the other with their planes parallel to each other. The intensity of light emerging from second polaroid is *I*/4 The angle between the pass axes of the polaroids is [KCET 2023]

(A) 45° (B) 0°

(C) 60° (D) 30°

Q23 In the Young's double slit experiment, the intensity of light passing through each of the two double slits is 2×10^{-2} Wm^{-2} The screen-slit distance is very large in comparison with slit-slit distance. The fringe width is B. The distance between the central maximum and a point *P* on the screen is $x = \frac{\beta}{3}$, Then, the total light intensity at the point is

(A) 8×10^{-2} Wm^{-2}

(B) 4×10^{-2} Wm^{-2}

(C) 2×10^{-2} Wm^{-2}

(D) 16×10^{-2} Wm^{-2}

Q24 A radioactive sample has half-life of 3 years. The time required for the activity of the sample to reduce to 1/5 th of its initial value is about [KCET 2023]

(A) 10 years (B) 7 years

(C) 15 years (D) 5 years

Q25 When a *p-n* junction diode is in forward bias, which type of charge carriers flows in the connecting wire?

(A) Free electrons

(B) Ions

(C) Protons

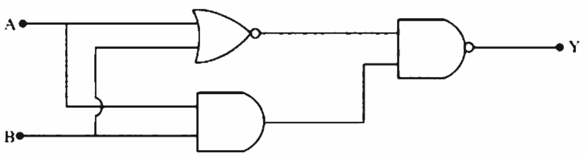
(D) Holes

Q26 A full-wave rectifier with diodes D_1 and D_2 is used to rectify 50 Hz alternating voltage. The diode D_1 conducts ……… times in one second [KCET 2023]

(A) 100 (B) 25

(C) 75 (D) 50

Q27 A truth table for the given circuit is [KCET 2023]



(A)

A	B	Y
1	1	1
1	0	1
0	1	0
0	0	1

(B)

A	B	Y
1	1	1
1	0	0
0	1	0
0	0	1

(C)

A	B	Y
1	1	1
1	0	1
0	1	1
0	0	1

(D)

A	B	Y
1	1	1
1	0	1
0	1	1
0	0	0

Q28 The energy gap of an LED is 2.4 *eV*. When the LED is switched ON, the momentum of the emitted photons is [KCET 2023]

(A) 1.28×10^{-27} kg ms^{-1}

(B) 2.56×10^{-27} kg ms^{-1}

(C) 1.28×10^{-1} kg ms^{-1}

(D) 0.64×10^{-27} kg ms^{-1}

Q29 In the following equation representing β^- decay, the number of neutrons in the nucleus X is

${}^{210}_{83}Bi \to X + e^{-1} + \overline{v}$ [KCET 2023]

(A) 126 (B) 127

(C) 125 (D) 84

Q30 A nucleus with mass number 220 initially at rest emits an alpha particle. If the Q value of reaction is 5.5 MeV. Calculate the value of kinetic energy of alpha particle [KCET 2023]

(A) 6.5 MeV (B) 5.4 MeV

(C) 7.4 MeV (D) 4.5 MeV

Q31 A particle is in uniform circular motion, related to one complete revolution of the particle, which among the statements is incorrect? [KCET 2023]

(A) Average acceleration of the particle is zero.

(B) Displacement of the particle is zero.

(C) Average speed of the particle is zero.

(D) Average velocity of the particle is zero.

Q32 A body of mass 10 kg is kept on a horizontal surface. The coefficient of kinetic friction between the body and the surface is 0.5. A horizontal force of 60 N is applied on the body. The resulting acceleration of the body is about [KCET 2023]

(A) 1 ms^{-2} (B) 5 ms^{-2}

(C) 6 ms^{-2} (D) Zero

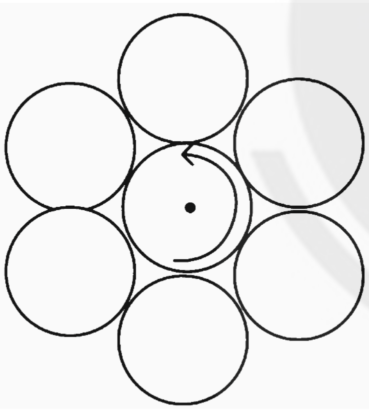
Q33 A ball of mass 0.2 kg is thrown vertically down from a height of 10 m. It collides with the floor and loses 50% of its energy and then rises back to the same height. The value of its initial velocity is [KCET 2023]

(A) Zero
(B) 14 ms^{-1}
(C) 169 ms^{-1}
(D) 20 ms^{-1}

Q34 The moment of inertia of a rigid body about an axis [KCET 2023]

(A) Does not depend on its mass
(B) Does not depend on its shape
(C) Depends on the position of axis of ratation
(D) Does not depend on its size

Q35 Seven identical discs are arranged in a planar pattern, so as to touch each other as shown in the figure. Each disc has mass *m* radius *R*. What is the moment of inertia of system of six discs about an axis passing through the centre of central disc and normal to plane of all discs? [KCET 2023]



(A) 27 mR^2
(B) 100 mR^2
(C) 55 $mR^2/2$
(D) 85 $mR^2/2$

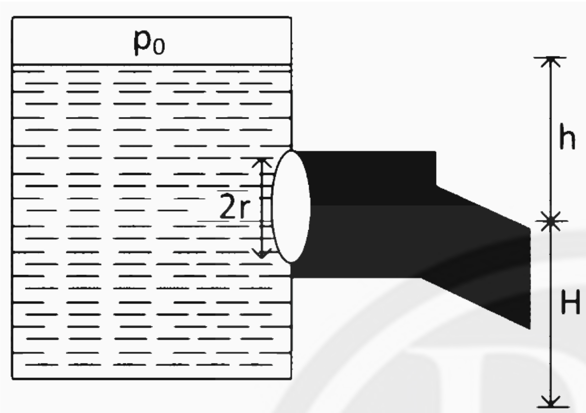
Q36 The true length of a wire is 3.678 cm. When the length of this wire is measured using instrument A, the length of the wire is 3.5 cm. When the length of the wire is measured using instrument B, it is found to have length 3.38 cm. Then, the [KCET 2023]

(A) Measurement with A is more accurate and precise.
(B) Measurement with A is more accurate while measurement with B is more precise.
(C) Measurement with B is more accurate and precise.
(D) Measurement with A is more precise while measurement with B is more constant

Q37 A body is moving along a straight line with initial velocity v_0. Its acceleration a is constant. After t seconds, its velocity becomes v. The average velocity of the body over the given time interval is [KCET 2023]

(A) $\overline{v} = \frac{v^2 - v_0^2}{at}$
(B) $\overline{v} = \frac{v^2 + v_0^2}{2at}$
(C) $\overline{v} = \frac{v^2 + v_0^2}{at}$
(D) $\overline{v} = \frac{v^2 - v_0^2}{2at}$

Q38 A closed water tank has cross-sectional area A. It has a small hole at a depth of *h* from the free surface of water. The radius of the hole is *r* so that $r << \sqrt{\frac{A}{\pi}}.\ if\ p_o$ is the pressure inside the tank above water level and p_a is the atmospheric pressure, the rate of flow of the water coming out of the hole is (*p* is density of water) [KCET 2023]



(A) $\pi r^2\sqrt{2gh}$

(B) $\pi r^2\sqrt{2gh+\frac{2(p_0-p_a)}{p}}$

(C) $\pi r^2\sqrt{2gh}$

(D) $\pi r^2\sqrt{gh+\frac{2(p_0-p_0)}{p}}$

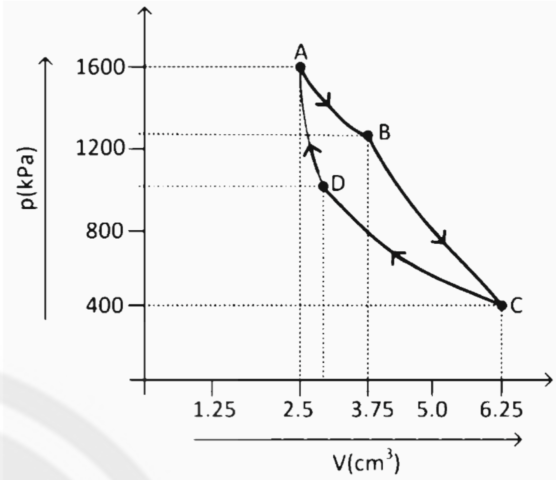
Q39 100 g of ice at 0°C is mixed with 100 g of water at 100°C. The final temperature of the mixture is [KCET 2023]

[Take $L_f = 3.36\times10^5\,Jkg^{-1}\ and\ s_w = 4.2\times10^3\,Jkg^{-1}K^{-1}$]

(A) 40°C (B) 10°C

(C) 50°C (D) 1°C

Q40 The *p*–*V* diagram of a Carnot's engine is shown in the graph below. The engine uses 1 mole of an ideal gas as working substance. From the graph, the area enclosed by the *p*–*V* diagram is [The heat supplied to the gas is 8000 J] [KCET 2023]



(A) 1200 J (B) 2000 J

(C) 3000 J (D) 1000 J

Q41 When a planet revolves around the Sun, in general, for the planet [KCET 2023]

(A) Linear momentum and linear velocity are constant.

(B) Linear momentum and areal velocity are constant.

(C) Kinetic and potential energy of the planet are constant.

(D) Angular momentum about the Sun and areal velocity of the planet are constant.

Q42 A stretched wire of a material whose young's modulu $Y = 2\times10^{11}\,Nm^{-2}$ has poisson's ratio 0.25 . Its lateral strain $\varepsilon_l = 10^{-3}$. The elastic energy density of the wire is

(A) 1.6 × 10^6 Jm^{-3}

(B) 1 × 10^5 Jm^{-3}

(C) 4 × 10^5 Jm^{-3}

(D) 8 × 10^5 Jm^{-3}

Q43 The speed of sound in an ideal gas at a given temperature T is v. The rms speed of gas molecules at that temperature is v_{rms}. The ratio of the velocities v and v_{rms} for helium and oxygen gases are X and X' respectively. Then, $\frac{X}{X'}$ is equal to [KCET 2023]

(A) $\frac{21}{\sqrt{5}}$ (B) $\frac{5}{\sqrt{21}}$

(C) $\sqrt{\frac{5}{\sqrt{21}}}$ (D) $\frac{21}{5}$

Q44 A positively charged glass rod is brought near uncharged metal sphere, which is mounted on an insulated stand. If the glass rod is removed, the net charge on the metal sphere is [KCET 2023]

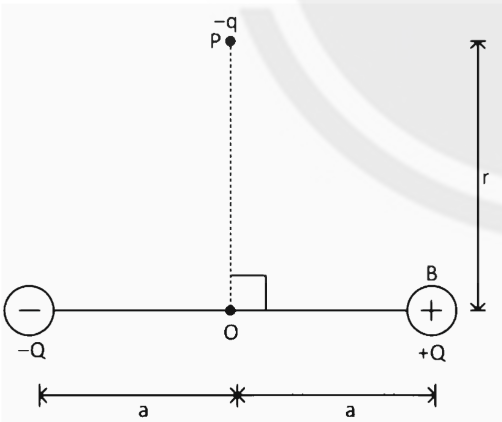
(A) Negative charge

(B) Zero

(C) 1.6×10^{-19} C

(D) Positive charge

Q45 In the situation shown in the diagram, magnitude, if $q << |Q|$ and $r >>> a$. The net force on the free charge $-q$ and net torque on it about O at the instant shown are respectively. ($p = 2aQ$ is the dipole moment)



(A) $\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^3}\hat{i}, -\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^2}\hat{k}$

(B) $\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^3}\hat{k}, \frac{1}{4\pi\varepsilon_o}\frac{pq}{r^2}\hat{i}$

(C) $-\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^3}\hat{k}, -\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^3}\hat{i}$

(D) $\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^3}\hat{i}, +\frac{1}{4\pi\varepsilon_o}\frac{pq}{r^2}\hat{k}$

Q46 Pressure of ideal gas at constant volume is proportional to .... [KCET 2023]

(A) Force between the molecules

(B) Average potential energy of the molecules

(C) Total energy of the gas

(D) Average kinetic energy of the molecules

Q47 A block of mass m is connected to a light spring of force constant k. The system is placed inside a damping medium of damping constant b. The instantaneous values of displacement, acceleration and energy of the block are x, a and E respectively. The initial amplitude of oscillation is A and ω' is the angular frequency of oscillations. The incorrect expression related to the damped oscillations is

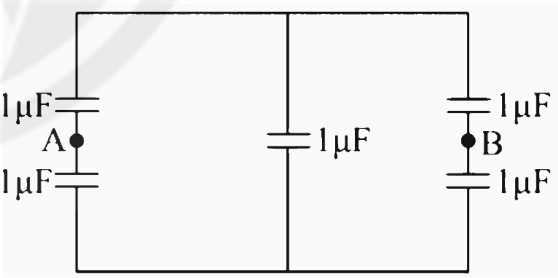
(A) $x = Ae^{-\frac{b}{m}}\cos(\omega't + \phi)$

(B) $\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

(C) $E = \frac{1}{2}kA^2e^{-\frac{bt}{m}}$

(D) $m\frac{d^2x}{dt^2}b\frac{dx}{dt} + kx = 0$

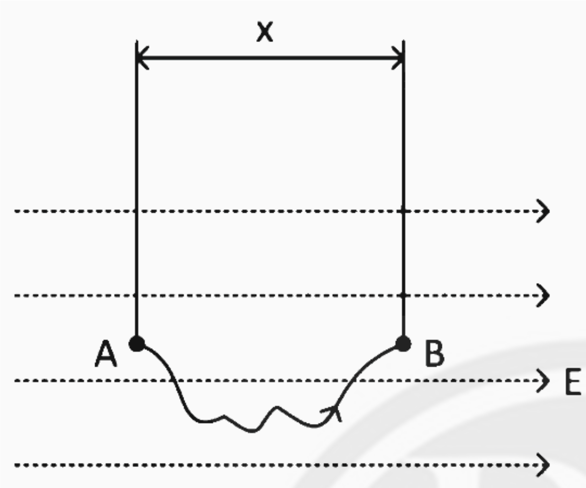
Q48 Five capacitance each of value $1\mu F$ are connected as shown in the figure. The equivalent capacitance between A and B is [KCET 2023]



(A) $3\mu F$ (B) $1\mu F$

(C) $2\mu F$ (D) $5\mu F$

Q49 A uniform electric field vector E exists along horizontal direction as shown. The electric potential at A is V_A. A small point charge q is slowly taken from A to B along the curved path as shown. The potential energy of the charge when it is at point B is [KCET 2023]

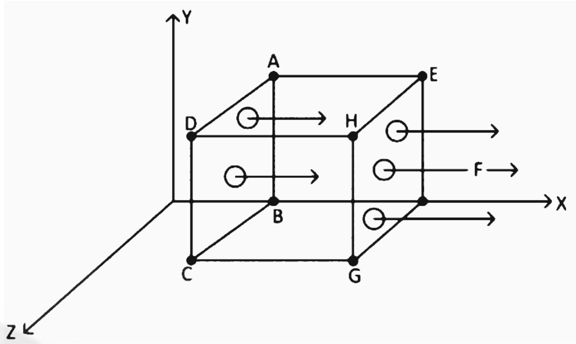


(A) $q[V_A - E_x]$ (B) $q[V_A + E_x]$
(C) $q[Ex - V_A]$ (D) qEx

Q50 A parallel plate capacitor of capacitance C_1 with a dielectric slab in between its plates is connected to a battery. It has a potential difference V_1 across its plates. When the dielectric slab is removed, keeping the capacitor connected to the battery, the new capacitance and potential difference are C_2 and V_2 respectively, Then [KCET2023]

(A) $V_1 = V_2, C_1 < C_2$
(B) $V_1 > V_2, C_1 > C_2$
(C) $V_1 < V_2, C_1 > C_2$
(D) $V_1 = V_2, C_1 > C_2$

Q51 A cubical Gaussian surface has side of length a = 10 cm. Electric field lines are parallel to X-axis as shown in figure. The magnitudes of electric fields through surfaces $ABCD$ and $EFGH$ are 6 kNC^{-1} and 9 kNC^{-1} respectively. Then, the total charge enclosed by the cube is [KCET 2023]
[Take $\varepsilon_o = 9 \times 10^{12} Fm^{-1}$]



(A) –0.27 nC (B) 1.35 nC
(C) –1.35 nC (D) 0.27 nC

Q52 Electric field at a distance r from an infinitely long uniformly charged straight conductor, having linear charge density λ is E_1. Another uniformly charged conductor having same linear charge density λ is bent into a semicircle of radius r. The electric field at its centre is E_2. Then [KCET 2023]

(A) $E_2 = \pi r E_1$ (B) $E_2 = E_1/r$
(C) $E_1 = E_2$ (D) $E_1 = \pi r E_2$

Q53 A wire of resistance R is connected across a cell of emf (ε) and internal resistance (r). The current through the circuit is I. In time t, the work done by the battery to establish the current I is [KCET 2023]

(A) εIt (B) $\frac{\varepsilon^2 t}{R}$
(C) IRt (D) $I^2 Rt$

Q54 For a given electric current the drift velocity of conduction electrons in a copper wire is v_d and their mobility is μ. When the current is increased at constant temperature [KCET 2023]

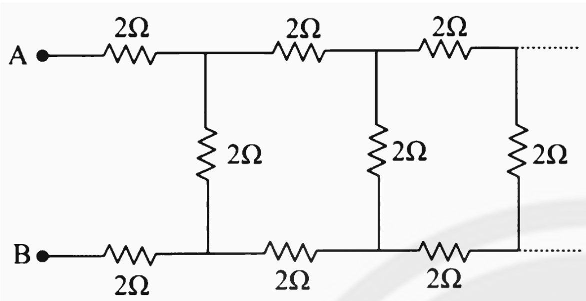
(A) v_d increases, μ remains the same
(B) v_d remains the same, μ increases
(C) v_d decreases, μ remains the same
(D) v_d remains the same, μ decreases

Q55 Ten identical cells each emf 2 V and internal resistance 1Ω are connected in series with two cells wrongly connected. A resistor of 10 Ω is connected to the combination. What is the current through th resistor? [KCET2023]

(A) 1.8 A (B) 2.4 A

(C) 0.6 A (D) 1.2 A

Q56 The equivalent resistance between the points A and B in the following circuit is [KCET 2023]



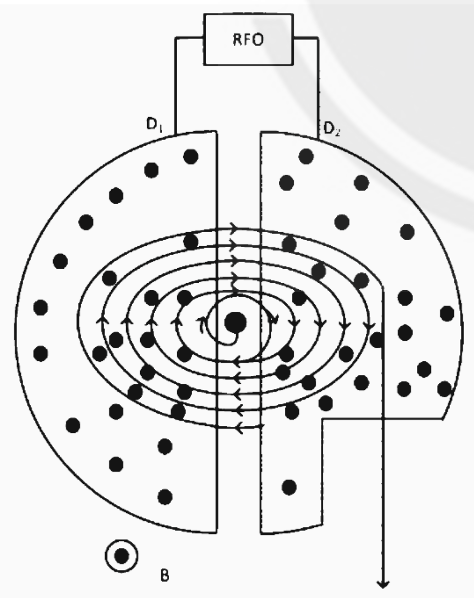
(A) 0.5 Ω

(B) 5.5 Ω

(C) 0.05 Ω

(D) 5 Ω

Q57 A charged particle is subjected to acceleration in a cyclotron as shown. The charged particle undergoes increase in its speed [KCET 2023]



(A) Only in the gap between D_1 and D_2

(B) Only inside D_2

(C) Inside D_1,

(D) D_2 and the gaps Only inside D_1

Q58 The resistance of a carbon resistor is $4.7k\Omega \pm 5\%$ The colour of the third band is [KCET 2023]

(A) Gold (B) Red

(C) Violet (D) Orange

Q59 The four bands of a colour coded resistor are of the colours grey, red, gold and gold. The value of the resistance of the resistor is [KCET 2023]

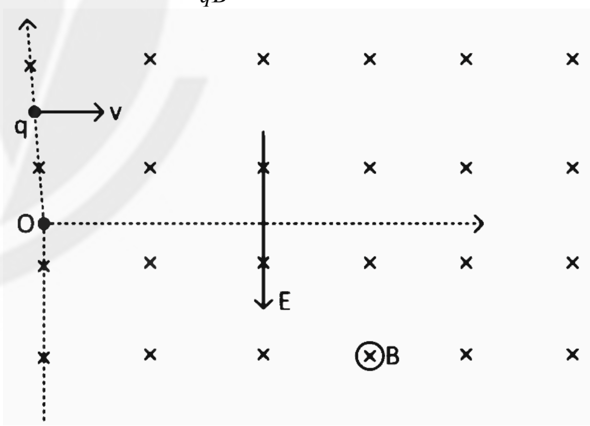
(A) $5.2\Omega \pm 5\%$

(B) $82\Omega \pm 10\%$

(C) $8.2\Omega \pm 5\%$

(D) $82\Omega \pm 5\%$

Q60 A positively charged particle *q* of mass *m* is passed through a velocity selector. It moves horizontally rightward without deviation along the line $y = \frac{2mv}{qB}$ with a speed *v*. The electric field is vertically downwards and magnetic field is into the plane of paper. Now, the electric field is switched off at *t*=0. The angular momentum of the charged particle about origin *O* at $t = \frac{\pi m}{qB}$ is [KCET 2023]



(A) $\frac{4m^2E^2}{qB^3}$ (B) $\frac{2mE^2}{9B^3}$

(C) Zero (D) $\frac{mE^3}{qB^2}$

Answer Key

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

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

We know that, magnetic susceptibility,

$\chi = \frac{C}{T-T_C}$

$\therefore \quad \chi \propto \frac{1}{T-T_C}$

$\Rightarrow \frac{\chi_{\text{cobalt}}}{\chi_{\text{iron}}} = \frac{T-(T_C)_{\text{iron}}}{T-(T_C)_{\text{cobalt}}}$

$= \frac{1600-1000}{1600-1400} = \frac{600}{200} = 3$

Q2 Text Solution:

Given, $\tau = 0$

$\Rightarrow MB\sin\theta = 0 \Rightarrow \sin\theta = 0$

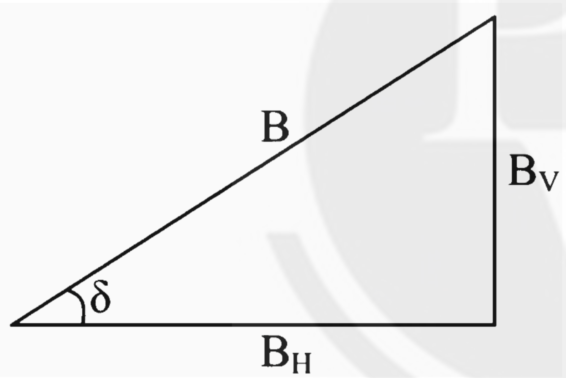
$\Rightarrow \quad \theta = 0^\circ$

Q3 Text Solution:

Given

$B_H = 3 \times 10^{-5} T$

$\delta = 45°$



From the diagram

$\cos\delta = \frac{B_H}{B}$

$\Rightarrow \quad B = \frac{B_H}{\cos\delta} = \frac{3\times10^{-5}}{\cos 45^\circ}$

$= 3\sqrt{2} \times 10^{-5}\text{T}$

Q4 Text Solution:

Radius of charged particle moving on circular path in uniform magnetic field,

$r = \frac{mv}{Bq}$

$r \propto \frac{m}{q}$

$\frac{r_p}{r_\alpha} = \frac{m_p}{m_\alpha} \cdot \frac{q_\alpha}{q_p} = \frac{m_p}{4m_p} \times \frac{2e}{e} = \frac{1}{2}$

$\Rightarrow r_p : r_\alpha = 1 : 2$

Q5 Text Solution:

Given,

$S = 10\Omega$

$G = 90\Omega$

$i = 5 \times 10^{-3}\text{A}$

Number of divisions on one side of zero $= 50$

$i_g = \frac{S}{S+G} \times i = \left(\frac{10}{90+10}\right)\left(5 \times 10^{-3}\right) = 5 \times 10^{-4}\text{A}$

Number of divisions per unit current

$= \frac{50}{5\times10^{-4}} = 1 \times 10^{-5}\ \text{div/A}$

Q6 Text Solution:

As the loop moves, there are three cases.

(i) When the loop moves fully outside the magnetic field, there is no change in flux.

$\therefore \varepsilon = \frac{d\phi}{dt} = 0$

(ii) When the loop is entering/leaving the area of magnetic field.

$\varepsilon = BLV = (0.5)\left(2 \times 10^{-2}\right)\left(2 \times 10^{-2}\right)$

$= 2 \times 10^{-4}\text{V}$

As flux is in opposite direction to magnetic field

ε when loop enters the field $= -2 \times 10^{-4}\text{V}$

ε when loop exits the field $= -\left(-2 \times 10^{-4}\text{V}\right)$

$= 2 \times 10^{-4}\text{V}$

(iii) When moving inside the magnetic field.

$\frac{d\phi}{dt} = 0$

No emf is induced.

Q7 Text Solution:

In L-C-R series resonance circuit,

$X_L = X_C$

$\therefore \tan\phi = \frac{X_L - X_C}{R} = \frac{0}{R} = 0$

$\Rightarrow \quad \phi = 0^\circ$

Q8 Text Solution:

For ideal transformer, input power is equal to output power.

Q9 Text Solution:

$\Delta I=5-2=3\text{A}$

$\Delta t=0.3\text{s}$

Induced emf $e=1\text{V}$

We know that, $e=\frac{LdI}{dt}$

$\Rightarrow \quad e=\frac{L\Delta I}{\Delta t}$

$\Rightarrow \quad L=\frac{e}{\frac{\Delta I}{\Delta t}}=\frac{1}{\frac{3}{0.3}}=0.1\text{H}=100\,\text{mH}$

Q10 Text Solution:

Given, $B_H=3\times10^{-5}\text{T}$

$l=1\text{m}$

velovity v = gt = 10 x 2 = 20 m/s

Hence, induced emf

$e= B_H vl=3\times10^{-5}\times 1x\ 20$

$=6\times10^{-4}\text{V}$

Q11 Text Solution:

Convex mirror always produces virtual, erect and diminished image in air.

Q12 Text Solution:

Red light has the longest wavelength and the smallest refractive index within the visible region. Thus, it bends least when passing from glass to air. As a result, its critical angle is maximum.

Q13 Text Solution:

Given

${}^a\mu_g=\frac{3}{2}, f_{\text{air}}=f$

${}^a\mu_w=\frac{4}{3}$

Using lens Maker's Formula, when lens in in air,

$$\frac{1}{f_{\text{air}}}=\left({}^a\mu_g-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\Rightarrow \quad \frac{1}{f}=\left(\frac{3}{2}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\Rightarrow \frac{1}{f}=\frac{1}{2}\left(\frac{1}{R_1}-\frac{1}{R_2}\right).......(i)$$

When lens is immersed in water, then

$$\frac{1}{f_w}=\left({}^w\mu_g-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)......(ii)$$

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{f_w}{f}=\frac{1}{2\left({}^w\mu_g-1\right)}$$

$$\Rightarrow \quad f_w=\frac{f}{2\left(\frac{\mu_g}{\mu_w}-1\right)}=\frac{f}{2\left(\frac{\frac{3}{2}}{\frac{4}{3}}-1\right)}=\frac{f}{\frac{1}{4}}=4f$$

$$\Rightarrow \quad f_w=4f$$

Percentage change in focal length

$$=\frac{f_w-f}{f}\times100$$

$$=\frac{4f-f}{f}\times100=300\%$$

Q14 Text Solution:

Given:

Focal length, $f=10$ cm

Speed of the object, $\frac{du}{dt}=1$ m/s

Speed of the image, $\frac{dv}{dt}=1$ m/s

Using the Lens Formula:

$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ (i)

$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{u-f}{fu}\Rightarrow v=\frac{fu}{u-f}$ (ii)

Differentiating Equation (i) with respect to *t*:

$$\frac{d\left(\frac{1}{f}\right)}{dt}=\frac{d\left(\frac{1}{u}\right)}{dt}+\frac{d\left(\frac{1}{v}\right)}{dt}$$

Since $1/f$ is a constant, its derivative is zero:

$$0=-\frac{1}{u^2}\cdot\frac{du}{dt}-\frac{1}{v^2}\cdot\frac{dv}{dt}$$

which simplifies to:

$$\frac{1}{u^2}\cdot\frac{du}{dt}=-\frac{1}{v^2}\cdot\frac{dv}{dt}$$

Further simplifying, we have:

$$-\frac{v^2}{u^2}=\frac{dv}{dt}\cdot\frac{dt}{du}$$

Substitute values from Equation (ii):

$$-\frac{(fu)^2}{(u-f)^2}\cdot\frac{1}{u^2}=\frac{dv}{dt}\cdot\frac{dt}{du}$$

This results in:

$$(u-f)^2=f^2\cdot\frac{du}{dt}\cdot\frac{dt}{dv}$$

Substitute the given values into the equation:

$$(u-10)^2=(10)^2\cdot1\cdot\frac{1}{1}=10^2$$

Thus, $u-10=10\Rightarrow u=20$ cm

Therefore, the object must be 20 cm from the optical center of the lens for the image to move at the same speed.

Q15 Text Solution:

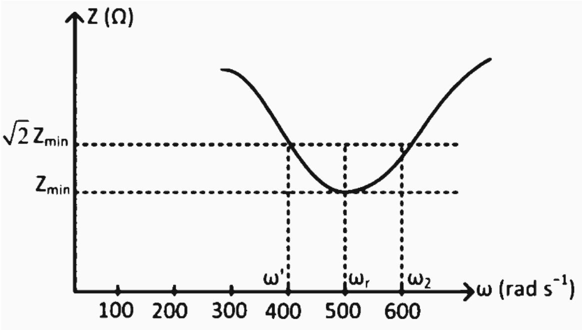
According to Huygen's principle, in homogeneous medium, velocity of primary wavefront is equal to velocity of secondary wavelets.

Q16 Text Solution:

According to given diagram,

$\omega_1=400\,\text{rad/s};\quad \omega_r=500\,\text{rad/s}$

$\omega_2=600\,\text{rad/s}$



Quality factor,

$Q = \frac{\omega_r}{\omega_2 - \omega_1}$

$= \frac{500}{600-400} = \frac{500}{200} = 2.5$

Q17 Text Solution:

As we know

$v = \frac{\mathbf{E}}{\mathbf{B}} \text{or} v = \frac{|\mathbf{E}|}{|\mathbf{B}|}$

For an electromagnetic wave $v = c$

$\therefore \frac{|\mathbf{E}|}{|\mathbf{B}|} = c = 3 \times 10^8 \text{ ms}^{-1}$

$\therefore |\mathbf{E}| : |\mathbf{B}|$ is the order of 10^8 ms^{-1}

Q18 Text Solution:

Given $P = 60\text{W}$

$\lambda = 662.5\text{nm} = 6.625 \times 10^{-7}\text{m}$

Energy of 1 Photon $= hv = h\frac{c}{\lambda}$

$= \frac{6.625\times10^{-34}\times3\times10^{8}}{6.625\times10^{-7}} = 3 \times 10^{-19}\text{J}$

Number of photons emitted per second

$= \frac{\text{Power of source}}{\text{Energy of one photon}}$

$= \frac{60}{3\times10^{-19}}$

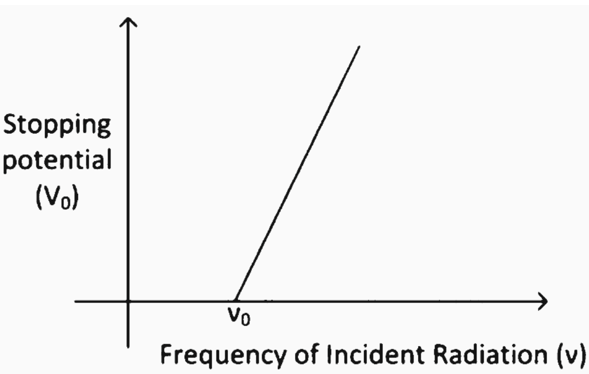
$= 20 \times 10^{19}$

$= 2 \times 10^{20}$

Q19 Text Solution:

The maximum kinetic energy of emitted photoelectrons is given as

$K_{mac} = hv - \phi_0$



$\Rightarrow \quad eV_0 = hv - \phi_0$

$\Rightarrow \quad V_0 = \left(\frac{h}{e}\right) v - \frac{\phi_0}{e}$

Comparing with $y = mx + c$, we get

$m = \frac{h}{e} \text{and} c = -\frac{\phi_0}{e} = -\frac{hv_0}{e}$

$\therefore$ Slope $= m = \frac{h}{e}$

and y-intercept $= c = -\frac{hv_0}{e}$

Q20 Text Solution:

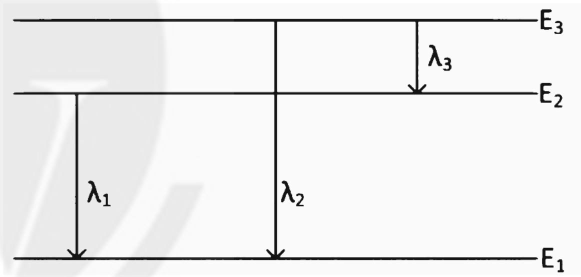
In the Rutherford's α-scattering experiment, impact parameter (b) and scattering angle θ are related as,

$$b = \frac{1}{4\pi\varepsilon_0} \cdot \frac{ze^2 \cot\frac{\theta}{2}}{\left(\frac{1}{2}mv^2\right)}$$

$$\Rightarrow \quad b \propto \cot\frac{\theta}{2}$$

Thus, with the increase of impact parameter (b), $\cot\frac{\theta}{2}$ increases. It is possible only when θ will decrease.

Q21 Text Solution:



From the given diagram,

$E_2 - E_1 = \frac{hc}{\lambda_1}$

$E_3 - E_2 = \frac{hc}{\lambda_3}$

$E_3 - E_1 = \frac{hc}{\lambda_2} \quad \ldots\ldots(\text{ii})$

Adding Eq. (i) and Eq. (ii), we get

$E_3 - E_1 = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_3}$

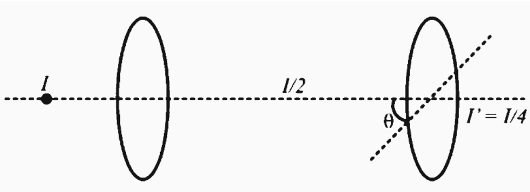
$\Rightarrow \frac{hc}{\lambda_2} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_3} \quad$ [From Eq. (iii)]

$\Rightarrow \frac{1}{\lambda_2} = \frac{1}{\lambda_1} + \frac{1}{\lambda_3}$

$\Rightarrow \lambda_2 = \frac{\lambda_1\lambda_3}{\lambda_1+\lambda_3}$

Q22 Text Solution:

The given situation is shown in the figure.



According to law of Malus,

$$I' = \left(\frac{I}{2}\right)\cos^2\theta$$

$$\Rightarrow \quad \frac{I}{4} = \frac{I}{2}\cos^2\theta$$

$$\Rightarrow \cos^2\theta = \frac{1}{2}$$

$$\Rightarrow \cos\theta = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad \theta = 45^\circ$$

Q23 Text Solution:

Given

$$x = \frac{\beta}{3}$$

$$I_0 = 2\times10^{-2}\ \mathrm{Wm}^{-2}$$

For YDSE where $D \ggg d, \Delta x = d\sin\theta$

Also $\sin\theta \simeq \tan\theta \simeq \frac{x}{D} = \frac{\beta}{3D} = \frac{\lambda D}{d \times 3D} = \frac{\lambda}{3d}$

$$\therefore \Delta = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda} d\sin\theta = \frac{2\pi}{\lambda}\times\frac{d\times\lambda}{3d} = \frac{2\pi}{3}$$

$$= \Delta\phi$$

$$I = 4I_0\cos^2\left(\frac{\Delta\phi}{2}\right) = 4I_0\cos^2\left(\frac{2\pi}{3}\times\frac{1}{2}\right)$$

$$= 4I_0\cos^2\left(\frac{\pi}{3}\right) = 4\times I_0\times\frac{1}{4}$$

$$\therefore I = I_0 = 2\times10^{-2}\ \mathrm{Wm}^{-2}$$

Q24 Text Solution:

given $T_{1/2} = 3$

We know that $R = R_0 e^{-\lambda t}$

Here, $R = \frac{R_0}{5}$

$$\Rightarrow \quad \frac{R_0}{5} = R_0 e^{-\lambda t} \Rightarrow \frac{1}{5} = e^{-\lambda t}$$

$$\Rightarrow \ln(5)^{-1} = \ln\left(e^{-\lambda t}\right)$$

$$\Rightarrow \quad t = \frac{\ln 5}{\lambda} = \frac{\ln 5}{\frac{0.693}{t_{1/2}}} = \frac{\ln 5}{0.693}\times t_{1/2} = \frac{\ln 5}{0.693}\times 3$$

$$= 6.96 \simeq 7\text{years}$$

Q25 Text Solution:

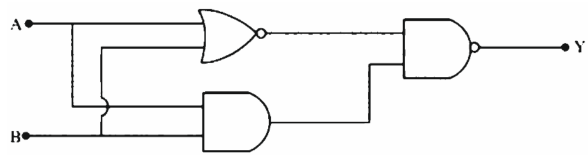
When *p-n* junction diode is forward biased, then free electrons flow in the connecting wire.

Q26 Text Solution:

In full wave rectifier, one diode works for positive half cycle and another diode works for negative half cycle of alternating voltage. Thus, each diode works one time in one complete cycle of input AC signal. Hence, for 50 Hz AC supply, diode D_1 conducts 50 times in 1s.

Q27 Text Solution:

The given logic circuit diagram is



Output of the logic gate is

$$Y = \overline{\left(\overline{A+B}\cdot(AB)\right)} = \overline{A+B} + \overline{AB}$$

$$= A + B + \bar{A} + \bar{B}$$

$$= (A+\bar{A}) + (B+\bar{B}) \quad [\because x+\bar{x}=1]$$

$$= 1 + 1 = 1$$

Thus output is always 1 for all value of inputs *A* and *B*. Hence, option (c) is correct.

Q28 Text Solution:

To determine the momentum of the emitted photons from an LED with an energy gap of 2.4 *eV*, we need to use the relationship between energy and momentum for photons. The energy of a photon is given by:

$E = pc$

where:

E is the energy of the photon

p is the momentum of the photon

c is the speed of light in a vacuum $\approx 3\times10^8\, m/s$

First, let's convert the energy from electron volts (eV) to joules (J). The conversion factor is:

$1\ \mathrm{eV} = 1.6\times10^{-19}\ \mathrm{J}$

Thus, the energy in joules is:

$E = 2.4\ \mathrm{eV}\times1.6\times10^{-19}\ \mathrm{J/eV} = 3.84\times10^{-19}\ \mathrm{J}$

Now we can use the relationship E = pc to find the momentum:

$p = \frac{E}{c}$

Substituting the known values:

$p = \frac{3.84\times10^{-19}\ \mathrm{J}}{3\times10^{8}\ \mathrm{m/s}} = 1.28\times10^{-27}\ \mathrm{kg\ m/s}$

Therefore, the momentum of the emitted photons is:

Option A:

Q29 Text Solution:

In β^- decay, reaction is given as

$^{210}_{83}\mathrm{Bi} \longrightarrow ^{210}_{84} X + e^{-1} + \bar{v}$

Number of neutrons $= 210 - 84 = 126$

Q30 Text Solution:

Given, Q = 5.5MeV

Mass number of nucleus = 220

By conservation of linear momentum.

$M_\alpha v_\alpha = M_y v_y$

Where, $M_\alpha v_\alpha$ are mass and velocity of a-particle, and M_X v_X are mass and velocity of the daughter nuclei X. Since, $Q = (KE)_\alpha + (KE)_X ....(i)$

Let Y be the nucleus with the mass number 220 and X be the daughter nuclei produced.

Hence, we have $^{220}Y \rightarrow ^{216} X +^2_4 \alpha$

Using conservation of linear momentum

$M_\alpha v_\alpha = M_X v_X$

$\Rightarrow \quad v_x = \frac{M_\alpha v_\alpha}{M_X}$

$\therefore$ From Eq. (i),$Q = \frac{1}{2} M_\alpha v_\alpha^2 + \frac{1}{2} M_X v_X^2$

$\Rightarrow \quad 5.5 = \frac{1}{2} M_\alpha v_\alpha^2 + \frac{1}{2} \frac{M_\alpha^2 v_\alpha^2}{M_x}$

$\Rightarrow \quad 5.5 = \frac{1}{2} M_\alpha v_\alpha^2 \left[1 + \frac{M_\alpha}{M_X}\right]$

$\Rightarrow \quad 5.5 = (\mathrm{KE})_\alpha \left(1 + \frac{4}{216}\right)$

$\Rightarrow \quad \mathrm{KE}_\alpha = 5.4\,\mathrm{MeV}$

Q31 Text Solution:

Since, distance travelled by the body is not zero in one complete revolution, hence average speed is not zero.

In a circular motion, the displacement of the particle is zero, if it completes one revolution.

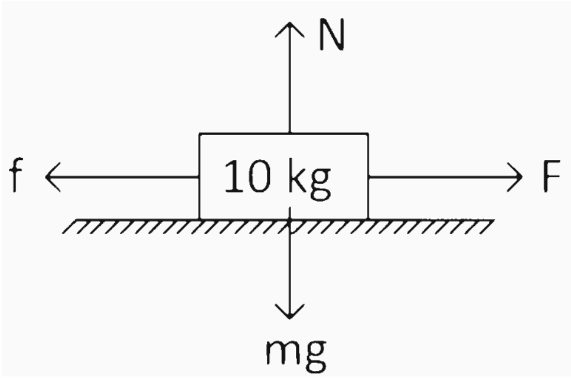
Therefore average velocity which is ratio of total displacement to the total time taken is also zero.

Q32 Text Solution:

Given, mass of the body, m = 10kg

Coefficient of kinetic friction, μ_k = 0.5

Force applied in horizontal direction, F = 60N



Let f be the frictional force on the body.

Thus, $ma = F - \mu mg$

$= 60 - 10 \times (10)(0.5) = 60 - 50$

$\Rightarrow 10 \times a = 10 \Rightarrow a = 1\mathrm{m/s}^2$

Q33 Text Solution:

Given, mass of the ball, m = 0.2kg

Height from the surface of floor, h = 10 m

Let initial velocity be u.

Total energy as initial point TE = 1/2 mv^2 + mgh

After collision, remaining energy

$= \frac{\frac{1}{2}mu^2 + mgh}{2}$

With this remaining energy the ball bounces upto height h

Therefore

Therefore, $\frac{\frac{1}{2}mu^2 + mgh}{2} = mgh$

$\Rightarrow \frac{1}{2}mu^2 + mgh = 2mgh$

$\Rightarrow u^2 = \sqrt{2gh}$

$= \sqrt{2 \times 10 \times 10} = 14\mathrm{m/s}$

Q34 Text Solution:

Moment of inertia of a body depends on the mass of the body, distribution of mass in the body, position of axis of rotation of the body and on the distance from the axis of rotation

Q35 Text Solution:

Parallel axis theorem for outer disc,

$$I= I_{\text{COM}} + Md_2$$

$$= \frac{1}{2}MR^2 + M(2R)^2$$

$$For\ 6\ outer\ disc,$$

$$I = 6x\frac{9}{2}MR^2 \quad = \ 27\ MR^2$$

Q36 Text Solution:

Given, actual length of wire (l_0) = 3.678cm

Measurement with instrument, A = 3.5 cm

Measurement with instrument, B = 3.38 cm

Measurement of A is close to l_0 so it is more accurate but measurement of B is more precise as it can count upto two decimal places.

Q37 Text Solution:

To determine the average velocity of a body moving along a straight line with a constant acceleration a, given its initial velocity v_0 and its final velocity v after t seconds, we can use the following approach:

Information Given:

Initial velocity, v_0

Final velocity after time t, v

Constant acceleration, a

Using the Equation of Motion:

The equation related to velocity and displacement is:

$$v^2 = u^2 + 2as$$

Rearranging for displacement s:

$$s = \frac{v^2 - v_0^2}{2a}$$

This equation gives us the total distance covered.

Calculating Average Velocity:

The average velocity $\overline{v}$ over an interval is the total distance divided by the total time:

$$\overline{v} = \frac{\text{Total distance}}{\text{Total time}} = \frac{s}{t}$$

Substituting for s from the displacement equation:

$$\overline{v} = \frac{\frac{v^2 - v_0^2}{2a}}{t}$$

Simplifiyng

$$\overline{v} = \frac{v^2 - v_0^2}{2at}$$

Hence, the average velocity is given by:

$$v_{avg} = \frac{v^2 - v_0^2}{2at}$$

This formula provides the average velocity of the body over the given time interval t.

Q38 Text Solution:

From Bernoulli's principle we have

$$\frac{1}{2}\rho v^2 + p_0 + \rho gh = \frac{1}{2}\rho v_A^2 + p_A + \rho g(0)$$

$$p_0 - p_A + \rho gh = \frac{1}{2}\rho v_A^2 - \frac{1}{2}\rho v^2$$

$$\Rightarrow v^2 = \frac{2(p_0 - p_A)}{\rho} + \frac{2\rho gh}{P} \quad \left(\because v = 0\text{at top}\right)$$

$$\Rightarrow v = \sqrt{\frac{2(p_0 - p_A)}{\rho} + 2gh}$$

$$\text{Water coming out of hole} = \text{area} \times \text{velocity}$$

$$= \pi r^2\sqrt{2gh + \frac{2(p_0 - p_A)}{\rho}}$$

Q39 Text Solution:

Let the final temperature of mixture be T.

Heat absorbed by ice = heat lost by water

$mL+mc(T-0)\ mc = (100-T)$

Substituting values,

(100 × 80) + (100 × 1) T = 100 × 1(100 – T)

8000 + 100T = 10000 – 100T T

200 T = 2000

T = 10°C

Q40 Text Solution:

[Hint Area enclosed by p-V diagram is equal to work done] Total work done by gas in one carnot cycle is given by.

$$W = \mu RT_1\ In\frac{V_2}{V_1} - \mu RT_2\ in\frac{V_3}{V_4}$$

Q41 Text Solution:

When a planet revolves around the sun, net external torque is zero. Therefore its angular momentum is conserved. As a consequence, its areal velocity remains the same/constant

Q42 Text Solution:

Given, Young's modulus, $Y = 2 \times 10^{11}\ \text{Nm}^{-2}$

Poisson ratio, $\sigma = 0.25$

Lateral strain, $\varepsilon_1 = 10^{-3}$

Elastic potential energy density is given by,

$$\text{PE} = \frac{1}{2} \times Y \times (\text{strain})^2$$

$$\text{Poisson ratio} = \frac{\text{Lateral strain}}{\text{longitudinal strain}}$$

$$= \frac{\varepsilon_1}{\text{longitudinal strain}}$$

$$\Rightarrow \sigma = \frac{\varepsilon_1}{\text{longitudinal strain}}$$

$$\Rightarrow \text{longitudinal strain} = \frac{\varepsilon_1}{\sigma} = \frac{10^{-3}}{0.25} = c \times 10^{-3}$$

$$= \frac{1}{2} \times Y \times \left(\frac{E_1}{\sigma}\right)^2$$

$$= \frac{1}{2} \times 2 \times 10^{11} \times \left(4 \times 10^{-3}\right)^2$$

$$= 10^{11} \times 16 \times 10^{-6} = 16 \times 10^5\ \text{Jm}^{-3}$$

Q43 Text Solution:

The speed of sound at a given temperature is given by

$$v_{\text{sound}} = \sqrt{\frac{rRT}{M}} \Rightarrow v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

For oxygen molecules; $\frac{v_0}{v_{\text{rms}}} = \frac{\sqrt{\frac{r_0 RT}{M}}}{\sqrt{\frac{3RT}{M}}} = \sqrt{\frac{r_0}{3}}$

For helium molecules;

$$\frac{v_{\text{He}}}{v_{\text{rms}}} = \frac{\sqrt{r_{\text{He}} \frac{RT}{M}}}{\sqrt{\frac{3RT}{M}}} = \sqrt{\frac{r_{\text{He}}}{3}} \left(r_{\text{He}} = \frac{5}{3}, r_{\text{O}} = \frac{7}{5}\right)$$

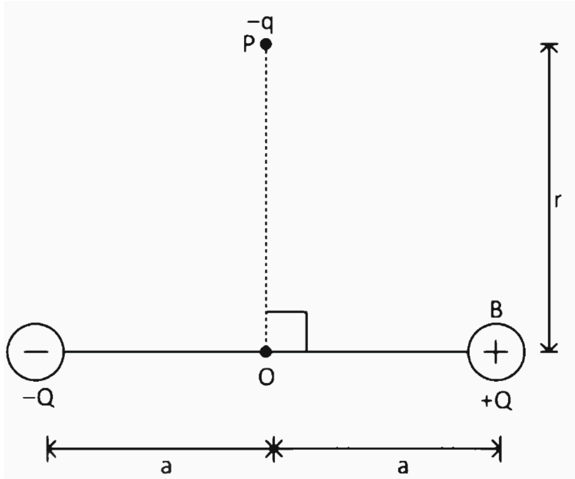
$$\frac{x'}{x} = \frac{\sqrt{\frac{5}{9}}}{\sqrt{\frac{7}{15}}} = \sqrt{\frac{25}{21}} = \frac{5}{\sqrt{21}}$$

Q44 Text Solution:

If the metal sphere is connected to insulated mount, then net flow due to induction of charges is zero and hence even after, the net charge on the metal sphere will be zero

Q45 Text Solution:

Net force due to dipole on equatorial line, $F_{eq} = E.q$



$$= \frac{K\mathbf{p}}{r^3}\hat{\mathbf{i}}q = \frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{\mathbf{i}}$$

$$\tau = r_\perp x F$$

$$= r\left(\hat{\mathbf{j}}\right) x \frac{1}{4}\pi \frac{pq}{r^3}\hat{\mathbf{i}} = \frac{-1}{4\pi\varepsilon_0}\frac{pq}{r^2}\hat{\mathbf{k}}$$

Hence, Option (d) is correct

Q46 Text Solution:

Gay Lussac's law states that the pressure of a fixed mass of a gas at constant volume is directly proportional to the temperature.

$i.e,\ p \propto T$

$or\ p \propto \frac{1}{2} K_B T$

Since kinetic energy of the molecules is directly proportional to the temperature.

Q47 Text Solution:

Equation of motion for damped oscillation is $\frac{md^2x}{dt^2} + \frac{bdx}{dt} + kx = 0$

Angular frequency is $\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

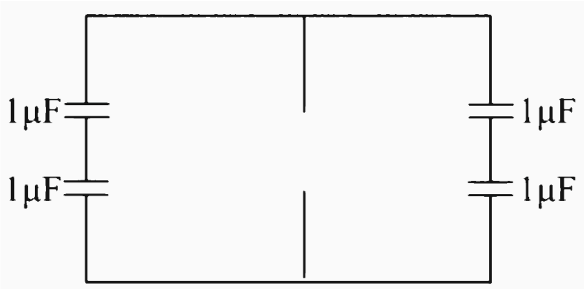
Displacement is given by,

$$x = A_0 e^{-\frac{b}{2m}t} \cos\left(\omega t + \phi\right)$$

and energy is given by $E = \frac{1}{2} k A^2 e^{-\frac{b}{m}t}$

Q48 Text Solution:

Since, the middle branch conducts no current, therefore the middle capacitor represents open circuit and hence reduced circuit is shown.



Now $\frac{1}{C_{\text{series}}} = \frac{1}{1} + \frac{1}{1}$

$C_{\text{series}} = 0.5\mu\text{F}$

$C_{\text{parallel}} = 0.5 + 0.5$

or $C_{AB} = 1\mu\text{F}$

Q49 Text Solution:

Potential energy at B = Potential difference Charge + Energy spent by moving charge from A to B

$= V_A \times q - q.E.x = q(V_A - Ex)$

Q50 Text Solution:

To solve this problem, let's break it down step by step

First, recall the relationship between the capacitance and the presence of a dielectric material. The capacitance C of a parallel plate capacitor with a dielectric is given by

$C = kC_o$

where:

k is the dielectric constant of the material

C_0 is the capacitance without the dielectric

Given that:

C_1 is the capacitance with the dielectric.

C_2 is the capacitance without the dielectric.

Since the dielectric constant k is greater than 1, it follows that:

$C_1 > C_2$

When the capacitor is connected to a battery, the potential difference across its plates is determined by the battery. So, if we keep the capacitor connected to the battery while removing the dielectric slab, the potential difference across the plates remains unchanged.

Therefore:

$V_1 = V_2$

Given the above analysis, the correct relationship is:

$C_1 < C_2 \ and \ V_1 = V_2$

Thus, the correct option is: D

Q51 Text Solution:

Total flux $\phi_E = E \cdot ds$

$= 9\text{k} - 6\text{k} \times \left(10^{-2} \times 10\right)^2$

$= 3 \times 10^3 \times 10^{-2} = 30\,\text{NC}^{-1}\,\text{m}^2$

According to Gauss's Law, $\frac{q}{\varepsilon_0} = \phi_E$

$\Rightarrow q_{\text{enclosed}} = 3 \times \varepsilon_0$

$= 30 \times 9 \times 10^{-12}\text{C} = 270 \times 10^{-9} \times 10^{-3}$

$= 0.27 \times 10^{-9}\text{C} = 0.27\,\text{nC}$

Q52 Text Solution:

Electric field due to infinitely charged long wire $E_1 = \frac{2k\lambda}{r}$

Electric field at the centre of semicircular ring,

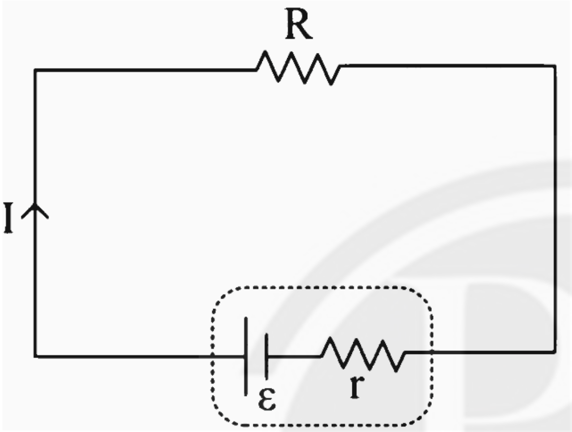
$E_2 = \frac{2k\lambda}{r}$

Therefore, $E_1 = E_2$

Q53 Text Solution:

The given situation is shown in the diagram.

In time *t*, work done by the battery to establish the current *I* is given as,



$W = Vq = \varepsilon It \quad [\because q = It]$

Q54 Text Solution:

We know that, mobility of electron,

$\mu = \frac{e\tau}{m}$

$\Rightarrow \quad \mu \propto \tau \quad [\tau \to \text{relaxation time}]$

Thus, for constant temperature, μ remains the same.

Since $\quad I = neAv_d$

$\Rightarrow \quad v_d \propto I$

Hence, when current is increased, then drift velocity (v_d) also increases.

Q55 Text Solution:

According to given situation,

Net emf of the combination

E_{net} = 8 x emf of one cell –2 x emf of one cell

= 8 × 2 – 2 × 2 = 12V

Equivalent resistance of the circuit

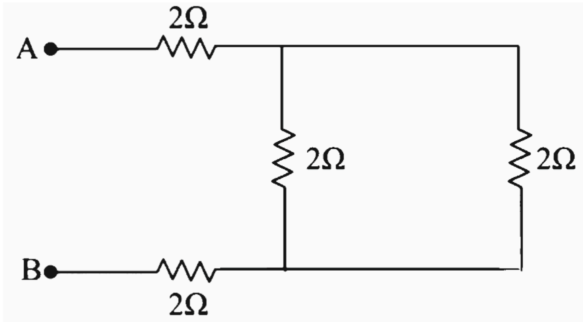
R' = 10*r* + *R* = 10 × 1 + 10 = 20V

Current through the resistor,

$I = \frac{E_{net}}{R'} = \frac{12}{20} = 0.6A$

Q56 Text Solution:

Let x be the equivalent resistance of the circuit, then



$\therefore \quad R_{AB} = x$

$\Rightarrow \quad \frac{x \times 2}{2+x} + 2 + 2 = x$

$\Rightarrow \quad \frac{2x}{x+2} = x - 4$

$\Rightarrow \quad 2x = (x-4)(x+2)$

$\Rightarrow \quad 2x = x^2 + 2x - 4x - 8$

$\Rightarrow \quad x^2 - 4x - 8 = 0$

$\Rightarrow \quad x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4 \times 1 \times (-8)}}{2 \times 1}$

$= \frac{4 \pm \sqrt{48}}{2} = \frac{4 \pm 4\sqrt{3}}{2}$

$= 2 + 2\sqrt{3} = 5.46\Omega \simeq 5.5\Omega$

Q57 Text Solution:

A charged particle experiences two different forces in a cyclotron as follows.

(i) Inside the Dees It is accelerated due to the magnetic field inside the dees.

(ii) In the Gaps It is accelerated due to the electric field.

Q58 Text Solution:

Given, resistance of carbon resistor

R = 4.7 kΩ $\pm$ 5% = 47 $\times$ 10^2 Ω $\pm$ 5%

The colour of four bands will be

4 $\to$ yellow

7 $\to$ Violet

2 $\to$ Red

± 5 $\to$ Gold

Thus, colour of third band is red.

Q59 Text Solution:

Colours in sequence,

Gray $\to 8$ (1st digit)

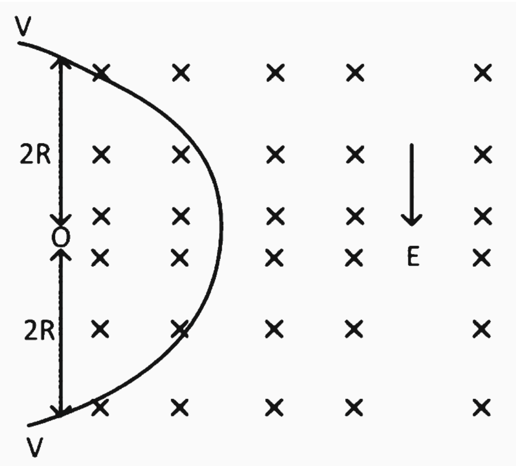
Red $\to 2$ (2nd digit)

Gold $\to 0.1$ (Multiplier)

Gold $\to \pm 5\%$ (Tolerance)

$\Rightarrow (82 \times 0.1) \pm 5\% \Rightarrow R = 8.2\Omega \pm 5\%$

Q60 Text Solution:



Radius of the circle, $r = \frac{mv}{Bq}$

Equation of line, $y = \frac{2mv}{Bq} = 2R$

Time period, $T = \frac{2\pi m}{Bq}$

$t = \frac{\pi m}{Bq} = \frac{T}{2}$

Angular momentum of charged particle about origin

$$L = mvy + mvy = 2mvy$$

$$= 2mv \times 2R$$

$$= 4mv \times \frac{mv}{Bq} = \frac{4m^2v^2}{Bq}$$

From velocity selector,

$$v = \frac{E}{B}$$

$$\therefore \quad L = \frac{4m^2E^2}{qB^3}$$

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