1. The value of acceleration due to gravity at a height of $10\,\text{km}$ from the surface of earth is x. At what depth inside the earth is the value of the acceleration due to gravity has the same value x?

   (a) $5\,\text{km}$ (b) $20\,\text{km}$ (c) $10\,\text{km}$ (d) $15\,\text{km}$

   Ans: (b)

   Sol: $g_h = g\left(1 - \frac{2h}{R}\right)$

   $g_d = g\left(1 - \frac{d}{R}\right)$

   $g_h = g_d$

   $g\left(1 - \frac{2h}{R}\right) = g\left(1 - \frac{d}{R}\right)$

   $d = 2R$

   $= 2 \times 10 = 20\,\text{km}$

2. Young's modulus of a perfect rigid body is

   (a) Zero (b) Unity

   (c) Infinity (d) Between zero and unity

   Ans: (c)

   Sol: For a perfect rigid body elongation $\Delta l = 0$

   $Y = \left(\frac{F}{A}\right)\frac{l}{\Delta l}$ becomes infinity

3. A wheel starting from rest gains an angular velocity of $10\,\text{rad}\,\text{s}^{-1}$ after uniformly accelerated for $5\,\text{s}$. The total angle through which it has turned is

   (a) $25\,\text{rad}$ (b) $100\,\text{rad}$

   (c) $25\pi\,\text{rad}$ (d) $50\pi\,\text{rad}$ about a vertical axis

   Ans: (a)

   Sol: $\omega_1 = 0$

   $\omega_2 = 10\,\text{rad}\,\text{s}^{-1}$

   $t = 5\text{s}$

   $\theta = \left(\frac{\omega_1 + \omega_2}{2}\right) \times t$

   $\theta = \frac{(0+10)\times 5}{2} = 25\,\text{rad}$

4. Iceberg floats in water with part of it submerged. What is the fraction of the volume of iceberg submerged if the density of ice is $\rho_i = 0.917\,\text{g}\,\text{cm}^{-3}$?

   (a) 0.917 (b) 1 (c) 0.458 (d) 0

Ans: (a)

Sol: $V_b \cdot \rho_b = V_i \cdot \rho_l$

$$\frac{V_i}{V_b} = \frac{\rho_b}{\rho_l} = \frac{0.917}{1} = 0.917$$

5. A sphere, a cube and a thin circular plate all of same material and same mass initially heated to same high temperature are allowed to cool down under similar conditions. Then the
   (a) plate will cool the fastest and cube the slowest
   (b) sphere will cool the fastest and cube the slowest
   (c) plate will cool the fastest and sphere the slowest
   (d) cube will cool the fastest and plate the slowest

Ans: (c)

Sol: From $E = A\sigma T^4$

$E \propto A$

Surface area is more for plate and less for sphere. Hence plate will cool the fastest and sphere the slowest

6. In an adiabatic expansion of an ideal gas the product of pressure and volume
   (a) Decreases
   (b) Increases
   (c) Remains constant
   (d) At first increases and then decreases

Ans: (a)

Sol: In an adiabatic expansion as temperature decreases from ideal gas equation $PV = nRT$ the product of pressure and volume decreases

7. A certain amount of heat energy is supplied to a monoatomic ideal gas which expands at constant pressure. What fraction of the heat energy is converted into work?

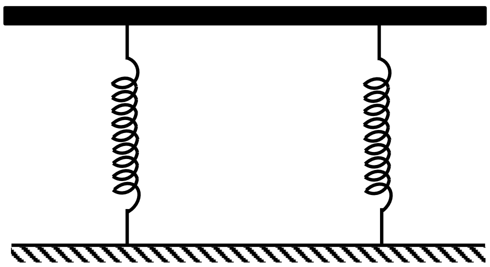
   (a) 1 (b) $\frac{2}{3}$ (c) $\frac{2}{5}$ (d) $\frac{5}{7}$

Ans: (c)

Sol: $\frac{dW}{dQ} = 1 - \frac{1}{\gamma} = 1 - \frac{1}{\left(\frac{5}{3}\right)}$

$= \frac{2}{5}$

8. A tray of mass $12\,\text{kg}$ is supported by two identical springs as shown in figure. When the tray is pressed down slightly and then released, it executes SHM with a time period of $1.5\,\text{s}$. The spring constant of each spring is



(a) $50\,\text{Nm}^{-1}$ (b) 0

(c) $105\,\text{Nm}^{-1}$ (d) ∞

Ans: (c)

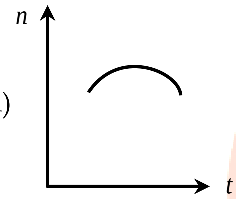
Sol: $T = 2\pi\sqrt{\dfrac{m}{k_{\text{eff}}}}$

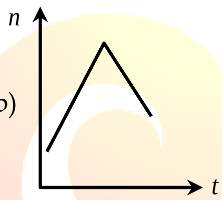
$\dfrac{3}{2} = 2\pi\sqrt{\dfrac{12}{2k}}$

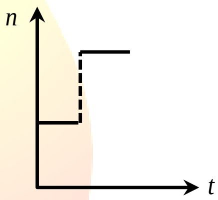
$\dfrac{9}{4} = 4\pi^2 \times \dfrac{12}{2k}$

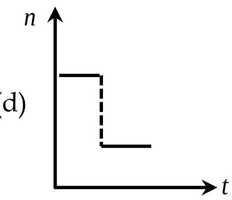
$k \simeq 105\,\text{Nm}^{-1}$

9. A train whistling at constant frequency $'n'$ is moving towards a station at a constant speed V. The train goes past a stationary observer on the station. The frequency $'n'$ of the sound as heard by the observer is plotted as a function of time $'t'$. Identify the correct curve

(a) 

(b) 

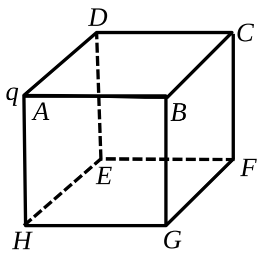
(c) 

(d) 

Ans: (d)

Sol: As the train approaches the observer, the apparent frequency is higher than the actual frequency. As the train moves away from the observer, the apparent frequency is lower than the actual frequency.

10. A point charge $'q'$ is placed at the corner of a cube of side $'a'$ as shown in the figure. What is the electric flux through the face $ABCD$?



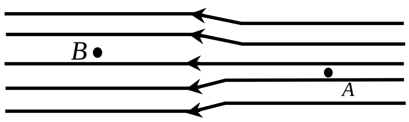
(a) 0 (b) $\dfrac{q}{24\varepsilon_0}$

(c) $\dfrac{q}{6\varepsilon_0}$ (d) $\dfrac{q}{72\varepsilon_0}$

Ans: (c)

Sol: $\phi_{ABCD} = \frac{\phi}{6} = \frac{q}{6\varepsilon_0}$

11. The electric field lines on the left have twice the separation on those on the right as shown in figure. If the magnitude of the field at A is $40\,\text{Vm}^{-1}$. What is the force on $20\,\mu\text{C}$ charge kept at B?



(a) $4\times10^{-4}\,\text{Vm}^{-1}$ (b) $8\times10^{-4}\,\text{Vm}^{-1}$ (c) $16\times10^{-4}\,\text{Vm}^{-1}$ (d) $1\times10^{-4}\,\text{Vm}^{-1}$

Ans: (a)

Sol: Electric field strength is proportional to the number of field lines. Since lines are twice as crowded at A than at B,

$E_A = 2E_B$

or $E_B = \frac{E_A}{2} = \frac{40}{2} = 20\,\text{Vm}^{-1}$

$F = E_B\, q$

$= 20\times20\times10^{-6}$

$= 4\times10^{-4}\,\text{Vm}^{-1}$

12. An infinitely long thin straight wire has uniform charge density of $\frac{1}{4}\times10^{-2}\,\text{cm}^{-1}$. What is the magnitude of electric field at a distance $20\,\text{cm}$ from the axis of the wire?

(a) $1.12\times10^{8}\,\text{NC}^{-1}$ (b) $4.5\times10^{8}\,\text{NC}^{-1}$ (c) $2.25\times10^{8}\,\text{NC}^{-1}$ (d) $9\times10^{8}\,\text{NC}^{-1}$

Ans: (c)

Sol: $E = \frac{\lambda}{2\pi\varepsilon_0 \cdot r}$

$= \frac{1}{4}\times\frac{10^{-2}}{10^{-2}}\times18\times10^{9}\times\frac{1}{20\times10^{-2}}$

$= 2.25\times10^{8}\,\text{NC}^{-1}$

13. A dipole moment 'P' and moment of inertia I is placed in a uniform electric field $\vec{E}$. If it is displaced slightly from its stable equilibrium position, the period of oscillation of dipole is

(a) $\sqrt{\frac{PE}{I}}$ (b) $2\pi\sqrt{\frac{I}{PE}}$ (c) $\frac{1}{2\pi}\sqrt{\frac{PE}{I}}$ (d) $\pi\sqrt{\frac{I}{PE}}$

Ans: (b)

Sol: $T = 2\pi\sqrt{\frac{I}{PE}}$

14. The difference between equivalent capacitances of two identical capacitors connected in parallel to that in series is $6\,\mu F$. The value of capacitance of each capacitor is

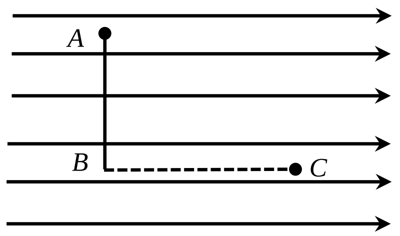
(a) $2\,\mu F$ (b) $3\,\mu F$ (c) $4\,\mu F$ (d) $6\,\mu F$

Ans: (c)

Sol: $C_P - C_S = 6\,\mu F$

$$2C - \frac{C}{2} = 6 \Rightarrow C = 4\,\mu F$$

15. Figure shows three points A, B and C in a region of uniform electric field $\vec{E}$. The line AB is perpendicular and BC is parallel to the field lines. Then which of the following holds good? (V_A, V_B and V_C represent the electric potential at points A, B and C respectively)



(a) $V_A = V_B = V_C$ (b) $V_A = V_B > V_C$

(c) $V_A = V_B < V_C$ (d) $V_A > V_B = V_C$

Ans: (b)

Sol: Since the electric potential decreases along the direction of electric field. $V_A = V_B > V_C$

16. When a soap bubble is charged?

(a) Its radius increases (b) Its radius decreases

(c) The radius remains the same (d) Its radius may increase or decrease

Ans: (a)

Sol: When a soap bubble is charged, there will be either net positive or net negative charge on the bubble. Due to repulsion between like charges size of the bubble will increase.

17. A hot filament liberates an electron with zero initial velocity. The anode potential is $1200\,V$. The speed of the electron when it strikes the anode is

(a) $1.5\times10^5\ ms^{-1}$ (b) $2.5\times10^6\ ms^{-1}$ (c) $2.1\times10^7\ ms^{-1}$ (d) $2.5\times10^8\ ms^{-1}$

Ans: (c)

Sol: $\frac{1}{2}mv^2 = Vq$

$$v = \sqrt{\frac{2Vq}{m}} = 2.1\times10^7$$

18. A metal rod of length $10\,\text{cm}$ and a rectangular cross-section of $1\,\text{cm}\times\frac{1}{2}\,\text{cm}$ is connected to a battery across opposite faces. The resistance will be

(a) maximum when the battery is connected across $1\,\text{cm}\times\frac{1}{2}\,\text{cm}$ faces

(b) maximum when the battery is connected across $10\,\text{cm}\times\frac{1}{2}\,\text{cm}$ faces

(c) maximum when the battery is connected across $10\,\text{cm}\times 1\,\text{cm}$ faces

(d) same irrespective of the three faces

Ans: (a)

Sol: $R\propto\frac{l}{A}$

Maximum when the battery is connected across $1\,\text{cm}\times\frac{1}{2}\,\text{cm}$ faces

19. A car has a fresh storage battery of e.m.f $12\,\text{V}$ and internal resistance $2\times10^{-2}\,\Omega$. If the starter motor draws a current of $80\,\text{A}$. Then the terminal voltage when the starter is on is

(a) $12\,\text{V}$ (b) $8.4\,\text{V}$ (c) $10.4\,\text{V}$ (d) $9.3\,\text{V}$

Ans: (c)

Sol: $V = E - ir = 10.4\,\text{V}$

20. A potentiometer has a uniform wire of length $5\,\text{m}$. A battery of emf $10\,\text{V}$ and negligible internal resistance is connected between its ends. A secondary cell connected to the circuit gives balancing length at $200\,\text{cm}$. The emf of the secondary cell is

(a) $4\,\text{V}$ (b) $6\,\text{V}$ (c) $2\,\text{V}$ (d) $8\,\text{V}$

Ans: (a)

Sol: $\frac{E_1}{E_2}=\frac{l_1}{l_2}\Rightarrow\frac{10}{E_2}=\frac{5}{2}\Rightarrow E_2=4\,\text{V}$

21. The colour code for a carbon resistor of resistance $0.28\,\text{k}\Omega\pm10\%$ is

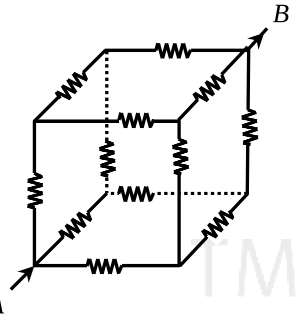
(a) Red, Grey, Brown, Silver (b) Red, Green, Brown, Silver

(c) Red, Grey, Silver, Silver (d) Red, Green, Silver

Ans: (a)

Sol: Red, Grey, Brown, Silver

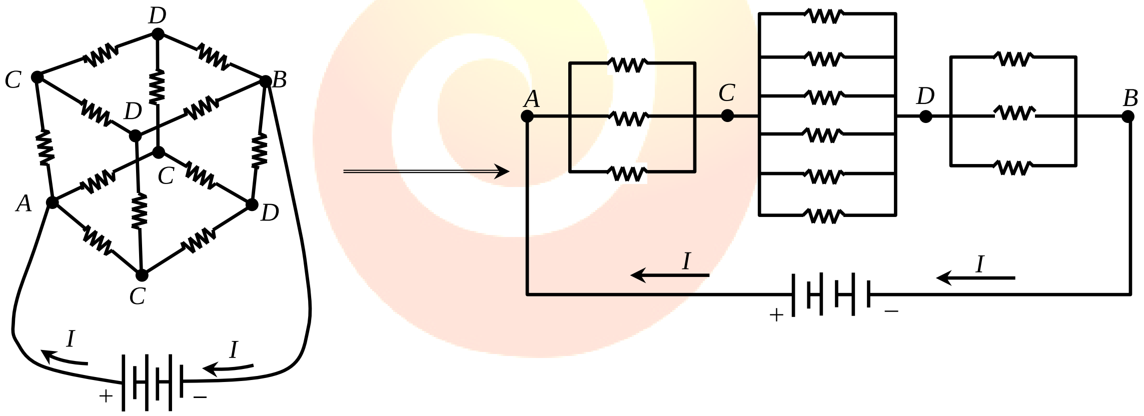
22. Each resistance in the given cubical network has resistance of 1Ω and equivalent resistance between A and B is



(a) $\frac{5}{6}\Omega$ (b) $\frac{6}{5}\Omega$ (c) $\frac{5}{12}\Omega$ (d) $\frac{12}{5}\Omega$

Ans: (a)

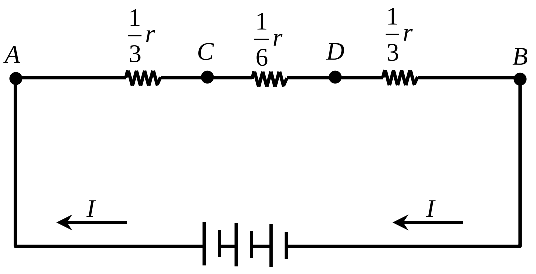
Sol: The picture on the left below shows resistor cube whose vertices on one of its space diagonals are connected to a voltage source. These two vertices are labelled by A and B. Edges labelled by AC are symmetric paths in front of electric current I, that enters A. So the current I, splits equally between these three branches, and electric potential drop on them are also the same. So electric potential on vertices labelled by C, are equal, and these vertices can be shorted. This argument is also applicable to the vertices labelled by D, and they can be shorted. The picture on the right below shows the electric circuit of our resistor cube with shorted vertices C and D.



If the resistance of each resistor is r, you can find equivalent resistance of parallel resistors between points A and C, D and B, C and D, as follows:

$R_{AC} = R_{DB} = (1/3)r$, and $R_{CD} = (1/6)r$

So the above electric circuit, can be simplified as:



That is three resistors connected in series, between points A and B.

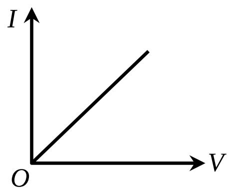
So the electric resistance between points A, and B, is:

$R_{AB} = R_{AC} + R_{CD} + R_{DB}$

So: $R_{AB} = (2/3)r + (1/6)r = (5/6)r$

and if $r = 1\Omega$, then $R_{AB} = 5/6\Omega$

23. $I - V$ characteristic of a copper wire of length L and area of cross-section A is shown in figure. The slope of the curve becomes



(a) More if experiment is performed at higher temperature

(b) More if a wire of steel of same dimension is used

(c) Less if the area of the wire is increased

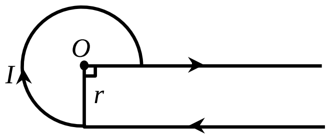
(d) Less if the length of the wire is increased

Ans: (d)

Sol: Slope $= \frac{1}{R} = \frac{A}{\rho \times l}$

Less if the length of the wire is increased

24. In the given figure, the magnetic field at $'O'$.



(a) $\frac{3}{4}\frac{\mu_0 I}{r} + \frac{\mu_0 I}{4\pi r}$ (b) $\frac{3}{10}\frac{\mu_0 I}{r} - \frac{\mu_0 I}{4\pi r}$

(c) $\frac{3}{8}\frac{\mu_0 I}{r} + \frac{\mu_0 I}{4\pi r}$ (d) $\frac{3}{8}\frac{\mu_0 I}{r} - \frac{\mu_0 I}{4\pi r}$

Ans: (c)

Sol: $B_{\text{net}} = B_1 + B_2 + B_3$

$= \frac{3}{8}\frac{\mu_0 I}{r} + \frac{\mu_0 I}{4\pi r} + 0$

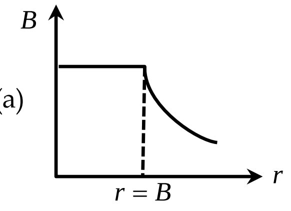
25. The magnetic field at the origin due to a current element $i\vec{dl}$ placed at a point with vector position $\vec{r}$ is

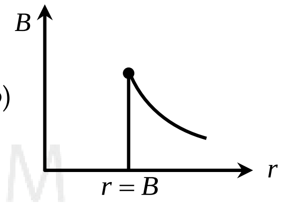
(a) $\frac{\mu_0 i}{4\pi}\frac{\vec{dl} \times \vec{r}}{r^3}$ (b) $\frac{\mu_0 i}{4\pi}\frac{\vec{r} \times \vec{dl}}{r^3}$ (c) $\frac{\mu_0 i}{4\pi}\frac{\vec{dl} \times \vec{r}}{r^2}$ (d) $\frac{\mu_0 i}{4\pi}\frac{\vec{r} \times \vec{dl}}{r^2}$

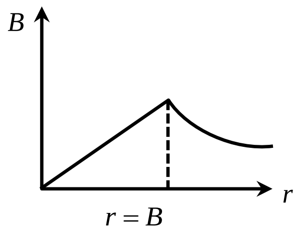
Ans: (a)

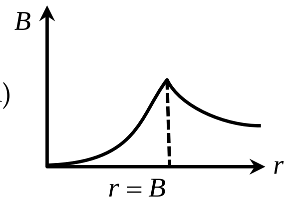
Sol: $\frac{\mu_0 i}{4\pi} \frac{\vec{dl} \times \vec{r}}{r^3}$

26. A long cylindrical wire of radius R carries a uniform current I flowing through it. The variation of magnetic field with distance $'r'$ from the axis of the wire is shown by

(a)


(b)


(c)


(d)


Ans: (c)

Sol: Conceptual

27. A cyclotron is used to accelerate protons $\left({}_1^1H\right)$, Deuterons $\left({}_1^2H\right)$ and $\alpha -$particles $\left({}_2^4He\right)$. While exiting under similar conditions, the minimum K.E. is gained by

(a) $\alpha -$particle (b) Proton (c) Deuteron (d) Same for all

Ans: (c)

Sol: $\mathrm{K \cdot E} = \frac{q^2 B^2 r}{2m}$

$\mathrm{K \cdot E} = \frac{q^2}{m}$

Minimum K.E is gained by deuteron

28. A paramagnetic sample shows a net magnetization of $8\,\mathrm{Am^{-1}}$ when placed in an external magnetic field of $0.6\,\mathrm{T}$ at a temperature of $4\,\mathrm{K}$. When the same sample is placed in an external magnetic field of $0.2\,\mathrm{T}$ at a temperature of $16\,\mathrm{K}$, the magnetization will be

(a) $\frac{32}{3}\,\mathrm{Am^{-1}}$ (b) $\frac{2}{3}\,\mathrm{Am^{-1}}$ (c) $6\,\mathrm{Am^{-1}}$ (d) $2.4\,\mathrm{Am^{-1}}$

Ans: (b)

Sol: $I \propto \frac{B}{T}$

$\frac{I_2}{I_1} = \frac{B_2}{B_1} \times \frac{T_1}{T_2}$

$$\frac{I_2}{8} = \frac{0.2}{0.6} \times \frac{4}{16}$$

$$I_2 = \frac{2}{3}\,\text{Am}^{-1}$$

29. The ratio of magnetic field at the centre of a current carrying circular coil to its magnetic moment is 'x' if the current and the radius both are doubled. The new ratio will become

(a) $2x$ (b) $4x$ (c) $\frac{x}{4}$ (d) $\frac{x}{8}$

Ans: (d)

Sol: $\frac{B}{M} = \frac{\left(\frac{\mu_0 IN}{2r}\right)}{NI\pi r^2}$

$$\frac{B}{M} = \alpha \frac{1}{r^3}$$

$$x = \frac{B}{M}\,(\text{let})$$

$$\frac{x_2}{x} = \left(\frac{r}{2r}\right)^3 = \frac{x}{8}$$

30. In a permanent magnet at room temperature

(a) Magnetic moment of each molecule is zero

(b) The individual molecules have non-zero magnetic moment which are all perfectly aligned

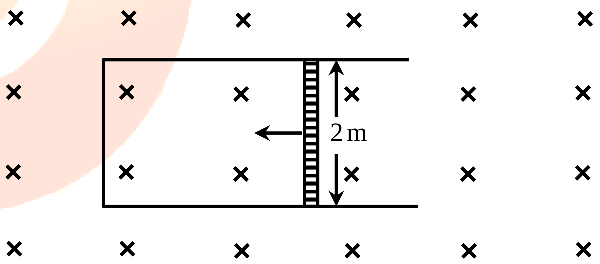
(c) Domains are partially aligned

(d) Domains are all perfectly aligned

Ans: (d)

Sol: Domains are all perfectly aligned

31. A rod of length $2\,\text{m}$ slides with a speed of $5\,\text{ms}^{-1}$ on a rectangular conducting frame as shown in figure. There exists a uniform magnetic field of $0.04\,\text{T}$ perpendicular to the plane of the figure. If the resistance of the rod is $3\,\Omega$. The current through the rod is



(a) $75\,\text{mA}$ (b) $133\,\text{mA}$ (c) $0.75\,\text{A}$ (d) $1.33\,\text{A}$

Ans: (b)

Sol: $i = \frac{Blv}{R} = \frac{0.04 \times 2 \times 5}{3}$

$= 133\,\text{mA}$

32. The current in a coil of inductance $0.2\,\text{H}$ changes from $5\,\text{A}$ to $2\,\text{A}$ in $0.5\,\text{s}$. The magnitude of the average induced emf in the coil is

(a) $0.6\,\text{V}$ (b) $1.2\,\text{V}$ (c) $30\,\text{V}$ (d) $0.3\,\text{V}$

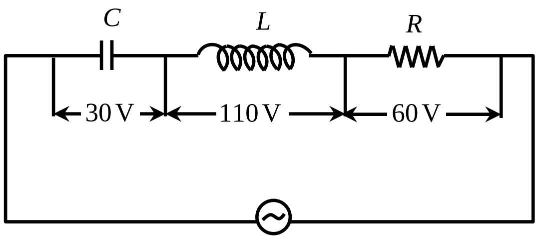
Ans: (b)

Sol: $e = L\dfrac{di}{dt}$

$= 0.2\left(\dfrac{5-2}{0.5}\right)$

$= \dfrac{2}{5}\times 3 = 1.2\,\text{V}$

33. In the given circuit the peak voltage across C, L and R are $30\,\text{V}$, $110\,\text{V}$ and $60\,\text{V}$ respectively. The rms value of the applied voltage is a



(a) $100\,\text{V}$ (b) $200\,\text{V}$

(c) $70.7\,\text{V}$ (d) $141\,\text{V}$

Ans: (c)

Sol: $V_0 = \sqrt{V_R^2 + (V_L - V_C)^2}$

$= \sqrt{(60)^2 + (110-30)^2}$

$= 100$

$V_{\text{rms}} = \dfrac{V_0}{\sqrt{2}} = \dfrac{100}{\sqrt{2}} \times \dfrac{\sqrt{2}}{\sqrt{2}}$

$= 100\left(\dfrac{\sqrt{2}}{2}\right)$

$= 100\left(\dfrac{1.414}{2}\right)$

$= 70.7\,\text{V}$

34. The power factor of $R-L$ circuit is $\dfrac{1}{\sqrt{3}}$. If the inductive reactance is $2\,\Omega$. The value of resistance is

(a) $2\,\Omega$ (b) $\sqrt{2}\,\Omega$ (c) $0.5\,\Omega$ (d) $\dfrac{1}{\sqrt{2}}\,\Omega$

Ans: (b)

Sol: $\cos\phi = \dfrac{1}{\sqrt{3}}$

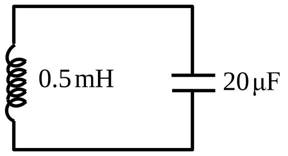
$\tan\phi = \frac{\sqrt{2}}{1}$

$\tan\phi = \frac{X_L}{R}$

$\sqrt{2} = \frac{2}{R}$

$R = \frac{2}{\sqrt{2}} = \sqrt{2}\,\Omega$

35. In the given circuit, the resonant frequency is



(a) 15.92 Hz (b) 159.2 Hz

(c) 1592 Hz (d) 15910 Hz

Ans: (c)

Sol: $\upsilon = \frac{1}{2\pi\sqrt{LC}}$

$= \frac{1}{2\pi\sqrt{0.5\times10^{-3}\times20\times10^{-6}}}$

$= 1592\text{ Hz}$

36. A light beam of intensity 20 W cm^{-2} is incident normally on a perfectly reflecting surface of sides $25\text{ cm}\times15\text{ cm}$. The momentum imparted to the surface by the light per second is

(a) $2\times10^{-5}\text{ kg ms}^{-1}$ (b) $1\times10^{-5}\text{ kg ms}^{-1}$ (c) $5\times10^{-5}\text{ kg ms}^{-1}$ (d) $1.2\times10^{-5}\text{ kg ms}^{-1}$

Ans: (c)

Sol: $I = \frac{E}{A}$

$E = IA$

$p = \frac{2E}{c}$

$p = \frac{2IA}{c} = \frac{2\times20\times25\times15}{3\times10^8} = 5\times10^{-5}\text{ kg ms}^{-1}$

37. An object approaches a convergent lens from the left of the lens with a uniform speed 5 ms^{-1} and stops at the focus, the image

(a) Moves away from the lens with an uniform speed 5 ms^{-1}

(b) Moves away from the lens with an uniform acceleration

(c) Moves away from the lens with a non-uniform acceleration

(d) Moves towards the lens with a non-uniform acceleration

Ans: (c)

Sol: Moves away from the lens with a non-uniform acceleration.

38. The refracting angle of prism is A and refractive index of material of prism is $\cot\frac{A}{2}$. The angle of minimum deviation is

(a) $180° - 3A$ (b) $180° + 2A$ (c) $90° - A$ (d) $180° - 2A$

Ans: (d)

Sol: $n = \dfrac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\frac{A}{2}}$

$$\cot\frac{A}{2} = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\frac{A}{2}}$$

$$\frac{\cos\frac{A}{2}}{\sin\frac{A}{2}} = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\frac{A}{2}}$$

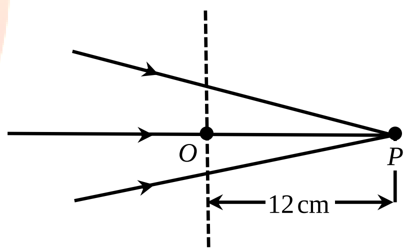
$$\sin\left(90 - \frac{A}{2}\right) = \sin\left(\frac{A+d_m}{2}\right)$$

$$90 - \frac{A}{2} = \frac{A+d_m}{2}$$

$$180 - A - A = d_m$$

$$180 - 2A = d_m$$

39. The following figure shows a beam of light converging at point P. When a concave lens of focal length $16\,\text{cm}$ is introduced in the path of the beam at a place shown by dotted line such that OP becomes the axis of the lens, the beam converges at a distance x from the lens. The value of x will be equal to



(a) $12\,\text{cm}$ (b) $24\,\text{cm}$ (c) $36\,\text{cm}$ (d) $48\,\text{cm}$

Ans: (d)

Sol: $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$

$f = -16\,\text{cm}$, $u = 12\,\text{cm}$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$\frac{1}{v}-\frac{1}{12}=-\frac{1}{16}$

$\frac{1}{v}=\frac{1}{12}-\frac{1}{16}=\frac{4-3}{48}=\frac{1}{48}$ $\therefore\ v=48\,\text{cm}$

40. Three polaroid sheets P_1, P_2 and P_3 are kept parallel to each other such that the angle between pass axes of P_1 and P_2 is $45°$ and that between P_2 and P_3 is $45°$. If unpolarised beam of light of intensity $128\,\text{Wm}^{-2}$ is incident on P_1. What is the intensity of light coming out of P_3?

(a) $128\,\text{Wm}^{-2}$ (b) 0 (c) $16\,\text{Wm}^{-2}$ (d) $64\,\text{Wm}^{-2}$

Ans: (c)

Sol: $I=\frac{I_0}{2}\left(\cos^2\theta\right)^2=\frac{128}{2}\left(\cos^2 45°\right)^2=64\times\left[\left(\frac{1}{\sqrt{2}}\right)^2\right]^2=64\times\frac{1}{4}=16\,\text{Wm}^{-2}$

41. Two poles are separated by a distance of $3.14\,\text{m}$. The resolving power of human eye is 1 minute of an arc. The maximum distance from which he can identify the two poles distinctly is

(a) $10.8\,\text{km}$ (b) $5.4\,\text{km}$ (c) $188\,\text{m}$ (d) $376\,\text{m}$

Ans: (a)

Sol: $\theta=1\text{min}=(1/60)^{\circ}=1/60\times\frac{\pi}{180}=\frac{\pi}{10800}\text{rad}$ and $d=3.14\times10^{-3}\text{km}$

$\theta=\frac{d}{D}\ \therefore\ D=\frac{d}{\theta}=\frac{3.14\times10^{-3}}{\pi/10800}=10.8\text{km}$

42. In Young's Double Slit Experiment, the distance between the slits and the screen is $1.2\,\text{m}$ and the distance between the two slits is $2.4\,\text{mm}$. If a thin transparent mica sheet of thickness $1\mu\text{m}$ and R.I. 1.5 is introduced between one of the interfering beams, the shift in the position of central bright fringe is

(a) $2\,\text{mm}$ (b) $0.5\,\text{mm}$ (c) $0.125\,\text{mm}$ (d) $0.25\,\text{mm}$

Ans: (d)

Sol: Shift $=(\mu-1)t\frac{D}{d}=(1.5-1)\times1\times10^{-6}\times\frac{1.2}{2.4\times10^{-3}}=0.25\,\text{mm}$

43. The de-Broglie wavelength associated with electron of hydrogen atom in this ground state is

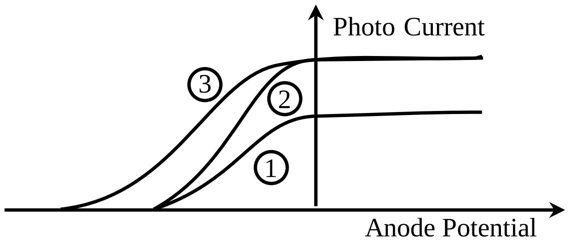
(a) $0.3\,\text{Å}$ (b) $3.3\,\text{Å}$ (c) $6.26\,\text{Å}$ (d) $10\,\text{Å}$

Ans: (b)

Sol: $\lambda=\frac{12.27}{\sqrt{E}}(\text{in Å})$ and $E=13.6\text{V}$ in ground state

$\therefore\ \lambda=\frac{12.27}{\sqrt{13.6}}=\frac{12.27}{3.68}=3.33\,\text{Å}$

44. The following graph represents the variation of photo current with anode potential for a metal surface. Here I_1, I_2 and I_3 represents intensities and $\gamma_1, \gamma_2, \gamma_3$ represent frequency for curves 1, 2 and 3 respectively, then



(a) $\gamma_1 = \gamma_2$ and $I_1 \neq I_2$ (b) $\gamma_1 = \gamma_3$ and $I_1 \neq I_3$

(c) $\gamma_1 = \gamma_2$ and $I_1 = I_2$ (d) $\gamma_2 = \gamma_3$ and $I_1 = I_3$

Ans: (a)

Sol: Stopping potential same

So frequencies same $(\gamma_1 = \gamma_2)$

Currents are different

So intensity are different

$I_1 \neq I_2$

45. The period of revolution of an electron revolving in nth orbit of $H-$atom is proportional to

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

(c) n^3 (d) Independent of n

Ans: (c)

Sol: The time period of revolution (T_n) of an electron in an orbit is the time taken by the electron to complete one revolution round the nucleus.

$$T_n = \frac{2\pi r_n}{v_n},$$

Put $r_n = \frac{n^2 h^2 \varepsilon_o}{\pi Z^2 em}$ and $v_n = \frac{Ze^2}{2nh\varepsilon_o}$

$$T_n = 2\pi \frac{\left[\frac{n^2 h^2 \varepsilon_o}{\pi Z e^2 m}\right]}{\left[\frac{Ze^2}{2nh\varepsilon_o}\right]} \Rightarrow T_n = \frac{4n^3 h^3 \varepsilon_o^2}{Z^2 e^4 m} \qquad \therefore\ T \propto n^3$$

46. Angular momentum of an electron in hydrogen atom is $\frac{3h}{2\pi}$ (h is the Planck's constant). The K.E. of the electron is

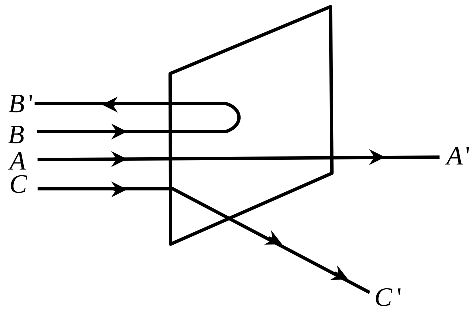
(a) 4.35 eV (b) 1.51 eV (c) 3.4 eV (d) 6.8 eV

Ans: (b)

Sol: $mvr = \frac{nh}{2\pi}$

$n = 3$

47. A beam of fast moving alpha particles were directed towards a thin film of gold. The parts A, B and C of the transmitted and reflected beams corresponding to the incident parts A, B and C of the beam are shown in the adjoining diagram. The number of alpha particles in



(a) B' will be minimum and in C' maximum

(b) A' will be maximum and in C' minimum

(c) A' will be maximum and in B' minimum

(d) C' will be minimum and in B' maximum

Ans: (c)

Sol: Based on Rutherford, α-particle scattering experiment, we can say that A' will be maximum and B' will be minimum

48. Two protons are kept at a separation of $10\,\text{nm}$. Let F_n and F_e the nuclear force and the electromagnetic force between them

(a) $F_e = F_n$ (b) $F_e >> F_n$

(c) $F_e << F_n$ (d) F_e and F_n differ only slightly

Ans: (b)

Sol: At separation greater than fermi, nuclear force is negligible. So, electromagnetic force is much stronger than nuclear force.

49. During a β^- decay

(a) An atomic electron is ejected

(b) An electron which is already present within the nucleus is ejected

(c) A neutron in the nucleus decays emitting an electron

(d) A proton in the nucleus decays emitting an electron

Ans: (c)

Sol: A neutron in the nucleus decays emitting an electron

50. A radio-active elements has half-life of 15 years. What is the fraction that will decay in 30 years?

(a) 0.25 (b) 0.5 (c) 0.75 (d) 0.85

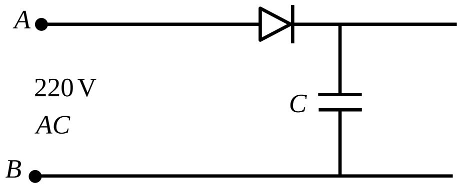
Ans: (c)

Sol: Fraction of remaining element

$$\left(1-\frac{N}{N_0}\right)\times 100 = \left(\frac{1}{2}\right)^{t/T} \times 100 = 0.25$$

The fraction that will decay in 30 years is 0.75

51. A $220\,\text{V}$ A.C supply is connected between points A and B as shown in figure what will be the potential difference V across the capacitor?



(a) $220\,\text{V}$ (b) $110\,\text{V}$

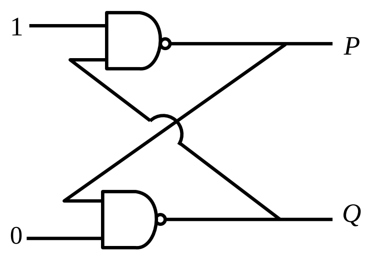
(c) 0 (d) $220\sqrt{2}\,\text{V}$

Ans: (d)

Sol: The potential difference a cross the capacitor is peak voltage.

$V_{\max} = V_{\text{rms}} \times \sqrt{2} = 220\sqrt{2}\,\text{V}$

52. In the following circuit what are P and Q :



(a) $P = 1,\ Q = 0$

(b) $P = 0,\ Q = 1$

(c) $P = 0,\ Q = 0$

(d) $P = 1,\ Q = 1$

Ans: (b)

Sol: $P = 0,\ Q = 1$

53. A positive hole in a semiconductor is

(a) An anti-particle of electron

(b) A vacancy created when an electron leaves a covalent bond

(c) Absence of free electrons

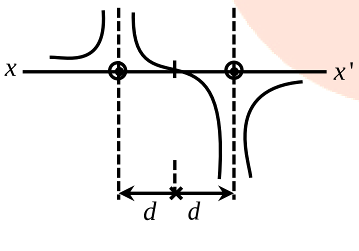
(d) An artificially created particle

Ans: (b)

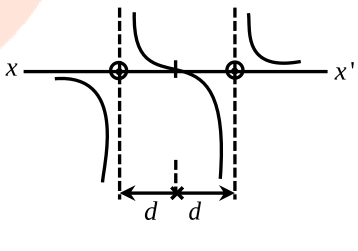
Sol: A vacancy created when an electron leaves a covalent bond.

54. Two long straight parallel wires are a distance $2d$ part. They carry steady equal currents flowing out of the plane of the paper. The variation of magnetic field B along the line xx' is given by

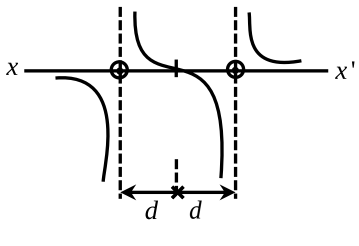
(a)



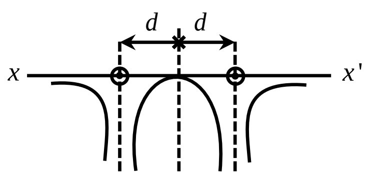
(b)



(c)



(d)



Ans: (b)

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

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

55. A cylindrical wire has a mass $(0.3\pm0.003)\,\text{g}$, radius $(0.5\pm0.005)\,\text{mm}$ and length $(6\pm0.06)\,\text{cm}$. The maximum percentage error in the measurement of its density is

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

Ans: (d)

Sol: $d=\frac{m}{V}=\frac{m}{\pi r^2 l}$

$$\frac{\Delta d}{d}\times100\%=\left(\frac{\Delta m}{m}\times100\%\right)+\left(2\frac{\Delta r}{r}\times100\%\right)+\left(\frac{\Delta l}{l}\times100\%\right)=4$$

56. At a metro station, a girl walks up a stationary escalator in $20\,\text{s}$. If she remains stationary on the escalator, then the escalator take her up in $30\,\text{sec}$. The time taken by her to walk up on the moving escalator will be

(a) $25\,\text{s}$ (b) $60\,\text{s}$ (c) $12\,\text{s}$ (d) $10\,\text{s}$

Ans: (c)

Sol: Let speed of girl on stationary escalator $=v_g=(v_1)$

Speed of only escalator $=v_e=(v_2)$

Slanted distance $=d$

Now, time to go up when escalator is stop, $t_g=\frac{d}{v_g}=(=t_1)\quad\Rightarrow v_g=\frac{d}{t_g}$

Time required to go up when girl stops and escalator moves, $t_e=\frac{d}{v_g}(=t_2)\ \Rightarrow\ v_e=\frac{d}{t_2}$

Now, when both girl and escalator moves up, velocity of girl with respect to ground $=v_g+v_e$

Time taken $=t=\frac{d}{v_g+v_e}=\frac{d}{\frac{d}{t_1}+\frac{d}{t_2}}$

$$t=\frac{t_1t_2}{t_1+t_2}=\frac{20\times30}{20+30}=12\,\text{s}$$

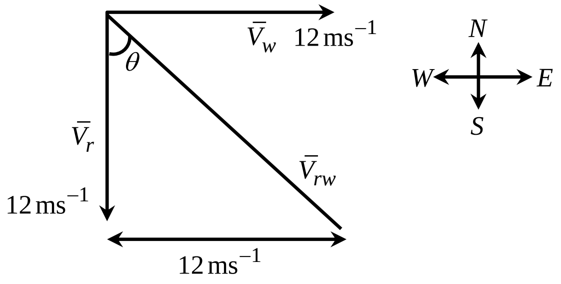
57. Rain is falling vertically with a speed of $12\,\text{ms}^{-1}$. A woman rides a bicycles with a speed of $12\,\text{ms}^{-1}$ in east to west direction. What is the direction in which she should hold her umbrella?

(a) 30° towards East (b) 45° towards East

(c) 30° towards West (d) 45° towards West

Ans: (b)

Sol:



$\tan\theta = \frac{|v_r|}{|v_m|} = \frac{12}{12} = 1$

$\theta = 45°$ towards East

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

(a) T (b) $T - \frac{mv^2}{l}$ (c) $T + \frac{mv^2}{l}$ (d) 0

Ans: (a)

Sol: The net force on the particle (directed towards the centre) is tension (T) in the string

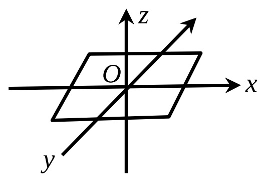
59. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time $'t'$ is proportional to

(a) $t^{1/2}$ (b) t (c) $t^{3/2}$ (d) t^2

Ans: (b)

Sol: $P = \frac{1}{2}\frac{mv^2}{t} = \frac{1}{2}\frac{m \times (at)^2}{t}$ $P \propto t$

60. A thin uniform rectangular plate of mass $2\,\text{kg}$ is placed in $X - Y$ plane as shown in figure. The moment of inertial about $x -$axis is $I_x = 0.2\,\text{kg m}^2$ and the moment of inertia about $y -$axis is $I_y = 0.3\,\text{kg m}^2$. The radius of gyration of the plate about the axis passing through O and perpendicular to the plane of the plate is



(a) 50 cm (b) 5 cm (c) 38.7 cm (d) 31.6 cm

Ans: (a)

Sol: $I_z = I_x + I_y = 0.5\,\text{kg m}^2$

$I = mK^2$

$K = 0.5\,\text{m} = 50\,\text{cm}$

Key Answers:

1. b	2. c	3. a	4. a	5. c	6. a	7. c	8. c	9. d	10. c
11. a	12. c	13. b	14. c	15. b	16. a	17. c	18. a	19. c	20. a
21. a	22. a	23. d	24. c	25. a	26. c	27. c	28. b	29. d	30. d
31. b	32. b	33. c	34. b	35. c	36. c	37. c	38. d	39. d	40. c
41. a	42. d	43. b	44. a	45. c	46. b	47. c	48. b	49. c	50. c
51. d	52. b	53. b	54. b	55. d	56. c	57. b	58. a	59. b	60. a