Solution

ELECTROSTATICS

1. $F = \frac{1}{(4\pi\varepsilon_0)} \frac{q_1 q_2}{kd^2}$ (in medium)

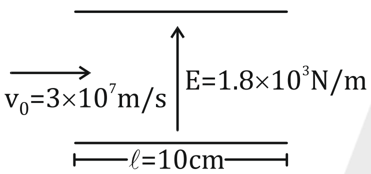
$F_{Air} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{d'^2}$

$F = F_{Air}$

$\frac{q_1 q_2}{4\pi\varepsilon_0 kd^2} = \frac{q_1 q_2}{4\pi\varepsilon_0 \, d'^2}$

$d' = d\sqrt{k}$

2.



$a = \frac{F}{m} = \frac{qE}{m} = (2 \times 10^{11})(1.8 \times 10^3)$

$= 3.6 \times 10^{14}\ m/s^2$

Time to cross plates $= \frac{d}{V}$

$t = \frac{0.10}{3 \times 10^7}$

$y = \frac{1}{2}at^2 = \frac{1}{2}(3.6 \times 10^{14})\left(\frac{0.01}{9 \times 10^{14}}\right)$

$= 0.2 \times 0.01$

$= 0.002\ m$

$= 2\ mm$

3. Potential at centre

$V = \frac{(\lambda \cdot \pi R_2)}{4\pi\varepsilon_0 R_2} + \frac{(\lambda \cdot \pi R_1)}{4\pi\varepsilon_0 R_1}$

$= \frac{\lambda}{2\varepsilon_0}$

4. $0.5e = \frac{1}{2}mv_x^2 \Rightarrow v_x = \sqrt{\frac{e}{m}}$

Along x $L = v_x t = \sqrt{\frac{e}{m}}t$

Along $y_y = \frac{eE}{m}t$

dividing $\frac{v_y}{L} = E\sqrt{\frac{e}{m}} = Ev_x$

$\Rightarrow \text{Tan}\,\theta = \frac{v_y}{v_x} = E \times L = 10 \times 0.1 = 1$

$\theta = 45°$

5. $\xleftrightarrow{2m}\ \xleftrightarrow{(x_0\text{-}2)cm}$

$E_P = \frac{K\times10}{2^2} - \frac{K\times40}{(x_0-2)^2} = 0$

$\frac{1}{2} = \frac{2}{x_0 - 2}$

$x_0 - 2 = 4$

$x_0 = 6\text{ cm}$

6. Gauss's Law of electrostatic

$\phi = \oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$

Faraday's law $\oint \vec{E} \cdot d\vec{l} = \frac{-d\phi_B}{dt}$

Gauss's law of magnetism $\oint \vec{B} \cdot d\vec{A} = 0$

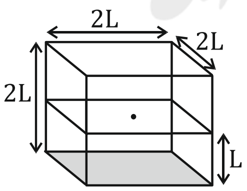
Ampere's Maxwell law

$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_C + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$

Where i_C : Conduction current

$\epsilon_0 \frac{d\phi_E}{dt}$: Displacement current

7. $\phi = \frac{Q/\varepsilon_0}{6}$

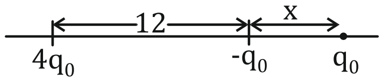


Flux passing through shaded face $= \frac{q}{6\varepsilon_0}$

8. $H = \frac{V^2}{R} \times t$

$\frac{H_1}{H_2} = \frac{\frac{V^2t}{R}}{\frac{V^2t}{3R}} = 3:1$

9.

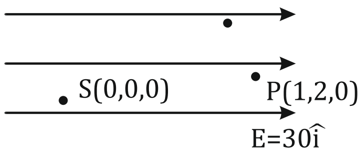


$$\frac{q_0}{x^2} = \frac{4q_0}{(x+12)^2}$$

$$x + 12 = 2x$$

$$x = 12$$

10. $\omega_E = q\vec{E}\cdot\vec{S}$



$$= 2\times10^{-2}[30\hat{i}\cdot(-\hat{i})]$$

$$= 2\times10^{-2}(-30)$$

$$= -60\times10^{-2}$$

$$= -\frac{60}{100} = -0.6\ \text{J}$$

$$= -600\ \text{mJ}$$

CURRENT ELECTRICITY

11. Equivalent resistance of circuit

$R_{eq} = 3 + 1 + 2 + 4 + 2 = 12\Omega$

Current through battery $i = \frac{24}{12} = 2$ A

$I_4 = \frac{R_5}{R_4 + R_5} \times 2 = \frac{5}{20+5} \times 2 = \frac{2}{5}$ A

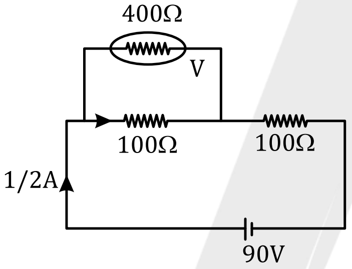
$I_5 = 2 - \frac{2}{5} = \frac{8}{5}$ A

12. $R = \rho \frac{\ell}{A}$, the cross-sectional area is $\pi(b^2 - a^2)$

$R = \rho \frac{\ell}{\pi(b^2 - a^2)}$

$= \frac{2.4 \times 10^{-8} \times 3.14}{3.14 \times (4^2 - 2^2) \times 10^{-6}}$

$= 2 \times 10^{-3}\Omega \rightarrow n = 2$

13. 

$R_{eq} = \frac{400 \times 100}{500} + 100 = 180\Omega$

$i = \frac{90}{180} = \frac{1}{2}$ A

Reading $= \frac{1}{2} \times \frac{400}{500} \times 100 = 40$volt

14. As volume is constant,

So resistance $\propto$ (length $)^2 \Rightarrow$ % change in resistance $= 20 + 20 + \frac{400}{100} = 44\%$

15. $I = 2$ A

$\Delta V = 3.4$ V

Using Ohm's Law

$R = \frac{3.4}{2} = 1.7\Omega$

$1.7 = \frac{\rho L}{A}$

$L = \frac{1.7(A)}{\rho}$

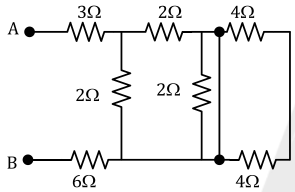
$M = (\text{ density volume })$

$\text{Volume} = \frac{8.92 \times 10^{-3}}{8.92 \times 10^{3}} = 10^{-6}$

$L^2 = \frac{1.7}{\rho}(10^{-6}) = \frac{1.7}{1.7} \times 10^2$

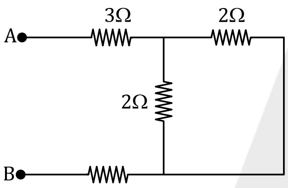
$L = 10 \text{ m}$

16.



Both 4Ω resistance gets short.

Remove the resistors that have no current.



$R_{eq} = 3 + (2 \parallel 2) + 6$

$R_{eq} = 3 + 1 + 6$

$R_{eq} = 10\Omega$

17.

$R_{\text{initial}} = \frac{\rho \ell}{A} = 5\Omega$

∵ Volume of wire is constant in stretching

$V_i = V_f$

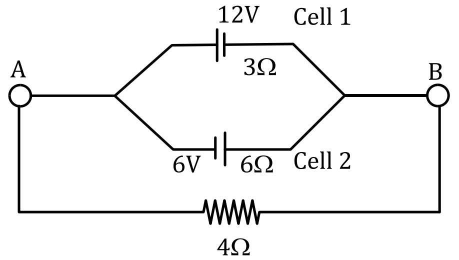
$A_i \ell_i = A_f \ell_f$

$A\ell = A'(5\ell)$

$A' = \frac{A}{5}$

$R_f = \frac{\rho \ell_f}{A_f} = \frac{\rho(5\ell)}{\left(\frac{A}{5}\right)} = 25\left(\frac{\rho \ell}{A}\right) = 25 \times 5 = 125\Omega$

18.

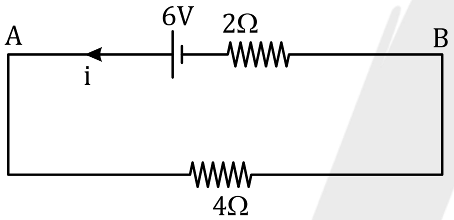


$$E_{eq} = \frac{\frac{12}{3} - \frac{6}{6}}{\frac{1}{3} + \frac{1}{6}}$$

$E_{eq} = 6\text{ V}$

$r_{eq} = 2\Omega$

$R = 4\Omega$



So, $i = \dfrac{6}{2+4} = 1\text{ A}$

19. Sensitivity of potentiometer wire is inversely proportional to potential gradient.

20. $\frac{R_1+R_2}{10} = \frac{60}{40} = \frac{3}{2} \Rightarrow R_1 + R_2 = 15$

Now $\dfrac{R_1R_2}{(R_1+R_2)\times 3}$

$= \dfrac{40}{60} = \dfrac{2}{3} \Rightarrow R_1R_2 = 30$

ELECTROMAGNETIC WAVES

21. Magnetic field vector will be in the direction of

$\hat{K} \times \hat{E}$

magnitude of $B = \frac{E}{C} = \frac{K}{\omega} E$

Or $\vec{B} = \frac{1}{\omega}(\vec{K} \times \vec{E})$

22. $C = \frac{\omega}{k} = \frac{E_0}{B_0}$

23. As, pointing vector

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

Given energy transport = negative z direction

Electric field = positive y direction

$(-\hat{k}) = (+\hat{j}) \times [\hat{i}]$

Hence according to vector cross product magnetic field should be positive x direction.

24. Speed of light does not depend on the motion of source as well as intensity.

25. Statement-I is correct as EMW are neutral Statement-II is wrong.

$$E_0 = \sqrt{\frac{1}{\mu_0 \varepsilon_0}} B_0$$

28. $< u_E > = < u_B > = \frac{1}{2} < u_{total} >$

So $\frac{\langle u_E \rangle}{\langle u_{total} \rangle} = \frac{1}{2}$

29. When an electromagnetic wave propagates from the source, it transfers energy to the objects in its path. Electric and magnetic fields serve as energy reservoirs for electromagnetic waves. An electromagnetic wave contains the same amount of energy as are contained in the electric and magnetic fields together. In such situation, the energy density of the electromagnetic wave is equal to the sum of the energies of the electric and magnetic fields.

The average electric and magnetic energy densities are given by

$$U_E = \frac{1}{2}\varepsilon_0 E^2$$

$$U_B = \frac{1}{2}\frac{B^2}{\mu_0}$$

30. The bombarding electrons can eject electrons from the inner shells of the atoms of the metal target. Those vacancies will be quickly filled by electrons dropping from higher levels, emitting x-rays with sharply defined frequencies associated with the difference between the atomic energy levels of the target atoms. Hence, X-rays are emitted when a metal target is bombarded with high energy electrons.

ALTERNATING CURRENT

31. $\Delta\omega = \frac{R}{L}$

$$Q = \frac{\omega_0}{\Delta\omega} = \omega_0 \frac{L}{R}$$

$$\omega_0 = \frac{1}{\sqrt{3 \times 27 \times 10^{-6}}} = \frac{1}{9 \times 10^{-3}}$$

$$\frac{Q}{\Delta\omega} = \frac{\omega_0 \frac{L}{R}}{\frac{R}{L}} = \omega_0 \frac{L^2}{R^2} = \sqrt{\frac{1}{LC} \frac{L^2}{R^2}} = \frac{1}{9 \times 10^{-3}} \times \frac{9}{100} = 10 \text{ s}$$

32. After long time an inductor behaves as a resistance-less path.

So current through cell

$$I = \frac{12}{R/3} = 3 \text{ A}\{\because R = 12\Omega\}$$

33. The resonance frequency of LC oscillations circuit is

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$L \to 2\text{ L} \Rightarrow C \to 8C \Rightarrow \omega = \frac{1}{\sqrt{2\text{ L} \times 8C}} = \frac{1}{4\sqrt{LC}} \Rightarrow \omega = \frac{\omega_0}{4}$$

$$\text{So } x = \frac{1}{4}$$

34. $f = \frac{1}{2\pi\sqrt{LC}}$

$$2000 \text{ Hz} = \frac{1}{2\pi\sqrt{L \times 62.5 \times 10^{-9}}}$$

$$L = \frac{1}{4\pi^2 \times 2000^2 \times 62.5 \times 10^{-9}} = 0.1\text{H} = 100\text{mH}$$

35. $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2+(X_C-X_L)^2}}$

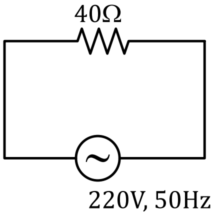
$$\cos\phi = \frac{80}{\sqrt{(80)^2 + (60)^2}} \Rightarrow \cos\phi = \frac{80}{100} \Rightarrow \frac{8}{10}$$

36. $\phi = Mi$

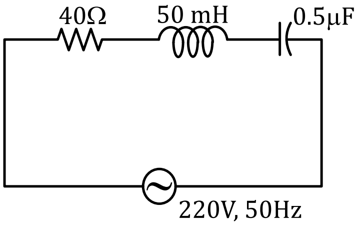
$\phi = (BA)$

$$\phi = \pi R^2 \left(4 \frac{\mu_0}{4\pi} \frac{i}{\left(\frac{L}{2}\right)} \sqrt{2}\right) \Rightarrow M = \frac{2\sqrt{2}\mu_0 R^2}{L}$$

37.



$$I_{rms} = \frac{220}{40} = 5.5\ \text{A}$$



X_L is not equal to X_C. So rms current in (b) can never be larger than (a).

38. $\frac{1}{2\pi fC} = 2\pi fL$

$$C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4 \times \pi^2 \times 49 \times 10^6 \times 2 \times 10^{-6}}$$

$$C = \frac{1}{3872}\ \text{F}$$

$$x = 3872$$

39. $A_c + A_m = 120 \Rightarrow\ A_c - A_m = 80$

$\therefore A_c = 100 \Rightarrow\ A_m = 20$

$$\text{Modulation index } = \frac{20}{100} = \frac{1}{5}$$

$$\text{Amplitude of each sideband } = A_c \frac{(\text{ mod ulation index })}{2} = 100 \times \frac{1}{10} = 10\ \text{volt}$$

40. $P = \frac{R}{Z} \Rightarrow P_1 = \frac{R}{\sqrt{R^2+X_L^2}} = \frac{R}{R\sqrt{2}}(\text{ as } X_L = R)$

$$P_1 = \frac{1}{\sqrt{2}} \Rightarrow P_2 = \frac{R}{\sqrt{R^2 + (X_L - X_L)^2}} = P_2 = 1$$

RAY OPTICS

41. $\frac{1}{f_1} = (1.75 - 1)\left(-\frac{1}{30}\right)$

$\Rightarrow f_1 = -40 \text{ cm}$

$\frac{1}{f_2} = (1.75 - 1)\left(\frac{1}{30}\right) \Rightarrow f_2 = 40 \text{ cm}$

Image from L_1 will be virtual and on the left of L_1 at focal length 40 cm. So the object for L_2 will be 80 cm from L_2 which is 2f. Final image is formed at 80 cm from L_2 on the right. So x = 120

42. Based on fact

43. $\frac{I}{f_{H_2O}} = \left(\frac{\mu_g}{\mu_{H_2O}} - 1\right)\left(\frac{2}{R}\right)$

$= \frac{1}{8}\left(\frac{2}{R}\right) = \frac{1}{(4f_{air})}$

So, $f_{H_2O} = 4f_{air} = 72 \text{ cm}$

So change in focal length = 72 − 18 = 54 cm

44. $\sin c = \frac{1}{\sqrt{2}}$

$c = 45^\circ$

$\sin c = \mu \sin \theta$

$\frac{1}{\sqrt{2}} = \sqrt{2} \sin \theta$

$\theta = 30^\circ$

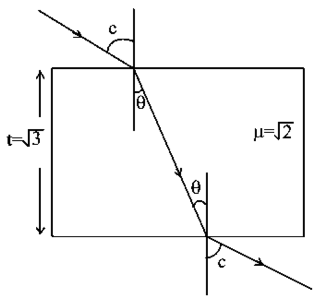
Lateral displacement:

$x = t\sin(i - r)\sec r$

$x = \sqrt{3}\sin(45^\circ - 30^\circ)\sec 30^\circ$

$x = \sqrt{3}(0.26)\left(\frac{2}{\sqrt{3}}\right)$

$x = 0.52 \text{ cm}$



45. Plane mirror forms erect, same sized, laterally inverted and virtual image of real object.

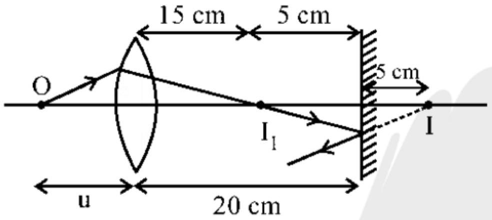
46. f = 10 cm

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

$$\frac{1}{15}-\frac{1}{-u}=\frac{1}{10}$$

$$\Rightarrow \frac{1}{u}=\frac{1}{10}-\frac{1}{15}$$

On solving we get value of u as 30 cm.



47. $P=\frac{2\mu\sin\,\theta}{1.22\lambda}$

48. $\frac{1}{V}-\frac{1}{u}=\frac{1}{f}$

$P = 2D = 2\ m^{-1}$

$$\Rightarrow \frac{1}{f}=\frac{2}{100}\ cm^{-1}$$

$$\frac{1}{V}-\left(-\frac{1}{25}\right)=\frac{2}{100}$$

$$\Rightarrow \frac{1}{V}=\frac{1}{50}-\frac{1}{25}$$

$\Rightarrow V=-50$ cm

49. $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

$$\frac{-1}{120}-\frac{1}{40}=\frac{1}{f},\ f=-30\text{ cm}$$

Now,

$$\frac{-1}{v^2}dv-\frac{1}{u^2}du=-\frac{1}{f^2}df$$

Now,

$$\frac{-1}{v^2}dv-\frac{1}{u^2}du=-\frac{1}{f^2}df$$

Also $dv = du = \frac{1}{20}$ cm

$$\frac{\frac{1}{20}}{(120)^2}+\frac{\frac{1}{20}}{(40)^2}=\frac{df}{(30)^2}$$

On solving

$$df=\frac{1}{32}\text{ cm}$$

$$\therefore k=32$$

50. $\delta_1=\delta_2$ [for no average deviation]

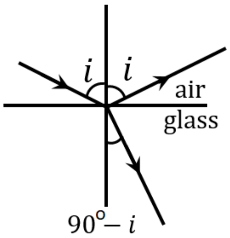
$\Rightarrow 6^\circ(1.54-1)=A(1.72-1)$

$$\Rightarrow A=\frac{6^\circ\times 0.54}{0.72}$$

$$=\frac{18^\circ}{4}=4.5^\circ$$

WAVE OPTICS

51.



$\mu_a \sin i_1 = \mu_g \sin(90 - i_1)$

$\tan i_1 = \dfrac{\mu_g}{\mu_a}$

When going from glass to air

$\tan i_2 = \dfrac{\mu_a}{\mu_g} = \cot i_1$

Hence

$i_2 = \dfrac{\pi}{2} - i_1$

52. Given D = 1 m

$\lambda = 600 \times 10^{-9}$ m

n = 5

As $y_{nth} = \dfrac{n\lambda D}{d} \Rightarrow \dfrac{5 \times 600 \times 10^{-9} \times 1}{d} = 5 \times 10^{-2}$

$\Rightarrow d = \dfrac{5 \times 600 \times 10^{-9} \times 1}{5 \times 10^{-2}} = 60 \times 10^{-6}\text{ m} \Rightarrow d = 60\mu\text{m}$

53. $A_2P - A_1P = \frac{\lambda}{2}$ (Condition of minima)

$\sqrt{D^2 + a^2} - D = \dfrac{\lambda}{2}$

$D\left(1 + \dfrac{a^2}{D^2}\right)^{1/2} - D = \dfrac{\lambda}{2} \Rightarrow D\left(1 + \dfrac{1}{2} \times \dfrac{a^2}{D^2}\right) - D = \dfrac{\lambda}{2}$

$\dfrac{a^2}{2D} = \dfrac{\lambda}{2} \Rightarrow a = \sqrt{\lambda . D} = \sqrt{800 \times 10^{-6} \times 50}$

a = 0.2 mm

54. By first polaroid P1 intensity will be halved then P2 and P3 will make intensity $\cos^2(60°)$ and $\cos^2(30°)$ times respectively. Intensity out

$= \dfrac{256}{2} \times \dfrac{1}{4} \times \left(\dfrac{\sqrt{3}}{2}\right)^2 = \dfrac{256 \times 3}{2 \times 4 \times 4} = 24$

55. $\mu_1 = \sqrt{2.8 \times 1} = \sqrt{2.8}$

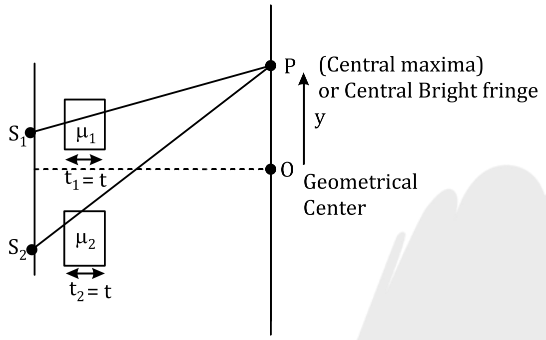
$\mu_2 = \sqrt{6.8 \times 1} = \sqrt{6.8}$

$\mu_1 \sin\ i = \mu_2 \cos i \tan\ i = \frac{\mu_2}{\mu_1} = \sqrt{\frac{6.8}{2.8}}$

$\tan\ i = \left(\frac{2.8+4}{2.8}\right)^{1/2} \quad i = \tan^{-1}\left(1+\frac{10}{7}\right)^{1/2}$

$\theta = 7$

56.



Path difference at P be Δx

$\Delta x = (\mu_2 - \mu_1)t = (1.55 - 1.51)0.1\text{ mm} = 0.04 \times 10^{-4}$

$\Delta x = 4 \times 10^{-6} = 4\mu m \Rightarrow y = \frac{\Delta x D}{d} = 4 \times 10^{-6}\frac{D}{d}$

{y is the distance of central maxima from geometric center}

$\underset{(\beta)}{\text{fringe width}} = \frac{\lambda D}{d} = 4 \times 10^{-6}\ m\frac{D}{d} = 4\mu m\frac{D}{d}$

$\therefore$ Central bright fringe spot will shift by ' x '

$\text{Number of shift} = \frac{y}{\beta} = \frac{4 \times 10^{-6}D/d}{4 \times 10^{-7}D/d} = 10$

57. $I = 4I_0\cos^2\left(\frac{\Delta\phi}{2}\right)$

$I_1 = 4I_0\cos^2\left(\frac{\pi}{4}\right) = 2I_0$

$I_2 = 4I_0\cos^2\left(\frac{2\pi}{3}\right) = I_0 \Rightarrow \frac{I_1 + I_2}{I_0} = 3$

58. $I_A = \frac{I_o}{2}$

$IC = \frac{I_o}{2}\cos^2\ 45 = \frac{I_o}{4}$

$I_B = I_C\cos^2\ 45 = \frac{I_o}{8}$

ATOMIC PHYSICS

61. density of nuclei $= \frac{\text{mass of nuclei}}{\text{volume of nuclei}}$

$$\rho = \frac{1.6 \times 10^{-27}\text{ A}}{\frac{4}{3}\pi(1.5 \times 10^{-15})^3\text{ A}}$$

$$= \frac{1.6 \times 10^{-27}}{14.14 \times 10^{-45}} = 0.113 \times 10^{18}$$

$$\rho_w = 10^3$$

Hence $\frac{\rho}{\rho_w} = 11.31 \times 10^{13}$

62. $\frac{hc}{\lambda} = \left[1 - \frac{1}{16}\right](13.6\text{eV})$

So, $\lambda = 94.1$ nm

63. __________n=4

__________n=3

__________n=2

__________n=1

Second excited state → first excited state

$n = 3 \rightarrow n = 2$

$$\frac{hc}{\lambda_0} = 13.6\left(\frac{1}{2^2} - \frac{1}{3^2}\right) \ldots\ldots\text{(i)}$$

Third excited state → second orbit

$n = 4 \rightarrow n = 2$

$$\frac{hc}{(20\lambda_0/x)} = 13.6\left(\frac{1}{2^2} - \frac{1}{4^2}\right) \ldots\ldots\text{(ii)}$$

(ii) ÷ (i)

$$\frac{x}{20} = \frac{\frac{1}{2^2} - \frac{1}{4^2}}{\frac{1}{2^2} - \frac{1}{3^2}}$$

$x = 27$

64. $\lambda = \frac{hc}{\Delta E}$

$\Delta E_A = 2.2\text{eV}$

$\Delta E_B = 5.2\text{eV}$

$\Delta E_C = 3\text{eV}$

$\Delta E_D = 10\text{eV}$

$$\lambda_A = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{2.2 \times 1.6 \times 10^{-19}}$$

$$= \frac{12.41 \times 10^{-7}}{2.2}\ \text{m}$$

$$= \frac{1241}{2.2}\ \text{nm} = 564\ \text{nm}$$

$$\lambda_B = \frac{1241}{5.2}\ \text{nm} = 238.65\ \text{nm}$$

$$\lambda_C = \frac{1241}{3}\ \text{nm} = 413.66\ \text{nm}$$

$$\lambda_D = \frac{1241}{10} = 124.1\ \text{nm}$$

65. $V_n \propto \frac{Z}{n}$

$$Z = 1, \therefore V_n \propto \frac{1}{n}$$

$$\therefore \frac{V_3}{V_7} = \frac{7}{3}$$

$$\therefore V_3 = \frac{7}{3} V_7$$

$$= \frac{7}{3} \times 3.6 \times 10^6\ \text{m/s}$$

$$= 8.4 \times 10^6\ \text{m/s}$$

66. $\frac{1}{\lambda} = Rz^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$\frac{1}{\lambda_1} = Rz^2\left[\frac{1}{1^2} - \frac{1}{3^2}\right] = \frac{8}{9}Rz^2 \quad \ldots\ldots(1)$$

$$\frac{1}{\lambda_2} = Rz^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3}{4}Rz^2 \quad \ldots\ldots(2)$$

$$1/2 \Rightarrow \frac{\lambda_2}{\lambda_1} = \frac{8}{9} \times \frac{4}{3} = \frac{32}{27}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{27}{32}$$

$= 27$

69. B.E of Helium $= (2m_P + 2m_N - m_{He})c^2$

$= 28.4\text{MeV}$

70. In the ground state energy $= -13.6\text{eV}$

So energy

$$\frac{-13.6\text{eV}}{n^2} = -13.6 + 12.75$$

$$\frac{-13.6\text{eV}}{n^2} = -0.85$$

$$n = \sqrt{16}$$

$$n = 4$$

Angular momentum $= \frac{nh}{2\pi} = \frac{4h}{2\pi} = \frac{2h}{\pi}$

Angular momentum $= \frac{2}{\pi} \times 4.14 \times 10^{-15}$

$$= \frac{828 \times 10^{-17}}{\pi}\text{eVs}$$

SEMICONDUCTORS

71. Photodiodes are operated in reverse bias as fractional change in current due to light is more easy to detect in reverse bias.

72. $Y = \overline{A_1 \odot B_1}$ NAND

A_1	B_1	X
0	0	1
0	1	1
1	0	1
1	1	0

73. Theory based

Photodiodes are operated in reverse bias condition. For P-N junction current in forward bias (for $V \geq V_0$) is always greater than current in reverse bias (for $V \leq V_z$).

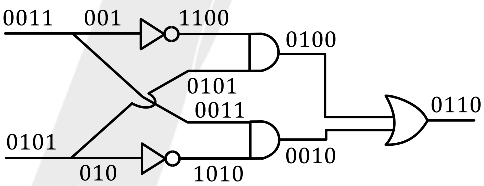
Hence Assertion if false but Reason is true

74. Statement –I is correct

When P-N junction is formed an electric field is generated form N-side to P-side due to which barrier potential arises & majority charge carrier can not flow through the junction due to barrier potential so current is zero unless we apply forward bias voltage.

75. LED works in forward biasing and light energy maybe slightly less or equal to band gap.

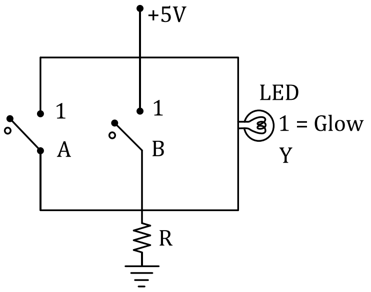
76.



77. As temperature increases, more electron excite to conduction band and hence conductivity increases, therefore resistance decreases.

79. Woks as voltage regulator in reverse bias and as simple P – n junction in forward bias.

80. Let's assume that when the path is short, the state is called state 1 and when it is open, the state is called state 0.



Depending up on whether the path is short or not in the circuit, the following table can be obtained:

A	B	Out
1	1	0
1	0	0
0	1	0
0	0	1

The above table is similar to the truth table corresponding to NOR gate. Hence, the circuit indicates a NOR logic gate.

ELECTROMAGNETIC INDUCTION

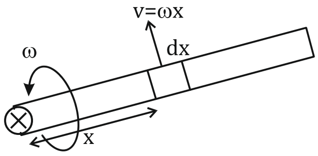
81. $\text{EMF} = \frac{d\phi}{dt} = \frac{BA-0}{t}$

$A = \pi r^2 = \pi\left(\frac{0.1^2}{\pi}\right) = 0.01$

$B = 0.5$

$\text{EMF} = \frac{(0.5)(0.01)}{0.5} = 0.01\text{ V} = 10\text{mV}$

82. $\int d\varepsilon = \int B(\omega x)dx$



$\varepsilon = B\omega\int_0^L x dx = \frac{B\omega L^2}{2}$

83. Induced emf across the ends $= Bv\ell$

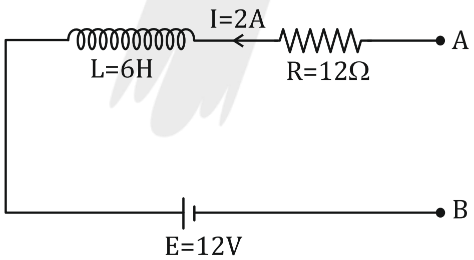
$= 2 \times 8 \times 1 = 16\text{ V}$

84. $\text{EMF} = \frac{d}{dt}(B\pi r^2)$

$= 2\,B\pi r\frac{dr}{dt} = 2 \times \pi \times 0.1 \times 0.8 \times 2 \times 10^{-2}$

$= 2\pi \times 1.6 = 10.06$ [round off $10.06 = 10$]

85. $\frac{dI}{dt} = -1\frac{A}{sec}$



$V_A - IR - L\frac{dI}{dt} - 12 = V_B$

$V_A - 2 \times 12 - 6(-1) - 12 = V_B$

$V_A - V_B = 36 - 6 = 30\text{ volt}$

86. $X_L = X_C$

So, $Z = R = 20\Omega$

$$i_{rms} = \frac{220}{20} = 11$$

$$i_{max} = 11\sqrt{2} = \sqrt{242}$$

87. Induced emf is given by Faraday's law

$$|\varepsilon| = \frac{d\phi}{dt}$$

where ϕ is the magnetic flux.

The rate of change of flux through a circuit is defined as emf. The formula for flux is $\phi = \vec{B} \cdot \vec{A}$. In the statements A & B given in the question, the magnetic flux in the coil in uniform magnetic field does not change. So, no emf is induced.

But in statement C, the angle between the area vector and the magnetic field continuously changes hence, an emf is generated. In statement D, the area is changing in unit time so magnetic flux will change and an emf is generated.

88. The formula to calculate the average electric energy density is given by

$$U_E = \frac{1}{2}\varepsilon_0 E^2 \ \dots(1)$$

and, the formula to calculate average magnetic energy density is given by

$$U_B = \frac{1}{2\mu_0}B^2 \dots(2)$$

For any particular electromagnetic wave, both magnetic and electric field are equally involved in contributing to energy density. Hence, the ratio of average electric energy density to magnetic energy density is 1.

89. Let the magnetic field of the 200 turns be B_1. The formula of magnetic field is given by $B = \frac{\mu_0 i}{2r}$

Let $r = 1000$ cm. Thus,

$$B_1 = \frac{n\mu_0 \times I}{2 \times 10} = \frac{200\mu_0 I}{2 \times 10}$$

The flux through the coil of radius $r_1 = 1$ cm is $\phi = 10 \times (\vec{B} \cdot \vec{A}) = 10 \times B_1 \pi r^2{}_1$

$$\Rightarrow \phi = 10 \times \frac{200\mu_0 I}{2 \times 10} \times \pi(0.01)^2$$

$$L = 10 \times \frac{200\mu_0}{2 \times 10} \times \pi(0.01)^2$$

$$= 10 \times \frac{200(4\pi \times 10^{-7})}{2 \times 10} \times \pi(0.01)^2$$

$$= 4 \times 10^{-8} H$$

90. The formula to calculate the motional emf induced in a moving conductor in a magnetic field is given by $\varepsilon = Blv$ .....(1)

Substitute the values of the known parameters into equation (1) and solve to calculate the required velocity of the rod.

$$0.08\text{ V} = 0.4\text{ T} \times \left(10\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}}\right) \times v$$

$$\Rightarrow v = \frac{0.08\text{ V}}{0.4\text{ T} \times 10\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}}}$$

$$= 2\text{ m s}^{-1}$$