Physics Solutions

1. (b) $\therefore E = \frac{1}{2}mv^2$

$\therefore$ % Error in K.E.

= % error in mass + 2 × % error in velocity

= 2 + 2 × 3 = 8 %

5. (d) $\frac{v_A}{v_B} = \frac{\tan\theta_A}{\tan\theta_B} = \frac{\tan 30°}{\tan 60°} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

6. (b) Range is given by $R = \frac{u^2 \sin 2\theta}{g}$

On moon $g_m = \frac{g}{6}$. Hence $R_m = 6R$

7. (b)

$$a = \frac{m_2}{m_1 + m_2} \times g = \frac{5}{4+5} \times 9.8 = \frac{49}{9} = 5.44\ m/s^2$$

8. (b) Work done by centripetal force is always zero.

9. (d)

10. (a) $\frac{v_p}{v_e} = \sqrt{\frac{M_p}{M_e} \times \frac{R_e}{R_p}} = \sqrt{2 \times \frac{1}{3}} = \sqrt{\frac{2}{3}}\ \therefore\ v_p = \sqrt{\frac{2}{3}}v_e$

8. (c) $l = \frac{MgL}{YA} = \frac{1 \times 10 \times 1}{2 \times 10^{11} \times 10^{-6}} = 0.05\ mm$

9. (a) From the Bernoulli's theorem

$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2) = \frac{1}{2} \times 1.3 \times [(120)^2 - (90)^2]$$

$= 4095\ N/m^2$ or *Pascal*

10. (c) Total heat required

$$Q = Q_1 + Q_2 = 1 \times 80 + 1 \times 1 \times (100 - 0) = 180\ cal$$

11. **(c)**

12. (d) Work done = Area under curve $= \frac{6P_1 \times 3V_1}{2} = 9\ P_1V_1$

13. (b) In series $R_{eq} = R_1 + R_2 \Rightarrow \frac{2l}{K_{eq}A} = \frac{l}{K_1A} + \frac{l}{K_2A}$

$\Rightarrow \frac{2}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2} \Rightarrow K_{eq} = \frac{2K_1K_2}{K_1 + K_2}$

14. (a) Inside the mine g decreases

hence from $T = 2\pi\sqrt{\frac{l}{g}}$; T increase

15. (b) From the given equation amplitude $a = 0.04\,m$

Frequency $= \frac{\text{Co–efficient of t}}{2\pi} = \frac{\pi/5}{2\pi} = \frac{1}{10}Hz$

Wave length $\lambda = \frac{2\pi}{\text{Co–efficient of } x} = \frac{2\pi}{\pi/9}$

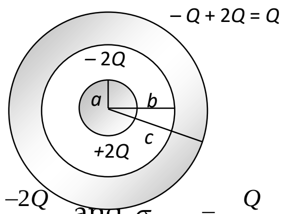
=18m.

Wave speed $v = \frac{\text{Co - efficient of } t}{\text{Co - efficient of } x}$

$= \frac{\pi/5}{\pi/9} = 1.8m/s.$

16. (b) $F_a = \frac{q_1q_2}{4\pi\varepsilon_0 r^2}, F_b = \frac{q_1q_2}{K4\pi\varepsilon_0 r^2} \Rightarrow F_a : F_b = K:1$

17. (a) Surface charge density $(\sigma) = \frac{\text{Charge}}{\text{Surface area}}$



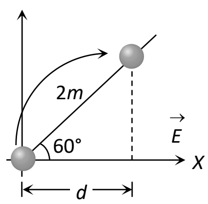
So $\sigma_{inner} = \frac{-2Q}{4\pi b^2}$ and $\sigma_{Outer} = \frac{Q}{4\pi c^2}$

18. (d) $W = qV = qE.d$

$\Rightarrow 4 = 0.2 \times E \times (2 \cos 60°)$

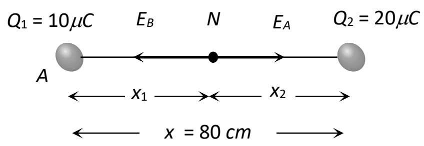
$= 0.2\ E \times (2 \times 0.5)$

$\therefore\ E = \frac{4}{0.2} = 20\ NC^{-1}$



19. (b) At centre $E = 0,\ V \neq 0$

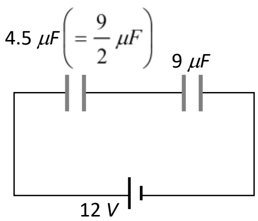
20. (c) Suppose electric field is zero at N. Hence $|E_A| = |E_B|$



Which gives $x_1 = \dfrac{x}{\sqrt{\dfrac{Q_2}{Q_1}}+1} = \dfrac{80}{\sqrt{\dfrac{20}{10}}+1} = 33\ cm$

21. (b) Charge enclosed by cylindrical surface (length 100 cm) is $Q_{enc} = 100\,Q$. By applying Gauss's law $\phi = \dfrac{1}{\varepsilon_0}(Q_{enc.}) = \dfrac{1}{\varepsilon_0}(100\,Q)$

22. (d) The given circuit can be redrawn as follows potential difference across 4.5 μF capacitor



$V = \dfrac{9}{\left(\dfrac{9}{2}+9\right)} \times 12$

$= 8\ V$

23. (b) $V_d = \dfrac{i}{neA} = \dfrac{40}{10^{29} \times 10^{-6} \times 1.6 \times 10^{-19}}$

$= 2.5 \times 10^{-3}\ m/sec$.

24. (b)

25. (b) Resistance across $XY = \dfrac{2}{3}\Omega$

Total resistance

$= 2 + \dfrac{2}{3} = \dfrac{8}{3}\Omega$

Current through ammeter

$= \dfrac{2}{8/3} = \dfrac{6}{8} = \dfrac{3}{4} A$

26. (b) Kirchhoff's second law is based on the law of conservation of energy.

27. (c) The voltage across cell terminal will be given by

$= \dfrac{E}{R+r} \times R \ = \dfrac{2}{(3.9+0.1)} \times 3.9 = 1.95\,V$

28. (c) Total cells $= m \times n = 24$ .... (i)

For maximum current in the circuit $R = \dfrac{mr}{n}$

$\Rightarrow 3 = \dfrac{m}{n} \times (0.5) \Rightarrow m = 6n$ ..... (ii)

On solving equation (i) and (ii), we get $m = 12,\ n = 2$

60. (a) $\dfrac{R_1}{R_2} = \dfrac{(1+\alpha t_1)}{(1+\alpha t_2)} \Rightarrow \dfrac{10}{R_2} = \dfrac{(1+5\times 10^{-3} \times 20)}{(1+5\times 10^{-3}\times 120)} \Rightarrow$

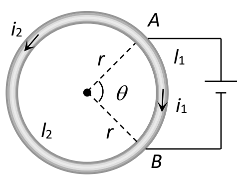
$R_2 \approx 15\Omega$

Also $\dfrac{i_1}{i_2} = \dfrac{R_2}{R_1} \Rightarrow \dfrac{30}{i_2} = \dfrac{15}{10} \Rightarrow i_2 = 20\ mA$

30. (b) $i = \dfrac{q}{T} = \dfrac{2 \times 1.6 \times 10^{-19}}{2} = 1.6 \times 10^{-19} A$

$\therefore B = \dfrac{\mu_o i}{2r} = \dfrac{\mu_o \times 1.6 \times 10^{-19}}{2 \times 0.8} = \mu_o \times 10^{-19}$

31. (d) Directions of currents in two parts are different, so directions of magnetic fields due to these currents are opposite. Also applying Ohm's law across AB



$i_1 R_1 = i_2 R_2 \Rightarrow i_1 l_2 = i_2 l_2 \quad \left(\because R = \rho \dfrac{l}{A}\right)$

Also $B_1 = \dfrac{\mu_o}{4\pi} \times \dfrac{i_1 l_1}{r^2}$ and $B_2 = \dfrac{\mu_o}{4\pi} \times \dfrac{i_2 l_2}{r^2}$ ($\because l = r\theta$)

$\therefore \dfrac{B_2}{B_1} = \dfrac{i_1 l_1}{i_2 l_2} = 1$

Hence, two field induction's are equal but of opposite direction. So, resultant magnetic induction at the centre is zero and is independent of θ.

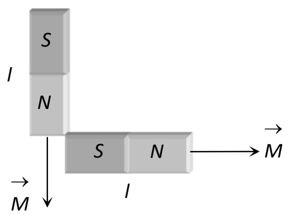
(a) $B = \mu_0 ni \Rightarrow \frac{B}{B'} = \frac{n}{n'} \times \frac{i}{i'} = \frac{1}{(1/2)} \times \frac{1}{2} = 1 \Rightarrow B' = B$

32. (b) This is according to the cross product $\vec{F} = q(\vec{v} \times \vec{B})$ otherwise can be evaluated by the left-hand rule of Fleming.

34. (d) $S = \left(\frac{i_g}{i - i_g}\right) \times G = \frac{100 \times 10^{-6}}{(10 \times 10^{-3} - 100 \times 10^{-6})} \times 50 \approx$ $0.5\,\Omega$ (in parallel)

35. (a)

36. (c)



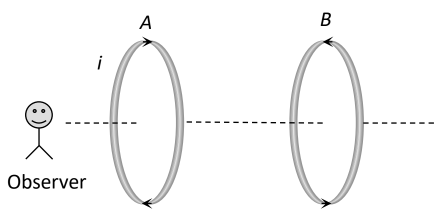
$M_{net} = \sqrt{2}M = \sqrt{2}ml$.

37. (c) $e = -N\left(\frac{\Delta B}{\Delta t}\right).A\cos\theta$

$= -100 \times \frac{(6-1)}{2} \times (40 \times 10^{-4})\cos 0$

$\Rightarrow |e| = 1\ V$

38. (d)



If current through A increases, crosses (X) linked with coil B increases, hence anticlockwise current induces in coil B. As shown in figure both the current produces repulsive effect.

39. (b) $N_2\phi_2 = Mi_1 \Rightarrow 9 \times 10^{-5} = M \times 3$

$\Rightarrow M = 3 \times 10^{-5}\, H$

40. (d) Phase angle $\phi = 90^o$, so power $P = Vi\cos\phi = 0$

41. (b) Reading of ammeter $= i_{rms} = \frac{V_{rms}}{X_C} = \frac{V_0 \omega C}{\sqrt{2}}$

$= \frac{200\sqrt{2} \times 100 \times (1 \times 10^{-6})}{\sqrt{2}} = 2 \times 10^{-2}\, A = 20\ mA$

42. (c) $V^2 = V_R^2 + (V_L - V_C)^2 \Rightarrow V_R = V = 220\ V$

Also $i = \frac{220}{100} = 2.2\ A$

43. (a) E_x and B_y would generate a plane EM wave travelling in z-direction. $\vec{E}$, $\vec{B}$ and $\vec{k}$ form a right handed system $\vec{k}$ is along z-axis. As $\hat{i} \times \hat{j} = \hat{k}$

$\Rightarrow E_x\hat{i} \times B_y\hat{j} = C\hat{k}$ *i.e.* E is along x-axis and B is along y-*axis.*

44. (c)

45. (c) From the formula $\sin C = \frac{1}{{}_1\mu_2} \Rightarrow \sin C = {}_2\mu_1$

$= \frac{u_1}{u_2} = \frac{v_2}{v_1} \Rightarrow \sin C = \frac{10x/t_2}{x/t_1}$

$\Rightarrow \sin C = \frac{10\,t_1}{t_2} \Rightarrow C = \sin^{-1}\left(\frac{10\,t_1}{t_2}\right)$

46. (b) $\frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} \Rightarrow \frac{-0.5}{0.2} = \frac{1.5 - 1}{{}_l\mu_g - 1} \Rightarrow$ ${}_l\mu_g - 1 = -0.2$

$\Rightarrow {}_l\mu_g = 0.8 = \frac{4}{5} \Rightarrow \frac{{}_a\mu_g}{{}_a\mu_l} = \frac{4}{5} \Rightarrow \frac{1.5}{{}_a\mu_l} = \frac{4}{5}$

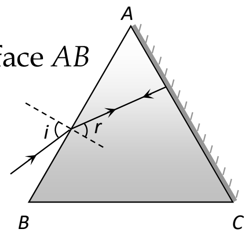
$\Rightarrow {}_a\mu_l = \frac{15}{8}$.

47. (c) $A = r + 0 \Rightarrow r = 30^o$

From Snell's law at surface *AB*

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

$\Rightarrow \sqrt{2} = \frac{\sin i}{\sin 30^o} \Rightarrow i = 45^o$



48. (c) $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{\frac{I_1}{I_2}}+1}{\sqrt{\frac{I_1}{I_2}}-1}\right)^2 = \left(\frac{\sqrt{\frac{25}{4}}+1}{\sqrt{\frac{25}{4}}-1}\right)^2 = \frac{49}{9}$

49. (b) $n_1\lambda_1 = n_2\lambda_2 \Rightarrow n_2 = n_1 \times \frac{\lambda_1}{\lambda_2} = 12 \times \frac{600}{400} = 18$

50. (c) If an unpolarised light is converted into plane polarised light by passing through a polaroid, it's intensity becomes half.

51. (a) $\lambda_{neutron} \propto \frac{1}{\sqrt{T}} \quad \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{T_2}{T_1}}$

$\Rightarrow \frac{\lambda}{\lambda_2} = \sqrt{\frac{(273+927)}{(273+27)}} = \sqrt{\frac{1200}{300}} = 2 \quad \Rightarrow$

$\lambda_2 = \frac{\lambda}{2}$.

52. (c) By using $I = \frac{P}{A}$; where P = radiation power

$\Rightarrow P = I \times A \Rightarrow \frac{nhc}{t\lambda} = IA \Rightarrow \frac{n}{t} = \frac{IA\lambda}{hc}$

Hence number of photons entering per sec the eye $\left(\frac{n}{t}\right) = \frac{10^{-10} \times 10^{-6} \times 5.6 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^{8}} =$ 300.

53. (c) $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3R}{16} \Rightarrow \lambda = \frac{16}{3R} = \frac{16}{3} \times 10^{-5} cm$

Frequency $n = \frac{c}{\lambda} = \frac{3 \times 10^{10}}{\frac{16}{3} \times 10^{-5}} = \frac{9}{16} \times 10^{15} Hz$

54. (b)Kinetic energy = |Total energy|

55. (a)Let the percentage of B^{10} atoms be *x*,

then Average atomic weight

$= \frac{10x + 11(100 - x)}{100} = 10.81$

$\Rightarrow x = 19 \quad \therefore \frac{N_{B^{10}}}{N_{B^{11}}} = \frac{19}{81}$

56. (a)

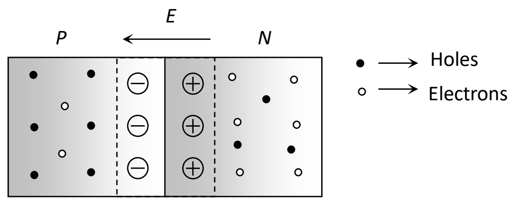
B.E.= $\Delta mc^2 = [2(1.0087 + 1.0073) - 4.0015] = 28.4\ MeV$

57. (a) $n_i^2 = n_h n_e \Rightarrow (10^{19})^2 = 10^{21} \times n_e$

$\Rightarrow n_e = 10^{17} / m^3$.

58. (a) The potential of *P*-side is more negative that of *N*-side, hence diode is in reverse biasing. In reverse biasing it acts as open circuit, hence no current flows.

59. (c) At junction a potential barrier/depletion layer is formed, with *N*-side at higher potential and *P*-side at lower potential. Therefore there is an electric field at the junction directed from the *N*-side to *P*-side



60. (b) Half wave rectifier, rectifies only the half cycle of input ac signal and it blocks the other half.