PHYSICS

31. (3)

$$\sigma = \frac{q_A}{4\pi a^2}$$

$$q_A = \sigma 4\pi a^2$$

$$q_b = -\sigma 4\pi b^2$$

$$q_c = \sigma 4\pi c^2$$

$$V_B = \frac{1}{4\pi \in 0}\sigma\left[\frac{4\pi a^2}{b} - \frac{q_B}{b} + \frac{q_C}{c}\right]$$

$$V_B = \frac{1}{4\pi \in 0}\sigma\left[\frac{4\pi a^2}{b} - \frac{4\pi b^2}{b} + \frac{4\pi c^2}{c}\right]$$

$$V_B = \frac{\sigma}{\in 0}\left[\frac{a^2 - b^2}{b} + c\right]$$

32. (1)

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

$$I' = \frac{MR^2}{2} + 4MR^2 = \frac{9}{2}MR^2$$

$$I = \frac{MR^2}{2} + 6 \times \frac{9}{2}MR^2$$

$$I = \frac{55}{2}MR^2$$

$$I_p = \frac{55}{2}MR^2 + 7M \times (3R)^2$$

$$I_p = \frac{181}{2}MR^2$$

33. (2)

Mass of $\pi R^2 = 9M$

,, ,, 1 Area $= \frac{9M}{\pi R^2}$

Mass of $\pi\left(\frac{R^2}{9}\right) = \frac{9M}{\pi R^2} \times \pi\frac{R^2}{9} = \frac{9M}{9} = M.$

Remaining moment of inertia

$I = I_{total} - I_{hole}$

$$I = \frac{9MR2}{2} - \frac{MR^2}{2}$$

$$I_{hole} = \frac{M\left(\frac{R}{3}\right)^2}{2} + M\left(\frac{2R}{3}\right)^2$$

$$I_{hole} = \frac{MR^2}{9 \times 2} + \frac{4r^2MR^2}{9 \times 2}$$

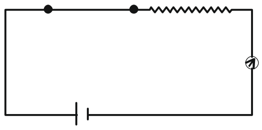
$$= \frac{5}{9}\frac{MR^2}{2}$$

$I = 4MR^2$

34. (4)

Since the diode is non-ideal so there will be a voltage drop of 0.7V across it.

$$i = \frac{3 - 0.7}{200} \times 10^3 = 11.5 \text{ mA}$$



35. (4)

$$2^1 = \frac{2_0}{2}\cos^2\theta$$

$$\frac{2_0}{8} = \frac{2_0}{2}\cos^2\theta = \cos^2\theta$$

$$\frac{1}{4} = \cos^2\theta$$

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

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

$\theta = 45°$

36. (2)

Quality Factor

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

37. (3)

$m_1 = 5$ kg

$m_2 = 10$ kg

$\mu = 0.15$

for stopping the motion.

$T = f_2 = \mu(m + m_2)g.$ ________ (1)

$T = m_1 g.$ ________(2)

$m_1 g = \mu(m_1 + m_2)g$

$$m + m_2 = \frac{m_1}{\mu}$$

$$m = \frac{m_1}{\mu} - m_2 = \frac{5}{0.15} - 10 = \frac{500}{15} - 10$$

$m = 23.33$ kg.

$\therefore$ Minimum $m = 27.3$ kg

38. (3)

$$\frac{1}{2}mv_2^2 + \frac{1}{2}mv_1^2 = \frac{150}{100} \times \frac{1}{2}mv_0^2$$

$$v_1^2 + v_2^2 = \frac{3}{2}v_0^2 \rightarrow (1)$$

$$mv_0 = -mv_1 + mv_2$$

$$v_0 = v_2 - v_1 \rightarrow (2)$$

Solving these 2 equations, we have

$$v_1 + v_2 = \sqrt{2}\,v_0$$

39. (4)

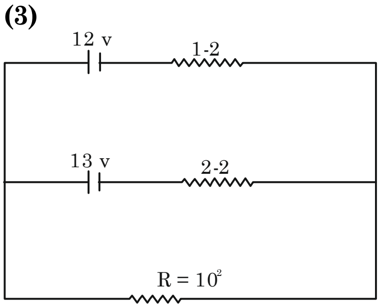
$F \propto \frac{1}{R^2}$

$\frac{mv^2}{R} = \frac{k}{R^n} \Rightarrow \frac{mv^2}{R^2} = m\omega^2 = \frac{k}{R^{n+1}}$

$\frac{m4\pi^2}{T^2} = \frac{k}{R^{n+1}}$

$\Rightarrow T \propto R^{(n+1)/2}$

40. (3)



$\frac{\sum\left(\frac{E}{r}\right)}{\sum\frac{1}{r}} = \text{Net Emf.}$

$\text{Net Emf} = \frac{\frac{12}{1}+\frac{13}{2}}{\left(\frac{1\times 2}{1\times 2}\right)\frac{3}{2}} = \frac{37}{3}$

$I = \frac{\left(\frac{37}{3}\right)}{\frac{2}{3}+10} = \frac{37}{3}\times\frac{3}{32} = \frac{37}{32}\text{A.}$

$V_R = IR$

$V_R = \frac{37}{32}\times 10 = 11.56 \text{ volt}$

Max voltage = 11.56 which lies in only option (3).

41. (3)

$i_{rms} = \frac{20}{\sqrt{2}}$

walters current = $i_{rms} \sin\phi$

$= \frac{20}{\sqrt{2}}\times\frac{1}{\sqrt{2}}$

= 10 A

power = $v_{rms}\, i_{rms} \cos\theta$

$\frac{100}{\sqrt{2}}\times\frac{20}{\sqrt{2}}\times\frac{1}{\sqrt{2}} = \frac{1000}{\sqrt{2}}$

42. (4)

$\vec{E}_1 = E_{01}\hat{x}\cos\left[2\pi\nu\left(\frac{z}{c}-t\right)\right]$

$\vec{E}_1 = E_{01}\hat{x}\cos\left[\left(\frac{2\pi c}{\lambda}\right)\left(\frac{z}{c}-t\right)\right]$

$\vec{E}_1 = E_{01}\hat{x}\cos\left[k(z-ct)\right]$

$k_1 = k.$

$\vec{E}_2 = E_{02}\hat{x}\cos\left[k2(z-\frac{c}{2}t)\right]$

$k_2 = 2k$

we know that

$k = \sqrt{\epsilon_r}$

$\frac{\epsilon_{r1}}{\epsilon_{r2}} = \left(\frac{k_1}{k_2}\right)$

$\frac{\epsilon_{r1}}{\epsilon_{r2}} = \left(\frac{k_1}{2k}\right)^2 = \frac{1}{4}$

43. (4)

$10\% \text{ of } 10 \text{ 6thr} = 10\times 10\times\frac{10}{100} = 109 \text{ Hz}$

$\text{No. of channels} = \frac{10^9}{5\times 10^3} = \frac{10^6}{5} = 2\times 10^5$

44. (2)

$v = \sqrt{\frac{y}{\rho}} = \sqrt{\frac{9.27\times 10^{10}}{2.7\times 10^3}}$

$\nu = \frac{1}{1.2}\sqrt{\frac{y}{\rho}}$

$\nu = \frac{1}{1.2}\sqrt{\frac{9.27\times 10^{10}}{2.7\times 10^3}}$

$\nu = 4.85\times 10^3$

$\nu \approx 5\text{khz}$

45. (2)

$e = 1,\ v_2 = 0,\ u_1 = u$

$v_1 = \frac{m_1 - m_2}{m_1 + m_2}u$

$\text{Fraction less of KE} = \frac{KEi - KE_f}{KE_i} = \frac{m_1v^2 - m_1v_1^2}{m_1v^2}$

$= \frac{v^2 - v_1^2}{v^2} = \frac{(m_1+m_2)^2-(m_1-m_2)^2}{(m_1+m_2)^2} = \frac{4m_1m_2}{(m_1+m_2)^2}$

For deuterium, $m_1 = m$ and $m_2 = 2m$

$P_d = \frac{4\times m\times 2m}{(m+2m)^2} = \frac{8}{9} = 0.89$

For carbon, $m_1 = m$ and $m_2 = 12m$

$P_c = \frac{4\times m\times 12m}{(m+12m)^2} = \frac{48}{169} = 0.28$

46. (4)

$P = \frac{m}{V} = \frac{m}{\ell^3}$

$\frac{\Delta P}{P}\times 100 = \frac{\Delta m}{m}\times 100 + 3\frac{\Delta\ell}{\ell}\times 100$

$= 1.5 + 3\times 1$

$$\frac{\Delta P}{P}\times 100 = 4.5\%$$

47. (4)

$n = 2$, $V_1 = V$, $T_1 = 27 + 273 = 300$ K

$\gamma = \frac{5}{3}$ (for monoatomic gas) $V_2 = 2V$, $T_2 = ?$

$$TV^{\gamma-1} = \text{Constant}$$

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

$$T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1} = 300\left(\frac{V}{2V}\right)^{\frac{5}{3}-1}$$

$$T_2 = 300\left(\frac{1}{2}\right)^{\frac{2}{3}}$$

$$T_2 \approx 189\text{K}$$

$$dQ = dv + dw$$

$$dv = -dw$$

$$dv = -\frac{1}{\gamma-1}(P_1V_1 - P_2V_2)$$

$$dv = -\frac{nR}{\gamma-1}(300-189)$$

$$dv = -\frac{2\times 8.3}{0.6}\times 111 = -2.7\text{ kJ}$$

48. (4)

$$K = \frac{\Delta P}{\Delta V/V}$$

$$\Rightarrow \frac{\Delta V}{V} = \frac{\Delta P}{K} = \frac{mg}{Ka}$$

$$\Rightarrow \frac{dr}{r} = \frac{1}{3}\frac{\Delta V}{V} = \frac{mg}{3Ka}$$

49. (2)

$q_0 = C_0V$

$q = KC_0V$

Induced charge, $q_i = q - q_0 = C_0V(K-1)$

$= 90\times 10^{-12}\times 20\times 2/3$

$= 1200\times 10^{-12} = 1.2$ nC

50. (4)

$M = iA = \pi r^2 A \Rightarrow M \propto r^2$

$$B = \frac{\mu_0 i}{2r} \Rightarrow B \propto \frac{1}{r}$$

$$\Rightarrow \frac{r_1}{r_2} = \sqrt{\frac{M_1}{M_2}}$$

$$\text{Now, } \frac{M_1}{M_2} = \frac{r_1^2}{r_2^2} = \frac{1}{2}$$

$$\Rightarrow \frac{r_1}{r_2} = \frac{B_2}{B_2} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \frac{B_1}{B_2} = \sqrt{2}$$

51. (2)

K.E. of $\bar{e}$ in n^{th} orbit $= \frac{13.6}{n^2} = \frac{1}{2}\frac{p^2}{m_e}$

$\Rightarrow P = \frac{\sqrt{27.2me}}{n} = \frac{k_1}{n}$ {Let say $K_1 = \sqrt{27.2me}$

Now $\lambda_n = \frac{h}{p} = \frac{hn}{k_1} \Rightarrow \lambda_n = k_2 n$

$$\frac{h}{\lambda n} = 13.6\left[1-\frac{1}{n^2}\right] = 13.6$$

$$\frac{hc}{\wedge_n} = 13.6 - \frac{13.6}{n^2} = 13.6\left[\frac{n^2-1}{n^2}\right]$$

$$\wedge_n = \frac{hc}{13.6}\cdot\frac{n^2}{n^2-1} = \frac{hc}{13.6} + \frac{hc}{13.6(n^2-1)}$$

$$\wedge_n \approx \frac{hc}{13.6} + \frac{hc}{13.6n^2}$$

$$\Rightarrow \wedge_n = A + \frac{hcK_2^2}{13.6\lambda_n^2} = A + B/\lambda_n^2$$

52. (2)

$F = \Delta p/1\text{ sec} = 2mv\cos\theta \times n$

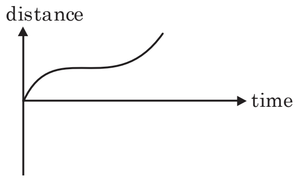
$$P = \frac{F}{A} = \frac{2mvn\cos\theta}{A} = \frac{2\times 3.32\times 10^{-27}\times 10^3\times 10^{23}}{2\times 10^{-4}\times\sqrt{2}}$$

$= 2.35\times 10^3$ N/m^2

53. (3)

If V vs time is a straight line with –ve slope,
Acceleration = –ve (constant)

Then displacement vs time will be parabola like



Obiviously incorrect option is (3).

54. (3)

$$r = \frac{mv}{qB} = \frac{mv^2}{qBv} = \frac{2k}{qBv}$$

$$\Rightarrow \ r \alpha \frac{1}{qv} \ \Rightarrow r = \frac{k}{qv}$$

$m_\alpha = 4mp$

$m_e << mp$

As KE of all particles is equal

$V_e >> V_p$

$v_\alpha = {}^{v_p}\!/_2$

Let $q_e = 1$, $q_p = 1$, $q_\alpha = 2$

So $\quad re = \frac{k}{v_e}$

$r_p = \frac{k}{v_p}$

$r_\alpha = \frac{k}{2 \times {}^{v_p}\!/_2} = \frac{k}{v_p}$

So, $r_p = r_\alpha$ and $r_e < r_p$ [$\therefore$ $v_e >> v_p$]

$\therefore$ Correct order is $r_e < r_p = r_\alpha$

55. (4)

$$\frac{R_1}{\ell} = \frac{R_2}{100 - \ell}$$

(4) $$\frac{R_2}{\ell - 10} = \frac{R_1}{110 - \ell}$$

$R_1 + R_2 = 1000$

Solving these equations, we have

$R_1 = 550\Omega$ & $R_2 = 450\Omega$.

56. (3)

Let us assume voltage gradient of **wire** = K

(3) Now emt of cell, e = 52k __________ (i)

Terminal voltage of cell, v = 40k

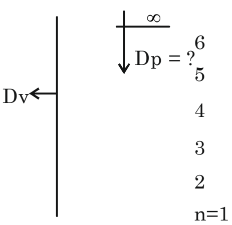
$$v = e - ir = e\left\{1 - \frac{r}{R + r}\right\} = 40\ k$$

$$\Rightarrow \ 52k\left[\frac{R}{R + r}\right] = 40\ k$$

$$\Rightarrow \frac{R}{R + r} = \frac{40}{52} = \frac{10}{13}$$

$$\Rightarrow \frac{5}{5 + r} = \frac{10}{13} \Rightarrow \ r = 1.5\ \Omega$$

57. (1)



Lyman $\frac{1}{\lambda} = \frac{\nu}{c}$

$$\frac{1}{\lambda_v} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]200$$

$$\frac{\nu_1}{C} = R.C\left[\frac{1}{1}\right]$$

$RC = \nu_C$ __________ (i)

Phund

$$\frac{\nu_P}{C} = \frac{1}{\lambda_p} = R\left[\frac{1}{(5)^2} - \frac{1}{\infty}\right]$$

$$\nu_P = \frac{\nu_L}{25}$$

58. (2)

$2\theta = 60°$

$\theta = 30°$

$d\ \sin\theta = \lambda$, (d=width of single slit=$1\,\mu m = 10^{-6}$ m.)

$\lambda = 10^{-6}\ Sin30°$

$\lambda = 0.5 \times 10^{-6}$

for Double Slit

$\beta = \frac{D\lambda}{d}$ (d = slit separation, D= 50 cm = 0.5 m)

$$10^{-2} = \frac{0.5 \times 0.5 \times 10^{-6}}{d}$$

$d = 25 \times 10^{-6}$ m = 25 μ m

59. (4)

$$U = \frac{-k}{2r^2}$$

$$F = \frac{-dU}{dr} = +\frac{d}{dr}\left(\frac{k}{2r^2}\right) = \frac{k}{2}\frac{d}{dr}\left(r^{-2}\right)$$

$$F = \frac{k}{2}(-2)r^{-3} = \frac{-k}{r^3} = \frac{mv^2}{r}$$

$$K.E = \left|\frac{1}{2}mv^2\right| = \left|\frac{-k}{2r^2}\right| = \frac{k}{2r^2}$$

T.E = K.E + P.E

$$T.E = \frac{k}{2r^2} - \frac{k}{2r^2} = 0$$

60. (3)

$\nu = 10^{12}$Hz

$108 = 6.02 \times 10^{23}$m.

$$m = \frac{108 \times 10^{-3}}{6.02 \times 10^{23}}kg$$

$$\frac{1}{\nu} = T = 2\pi\sqrt{\frac{m}{k}}$$

$$\frac{1}{\nu^2} = 4\pi^2\frac{m}{k}$$

$k = 4\pi^2 m\nu^2$

$$k = \frac{4 \times 9.8596 \times 108 \times 10^{+24}}{6.02 \times 10^{23}}$$

k = 7.07 N/m.