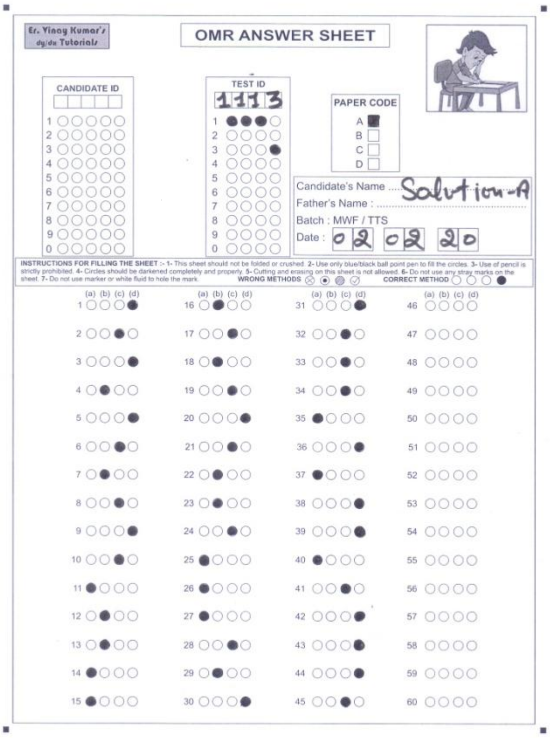
# SET-A




**Q11.** $\frac{M_1}{M_2} = \frac{13}{5}$ ..... (1)

$$T_1 = 2\pi\sqrt{\frac{I}{(M_1+M_2)B_0}} \quad .....(2)$$

$$T_2 = 2\pi\sqrt{\frac{I}{(M_1-M_2)B_0}} \quad .....(3)$$

$$\frac{(2)}{(3)} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_1-M_2}{M_1+M_2}} \Rightarrow \frac{f_2}{f_1} = \sqrt{\frac{\frac{M_1}{M_2}-1}{\frac{M_1}{M_2}+1}}$$

$$\Rightarrow \frac{f_2}{15} = \sqrt{\frac{\frac{13}{5}-1}{\frac{13}{5}+1}} \Rightarrow \frac{f_2}{15} = \sqrt{\frac{8}{18}}$$

$$\Rightarrow \frac{f_2}{15} = \sqrt{\frac{4}{9}} \Rightarrow \frac{f_2}{15} = \frac{2}{3} \Rightarrow f_2 = 10$$

**Q12.** $V = i_g G \Rightarrow 0.5 = i_g \times 0.5 \Rightarrow i_g = 1A$

$$R = \left(\frac{i_g}{i-i_g}\right)G = \left(\frac{1}{10-1}\right)\times 0.5 = \frac{0.5}{9} = 0.055\,\Omega$$

**Q13.** $R = \frac{V}{i_A} - R_A = \frac{100}{1} - 0.5$

$= 99.5\ \Omega$

**Q14.** $\frac{V_S}{V_P} = \frac{N_S}{N_P} \Longrightarrow \frac{V_S}{240} = \frac{1}{20}$

$$\Rightarrow V_S = \frac{240}{20} = 12V$$

$$i_S = \frac{V_S}{R_S} = \frac{12}{6} = 2A$$

$$\frac{i_P}{i_S} = \frac{N_S}{N_P} \Longrightarrow \frac{i_P}{2} = \frac{1}{20} \Longrightarrow i_P = 0.10\ A$$

**Q15.** $V_L = V_C = 400$ V

$$e = \sqrt{V_R^2 + (V_L \sim V_C)^2}$$

$$\Rightarrow 100 = \sqrt{V_R^2 + (400 \sim 400)}$$

$\Rightarrow V_R = 100\ V \Rightarrow$ Reading on voltmeter which reads the resistance voltage is 100 V

Since $V_L = V_C \Longrightarrow X_L = X_C$

$$Z = \sqrt{R^2 + (X_L \sim X_C)^2}$$

$$\Rightarrow Z = \sqrt{50^2 + 0} \Rightarrow Z = 50\,\Omega$$

$$I = \frac{e}{Z} = \frac{100}{50} = 2A$$

**Q16.** $e = \sqrt{V_R^2 + (V_L \sim V_C)^2}$

$$\Rightarrow e = \sqrt{10^2 + (10 \sim 10)^2}$$

$\Longrightarrow e = 10$ V

When the capacitance is short circuited there remain resistance and inductance only in the circuit.

If all the devices initiallyhave equal potential drops in series they have equal resistance and reactance values.

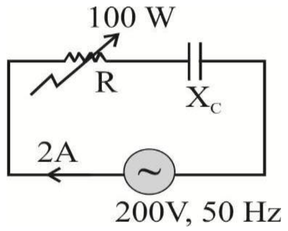
Therefore in second case also

$R = X_L \Rightarrow V_R = V_L$

$e = \sqrt{V_R^2 + V_L^2} \Longrightarrow 10 = \sqrt{V_L^2 + V_L^2}$

$\Rightarrow 10 = \sqrt{2}V_L \Longrightarrow V_L = 5\sqrt{2}\ V$

**Q17.**




$$\boldsymbol{Z = \frac{e}{i} = \frac{200\,V}{2A} = 100}\ \Omega$$

$P = i^2 R \Rightarrow 100 = 2^2 \times R \Rightarrow R = 25\Omega$

$\boldsymbol{Z = \sqrt{R^2 + X_C^2}} \Rightarrow 100 = \boldsymbol{\sqrt{25^2 + X_C^2}}$

$\Rightarrow 10000 = 625 + \boldsymbol{X_C^2} \Rightarrow \boldsymbol{X_C^2} = 9375$

$\Rightarrow X_C = \sqrt{\mathbf{9375}} \Rightarrow X_C = \sqrt{\mathbf{625 \times 15}}$

$= 25\sqrt{\mathbf{15}}\Omega$

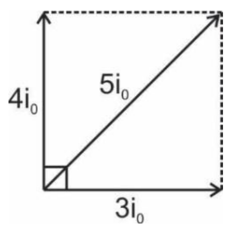
**Q18.** During resonance the current from main becomes absent because inductance & capacitor loop circuit does not take any current from the source and since resistance is in series (not in parallel) the current does not pass through the resistance also.

$\Rightarrow V_1 = V_2 = 0$

**Q21.** $i = 3\ i_0\ \sin\boldsymbol{\omega}t + 4i_0\ \cos\boldsymbol{\omega}t$

$\boldsymbol{i_{peak}} = 5i_0$

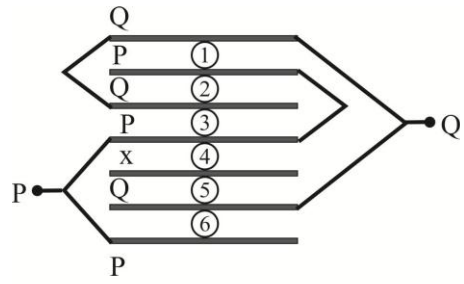
$\Rightarrow \boldsymbol{i_{rms}} = \frac{\mathbf{5}\boldsymbol{i_0}}{\sqrt{\mathbf{2}}}$

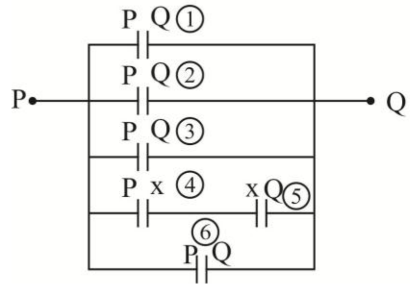



**Q22.** $P = e\ i\ \cos\boldsymbol{\phi} \Rightarrow 650 = 200 \times 5 \times \cos\boldsymbol{\phi}$

$\Rightarrow \cos\boldsymbol{\phi} = 0.65$

**Q23.**




Equivalent circuit :

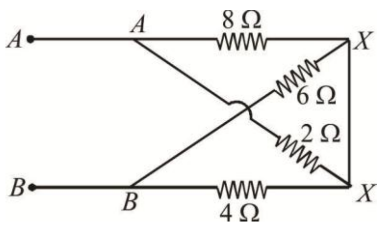
$$C_{eq} = C + C + C + \frac{C}{2} + C$$

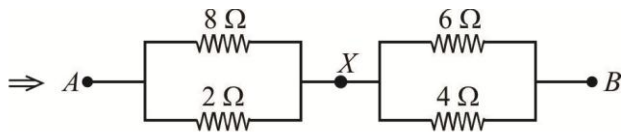
$$= 4C + \frac{C}{2} = \frac{9C}{2}$$

$$= \frac{9\epsilon_0 A}{2d}$$

**Q24.** This combination of cells gives no potential difference between any two points of the circuit

**Q25.**



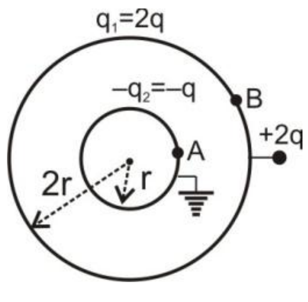




$$R = \frac{8\times 2}{8+2} + \frac{6\times 4}{6+4} = \frac{16}{10} + \frac{24}{10} = 1.6 + 2.4 = 4\,\Omega$$

**Q26.** $\frac{q_1}{q_2} = \frac{2r}{r} \Rightarrow \frac{2q}{q_2} = \frac{2r}{r} \Rightarrow q_2 = q$

$$V_B = \frac{1}{4\pi\epsilon_0}\left[\frac{2q}{2r} + \frac{-q}{2r}\right]$$

$$= \frac{1}{4\pi\epsilon_0}\ \frac{q}{2r}$$



$$V_A = 0 \quad \Rightarrow \quad \Delta V = V_B - V_A = \frac{1}{4\pi\epsilon_0}\frac{q}{2r}$$

**Q27.** $V = -\left[\int E_x dx + \int E_y dy + \int E_z dz\right]$

$$= -\left[\int 2dx + \int 3y^2 dy + \int 2z dz\right]$$

$$V = -\left[2x + y^3 + z^2 + c\right] \ldots\ldots (1)$$

At origin from eq. (1)

$$10 = -[0+0+0+c] \quad \Rightarrow \quad c = -10$$

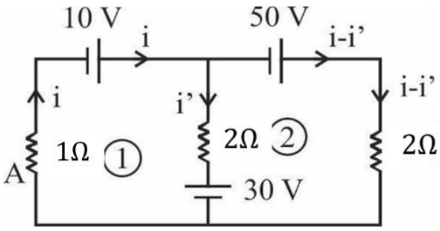
$$V = -\left[2x + y^3 + z^2 - 10\right]$$

$$V_{(2,1,2)} = -\left[2\times 2 + 1^3 + 2^2 - 10\right]$$

$$= -[4+1+4-10] = 1\,\mathbf{V}$$

**Q28. In loop** ① $-10 + 2i' + 30 + i = 0$

$$2i' + i = -20 \ldots..(1)$$



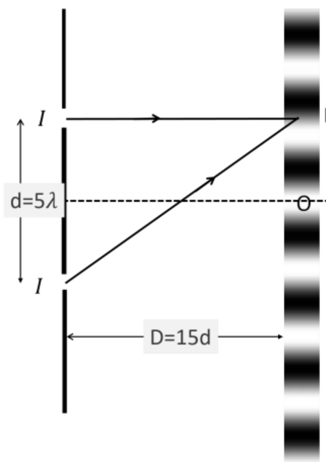

**In loop** ② $-50 + (i - i')\times 2 - 30 - 2i' = 0$

$$2i - 2i' - 2i' = 80$$

$$2i - 4i' = 80 \Rightarrow i - 2i' = 40 \ldots..(2)$$

$$(1) + (2) \Rightarrow \quad 2i = 20 \Rightarrow \text{i=10A}$$

**Q29.**




$$y = \Delta x\left(\frac{D}{d}\right) \Rightarrow \Delta x = y\left(\frac{d}{D}\right)$$

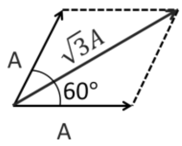
$$\Rightarrow \Delta x = \frac{d}{2}\left(\frac{d}{15d}\right)$$

$$\Rightarrow \Delta x = \frac{d}{30}$$

$$\Rightarrow \Delta x = \frac{5\lambda}{30} \quad \Rightarrow \Delta x = \frac{\lambda}{6}$$

$$I_{max} = I_0 \Rightarrow I = \frac{I_0}{4}$$

$$\Delta x = \frac{\lambda}{6} \Rightarrow \Delta\varphi = \frac{2\pi}{6} \Rightarrow \Delta\varphi = \frac{\pi}{3}$$




$$A_R = \sqrt{3}A \Rightarrow A_R{}^2 = 2A^2 \Rightarrow I_R = 3I$$

$$\Rightarrow I_R = 3\frac{I_0}{4} \Rightarrow I_R = \frac{3I_0}{4}$$

**Q30.**

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{b_1} + \sqrt{b_2}}{\sqrt{b_1} \sim \sqrt{b_2}}\right)^2$$

$$= \left(\frac{\sqrt{1} + \sqrt{16}}{\sqrt{1} \sim \sqrt{16}}\right)^2 = \left(\frac{1+4}{1\sim 4}\right)^2 = \left(\frac{5}{3}\right)^2 = \frac{25}{9}$$

**Q31.** <u>**For first maximum :**</u>

$$b\sin\theta = (2\cancel{n}^{\,1} + 1)\frac{\lambda}{2} \Rightarrow b\sin 30° = 3\frac{\lambda}{2} \Rightarrow b\frac{1}{2} = 3\frac{\lambda}{2}$$

$$\Rightarrow b = 3\lambda \ldots\ldots(1)$$

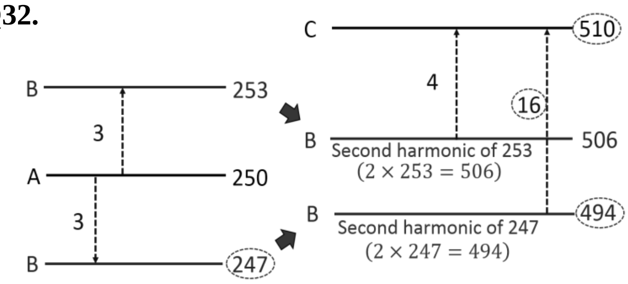
<u>**For first minimum :**</u>

$$b\sin\theta' = \cancel{n}^{\,1}\lambda \Rightarrow b\sin\theta' = \lambda \ldots (2)$$

From eq (1) and (2): $\Rightarrow 3\lambda\sin\theta' = \lambda \Rightarrow \sin\theta' = \frac{1}{3}$

$$\Rightarrow \boldsymbol{\theta' = \sin^{-1}\frac{1}{3}}$$

**Q32.**




**Q33.** $y = A\sin k(x-1)\cos\omega t$

Amplitude $\Rightarrow A\sin k(x-1)$

**To find position of nodes:**

$$\Rightarrow Amp_{\min} = 0\ (nodes) \Rightarrow \sin k(x-1) = 0$$

$$\Rightarrow k(x-1) = 0,\ \pi,\ 2\pi, 3\pi \ldots\ n\pi$$

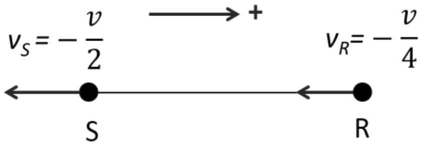
$$\Rightarrow k(x-1) = n\pi$$

$$\Rightarrow \frac{2\cancel{\pi}}{\lambda}\cdot(x-1) = n\cancel{\pi} \Rightarrow x - 1 = n\frac{\lambda}{2} \Rightarrow x = n\frac{\lambda}{2} + 1$$

$$where\ \ n = 0,1,2,3 \ldots..$$

$$\Rightarrow x = (+1), \left(\frac{\lambda}{2}+1\right), (\lambda+1), \left(\frac{3\lambda}{2}+1\right) \ldots\ldots\ldots$$

**Q34.**



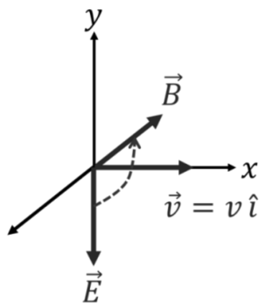

$$\Delta f = f\left[\frac{v_S - v_R}{v - v_S}\right] \quad \Rightarrow \frac{\Delta f}{f} = \left(\frac{v_S - v_R}{v - v_S}\right)$$

$$= \frac{\left(-\frac{v}{2}\right) - \left(-\frac{v}{4}\right)}{v - \left(-\frac{v}{2}\right)} = \frac{\frac{v}{4} - \frac{v}{2}}{\frac{3v}{2}} = \frac{-\frac{v}{4}}{\frac{3v}{2}} = -\frac{v}{4} \times \frac{2}{3v}$$

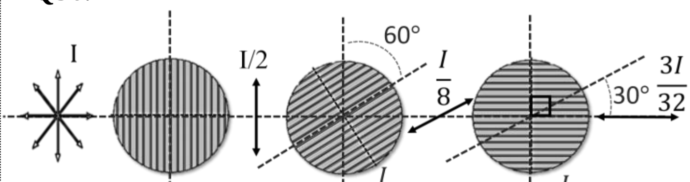
$$= -\frac{1}{6} \times 100 = -16.67\% \,(decreased)$$

**Q35.**

Direction of propagation is along $\vec{E} \times \vec{B}$




**Q36.**




$\frac{I}{2}cos^2 60°$

$= \frac{I}{2}\left(\frac{1}{2}\right)^2 = \frac{I}{2} \times \frac{1}{4}$

$= \frac{I}{8}$

$\frac{I}{8}cos^2 30°$

$= \frac{I}{8}\left(\frac{\sqrt{3}}{2}\right)^2$

$= \mathbf{\frac{3I}{32}}$

**Q37.** $\Delta U = (n^{1/3} - 1)\, 4\pi R^2 T$

$= [(10^6)^{1/3} - 1] 4 \times 3.14 \times (1 \times 10^{-2})^2 \times 460 \times 10^{-3}$

$= (100 - 1) \times 4 \times 3.14 \times 10^{-4} \times 460 \times 10^{-3}$

$= 0.057$ J

**Q39.** Work done to form a soap bubble

$W = 8\pi R^2 T$ (As $V \propto R^3 \therefore R \propto V^{1/3}$)

$\therefore W \propto V^{2/3}$

$$\frac{W_2}{W_1} = \left(\frac{V_2}{V_1}\right)^{\frac{2}{3}} \Rightarrow \frac{W_2}{W_1} = \left(\frac{2V}{V}\right)^{\frac{2}{3}}$$

$$\Rightarrow \frac{W_2}{W} = (2)^{2/3} \Rightarrow W_2 = (4)^{1/3} W$$

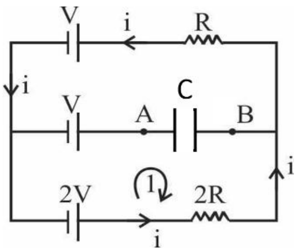
**Q40.** $h = \frac{2T}{Rdg} \Rightarrow hR = \frac{2T}{dg} = constant \Rightarrow R \propto \frac{1}{h}$

When $h$ decreases, R increases.

**Q41.** In outer loop

$-V - iR - i \times 2R + 2V = 0$

$3iR = V \;\Rightarrow\; i = \frac{V}{3R}$ ….. (1)




In loop (1)

$V_A - V_B = V - 2V + i \times 2R$

$= -V + \frac{V}{3R} \times 2R = -V + \frac{2V}{3}$

$= -\frac{V}{3}$

Value of potential drop $= \frac{V}{3}$

**Q42.** Current in the bulb $= \frac{P}{V} = \frac{4.5}{1.5} = 3A$

Current 1 $\Omega$ resistance $= \frac{1.5}{1} = 1.5A$

Hence total current from the cell
i = 3 + 1.5 = 4.5 A

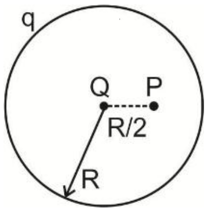
By using

E = V + ir ⇒ E = 1.5 + 4.5 × (2.67) = 13.5 V

**Q43.** $\frac{E}{E_0} = \left(\frac{R_P}{R_0+R_P}\right)\frac{l}{L} \Rightarrow \frac{0.4}{5} = \left(\frac{5}{45+5}\right) \times \frac{l}{10}$

$\Rightarrow \frac{4}{50} = \frac{5}{50} \times \frac{l}{10} \Rightarrow l = 8m$

**Q44.**




$$V_p = \frac{1}{4\pi\epsilon_0} \frac{q}{R} + \frac{1}{4\pi\epsilon_0} = \frac{(q+2Q)}{4\pi\epsilon_0 R}$$

**Q45.** $h = \frac{2T\cos\theta}{rdg}$

for same capillary r is same

$$\Rightarrow \frac{h_2}{h_1} = \frac{T_2}{T_1} \times \frac{\cos\theta_2}{\cos\theta_1} \times \frac{d_1}{d_2}$$

$$\Rightarrow \frac{h_2}{h_1} = \frac{140}{70} \times \frac{\cos 60^o}{\cos 0^o} \times \frac{1}{2} \times 1 = \frac{1}{2}$$

$$\Rightarrow h_2 = \frac{h_1}{2} = \frac{6}{2} = 3\ cm$$