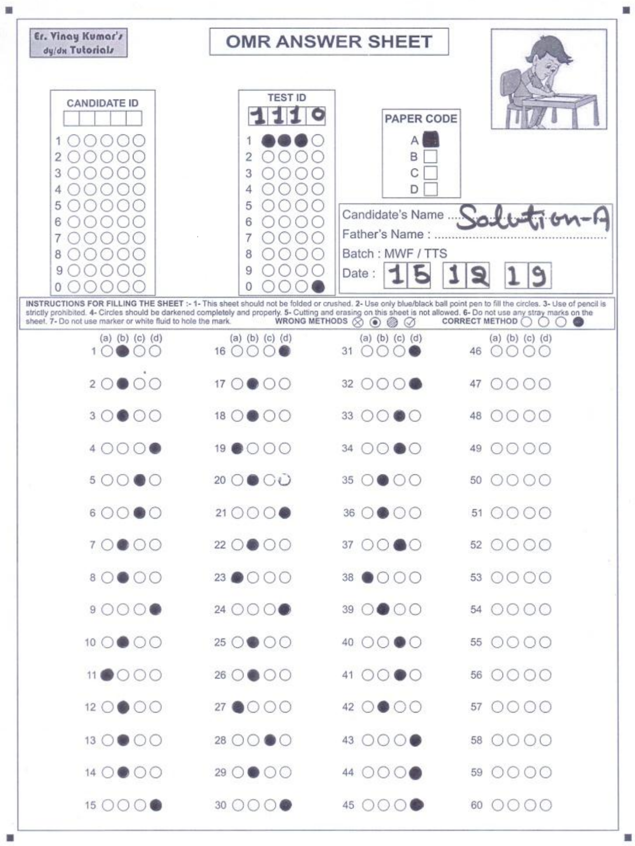
SET-A


Er. Vinay Kumar's dy/dx Tutorials

OMR ANSWER SHEET

CANDIDATE ID

TEST ID 1110

PAPER CODE A B C D

Candidate's Name ....Solution-A

Father's Name :

Batch : MWF / TTS

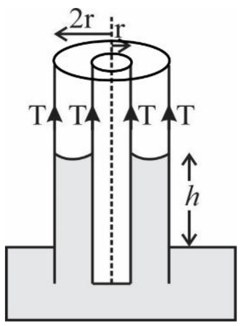
Date : 15 12 19

INSTRUCTIONS FOR FILLING THE SHEET :- 1- This sheet should not be folded or crushed. 2- Use only blue/black ball point pen to fill the circles. 3- Use of pencil is strictly prohibited. 4- Circles should be darkened completely and properly. 5- Cutting and erasing on this sheet is not allowed. 6- Do not use any stray marks on the sheet. 7- Do not use marker or white fluid to hole the mark.

WRONG METHODS CORRECT METHOD

Q1. $F = mg + (2\pi r + 4d)T = mg + 2(\pi r + 2d)T$

Q2.



Weight of liquid rise = Force created by surface tension

$[\pi(2r)^2 - \pi r^2]h\rho g = T \times [2\pi(2r) + 2\pi r] \quad \Rightarrow$

$[3\pi r^2 h\rho g = 6\pi r \cdot T \quad \Rightarrow \quad h = \dfrac{2T}{r\rho g}$

Q3. $\Delta U = U_f \sim U_i = (n^{1/3} - 1)\,4\pi b^2 T = \left(\dfrac{b}{a} - 1\right)4\pi b^2 T$

$= b\left(\dfrac{1}{a} - \dfrac{1}{b}\right)4\pi b^2 T \quad = \quad \left(\dfrac{1}{a} - \dfrac{1}{b}\right)4\pi b^3 T$

ΔU is converted into kinetic energy

$$\frac{1}{2}mv^2 = \left(\frac{1}{a} - \frac{1}{b}\right)4\pi b^3 T$$

$$\Rightarrow \quad \frac{1}{2}\cdot\frac{4}{3}\pi b^3 \rho \cdot v^2 = \left(\frac{1}{a} - \frac{1}{b}\right)4\pi b^3 T$$

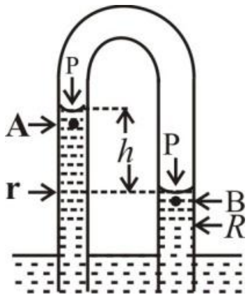
$$\Rightarrow \quad v = \left[\frac{6T}{\rho}\left(\frac{1}{a} - \frac{1}{b}\right)\right]^{1/2}$$

Q4. Change in area

$= 2\left[4\pi(2R)^2 - 4\pi R^2\right] = 2\left[4\pi(4R^2 - R^2)\right]$

$W = 24\pi R^2\ T$

Q5. $P_A = P - \dfrac{2T}{r}$ .... (1)



$P_B = P - \dfrac{2T}{R}$ .... (2)

$P_A + h\rho g = P_B$

$h\rho g = P_B - P_A$

$\Rightarrow \quad h\rho g = \left(P - \dfrac{2T}{R}\right) - \left(P - \dfrac{2T}{r}\right)$

$\Rightarrow \quad h\rho g = 2T\left(\dfrac{1}{r} - \dfrac{1}{R}\right)$

$\Rightarrow \quad h \times 0.7 \times 1000 \times 10$

$\Rightarrow \quad h = \dfrac{2 \times 70 \times \frac{1}{2}}{0.7 \times 1000 \times 10} = 0.01\ m = 10\ mm$

Q7. (a) Ideal liquid has negligible cohesive force hence surface tension is zero

(b) In satellite the liquid rises to the top of tube due to weightlessness

(c) If contact angle is 90^o the meniscus becomes flat hence no upward component of T force

(d) Sealed capillary may have air inside at high pressure which opposes capillary rise

Q8. $h\rho g = \dfrac{2T\cos\theta}{r}$ .... (1)

$a = \pi r^2 \quad \Rightarrow \quad r = \sqrt{\dfrac{a}{\pi}}$ .... (2)

from (1) & (2):

$h\rho g = \dfrac{2T\cos\theta}{\sqrt{a/\pi}} \quad \Rightarrow \quad h \propto \dfrac{1}{\sqrt{a}}$

$$\Rightarrow \quad \frac{h_2}{h_1}=\sqrt{\frac{a_1}{a_2}} \;\Rightarrow\; \frac{h_2}{h}=\sqrt{\frac{a}{4a}} \;\Rightarrow\; h_2=h/2$$

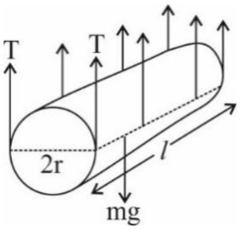
Q9. For floatation the weight of needle is balance by force due to surface tension.

$$T\times(4r+2l)=mg$$

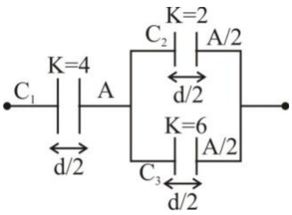
Since r << l then 4r is neglected

$$\Rightarrow \quad T\times 2l=\pi r^2 l\rho g$$

$$\Rightarrow \quad r=\sqrt{\frac{2T}{\pi\rho g}}$$



Q10. $C_1=\dfrac{\varepsilon_0\times 4\times A}{d/2}=\dfrac{3\varepsilon_0 A}{d}$



$$C_2=\frac{\varepsilon_0\times 2\times A/2}{d/2}=\frac{2\varepsilon_0 A}{d}$$

$$C_3=\frac{\varepsilon_0\times 6\times A/2}{d/2}=\frac{6\varepsilon_0 A}{d}$$

$$C_{23}=C_2+C_3=\frac{2\varepsilon_0 A}{d}+\frac{6\varepsilon_0 A}{d}=\frac{8\varepsilon_0 A}{d}$$

$$\frac{1}{C_{123}}=\frac{1}{C_1}+\frac{1}{C_{23}}=\frac{d}{8\varepsilon_0 A}+\frac{d}{8\varepsilon_0 A}=\frac{d}{4\varepsilon_0 A}$$

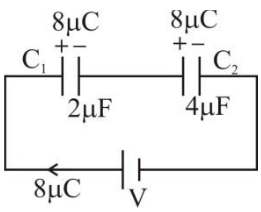
$$\frac{1}{C_{123}}=\frac{4\varepsilon_0 A}{d}$$

Q11. Max. charge capacity of $2\mu F$ & $4\mu C$

$=2\times 4=8\mu C$

Max. charge capacity of $4\mu F$ & 4V

$=4\times 4=16\mu C$



The charge should be flown in the circuit equal to $8\mu C$

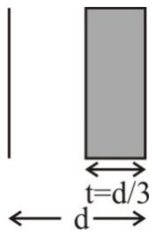
pot. on $C_1 \;\Rightarrow\; V_1=\dfrac{8}{2}=4V$ &

Pot. on $C_2 \;\Rightarrow\; V_2=\dfrac{8}{2}=2V$

Max. voltage can be given

$$\Rightarrow \quad V=V_1+V_2=4+2=6V$$

Q12. Initially : $C=\dfrac{\varepsilon_0 A}{d}$



finally after insertion of metal sheet $C'=\dfrac{\varepsilon_0 A}{d-t} \Rightarrow C'=\dfrac{\varepsilon_0 A}{d-d/3}$

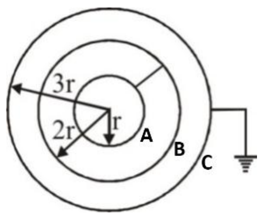
$$\Rightarrow \quad C'=\frac{3}{2}\frac{\varepsilon_0 A}{d} \;\Rightarrow\; C'=1.5\,C$$

Q13. As the capacitor is connected to cell, the potential across the capacitor remains same.

Due to removal of dielectric capacitance is decreased hence charge holding capacity of capacitor is reduced therefore some charge is returned to the cell from the capacitor.

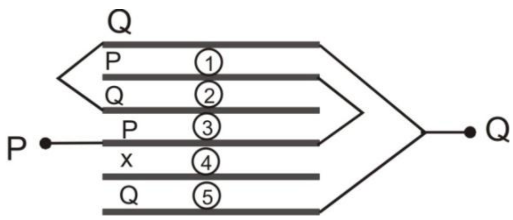
Since the charged plates of capacitor attract the slab hence work done is required in taking the slab out of the capacitor.

Q14. Only the spheres B & C can hold charge, not the sphere A as it is connected by conductor AB to the sphere B,

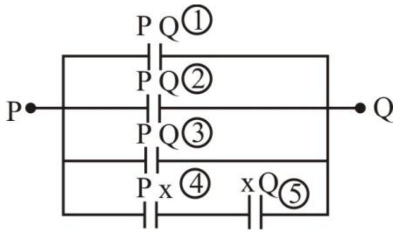


$$C=4\pi\epsilon_0\left[\frac{2r\times 3r}{3r-2r}\right]=24\pi\epsilon_0 r$$

Q15.

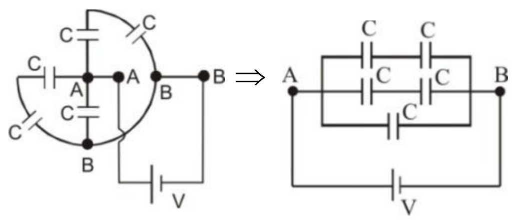


Equivalent circuit :



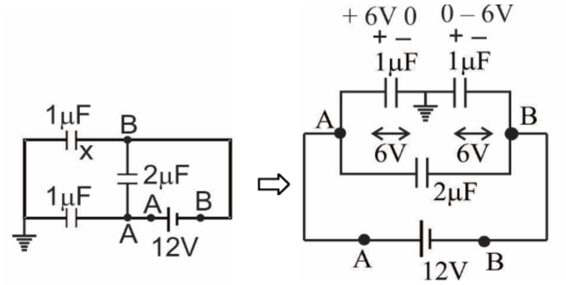
$$C_{eq}=C+C+C+\frac{C}{2}=\frac{7C}{2}=\frac{7\epsilon_0 A}{2d}$$

Q16.

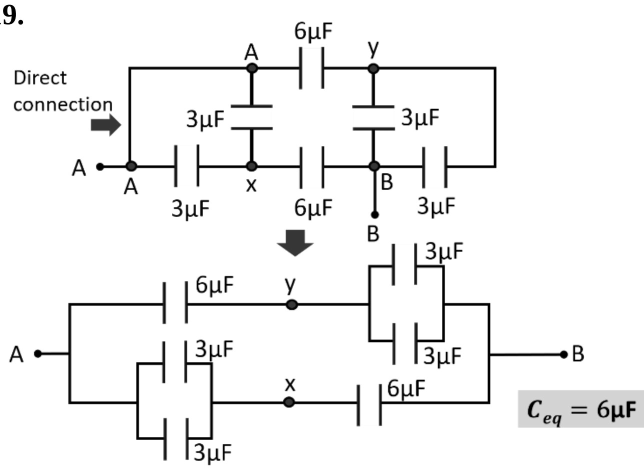


$$C_{eq} = \frac{C}{2} + \frac{C}{2} + C = 2C \quad \Rightarrow \quad q = C_{eq}V = 2CV$$

Q17. Equivalent circuit

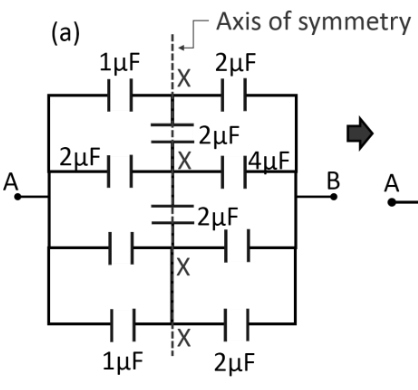


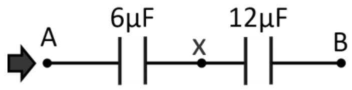
Q19.



$C_{eq} = 6\mu F$

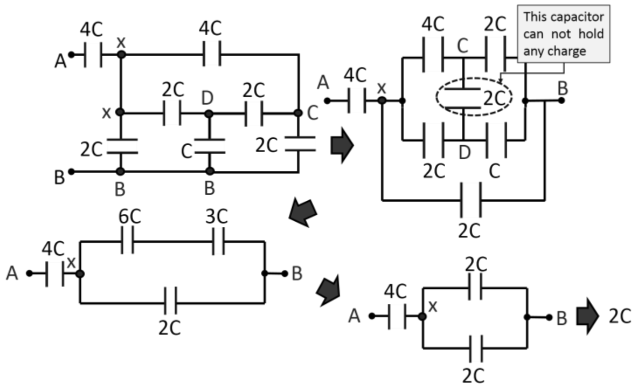
Q20.



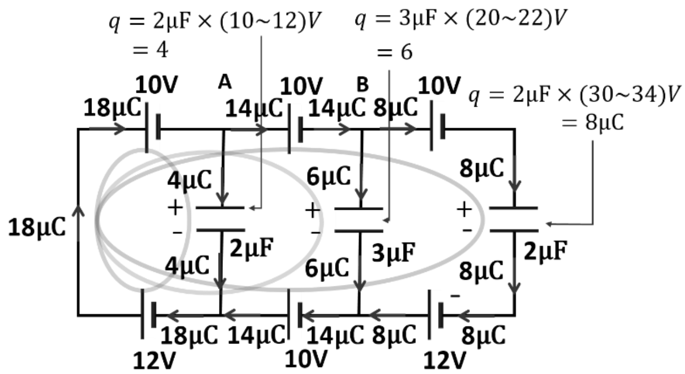


$$C_{eq} = \frac{6 \times 12}{6 + 12} = \frac{72}{18} = \mathbf{4\mu F}$$

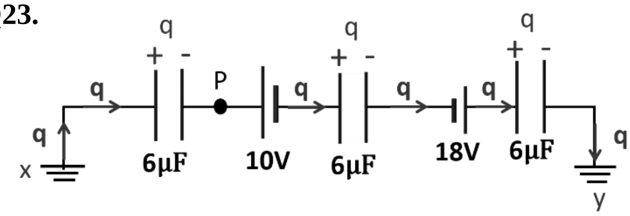
Q21.



Q22.



Q23.



$$V_x - V_y = \frac{q}{6} + 10 + \frac{q}{6} - 18 + \frac{q}{6}$$

$$0 - 0 = \frac{q}{2} - 8 \Rightarrow q = +16\mu C$$

$$V_x - V_P = +\frac{q}{6} \Rightarrow 0 - V_P = +\frac{(+16)}{6} \Rightarrow V_P = -\frac{8}{3}\mathbf{V}$$

Q24.

$$m = \frac{V_o}{V}$$

$$\Rightarrow m = \frac{500}{150}$$

$$\Rightarrow m = 3.33 \Rightarrow m = 4$$

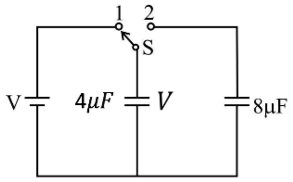
$$n = \frac{C_o}{C} \times m$$

$$\Rightarrow n = \frac{4}{1} \times 4 \Rightarrow n = 16$$

$$N = m \times n = 4 \times 16 = 64$$

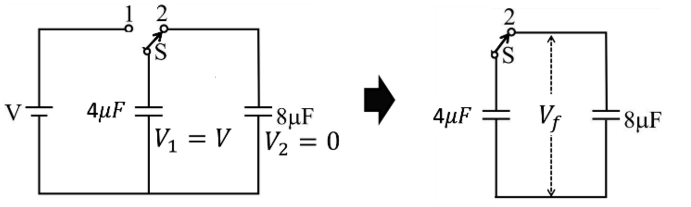
Q25.

Initially only the $4\mu F$ capacitor is charged by the battery upto the potential V.



$$U_i = \frac{1}{2} \times 4 \times V^2 = 2V^2$$

When the switch S is turned to position 2, charge on the capacitor $4\mu F$ is distributed on both the capacitors to assume final equilibrium.



Final voltage⇨ $V_f = \dfrac{C_1V_1 + C_2V_2}{(C_1 + C_2)} = \dfrac{4 \times V + 8 \times 0}{4+8} = \dfrac{V}{3}$

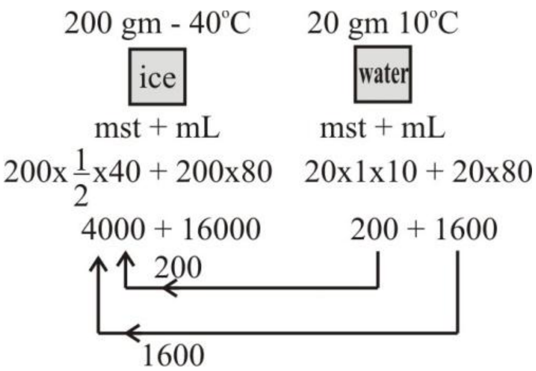
$$U_f = \frac{1}{2} \times (C_1 + C_2) \times V_f^2 = \frac{1}{2} \times (4+8) \times \left(\frac{V}{3}\right)^2$$

$$= \frac{1}{2} \times (12) \times \frac{V^2}{9} = \frac{2V^2}{3}$$

$$\frac{\Delta U}{U_i} \times 100 = \frac{U_i - U_f}{U_i} \times 100$$

$$= \frac{2V^2 - \frac{2V^2}{3}}{2V^2} \times 100 = \frac{2}{3} \times 100 = \mathbf{66.7\%}$$

Q26.



The above process shows that water reaches 0ºC and finally freezes. But since ***mst*** of ice still remains it does not reaches 0ºC hence final mixture has only ice at temperature lower than 0ºC. Let the temp. of final mixture be tºC.

Heat given = Heat taken

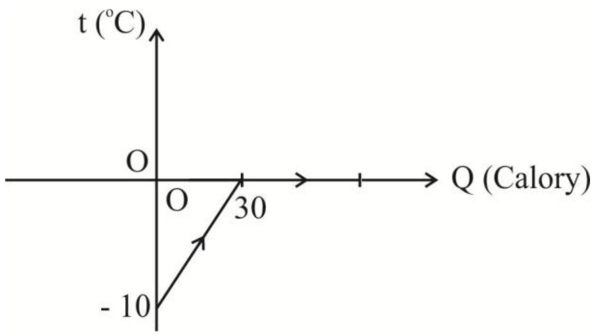
$$\Rightarrow 20 \times 1 \times (10-0) + 20 \times 80 + 20 \times \frac{1}{2} \times (0^o - t)$$

$$200 \times \frac{1}{2} \times [t - (-40)]$$

⇒ 200 + 1600 –10t = 100t + 4000

⇒ 110 t = – 1200 ⇒ t = – 20ºC

Q27.



$$Q = m\,S\Delta t \;\Rightarrow\; 30 = m \times \frac{1}{2} \times [0 - (-10)]$$

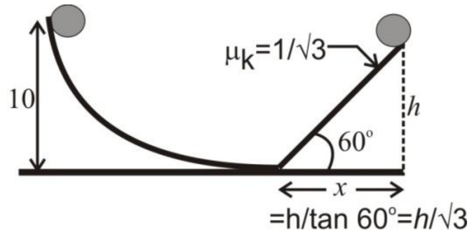
$$\Rightarrow\; 30 = 5m \;\Rightarrow\; m = 6gm$$

Q32. $KE = \dfrac{3}{2}\mu RT \Rightarrow KE = \dfrac{3}{2}\dfrac{M}{Mo}RT$

$\Rightarrow KE \propto \dfrac{M}{Mo}$ (in the mixture T is same)

$$\frac{He}{O_2} \Rightarrow \frac{KE_1}{KE_2} \;\Rightarrow\; \frac{M_1}{M_2} \times \frac{Mo_2}{Mo_1} = \frac{2}{1} \times \frac{32}{4} = \frac{16}{1}$$

Q33.



$$W = \Delta KE$$

$$\Rightarrow\; W_{mg} + W_R + W_{fr} = KE_f - KE_i$$

$$\Rightarrow\; (mg \times 10 - mgh) + 0 - \frac{1}{\sqrt{3}} mgx = 0 - 0$$

$$\Rightarrow 10mg - mgh - \frac{1}{\sqrt{3}} mg \frac{h}{\sqrt{3}} = 0$$

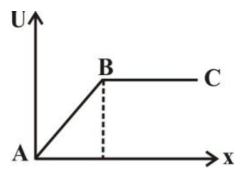
$$\Rightarrow 10mg - mgh - \frac{mgh}{3} = 0$$

$$\Rightarrow\; 10mg - \frac{4mgh}{3} = 0$$

$$\Rightarrow\; 10 = \frac{4}{3}h \;\Rightarrow\; h = \frac{30}{4} = 7.5m$$

Q34. Negative slope of U/x graph gives positive force

$$F = -\frac{dU}{dx}$$



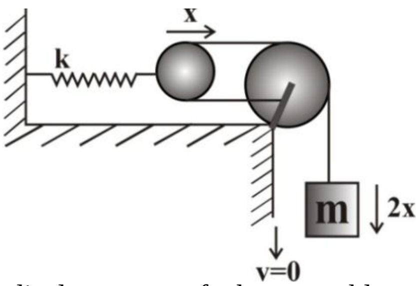
<u>AB part of the graph :</u>

slope⇒ (+) & constant

⇒ F ⇒ (-) and const.

<u>BC part</u> slope = 0 ⇒ F = 0

Q36. At maximum extension of spring final velocity becomes zero. The displacement of the body is double of the displacement of the movable pulley on the concept of dependent motion.

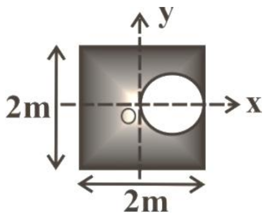


$W = \Delta KE$

$$\Rightarrow -\frac{1}{2}kx^2 + mg \cdot 2x = 0 - 0$$

$$\Rightarrow \quad \frac{1}{2}kx^2 = mg2x \;\Rightarrow\; x = \frac{4mg}{k}$$

Q37. $x_0 = \dfrac{m_1x_1 - m_2x_2}{m_1 - m_2}$



$m_1 = \sigma\ (2)^2 = 4\sigma,$

$x_1 = 0$

$$m_2 = \sigma \cdot \pi r^2 = \sigma \cdot \pi\left(\frac{1}{2}\right)^2 = \frac{\sigma\pi}{4}, \quad x_2 = \frac{1}{2}$$

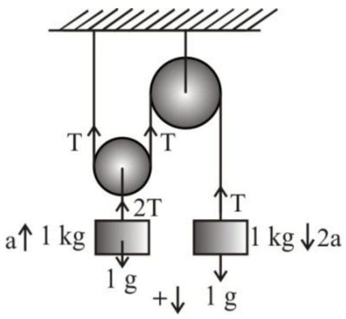
$$x_0 = \frac{4\sigma \times 0 - \frac{\sigma\pi}{4} \times \frac{1}{2}}{4\sigma - \frac{\sigma\pi}{4}} = \frac{-\frac{\sigma\pi}{8}}{\left(\frac{16-\pi}{4}\right)\sigma}$$

$$= -\frac{\pi}{8} \times \frac{4}{(16-\pi)} \Rightarrow x_0 = -\frac{\pi}{32 - 2\pi}$$

$y_0=0$ since y_1&y_2 both are zero.

Q38. $1 \times 2a = 1g - T$ ... (1)

$1.a = 2T - 1g$ ..... (2)



$\underline{(1) \times 2 + (2)}$:

$5a = g$

$$\Rightarrow a = \frac{g}{5} = \frac{10}{5}$$

$\Rightarrow a = +2 m/s^2$

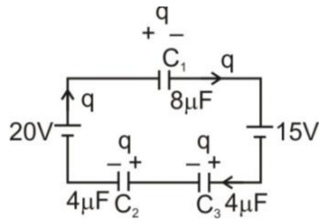
$Ma_0 = m_1a_1 + m_2 a_2$

$\Rightarrow \quad 2 \times a_0 = 1 \times 2a + 1\ (-a)$ (taking downward direction as +ve)

$\Rightarrow \quad 2a_0 = a$

$$\Rightarrow \quad a_0 = \frac{a}{2} = \frac{2}{2} = +1 m/s^2 \text{ downward}$$

Q39. Charge on each capacitor is same as all the capacitors are in series in the loop :



$$\frac{q}{8} + 15 + \frac{q}{4} + \frac{q}{4} - 20 = 0$$

$$\Rightarrow \quad \frac{5q}{8} = 5 \quad \Rightarrow \quad q = 8\mu C$$

Q40. $\alpha_1\ l_1 = \alpha_2\ l_2$

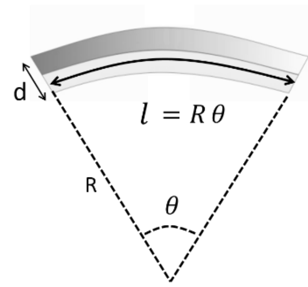
$\Rightarrow 1.6 \times 10^{-5} \times 80 = 2.0 \times 10^{-5} \times l_2$

$$\Rightarrow l_2 = \frac{1.6 \times 10^{-5} \times 80}{2.0 \times 10^{-5}}$$

$\Rightarrow \boldsymbol{l_2 = 64cm}$

Q41.

$$R = \frac{d}{(\alpha_B \sim \alpha_C)\,\Delta t}$$



Q43. **(a)** Field due to polarization always opposes the external field.

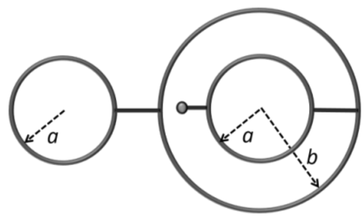
(b) Induce charges on the dielectric are bound charges which are not free hence they can not neutralize any charge.

(c) External field (not the induced field) should exceed the dielectric strength to ionize the dielectric.

(d) This option is correct.

Q44. (d) Field becomes half as potential remains same but distance is doubled $\left(\boldsymbol{E = \frac{V}{d}}\right)$.

Q45. Only outer spheres hold charges therefore capacitance is given by outer spheres only and both the outer spheres are equipotential.



$C = C_1 + C_2$

$= 4\pi\epsilon_0 a + 4\pi\epsilon_0 b$

$\Rightarrow \mathbf{C = 4\pi\epsilon_0(\boldsymbol{a + b})}$