

2SK-3028

BSE-1A

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Date _____

Q) $5+4 = 9 \mu F$

$$\frac{1}{C_L} = \frac{1}{9} + \frac{1}{6}$$

$$\frac{1}{C_L} = \frac{2}{18} + \frac{3}{18} = \frac{5}{18} \Rightarrow C_L = \frac{18}{5} = 3.6 \mu F$$

$$C_{23} = \frac{2+3}{3} = 5 \mu F$$

$$\frac{1}{3} + \frac{1}{5} + \frac{1}{7} \Rightarrow \frac{35}{105} \quad C_R = \frac{105}{35} = 3.0 \mu F$$

$$3.6 + 3.0 = 6.6 \mu F$$

22a) $E = \frac{\sigma}{\epsilon_0}$

$$V = Ed$$

$$\text{Top plate} = -\sigma_1$$

$$E_1 d + E_2 (2d) = 0$$

$$\text{Bottom plate} = -\sigma_2$$

$$\epsilon_1 = \sigma_1 - 0$$

$$\frac{\sigma_1}{A} = \sigma_1 = \epsilon_0 \epsilon_1$$

$$\frac{E_1}{\epsilon_0 A}$$

$$\frac{\sigma_2}{A} = \sigma_2 = \epsilon_0 \epsilon_2$$

$$E_2 = \frac{\sigma_2 + 0}{\epsilon_0 A}$$

$$(E_1)d + (E_2)(2d) = 0$$

$$(\sigma_1 - 0)d + 2(\sigma_2 + 0)d = 0$$

$$\sigma_1 - 0 + 2\sigma_2 + 20 = 0$$

$$\sigma_1 + 2\sigma_2 + 20 = 0$$

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Total charge induced must be $-Q$

$$Q_1 + Q_2 = Q$$

$$Q_1 = \frac{2}{3}Q \quad Q_2 = \frac{1}{3}Q$$

Induced Charges

$$Q_{\text{Top}} = -\frac{2}{3}Q$$

$$Q_{\text{Bottom}} = -\frac{1}{3}Q$$

b) $C_1 = \frac{\epsilon_0 A}{d}$ $C_2 = \frac{\epsilon_0 A}{2d}$

$$q_1 + q_2 = 0$$

$$\frac{q_1}{C_1} = \frac{q_2}{C_2}$$

$$q_1 = \frac{C_1}{C_1 + C_2} Q$$

$$q_2 = \frac{C_2}{C_1 + C_2} Q$$

Substituting $C_1 = \frac{\epsilon_0 A}{d}$ and $C_2 = \frac{\epsilon_0 A}{2d}$ then

$$C_1 : C_2 \approx 2 : 1$$

$$q_1 = \frac{2}{3}Q \quad q_2 = \frac{1}{3}Q$$

$$\text{Upper plate} = -\frac{2}{3}Q \quad \text{lower plate} = -\frac{1}{3}Q$$

$$V_{\text{middle}} = \frac{q_1}{C_1} = \frac{\left(\frac{2}{3}\right)Q}{\frac{\epsilon_0 A}{d}} = \frac{2Qd}{3\epsilon_0 A}$$

$$= \boxed{\frac{2}{3} \frac{Qd}{\epsilon_0 A}}$$

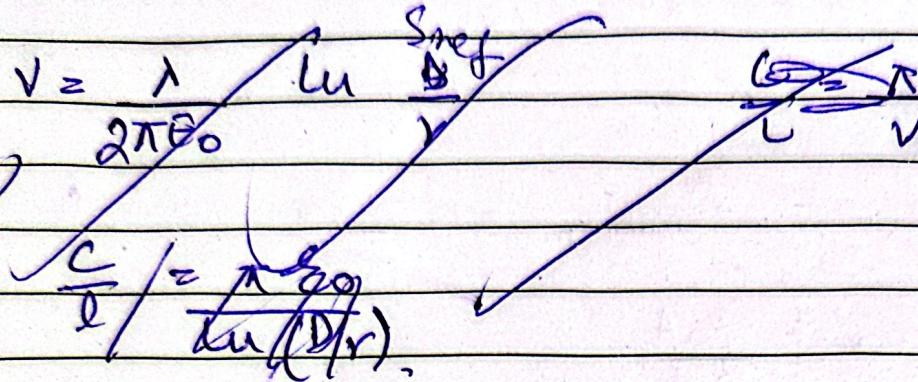
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$$\text{Q3} \quad \frac{C}{L} = \frac{\pi E_0}{\ln \frac{D}{r}} \quad \rightarrow \text{need to show}$$



$$V_1 = \frac{\lambda}{2\pi E_0} \ln \frac{S_{ref}}{r} - \frac{1}{2\pi E_0} \ln \frac{S_{ref}}{D}$$

$$\frac{\lambda}{2\pi E_0} \left(\ln \frac{S_{ref}}{r} - \frac{\ln S_{ref}}{D} \right)$$

$$V_1 = \frac{\lambda}{2\pi E_0} \ln \frac{D}{r}$$

$$V_2 = \frac{-1}{2\pi E_0} \ln \frac{D}{r}$$

$$V = V_1 - V_2$$

$$\frac{1}{2\pi E_0} \ln \frac{D}{r} - \left(-\frac{1}{2\pi E_0} \ln \frac{D}{r} \right) = \frac{1}{2\pi E_0} \ln \frac{D}{r}$$

$$\frac{C}{L} = \frac{1}{r} = \frac{1}{\frac{1}{2\pi E_0} \ln \frac{D}{r}} = \boxed{\frac{\pi E_0}{\ln \left(\frac{D}{r} \right)}}$$

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$$(Q4) \quad \sigma = \frac{\sigma}{280}$$

$$\frac{q_1}{\frac{280}{280}} = mg \quad \Rightarrow \frac{280mg}{9.8}$$

$$\sigma = \frac{2(8.854 \times 10^{-12})(0.010)(9.8)}{20.7 \times 10^{-6}} \approx 8.38 \times 10^{-8}$$

(Q5) Capacitor C_1 charged by battery B
voltage V_0 . 80% initial charge on TP C1

$$Q_{\text{initial}} = C_1 V_0$$

C_2 and C_3 unchanged

$$q_1 + q_2 + q_3 = C_1 V_0$$

$$q_i = C_i V_f \quad (i=1,2,3)$$

$$V_f = \frac{C_1 V_0}{C_1 + C_2 + C_3} \quad q_i = C_i V_f = \frac{C_i}{C_1 + C_2 + C_3} C_1 V_0$$

$$q_1 = \frac{C_1^2}{C_1 + C_2 + C_3} V_0 \quad q_2 = \frac{C_1 C_2}{C_1 + C_2 + C_3} V_0$$

$$q_3 = \frac{C_1 C_3}{C_1 + C_2 + C_3} V_0$$