15/04/24 Pg: 74 (3 mark)

16/4/24 Tuesday

21) Explain in detail how charges are distributed in a conductor, and the Principle behind the lightning conductor

 A ⇒ sphere

B ⇒ sphere

Thin wire conductor

charge density

Point charge

$$V = \frac{1}{4\pi\varepsilon_0} \frac{q}{r}$$

$$V_A = \frac{1}{4\pi\varepsilon_0} \frac{q_1}{r_1} \rightarrow (1)$$

$$V_B = \frac{1}{4\pi\varepsilon_0} \frac{q_2}{r_2} \rightarrow (2)$$

Equipotential surface

$V_A = V_B \rightarrow (3)$ (All point equal)

$$\frac{1}{4\pi\varepsilon_0} \frac{q_1}{r_1} = \frac{1}{4\pi\varepsilon_0} \frac{q_2}{r_2}$$

$$\frac{q_1}{r_1} = \frac{q_2}{r_2} \rightarrow (4)$$

$$q_1 = 4\pi r_1^2 \sigma_1$$

$\sigma \rightarrow$ charge density

$$q_2 = 4\pi r_2^2 \sigma_2$$

$$\frac{4\pi r_1^2 \sigma_1}{r_1} = \frac{4\pi r_2^2 \sigma_2}{r_2}$$

$$\frac{r_1^2 \sigma_1}{r_1} = \frac{r_2^2 \sigma_2}{r_2}$$

$$\sigma_1 r_1 = \sigma_2 r_2$$

$$\sigma r = \text{constant}$$

smaller sphere greater than charge density

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Exercise Problem

① when two object are rubbed with each other, approximately a charge of 50nC can be produced in each object. calculate the number of electron that must be transferred to produce this charge

Solution : $n \rightarrow nano \rightarrow 10^{-9} M$

charge

$q = 50nC = 50 \times 10^{-9} C$

number of electron?

$q = ne$

$n = \frac{q}{e}$

constant value

$e = 1.6 \times 10^{-19} C$

$n = \frac{50 \times 10^{-9}}{1.6 \times 10^{-19}}$

$n = \left(\frac{50}{1.6}\right) \times 10^{-9} \times 10^{+19}$

$n = 31.25 \times 10^{10}$ electrons

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Example 1.1

1) calculate the number of electron in one coulomb of negative charge

solution: one coulomb Negative charge (electron)

$q = ne$

$n = \frac{q}{e}$

$n = \frac{1}{1.6 \times 10^{-19}}$

$e = 1.6 \times 10^{-19} C$

$q = 1 \cdot C$

$$n = \frac{10^{19}}{1.6}$$

$$n = \frac{1}{1.6} \times 10^{19}$$

$$n = 6.25 \times 10^{18} \text{ electrons}$$

Exercise Problem

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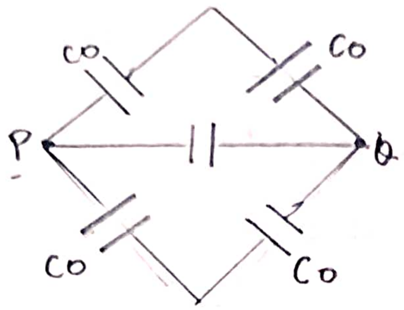
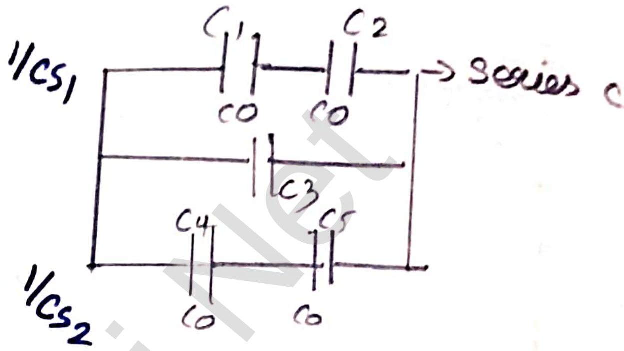
11) e)





i) series C

$$\frac{1}{C_{S_1}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{S_1}} = \frac{1}{C_o} + \frac{1}{C_o}$$

$$\frac{1}{C_{S_1}} = \frac{1+1}{C_o}$$

$$\frac{1}{C_{S_1}} = \frac{2}{C_o}$$

$$C_{S_1} = \frac{C_o}{2}$$

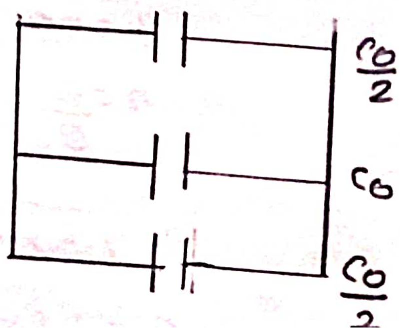
$$\frac{1}{C_{S_2}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{S_2}} = \frac{1}{C_o} + \frac{1}{C_o}$$

$$\frac{1}{C_{S_2}} = \frac{1+1}{C_o}$$

$$\frac{1}{C_{S_2}} = \frac{2}{C_o}$$

$$C_{S_2} = \frac{C_o}{2}$$



ii) Parallel connection

$C_p = C_1 + C_2 + C_3$

$C_p = \frac{C_0}{2} + C_0 + \frac{C_0}{2}$

$C_p = \frac{C_0}{2} + \frac{C_0}{2} + C_0$

$C_p = \frac{2C_0}{2} + C_0$

$C_p = C_0 + C_0$

$C_p = 2C_0$

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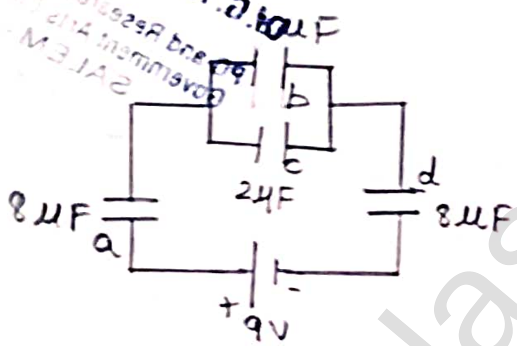
5 mark

14) For the given capacitor configuration



a) Find the charge on each capacitor

b) Potential difference across them

$V_a = V_{bc} = V_d = 9V$ (parallel)

$3V = 9$

$V = \frac{9}{3}$

$V = 3V$

b and c

$6\mu f$ $2\mu f$ $= 8\mu F$

$C_p = C_1 + C_2$

$C_p = 6 + 2 = 8\mu F$

a) Find the charge on each capacitor

charge $C = \frac{Q}{V}$ $Q = CV$

$Q_a = CV = 8 \times 10^{-6} \times 3 = 24 \times 10^{-6} f$

$Q_b = CV = 6 \times 10^{-6} \times 3 = 18 \times 10^{-6} f$

$Q_c = CV = 2 \times 10^{-6} \times 3 = 6 \times 10^{-6} f$

$Q_d = CV = 8 \times 10^{-6} \times 3 = 24 \times 10^{-6} f$

c) energy stored in each capacitor

$$U = \frac{1}{2} C V^2$$

$$U_a = \frac{1}{2} \times 8 \times 10^{-6} \times (3)^2$$

$$= 4 \times 10^{-6} \times 9$$

$$= 36 \times 10^{-6}\, J$$

$$U_b = U = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \times 6 \times 10^{-6} \times (3)^2$$

$$= 3 \times 10^{-6} \times 9 = 27 \times 10^{-6}\, J$$

$$U_c = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \times 2 \times 10^{-6} \times (3)^2$$

$$= 9 \times 10^{-6}\, J$$

$$U_d = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \times 8 \times 10^{-6} \times (3)^2$$

$$= 36 \times 10^{-6}\, J$$

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