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DEP : ELECT- ELECT. ENGINEERING

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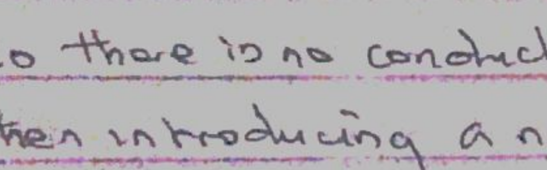
COVID19 HOLIDAY ASSIGNMENT

1(a)

Conside a neutral conducting sphere that is insulated so there is no conducting path for the charges to leave, then introducing a negatively charged rod brought in contact to the sphere. This makes some electron to move from the electrons to the sphere, and when the rod is removed the sphere remains negative -ly charged.

(i).

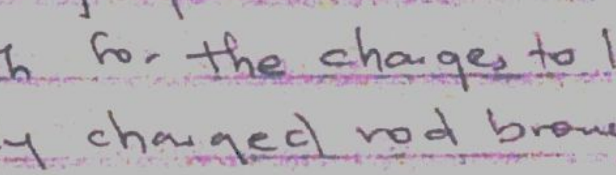


Rod [Negatively charge]

Neutral Sphere.

[0. in contact]

(ii).



[After contact]

1(b). $q_1 + q_2 = 5\times10^{-5}C$

$\therefore F = \cancel{\frac{k q_1 q_2}{r^2}} = k \cdot \frac{q_1 \cdot (5\times10^{-5}C - q_1)}{r^2}$

$F \cdot r^2 = k(5\times10^{-5} q_1 - q_1^2)$.

$\Rightarrow 1 \cdot 2^2 = 9\times10^9 (5\times10^{-5} q_1 - q_1^2)$.

$\Rightarrow \cancel{8} \cdot 9\times10^9 q_1^2 - 4.5\times10^5 q_1 + 4 = 0$

$q_1 = 3.8\times10^{-5}C$ or $1.1\times10^{-5}C$

$\therefore q_2 = (5\times10^{-5} - q_1)$

$= 1.1\times10^{-5}C$ or $3.89\times10^{-5}C$

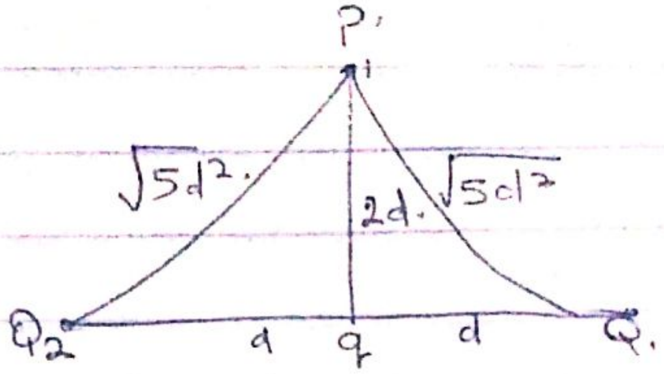
$\therefore$ Answer $q_1 = 3.87\times10^{-5}C$ $q_2 = 1.1\times10^{-5}$

or

$q_1 = 1.1\times10^{-5}C$ $q_2 = 3.8\times10^{-5}$

Scanned with CamScanner

1(c)



$$\vec{F} = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14}$$

Using $x^2 = y^2 + z^2$.

$$\overline{PQ} = \sqrt{(2d)^2 + d^2} = \sqrt{5d^2}$$

$$0 = \frac{K \cdot Q_2}{(\sqrt{5d^2})^2} + \frac{K \cdot q}{(2d)^2} + \frac{K \cdot Q_1}{(\sqrt{5d^2})^2}$$

$$0 = \frac{Q_2}{5d^2} + \frac{q}{4d^2} + \frac{Q_1}{5d^2}$$

$$\frac{q}{4d^2} = -\frac{1}{5d^2}\left(Q_2 + Q_1\right)$$

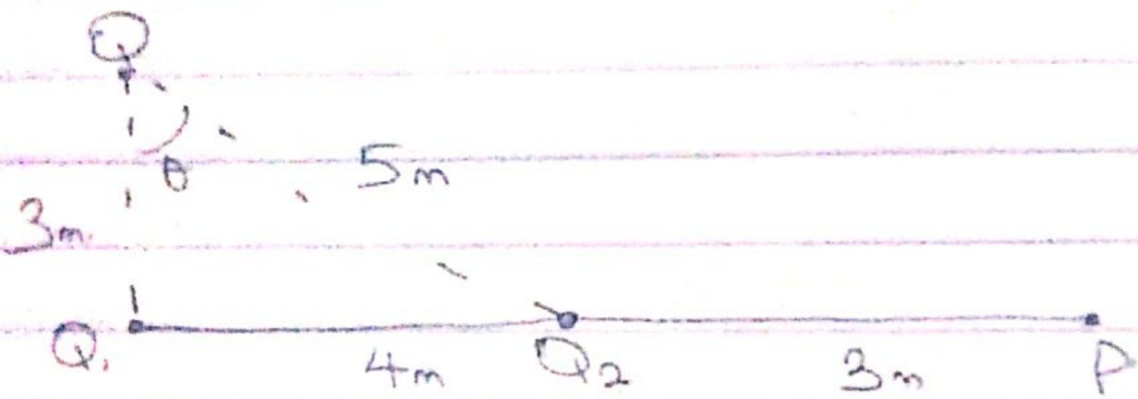
$$q = -\frac{4\cancel{d^2}}{5\cancel{d^2}}\left(Q_2 + Q_1\right)$$

$$= -\frac{4}{5}\left(1.6\times10^{-5}\right)$$

$$= -1.2\times10^{-5} \text{ or } -12\mu C. \quad -11NC$$

2(a) Electric Field is a region of space where an electric charge can experience an electric force, while Electric Field Intensity is the electric force per unit charge. Mathematically $E = \frac{F\,(N)}{q_o\,(C)}$.

b



$$E_{P_1} = \frac{KQ_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7} = 1.46\,N/C.$$

$$E_{P_2} = \frac{KQ_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{9} = 12\,N/C.$$

$$E_{Q_1} = \frac{KQ_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{9} = 8\,N/C$$

$$E_{Q_2} = \frac{KQ_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{25} = 4.32\,N/C$$

Vector	Angle	xcom	ycom
E_{P1}	0°	12cos(0)	
		0.9cos(0)	0.9sin(0).
E_{P2}	0°	12cos(0)	12 sin(0).
		12	0

$+$ 1.46.

13.46.

$\therefore \overline{E_p} = \sqrt{(13.46)^2 + 0}$

$= 13.46$ N/C

Vector	Angle	xcom	ycom.
E_{Q1}	90°	$8\cos(90^\circ)$	$8\sin(90^\circ)$
		$= 0$	$= 8$.
E_{Q2}	53.1°.	4.32 cos (53.1) = 2.59	4.32 sin(53.1) = 3.45.

2.59   11.45

$\therefore E_Q = \sqrt{(2.59)^2 + (11.45)^2}$

$= 11.7$ N/C

3(a).

(i) Volume charge density.

$$\rho = \frac{dQ}{dV} \rightarrow dQ = \rho dV.$$

(ii) Surface charge density.

$$\sigma = \frac{dQ}{dA} \rightarrow dQ = \sigma dA$$

(iii) Linear charge density.

$$\lambda = \frac{dQ}{dL} \rightarrow dQ = \lambda dL.$$

(b) Electric potential difference is the work done per unit charge against electric forces when a charge is transported from one point to another.

Mathematically:

$$V_B - V_A = \frac{W(A \rightarrow B)_{Ag}}{q_0}$$

110 $dW = F \cdot dL.$ — (i)

$F = -q_0 \cdot E.$ — (ii)

$dW = -q_0 \cdot E \, dL.$

$$W(A \rightarrow B)_{Ag} = -q_0 \int_A^B E \, dL$$

$$\Rightarrow V_B - V_A = \frac{W(A \rightarrow B)_{Ag}}{q_0}$$

Ans. 3(c).

$$V = K\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right].$$

when. $V = 0$.

$$0 = K\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right].$$

$K \longrightarrow 0$.

$$= \frac{Q_1}{r_1} + \frac{Q_2}{r_2}$$

$$-\frac{Q_1}{r_1} = \frac{Q_2}{r_2}.$$

$$Q_2 r_1 = -Q_1 r_2.$$

$$r_1 = \frac{-Q_1 r_2}{Q_2}.$$

$$r_1 = \frac{-10\times10^6 \times 4}{-2\times10^6}.$$

$$= 20.$$

$$\therefore V = K\left[\frac{10\times10^6}{20} + \frac{-2\times10^6}{4}\right] = 0$$

$\therefore$ radius is 20m, 4m.

4(a) A magnetic flux is the strength of magnetic field -sented by lines of force. it is represented by the symbol

(b). $W = \frac{qB}{m}$

where $q = 1.6 \times 10^{-19}$.

$\therefore W = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$

$= 6.15 \times 10^{10}$ rad/s

5 (a). Biot-Savart Law is based on the following observation for the magnetic field $\vec{dB}$ at a point P associated with a length element dl of a wire carrying a steady current I

(b) Applying the biot savart law:

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin\phi}{r^2} \qquad \sin(\pi - \phi) = \sin\phi$$

$$\therefore B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - \phi)}{r^2}$$

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - \phi)}{x^2 + y^2} \quad \text{--- (1)}$$

$$\text{Since } \sin(\pi - \phi) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}} \quad \text{--- (2)}$$

Substituting eqn (1) in eqn (2).

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} dl \, \frac{x}{(x^2+y^2)^{3/2}} \, dy$$

$$= \frac{\mu_0 I x}{4\pi} \int_{-a}^{a} \frac{1}{(x^2+y^2)^{3/2}} \, dy$$

$$B = \frac{\mu_0 I x}{4\pi}\left[\frac{y}{x^2(x^2+y^2)^{1/2}}\right]_{-a}^{a}$$

$$= \frac{\mu_0 I x}{4\pi}\left(\frac{2a}{x^2(x^2+a^2)^{1/2}}\right)$$

$$= \frac{\mu_0 I}{4\pi x}\left(\frac{2a}{(x^2+a^2)^{1/2}}\right).$$

Since $(x^2+a^2)^{1/2} \simeq a$ $\therefore$ $\frac{2a}{a} = 2$

$$B = \frac{\mu_0 I}{4\pi x} \cdot 2$$

$$B = \frac{\mu_0 I}{2\pi x} \quad \text{or} \quad \frac{\mu_0 I}{2\pi r}.$$