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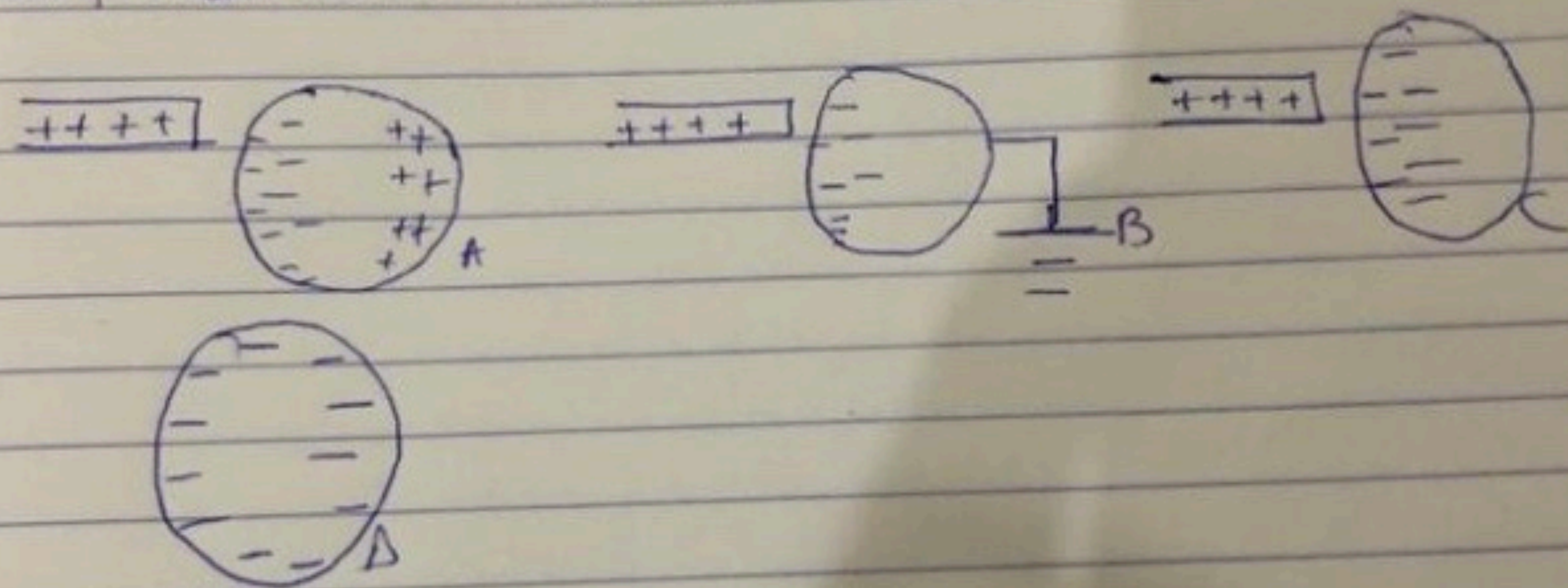
MBBS

Consider a positively charged rubber rod brought near a uncharged conducting sphere that is insulated so that there is no conducting path to ground. The repulsive force between the protons in the rod (positively charge) and those in the sphere causes a redistribution of charge on the sphere so that some proton move to the side of the sphere farthest away from the rod. The region of the sphere nearest the positively charge rod has an excess of negative charge because of the migration of proton away from the location. If a grounded conducting wire is then connected to the sphere some of the protons leave the sphere and travel to the earth. if the wire to ground is then removed, the conducting sphere is left with an excess induced negative charge. Then finally the rubber rod is then removed from the vicinity of the sphere the induced negative charge remain on the ungrounded sphere and become uniformly distributed over the surface of the sphere



1b) $q_1 + q_2 = 5.0 \times 10^{-5} C$

$k = 9 \times 10^9$

$r = 2m$

$F = 1N$

$$F = \frac{k_1 q_1 q_2}{r^2}$$

$$\frac{Fr^2}{k} = q_1 q_2$$

$$q_1 q_2 = \frac{1 \times 2^2}{9 \times 10^9} = 4.444 \times 10^{-10}$$

$q_1 + q_2 = 5.0\times10^{-5}$

$q_2 = 5.0\times10^{-5} - q_1$

$q_1(5.0\times10^{-5} - q_1) = 4.444\times10^{-10}$

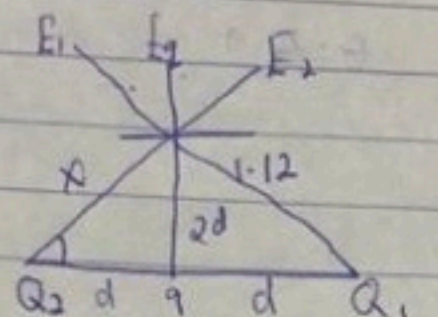
$q_1^2 - (5.0\times10^{-5} q_1) + 4.444\times10^{-10} = 0$

$$\frac{5.0\times10^{-5} + \sqrt{(5.0\times10^{-5})^2 - 4(4.444\times10^{-10})}}{2}$$

$q_1 = 3.84\times10^{-5}\,C$

$q_2 = 1.16\times10^{-5}\,C$

x)



$d = 0.5$

$x^2 = 1^2 + 0.5^2$

$\sqrt{x^2} = \sqrt{1.25}$

$x = 1.12$

$Q_2 = Q_1 = 8\times10^{-6}$

$E_2 = E_1$

$\tan\theta = \frac{Opp}{adj}$

$\theta = \tan^{-1}(1/0.5)$

$\theta = 63.43^\circ$

$E_2 = \frac{k_1 q_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.95918$

$E_1 = 57397.95978$

$E_q = \frac{kq}{r^2} = \frac{9\times10^9 \times q}{1} = 9\times10^9 q$

Vector	Angle	x-comp	Y-comp
$E_1 = 57397.95918$	63.4	25700.45785	51322.62839
$E_2 = 57397.95918$	63.4	−25700.45786	51322.62839
		$E_x = 0$	$E_y = 102645.256$

$$E_q = \sqrt{(0)^2 + (102645.2568)^2}$$

$$E_q = 0 + 102645.2568$$

$$q = \frac{E_q}{9 \times 10^9} = \frac{102645.2568}{9 \times 10^9}$$

$$q = 1.14 \times 10^{-5}\ C$$

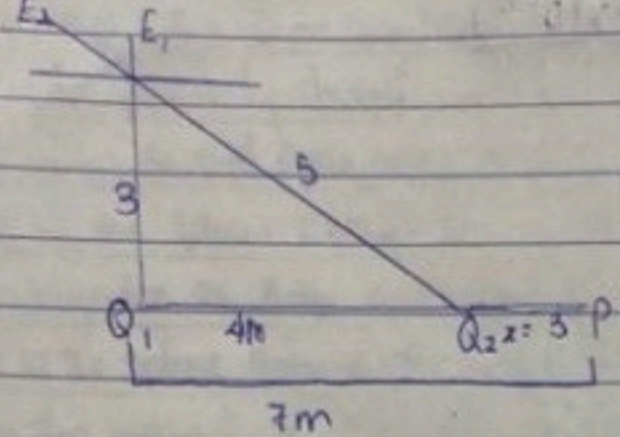
2a) Electric Field

An electric field is a region of space in which an electric charge will experience an electric force while

Electric field intensity

It is defined as the force per unit charge.

2b)



$\tan\theta = \frac{Opp}{Adj}$

$\theta = \tan^{-1}(3/4)$

$\theta = 36.9$

$E_{net} = E_1 + E_2$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469 N/C$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = \cancel{2.20}\ 12 N/C$

$E_{net} = 12 + 1.469$

$E_{net} = 13.469$ or $13.5 N/C$ //

ii) $E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8 N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32 N/C$

Vector	Angle	x - Comp	Y - Comp
$E_1 = 8 N/C$	90°	0	8
$E_2 = 4.32 N/C$	36.9°	-3.45	2.59
		$E_x = -3.45$	$E_y = 10.59$

$E_{net} = \sqrt{(-3.45)^2 + (10.59)^2}$

$= 11.14 N/C$

$\Rightarrow E\ net = 11.14 N/C$ //

4a) Magnetic flux is defined as the strength of magnetic field represented by lines of force

4b) $m = 9.11 \times 10^{-31}$ kg

$r = 1.4 \times 10^{-7}$ m

$B = 5.5 \times 10^{-1}$ tesla

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

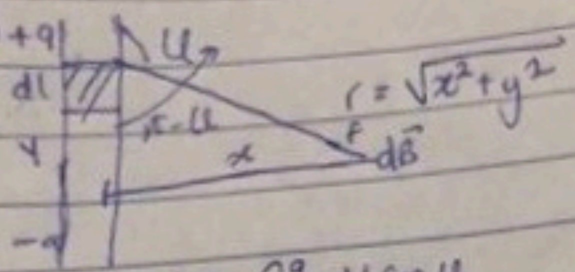
$$\omega = \frac{qB}{m} = \frac{-1.6 \times 10^{-19} \times 5.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$\omega = -6.15 \times 10^{19}$ rad/s

4c) The answer is negative because electron is involved which means negatively charge but the electron is moving at a Cyclotron frequency of 6.15×10^{10} rad/s.

5a) Biot-Savart law is an equation that describe the magnetic field Created by a current-Carrying wire and allows one to calculate its strength at Various point.

b)



$$B=\frac{\mu_0 I}{4\pi}\int_{-a}^{a}\frac{dl\sin u}{r^2}$$

$\sin(\pi-u)=\sin\theta$

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

From diagram $r^2=x^2+y^2$

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

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

Substituting (2) into (1)

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

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

Recall $dl=dy$

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

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

Using Special integrals

$$\int\frac{dy}{(x^2+y^2)^{3/2}}=\frac{1}{x^2}\frac{y}{(x^2+y^2)^{1/2}}$$

Equation (3) therefore becomes

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

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

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

$$(x^2+a^2)^{1/2} = a, \text{ as } a \rightarrow \infty$$

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