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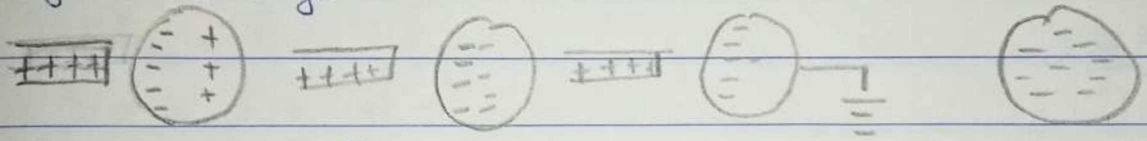
19/mhs01/127 MBBS

1a A positive charged rubber road will be brought near a neutral (uncharged) conducting sphere that is insultated so that there is no conducting path to the ground. The replusive force between the electrons in the rod and those in the sphere cause a redistribution of charges on the sphere. That, some proton move to the side of the sphere far from the rod. The region of the sphere nearest the positively charged rod has excess negative charge. Then a grounded conducting wire is then connected to the sphere. Then the wire to the ground is then removed, the conducting sphere is left with an excess of induced negative charge.



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

$F = \frac{kq_1q_2}{r^2}$

$1 = \frac{9\times10^9 \times (5\times10^{-5} - q_2)q_2}{2^2}$

$4 = 9\times10^9 \times (5\times10^{-5} - q_2)q_2$

$4 = (4.5\times10^5 - 9\times10^9 q_2)q_2$

$4 = (4.5\times10^5 q_2 - 9\times10^9 q_2^2$

$9\times10^9 q_2^2 - 4.5\times10^5 q_2 + 4 = 0$

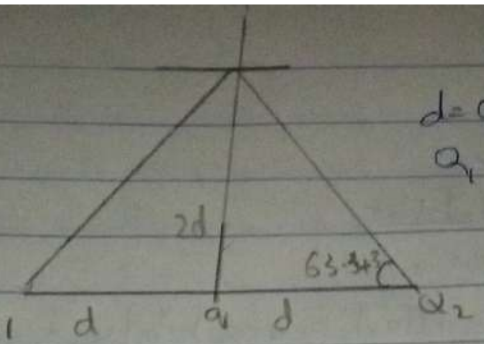
$q_2 = 3.84\times10^{-5}C$

Since its a quadratic equation

$q_1 = 1.156\times10^{-5}C$

$\therefore q_1 = 1.136\times10^{-5}C$ and $q_2 = 3.84\times10^{-5}C$

1c



$d = 0.5$

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

$\sqrt{0.5^2+1^2} = 1.12$ (pythagoras theorem)

$E_P = E_{Q_1} + E_{Q_2} + E_q$

$E_{Q_1} = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.12^2} = 57600 N/C$

$E_{Q_2} = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.12^2} = 57600 N/C$

$E_q = \frac{kQ}{r^2} = \frac{9\times10^9\times q}{1} = 9\times10^9\times q\ N/C$

	θ	x component	y component
57600 N/C	63.43°	$57600\cos63.43$ $= -25764$	$57600\sin63.43$ $= 51516.8$
57600 N/C	63.43	$57600\cos63.43$ $= +25764$	$57600\sin63.43$ $= 51516.8$
$9\times10^9 q$ N/C	90°	$9\times10^9 q\cos90$ $= 0$	$9\times10^9 q\sin90$ $= 9\times10^9 q$
		$E_{fx} = 0$	$E_{fy} = 103033.6 + 9\times10^9 q$

Point P = 0

$E_{net} = \sqrt{0^2 + (103033.6 + 9\times10^9 q)^2}$

$0 = 0 + 103033.6 + 9\times10^9 q$

$\frac{9\times10^9 q}{9\times10^9} = \frac{-103033.6}{9\times10^9}$

$q = -1.144817778\times10^{-5}$

$q = -11.4\times10^{-6}$

$q = -11.4\times10^{-6} N/C$

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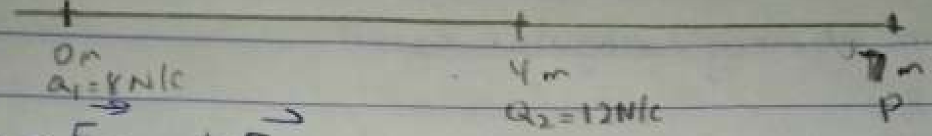
2

Electric field	Electric field intensity
It is a region of space in which an electric charge will experince an electric force	It is defined as the force per unit charge

2i



$\vec{E_p} = \vec{E_{q_1}} + \vec{E_{q_2}}$

$E_{q_1} = \frac{kq}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7^2} = \frac{72}{49} = 1.47 N/C$

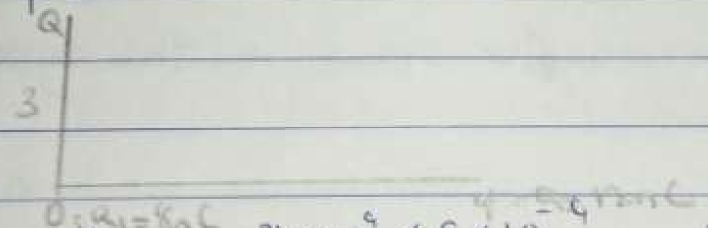
$E_{q_2} = \frac{kq}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{3^2} = \frac{108}{9} = 12 N/C$

$\vec{E_p} = \vec{E_{q_1}} + \vec{E_{q_2}}$

$E_p = 1.47 + 12$

$E_p = 13.5 N/C$

2ii



$E_{q_1} = \frac{kq}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{3^2} = 8 N/C$

$E_{q_2} = \frac{kq}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-19}}{5^2} = 4.32 N/C$

	x - compurent	y compurent
90	$8 \cos 90 = 0$	$8 \sin 90 = 8$
36.87	$4.32 \cos 36.87 = 3.46$	$4.32 \sin 36.87 = 2.59$
	x_{comp} 3.46	$Y_{comp} = 10.59$

magnitude $= \sqrt{(3.46)^2 + (10.59)^2}$

$= \sqrt{124.16}$

$E_Q = 11.14 N/C$

N º 4

4. Magnetic flux is a measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effects of the magnetic force on something occupying a given area.

b cyclotron frequency = angular speed

$$\omega = \frac{qB}{m_p}$$

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

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

6.15×10^{10} rad/s is the angular speed is often referred to as the cyclotron frequency because the charge particle circulates at this angular frequency or angular speed in the type of accelerator called cyclotron.

5a Biot - savart law

$$dB = \frac{\mu_0}{4\pi} \times \frac{I\,dl \times r}{r^2}$$

μ_0 is a constant called permeability of freespace

$$\mu_0 = 4\pi \times 10^{-7}\,T.m/A$$

5bi Using Biot - savart law, we have

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

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

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

$$r^2 = x^2 + y^2 \text{ (pythagoras theorem)}$$

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

$$\sin(\pi-\varphi) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}} \quad \cdots \text{equ(ii)}$$

Substituting equ(ii) into equ(i)

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

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

Recall $dl = dy$

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

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

Using special integrals

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

Equ (iii) therefore becomes

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

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

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

$$B = \frac{\mu_0 I}{2\pi r}$$ Biot- savart la

Show ~~that~~ the magnitude

a straight c