LEBILE MOTUNROLA CELINE
19/MHS01/235

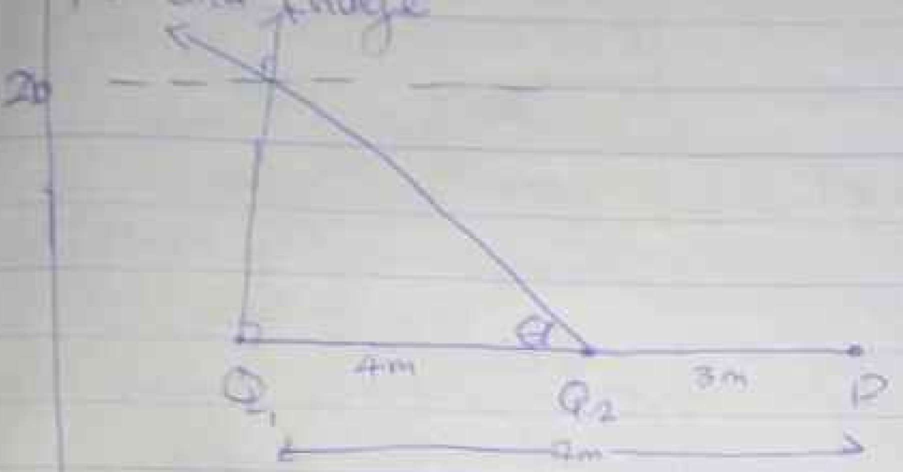
MBBS

PHY102 COVID ASSIGNMENT

2. **Electric field** is a region of space in which an electric charge will experience an electric force

Electric field intensity can be defined as a force per unit charge

2b



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

$$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9\ Nm^2/C^2 \times 12\times10^{-9}\ N/C}{3^2 m} = 12\ N/C$$

$$E_P\ Net = 1.469 + 12$$
$$= 13.469 = 13.5\ N/C$$

ii) $E_Q\ Net = \vec{E_1} + \vec{E_2}$

$$E_1 = \frac{Kq_1}{r^2} = \frac{9\times10^9\ Nm^2/C^2 \times 8\times10^{-9}\ N/C}{3^2 m} = 8\ N/C$$

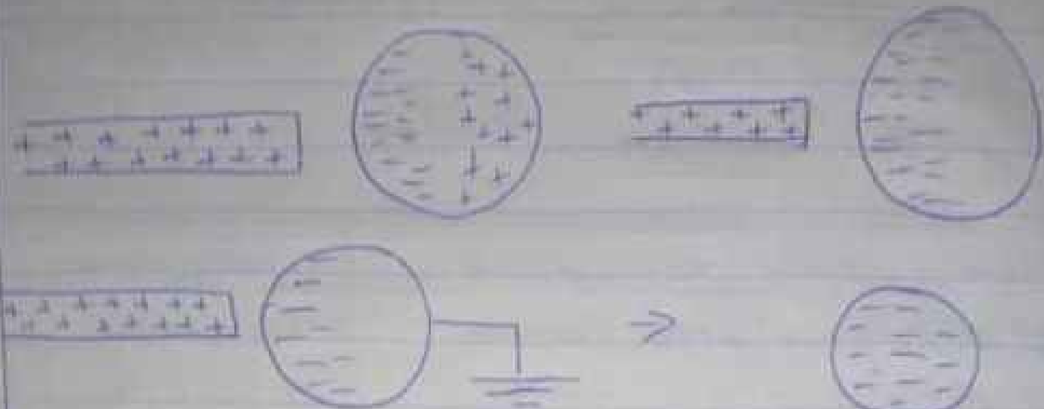
$$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9\ Nm^2/C^2 \times 12\times10^{-9}\ N/C}{5^2 m} = 4.32\ N/C$$

Vector	Angle	X-component	Y-component
$E_1 = 8\ N/C$	90^0	$8\cos 90 = 0$	$8 \sin 90 = 8$
$E_2 = 4.32\ N/C$	36.9	$-4.32\cos 36.9$ $= -3.45$	$+4.32 \sin 36.9$ $= 2.59$
		$E_{fx} = -3.45$	$E_{fy} = 10.59$

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

$= \underline{11.14\,\mu C}$ ——→ x

1)



Electric charges can be obtained on an object without touching it, by a process called electrostatic induction.

1b $K = 9 \times 10^9$

$q_1 + q_2 = 5 \times 10^{-5} C$, $F = 1N$, $d = 2m$, calculate the charge on each sphere

$K = 9 \times 10^9$

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

$\underline{1} = \frac{9 \times 10^9 \times (q_1 q_2 5 \times 10^{-5})}{2^2}$

$4 = 9 \times 10^9 \times 5 \times 10^{-5} q + 9 \times 10^9 q_2$

$4 = 4.5 \times 10^5 q_1 + 9 \times 10^9 q_2$

therefore $9 \times 10^9 q_2 - 4.5 \times 10^5 q_1 + 4 = 0$

$q_1 = 0.0000111C$

$q_2 = 0.0000388C$

$\Rightarrow q_1 = 1.11 \times 10^{-5} C$ & $q_2 = 3.8 \times 10^{-5} C$

1c $\underline{Q_1 = Q_2 = 8\mu C}$, $d = 0.5m$, determine Q_2, if electric field at $P = 0$

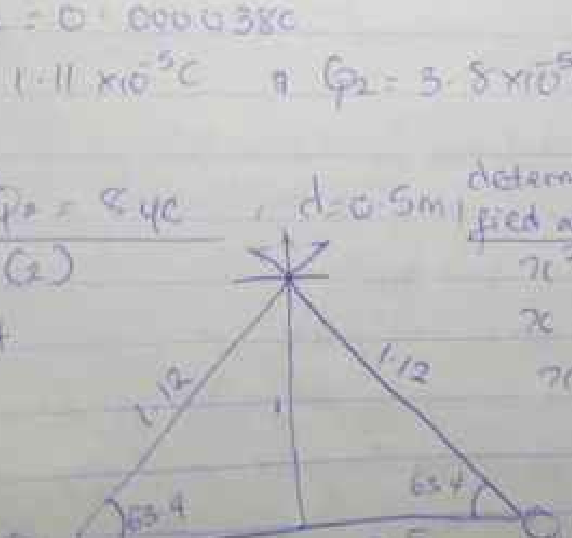
$\Theta = Tan^{-1}(2)$

$\underline{\Theta = 63.4}$

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

$x = \sqrt{1.25}$

$x = 1.12$



$E_1 = \frac{KQ_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5739.795918$

$E_2 = \frac{KQ_2}{r_2^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5739.795918$

$E_Q = \frac{Kq}{r^2} = \frac{9\times10^9 \times q}{1} = 9\times10^9 Q$

Vector	Angle	x-component	Y-component
$E_1 = 5739.795918$	$63.4°$	-2570.045785	5132.262839
$E_2 = 5739.795918$	$63.4°$	2570.045785	5132.262839
$E_q = 9\times10^9 Q$	$90°$	0	$9\times10^9 q$
		$\Sigma_{fx} = 0$	$\Sigma_{fy} = 10264.52568$

Magnitude $= \sqrt{(\Sigma_{fx})^2 + (\Sigma_{fy})^2}$

$= \sqrt{(0)^2 + (10264.52568)^2}$

$0 = 9\times10^9 q + 10264.52568$

making q subject of formular

$q = \frac{10264.52568}{9\times10^9}$

$Q = -1.140502853\times10^{-6}$

$q = -11.4\mu C$

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

4b $m = 9.11\times10^{-31}$ kg, $r = 1.4\times10^{-7}$ m, $B = 3.5\times10^{-1}$ weber/m^2

$q = 1.6\times10^{-19}$

$\omega = \frac{qB}{m} = \frac{1.6\times10^{-19} \times 3.5\times10^{-1}}{9.11\times10^{-31}}$

$\omega = 6.147\times10^{10}$

$\omega \simeq 6.15\times10^{10}$ rad/s

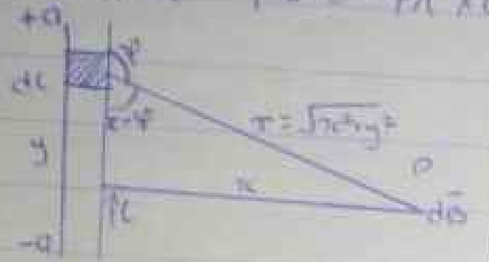
4c Cyclotron frequency is equal to the angular speed. The frequency is positive, therefore the charge circulates in a positive direction

5 Biot-savart law states that the magnetic field is directly proportional to the product permeability of free space (μ) the current (I), change in length, radius and inversely proportional to the square of radius.

$$\vec{dB} = \frac{\mu_0}{4\pi} \frac{I \vec{dl} \times \hat{r}}{r^2} \text{, Webers}/m^2$$

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

5b



Applying Biot-savart law, we find the magnitude of the field $\vec{dB}$

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

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

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

From diagram $r^2 = x^2 + y^2$ (Pythagoras theorem)

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

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

Substituting (2) in eq (1)

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

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

Recall $dl = dy$

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

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

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

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

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

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

Therefore $(x^2+a^2)^{1/2} = a$, $a \to \infty$

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

$$\left\{ \boxed{B = \frac{\mu_0 I}{2\pi r}} \right\}$$