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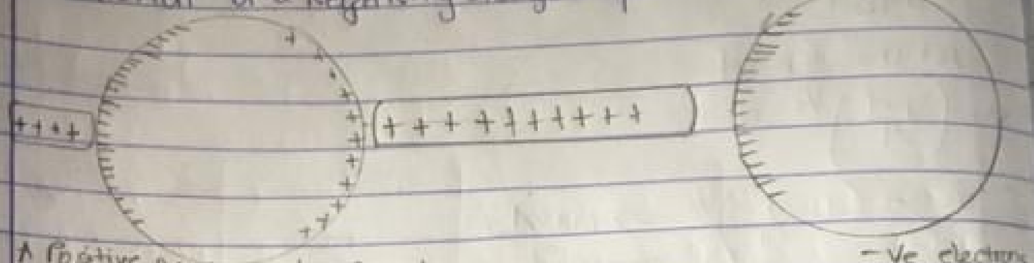
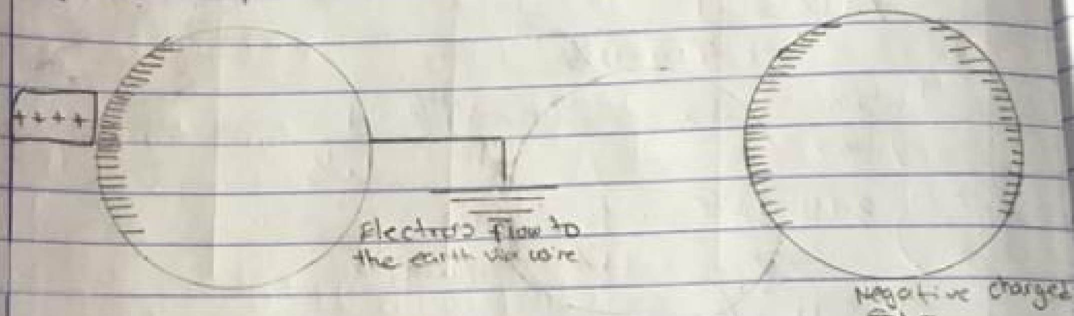
Matric number: 19/mh001/055
Course code: Phy 102

1. Production of a Negativity charged sphere by Induction





b. $K = 9\times10^{9}\ Nm^{-2}C^{-1}$, $F = 1.0N$, $r = 2.0m$

solution

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

$F = \frac{Kq_1q_2}{r^2}$

$1 = \frac{9\times10^{9}(q_1q_2)}{2^2}$

$\frac{4}{9\times10^{9}} = \frac{9\times10^{9}(q_1q_2)}{9\times10^{9}}$

$q_1q_2 = 4.44\times10^{-10}$ ---- (2)

from eqn (1)

$q_2 = 5\times10^{-5} - q_1$ --- (3)

substitute eqn (3) into (2)

$q_1(5\times10^{-5} - q_1) = 4.44\times10^{-10}$

$5\times10^{-5}q_1 - q_1^2 = 4.44\times10^{-10}$

$-q_1^2 + 5\times10^{-5}q_1 - 4.44\times10^{-10} = 0$ $(\times(-))$

$\therefore q_1^2 - 5\times10^{-3} q_1 + 4.44\times10^{-10} = 0$

Using Quadratic formula

$$q_1 = \frac{-(-5\times10^{-5}) \pm \sqrt{(-5\times10^{-5})^2 - 4(1)(4.44\times10)^{-10}}}{2(1)}$$

$$q_1 = \frac{5\times10^{-5} \pm \sqrt{2.5\times10^{-9} - 1.776\times10^{-9}}}{2}$$

$$q_1 = \frac{5\times10^{-5} \pm \sqrt{7.24\times10^{-10}}}{2}$$

$$\cancel{q_1} = \frac{5\times10^{-5} \pm 2.69\times10^{-5}}{2}$$

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

from eq^n (3)

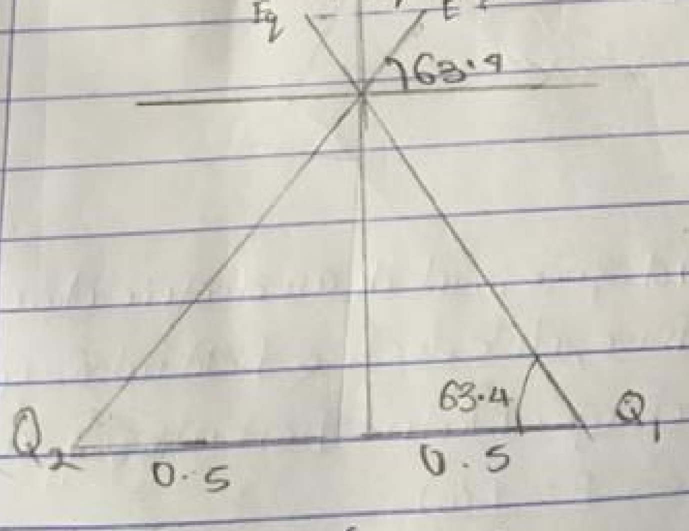
$\cancel{q_2}\ q_2 = 5\times10^{-5} - 3.84\times10^{-5}$

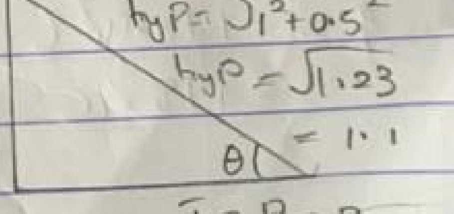
$= 1.16\times10^{-5}\,C$

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

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

c $Q_1 = Q_2 = 8\mu C,\ d = 0.5m$





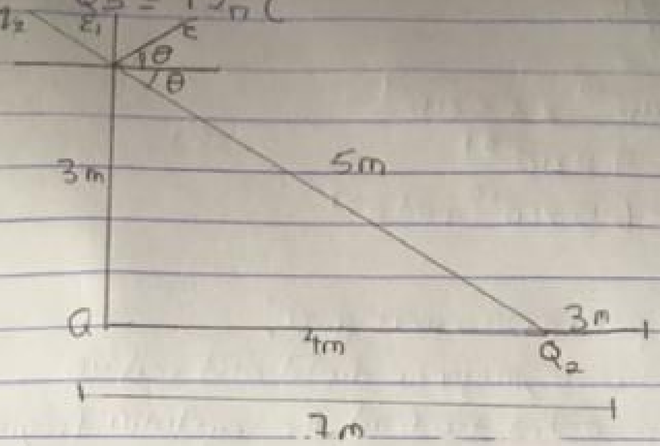
$\tan\theta = 2$

$\tan^{-1}(2) = 63$

$E_p = E_{q_1} + E_{q_2} + E_q \qquad = 59504\,NC^{-1}$

$$E_{q_1} = Kq = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2}$$

b $Q_1 = 8nC$, $Q_2 = 12nC$



1 $E_{net} = EQ_1 + EQ_2$

$EQ_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\ NC^{-1}$

$EQ_2 = \frac{kQ_2}{r_2^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32NC^{-1}$

$E_{net} = 8+12$
$= 20N/C$

Vector	Angle	x-comp	y-comp
$E_1 = 8N/C$	90^0	$E_1x = 8\times\cos 90$ $= 0$	$E_1y = 8\sin 90 = 8$
			$E_2y = 9.32\sin 36.9$ $= 2.59$
		$Efx = -3.45$	$Ef_y = 10.54$

4 Magnetic flux through a surface is the surface integral of the normal component of the magnetic field flux density passing through that surface. The S.I unit weber. It is represented by the symbol.

b. $m_e = 9\times10^{-31}kg$, $r = 1.4\times10^{-7}m$, $B = 3.5\times10^{-1}\ wbm^{-2}$
$\theta = 90^0$; $w = ?$, $q = -1.6\times10^{-19}C$

$$E_{q2} = \frac{kq_2}{r_2^2} = \frac{9\times10^9 \times 8\times10^{-6}}{r_2^2} = 59504\,NC$$

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

Vector	Angle	x-Component	y-Component
$E_{q1} = 59504$	63.4°	$59504\cos 63.4 = 26643.46$	$59504\sin 63.4 = 53205.75$
$E_{q_2} = 59504$	63.4	$59504\cos 63.4 = 2643.46$	$59504\sin 63.4 = 53205\,NC^{-1}$
$E_q = 9\times10^9$	90°	$9\times10^9\cos 90 = 0$ $Efx = 0$	$9\times10^9 q\sin 90 = 9\times10^9$ $Ef = 106410 + 9\times10^9 q$

$$E_p = \sqrt{0^2 + (106410 + 9\times10^9 q)^2}$$

$$E_p = 106410 + 9\times10^9 q$$

At $E_p = 0$

$$106410 + 9\times10^9 = 0$$

$$\frac{9\times10^9}{9\times10^9} = \frac{-106410}{9\times10^9}$$

$$q = -1.18\times10^{-5}C$$

$$= 1.18\,\mu C$$

2- Electric field is a region of space in which an electric charge will experience an electric force, while electric field intensity is defined as the force per unit charge. Electric field intensity can be expressed mathematically as $E = \frac{F(N)}{q_0(C)}$

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

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

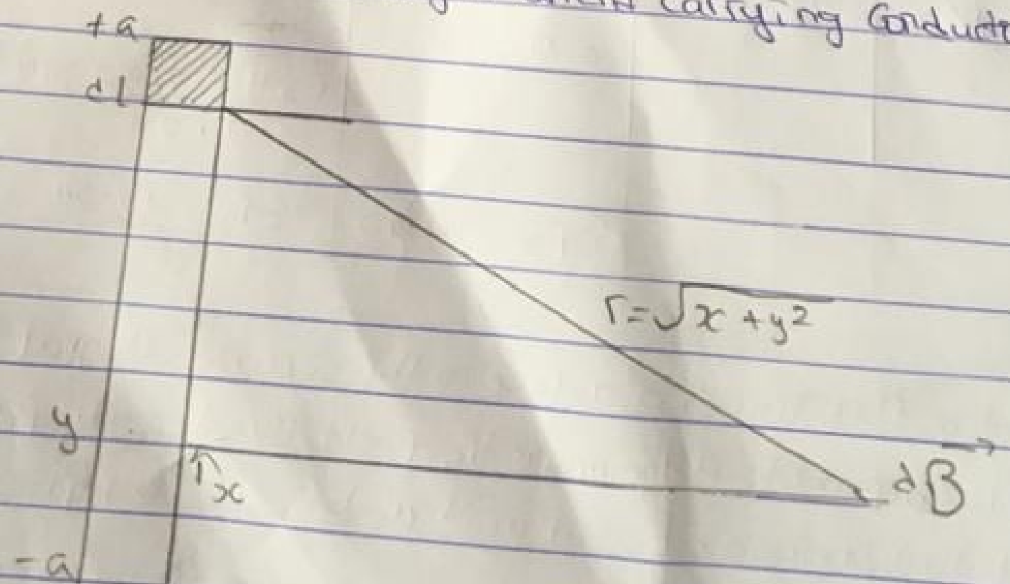
$$= -6.15\times10^{10}\ rads^{-1}$$

c. The same parameters were given;
Mass of electron, magnetic field and radius
We were asked to find the cyclotron frequency which equal or the same thing as angular speed.

$$\text{Angular speed } (\omega) = v/r = \frac{qB}{m}$$

5. Biot - Savart law states that the magnetic intensity at any point due to a steady current in an infinitely long straight wire is directly proportional to the current and inversely proportional to the distance from point to wire.

b. Magnetic field of a straight current carrying Conductor



Applying the Bios-Savart law, we find the magnitude if the field dB

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

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

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

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

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

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

substitute eqn (2) into (1)

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

Recall $dl = dy$

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

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

Using seperate integrals

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

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

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

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

When the length $2a$ of the conductor is very great in comparison to its distance x from point P, we consider it infinitely long i.e, when a is much larger than x; $(x^2+a^2)^{1/2} = a$ as $a \to \infty$

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