5a) Biot-Savart law states that the magnetic field is directly proportional to the product permeability of free Space (μ), the Current (I), the Change in length, the radius and inversely proportional to Square of radius (r^2). It Can be represented mathematically by;

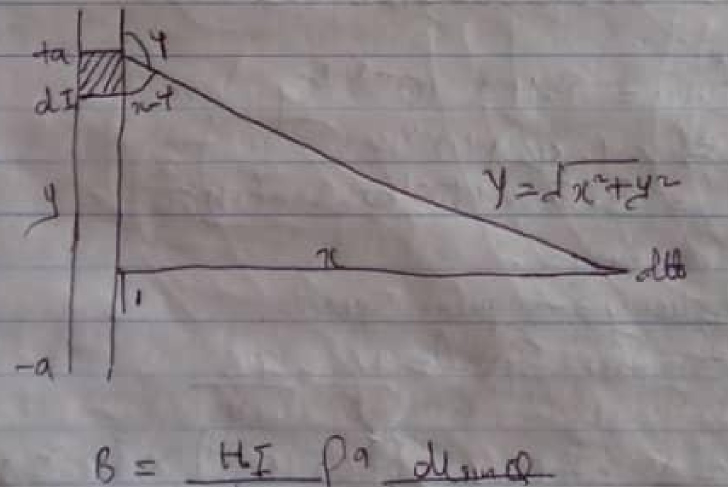
$$d.B = \frac{\mu_0}{4\pi}\frac{I\,dL \times r}{r^2}$$

Where μ_0 is a Constant Called permeability of free Space

$$\mu_0 = 4\pi \times 10^{-7}\ H/m$$

The Unit of B = weber/m²

5b) Magnetic field of a Straight Current Carrying Conductor



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

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

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

from diagram $r^2 = x^2+y^2$ (pythagoras theorem)

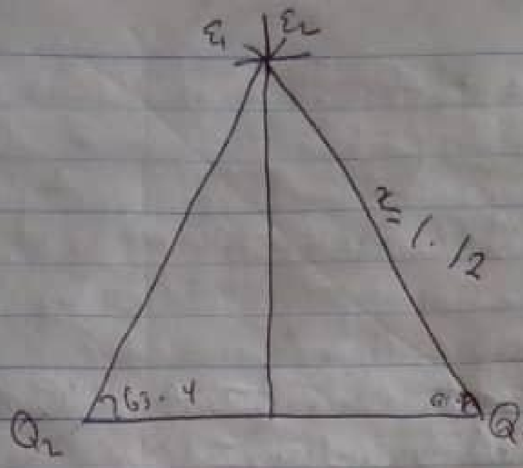
$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a}\frac{dl\sin(\pi-\theta)}{x^2+y^2} \quad \text{----} (*)$$

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

In a physical situation, we have axial symmentry about the y-axis. thus, at all points in a circle of radius, r, around the conductor, the magnitude of B is

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{----} (1)$$

Equation (1) defines the magnitude of the magnetic field of flux density B near a long, straight current carrying conductor



$x^2 = 1^2 + 0.5^2$
$\sqrt{x^2} = \sqrt{1.25}$
$x = 1.12$

$d = 0.5 \quad r = d = 0.5 \quad Q_1 = 8 \times 10^{-6} C$

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

$\tan\theta = \frac{1}{0.5} = 2$

$\tan^{-1}(2) = 63.4$

$$\varepsilon_1 = \frac{kq_1}{r_1^2} = \frac{(9 \times 10^9) \times (8 \times 10^{-6})}{(1.12)^2}$$
$$= 5739.79518$$

$$\varepsilon_2 = \frac{kq_1}{r^2} = \frac{(9 \times 10^9) \times (8 \times 10^{-6})}{(1.12)^2}$$
$$= 5739.795918$$

$$\varepsilon_q = \frac{kq}{r^2} = \frac{(9 \times 10^9) \times q}{1} = 9 \times 10^9 q$$

Vector	angle	x - Comp	y - Comp
$\varepsilon_1 = 5739.795918$	63.4	$\varepsilon_1 \times \cos\theta = 2570.045785$	5132.262839
$\varepsilon_2 = 5739.795918$	63.4	2570.045785	5132.262839
$\varepsilon_q = 9 \times 10^9 q$	90°	$\varepsilon_q \cos\theta = 0$	$9 \times 10^9 q$
		$\varepsilon_x = 0$	$\varepsilon_y = 10264.52568$

$$\text{Magnitude} = \sqrt{(\varepsilon_x)^2 + (\varepsilon_y)^2}$$
$$\varepsilon_q = \sqrt{(0)^2 + (10264.52568)^2}$$

Since $\varepsilon_x = 0$

$$0 = (9 \times 10^9 q) + (10264.52568)$$

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

Substituting ( ) ( )

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

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

Recall $dl = dy$

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

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

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 ( ) therefore becomes.

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

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

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

When the length $2a$ of the conductor is very great in comparison to its distance x from point P, we consider it infinitely long. That is, when a is much larger than x

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

Making q subject of formulae

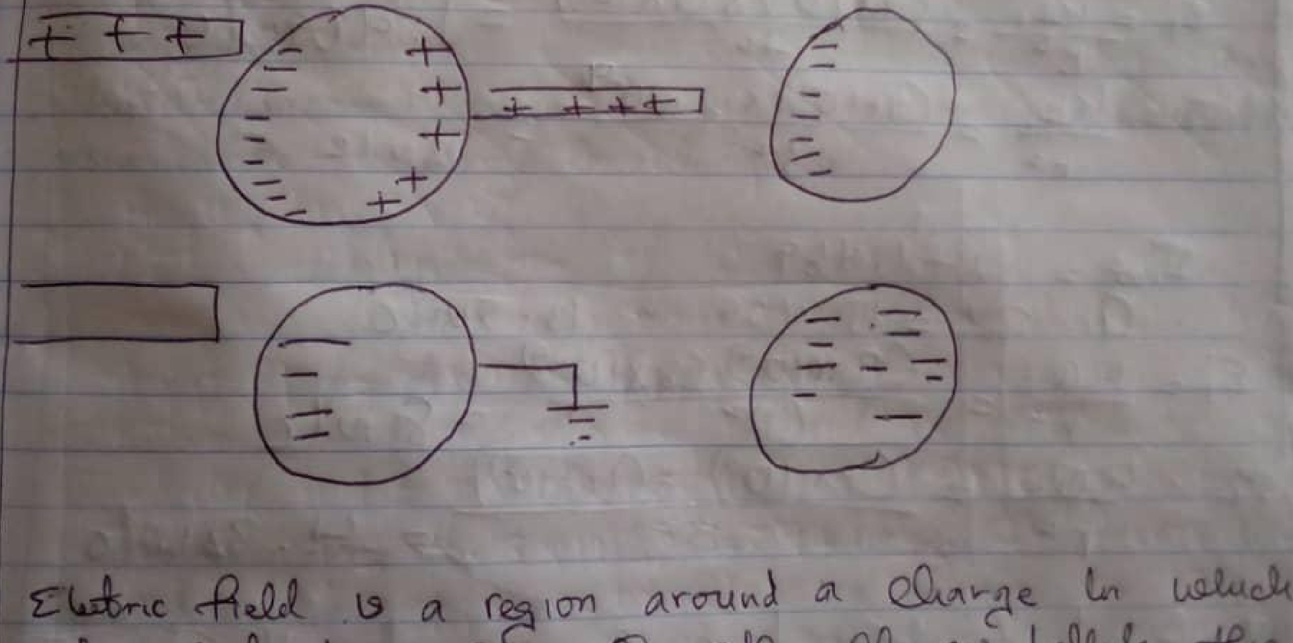
$$q = \frac{10264.52568}{9 \times 10^{9}}$$

$$q = 1.140502853 \times 10^{-6}$$

$$q = 11.44C$$

(c) Charging by Induction

Electric Charges can be obtained on an object without touching it, by a process called electrostatic Induction



3) Electric field is a region around a charge in which it exerts electrostatic force on other charges. While the strength of electric field at any point in space is called electric field intensity. It is a vector quantity. Its unit is NC^{-1}

Name:- Folorin Faith Tunmise
DEPT:- MBBS
Course Code:- PHY 102
Matric no:- G/MH501/174

(2) ~~Charging By Induction:-~~
~~Electric charges Can be obtained On an Object without touching it, by a process Called electrostatic Induction.~~

(3) $K = 9 \times 10^9$
$q_1 + q_2 = 5 \times 10^{-5} C$
$F = 1N$
$d = 2m$
Calculate the charge On each Sphere
Recall; $K = 9 \times 10^9$
$F = \frac{K q_1 q_2}{r^2}$
$1 = \frac{9 \times 10^9 \times (q_1 q_2 \times 5 \times 10^{-5})}{2^2}$
$4 = 9 \times 10^9 \times 5 \times 10^{-5} q_1 + 9 \times 10^9 q_2$
$4 = 4.5 \times 10^5 q_1^2 + 9 + 10^9 q_2$
$q_1 = 0.000011C$
$q_2 = 0.000038C$
$\therefore q_1 = 1.1 \times 10^{-5} C$
$\therefore q_2 = 3.8 \times 10^{-5} C$

(4)
(5) $Q_1 = Q_2 = 8\mu C$
$d = 0.5m$
determine Q if electric field at point P is zero

Section B

1a) Magnetic flux is defined as the strength of the magnet which can be represented by the line of force. It is represented by the symbol Φ. Mathematically given as $\Phi = \Phi dA$

1b) $m = 9 \times 10^{-31} kg$

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

$B = 3.5 \times 10^{-1}$ weber/m²

Cyclotron frequency = angular speed

$$\omega = \frac{v}{r} = \frac{qB}{m}$$

$$\omega = \frac{qB}{m} = \frac{(1.6 \times 10^{-19}) \times (3.5 \times 10^{-1})}{9 \times 10^{-31}}$$

$$\omega = 62222222222.222227^{-1}$$

1c) mass of electron = $9.11 \times 10^{-31} kg$

⊥ radius of $1.4 \times 10^{-4} m$

magnetic field = 3.5×10^{-1} weber/m²

Cyclotron frequency = ?

Cyclotron frequency = Angular speed.

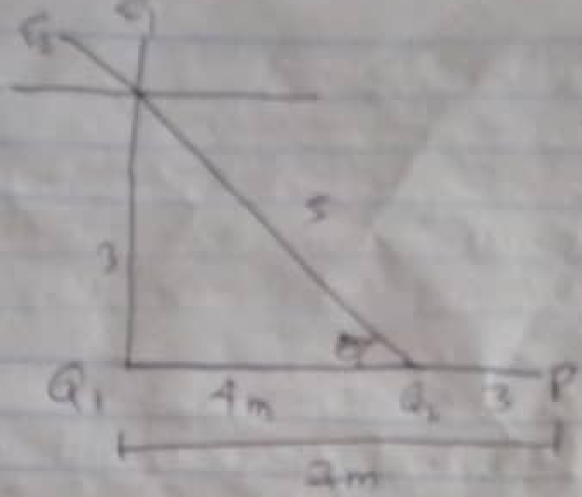
Recall; Angular Speed = $\frac{v}{r} = \frac{qB}{m}$

$$w = \frac{v}{r} = \frac{qB}{m} = \frac{(1.6 \times 10^{-19}) \times (3.5 \times 10^{-1})}{(9.11 \times 10^{-31})}.$$

$$\frac{qB}{m} = 62222222222.222227^{-1}$$

So since cyclotron frequency is equal to angular speed, the cyclotron frequency is equal to 62222222222.222227^{-1} having unit as $^{1}/_{T}$ which is equal to the unit of frequency dimension.

2a)



$\tan\theta = opp/adj$

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

$\theta = 36.9°$

$E_{net} = E_1 + E_2$

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

$E_2 = \frac{kq_2}{r^2} = \frac{(9\times10^9)\times12\times10^{-9}}{3^2} = 12 N/C$

$E_{net} = 12 + 1.469$

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

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

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

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
		$E_x = -3.45$	$E_y = 10.59$

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

$= 11.14 N/C$

$E_{net} = 11.14 N/C$