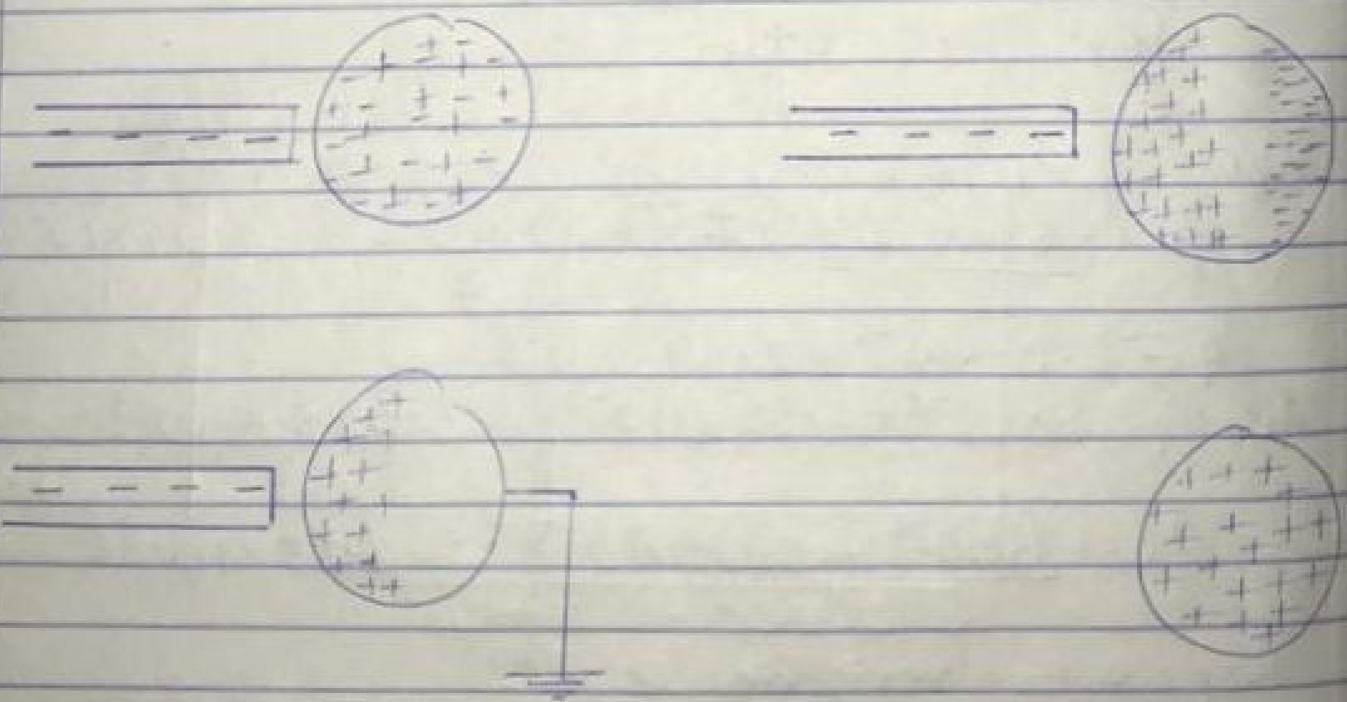
Name: PAPKA DIJA YUSUFU PHY 102 assignment
Matric number: 19/MHS01/381
Department: MBBS (Medicine and surgery)

1 Charging by Induction

Consider a negatively charged rod brought near a neutral (Uncharged) conducting sphere that is insulated and that there is no conducting path to the ground as shown below. The repulsive force between the electrons in the rod and those is the sphere causes a redistribution of charges on the path far away from the rod. The region of the sphere nearest the negatively charged rod has an excess of positive charge because of the migration of electrons away from the sphere. If a grounded conducting wire is then connected to the sphere as in some of the electrons leave the sphere and travel to the earth. If the wire to the ground is then removed, the conducting sphere is left with an excess of induced positive charge. Finally, when the rubber rod is removed from the sphere. The induced positive charge remains on the ungrounded sphere and becomes uniformly distributed on the surface of the sphere



1) $q_1 + q_2 = 50 \times 10^{-5}C$, $q_1 = 5.0 \times 10^{-5}C - q_2$

$F = 1.0N$

$r = 2.0m$

$K = 9 \times 10^4 \, Nm^2/C^2$

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

$$\Rightarrow 1.0 = \frac{9 \times 10^4 (q_1q_2)}{(r)^2}$$

$$4 = 9 \times 10^4 (q_1q_2)$$

$$q_1q_2 = \frac{4}{9 \times 10^4}$$

$$q_1q_2 = 4.44 \times 10^{-10}$$

Recall $q_1 = 5.0 \times 10^{-5}C - q^2$

Subst equation (1) into (2)

$$(5.0 \times 10^{-5} - q^2)\, q_2 = 4.44 \times 10^{-10}$$

$$5.0 \times 10^{-5} q - q_2 = 4.44 \times 10^{-10}$$

$$q_2 - 5.0 \times 10^{-5} q - 4.44 \times 10^{-10} = 0$$

Using $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

When $a = 1$, $b = 5.0 \times 10^{-5}$ $c = 4.44 \times 10^{-10}$

$$q = \frac{(-5.0 \times 10^{-5}) \pm \sqrt{(-5.0 \times 10^{-5})^2 - (4.44 \times 10^{-10})}}{2(1)}$$

$$q = 5.0 \times 10^{-5} + 2.69 \times 10^{-5}$$

For $q_1 = \frac{5 \times 10^{-5} + 2.69 \times 10^{-5}}{2} = 3.845 \times 10^{-5}C$

$$q_2 = \frac{5 \times 10^{-5} - 2.69 \times 10^{-5}}{2} = 1.15 \times 10^{-5}C$$

Replacing values into eqn (2)

$q_1 = 5.0 \times 10^{-5} - 3.845 \times 10^{-2}C = 1.15 \times 10^{-5}C$

$q_2 = 5.0 \times 10^{-5} - 1.15 \times 10^{-5}C = 3.845 \times 10^{-5}C$

$q_1 = 1.15 \times 10^{-5}C$, $q_2 = 3.845 \times 10^{-5}C$

C $E_1 = \frac{Kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1\cdot1^2} = 5\cdot9\times10^4$

$E_2 = \frac{Kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1\cdot1^2} = 5\cdot9\times10^4$

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

Vector	Angle	X-component	Y-component
$E_1 = 5\cdot9\times10^4$	$63\cdot4°$	$-2\cdot6\times10^4$	$5\cdot3\times10^4$
$E_2 = 5\cdot9\times10^4$	$63\cdot4°$	$2\cdot6\times10^4$	$5\cdot3\times10^4$
$E_q = 9\times10^9 q$	$90°$	0	$9\times10^9 q$
		$\lvert E_x\rvert = 0$	$\lvert E_y\rvert = 1.0\times10^5 + 9\times10^9 q$

$|E| = \sqrt{(E_x)^2 + (E_y)^2} = \sqrt{(0)^2 + (1\cdot0\times10^5)^2 + (9\times10^9 q)^2}$

$|E| = \sqrt{(1\cdot0\times10^5)^2 + (9\times10^9 q)^2}$

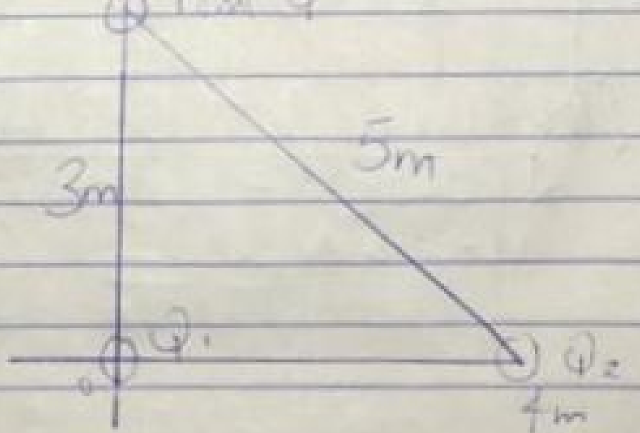
$|E| = 1\cdot0\times10^5 + 9\times10^9 q$

$0 = 1\cdot0\times10^5 + 9\times10^9 q$

$q = \frac{-1\cdot0\times10^5}{9\times10^9} = 1\cdot1\times10^{-5}C$

2 An electric field is a region of space in which an electric charge will experience an electric force while an electric field intensity can be defined as the force per unit charge

b)



Section B

4a) Magnetic flux is defined as the strength of the magnetic ~~flit~~ field represented by lines of force. It is represented by the symbol ϕ

b) $m = 9.1 \times 10^{-3} kg$, $r = 1.4 \times 10^{-7} m$, $B = 3.5 \times 10^{-1} m$
$q = 1.6 \times 10^{-19} C$

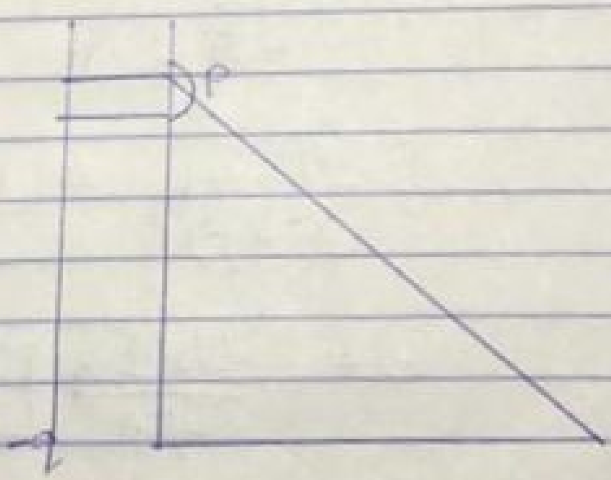
Cyclotron frequency $f = \frac{qB}{m}$

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

$$f = 6.147 \times 10^{10} rad/s$$

5 Biot-savart law state that the magnetic intensity of any point due to a steady current flow in an infinitely long straight wire is directly proportional to the current and inversely proportional to the distance from ~~that~~ the wire

Magnetic field of a straight current carrying conductor



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

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

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

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

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

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

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

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

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

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

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

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

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

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$\Rightarrow 1.0 = \frac{9 \times 10^{9} (q_1 q_2)}{(r)^2}$

$4 = 9 \times 10^{9} (q_1 q_2)$

$q_1 q_2 = \frac{4}{9 \times 10^{9}}$

$q_1 q_2 = 4.44 \times 10^{-10}$

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$q_1 = 1.15 \times 10^{-5} C$, $q_2 = 3.845 \times 10^{-5} C$

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

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

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

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

$$B = \frac{\mu_0 I}{2\pi x} \quad - (5)$$

(5) defines the magnitude of the magnetic field of the density B near a long straight conductor