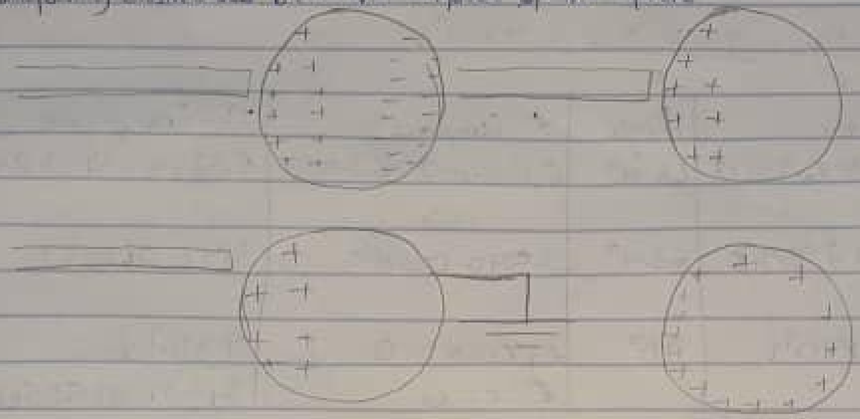
Adeola Kareemat Adeyinka
Medicine and Health science
Pharmacy
19/MHS11/1008
Phy 102.

1) The induced positive charge remains on the ungrounded sphere and becomes uniformly distributed over the surface of the sphere



2) $K = 9 \times 10^9$

$q_1 + q_2 = 5 \times 10^{-5}C$

$F = 1N$

$d = 2m$

Charge On each sphere = ?

$$F = \frac{Kq_1 q_2}{r_2}$$

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

$$4 = 9 \times 10^9 \times 5 \times 10^{-5} q_1 + 9 \times 10^9 q_2$$

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

Quadratic Equation

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

$q_1 = 0.0000111c \simeq 1.11 \times 10^{-5}C$

$q_2 = 0.000038c \simeq 3.8 \times 10^5 C$

c) $Q_1 = Q_2 = 8\mu C$

$d = 0.5m$

Q_1 If Electric field at a point P is zero

$$E_1 = \frac{kq_1}{r_2^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.9598$$

$$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.95918$$

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

Vector	Angle	X-Component	Y-Component
$E_1 = 57397.95918$	63.4°	$E_1 \cos\theta = 2570.045765$	$E_1 \sin\theta = 5132.262839$
$E_2 = 57397.95918$	63.4°	2570.045785	5132.262839
$E_q = 9\times\times10^9 q$	90°	$E_q \cos\theta = 0$	$9\times10^9 q$
		$\Sigma E_x = 0$	$\Sigma_y = 10264.52568$

$$\text{Magnitude} = \sqrt{(E_x)^2 + (E_y)^2}$$

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

Since $E_q = 0$

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

Making q subject of formula

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

$$q = 1.140502853\times10^{-16}$$

$$q = 11.4\mu C$$

Volume Charge density, $\rho = \frac{dQ}{dV}$ in $dQ = \rho dV$

Surface Charge density, $\sigma = \frac{dQ}{dA}$ in $dQ = \sigma dA$

Linear Charge density $\lambda = \frac{dQ}{dL}$ in $dQ = \lambda dL$

b) Electric potential difference is defined as the work done per charge against electrical forces when a charge is transported from one point to the other. Mathematically, it can be expressed as:

$$V = \frac{W}{q}$$

Where W = Workdone
q = Charge

Elemental workdone dw is given as:

$dw = F \cdot dL$ ...... (i)

But $F = -q_0 E$ ... (ii)

∴ Substituting eqn ii into i

$dw = -q_0 E dL$ ... (iii)

$W(A \to B)_{Ag} = -q_0 \int_A^B E dL$ ... (iv)

$\Rightarrow V_B - V_A = \frac{W(A \to B)_{Ag}}{q_0}$ .... (v)

∴ Putting eqn iv into v

$$V_B - V_A = -\int_A^B E dL$$

Where E = Electric field
A and B = Arbitrary points inside E

$Q_1 = 10 \mu C = 10 \times 10^{-6} C$

$Q_2 = -2 \mu C = -2 \times 10^{-6} C$

Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol Φ.

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

$r = 1.4 \times 10^{-9} m$

$B = 3.5 \times 10^{-1}$ weber/meter^2

Cyclotron frequency = angular speed

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

$\omega = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9 \times 10^{-31}}$ $\omega = 6.22 \times 10^{10}$ J^{-1}/l

4c) Mass of electron $= 9.11 \times 10^{-31} kg$

Radius $= 1.4 \times 10^{-7} m$

Magnetic field $= 3.5 \times 10^{-1}$ weber/meter^2

Cyclotron frequency can be called Angular Speed

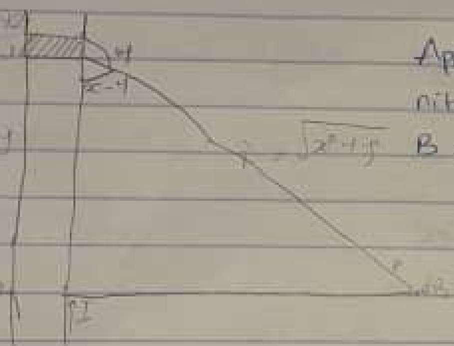
Recall that Angular Speed $\omega = \frac{v}{r} = \frac{qB}{m}$

Substituting we have $\omega = \frac{v}{r} = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}} = 6.22 \times 10^{10} T^{-1}/s$

So Cyclotron frequency $= 6.22 \times 10^{10} T^{-1}$ the unit is equal to unit of frequency dimensionally

5.) Biot Savart's Law is based on some set of observations for the magnetic field $d\vec{B}$ at a point P associated with a length element $d\vec{s}$ of a wire carrying a steady current I. It relates the magnetic field to the magnitude, direction, length and proximity of the electric current

b)



Applying the Biot-Savart law, we find the magnitude of the field $d\vec{B}$

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

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

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

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

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

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

Substituting (2) into (1)

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

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

Recall $dl = dy$

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

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

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 (3) therefore becomes

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

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

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

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

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

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

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{--- (4)}$$

Equation (4) defines the magnitude of the magnetic field (also called density) B near a long, straight current carrying conductor.