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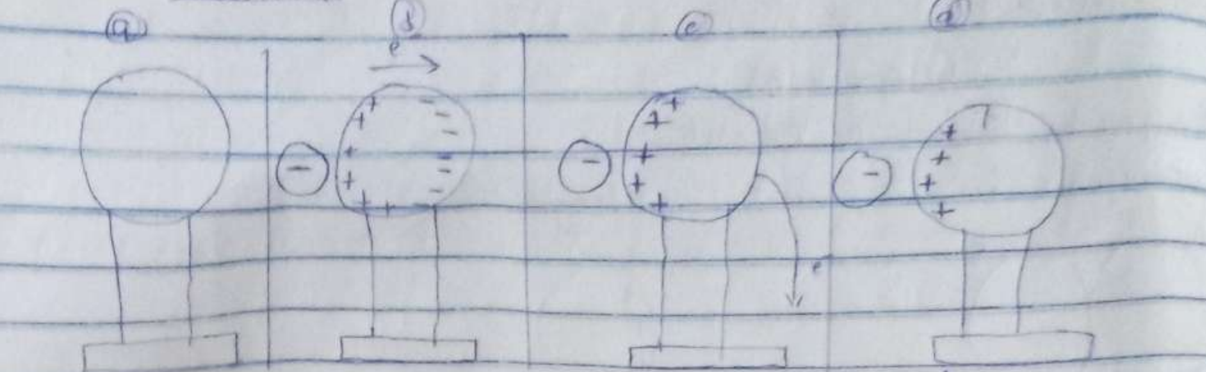
MAT NO:- 19/MHS02/082
COURSE:- PHY 102
DPTMNT:- NURSING.



(a) A metal sphere is mounted on a stand

(b) A balloon induces e^- movement from the left side to the right side of the balloon

(c) When touched, the e^- leave the sphere through the hand and enter the ground.

(d) The sphere is now charged positively with the excess charge attached to the balloon

(e)

The positive charge evenly distributes itself over the sphere.

(1b)

given: $q = 5.0\times10^{-5}C$ $q_1 = q_2 = 5.0\times10^{-5}C$. $k = 9\times10^9$, $F = 1.0N$

$d = 2.0m$.

Calculate the charge on each sphere.

$$F = \frac{kq_1q_2}{r^2} = \frac{(9\times10^9 \times 5.0\times10^{-5}\ q_1 q_2)}{2^2}$$

$$1.0 \times 4 = 9\times10^9 \times (5\times10^{-5} q_1 q_2)$$

$$4 = 9\times10^9 \times 5\times10^{-5} q_1 + 9\times10^9 q_2$$

$$4 = 4.5\times10^5 q_1 + 9\times10^9 q_2.$$

Using quatric equation:

$$9\times10^9 q_2 - 4.5\times10^5 q_1 + 4 = 0$$

$q_1 = 0.0000111C$

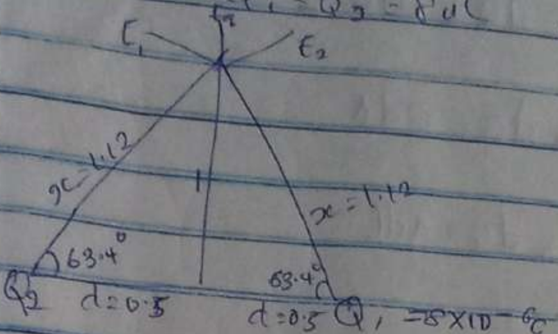
$q_2 = 0.000038C$

$\Rightarrow q_1 = 1.11\times10^{-5}C$

$\Rightarrow q_2 = 3.8\times10^{-5}C$

(1c)

Given: $Q_1 = Q_2 = 8\mu C$, $d = 0.5\,m$, $q = x$ $(P = 0)$



To get angle θ

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

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

$\therefore \theta = 63.4°$

Using pythagoras theorem

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

$= 1 + 0.25 = 1.25$

$x = \sqrt{1.25} = 1.12$.

$E_1 = \frac{kq_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.95918$

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

$E_q = kq/r^2 = 9\times10^9 \times q/1 = 9\times10^9 q$

Vector	~~Ang~~ Angle	x-Component	y-Component
$E_1 = 57397.95918$	63.4°	$E_1 x \cos\theta = 25700.46$	$E_1 y \sin\theta = 51322.65$
$E_2 = 57397.95918$	63.4°	$E_2 x \cos\theta = 25700.46$	$E_2 y \sin\theta = 51322.65$
$E_q = 9\times10^9 q$	90°	$E_q \cos\theta = 0$	$E_q \sin\theta = 9\times10^9 q$
		$\Sigma x = 0$	$\Sigma y = 102645.2$

Magnitude $= \sqrt{(\Sigma x)^2 + (\Sigma y)^2}$

$E_q = \sqrt{(0^2) + (102645.2)^2}$

Since $E_q = 0$

$0 = 9\times10^9 q + 102645.2$

$q = \frac{102645.2}{9\times10^9}$

$q = 1.1405\times10^{-5}$

$\approx q = 11.4\mu C$.

3

(103)

a) Volume Charge density $= \rho = \frac{dQ}{dV} \rightarrow dQ = \rho dV$

b) Surface charge density $= \sigma = \frac{dQ}{dA} \rightarrow dQ = \sigma dA$

c) Linear charge density $= \lambda = \frac{dQ}{dL} \rightarrow dQ = \lambda dL$

(3b)

Electric potential Difference between two points in an electric field Can be defined as the workdone per Unit charge against electrical force when a charge is transported from one point to the Other. It is measured in volt or Joules/Coulomb. Electric potential difference is a scalar quantity!

$dW = F \cdot dL$ ---- (1)

$F = -q_0 E$ ----- (2)

Substituting equation (2) in (1) yields

$dW = -q_0 E dL$ ---- (3)

Then total Workdone in moving the test charge from A to B is;

$W(A \rightarrow B)_{Ag} = -q_0 \int_A^B E dL$ --- (4)

From the definition;

$V_B - V_A = \frac{W(A \rightarrow B)_{Ag}}{q_0}$ ----- (5)

Put equation (4) in (5)

$V_B - V_A = \frac{-\cancel{q_0} \int_A^B E dL}{\cancel{q_0}} = -\int_A^B E dL$

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

4(a)

Magnetic flux:- this is defined as the strength of the magnetic field which Can be represented by line of forces. it is represented by the symbol ϕ. mathematically given as $\phi = B \cdot dA$

4(b)

Given:- $Me = 9.11 \times 10^{-31} kg$, $r = 1.4 \times 10^{-7} m$ $B = 3.5 \times 10^{-1}$ Weber/meter^2

cycloton frequency = angular speed.

$W = V/r = qB/m$

$W = qB/m = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9 \times 10^{-31}}$

$W = 6222222222.2222 T^{-1}$

(4c)

In the question, We were given parameters ;

i) mass of electron $= 9.11 \times 10^{-31} kg$ magnetic field $= 3.5 \times 10^{-1}$ weber/meter^2

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

To find the Cycloton frequency which is equal to angular speed, it is Called C.f because it is a frequency of an accelerator Called Cycloton.

Recall that angular speed is given as;

$W = V/r$

$W = 1.6 \times 10^{-10} \times 3.5 \times 10^{-1}$

$= 6222222222.22222 T^{-1}$

So, since Cycloton frequency is equal to angular speed the Cycloton frequency is equal to $= 6222222222.22222 T^{-1}$ having a Unit as $1/T$ which is equal to the Unit ~~of~~ frequency dimensionally.

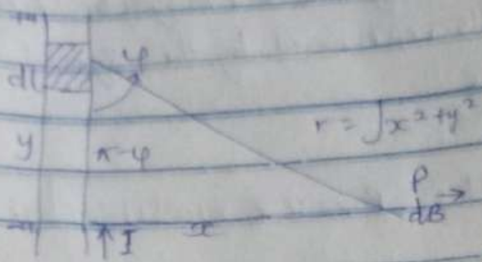
(5a)

Biot-savart law states that the magnetic flux 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). The mathematical expression is

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

Unit is Weber/meter^2

Magnetic field of a straight Current Carrying Conductor



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

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

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

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

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

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

Substitute eqn 2 into (1)

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

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

Recall $dL=dy$

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

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

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

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