UKWELA JOANNA IBEOJO

MBBS

19/MH301/418

Assignment

PHY102

4a Magnetic flux is defined as the strength of a magnet represented by lines of force. It symbol / it can be represented by ϕ

4b Charge, $q = -1.6 \times 10^{-19}$ C

$\theta = 90$

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

$\sin 90 = 1$

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

mass $= 9.11 \times 10^{-31}$ kg

Cyclotron frequency, $\omega = \frac{qB}{m}$

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

$= -6.15 \times 10^{10}$ rad/s

4c The Particle of mass, 9.11×10^{-31} is moving in ~~a~~ circle because its force is perpendicular to the velocity and

4c A/ The Particle with mass of 9.11×10^{-31} kg with charge -1.6×10^{-19} C which is perpendicular to the magnetic field 3.5×10^{-1} Tesla will move in a circular motion with a cyclotron frequency of 6.15×10^{10} rad/s

5

5a The Biot - savart Law is based of the following observation for magnetic field $d\vec{B}$ at point P, Length $d\hat{L}$ of a wire and steady current I.

i) The vector $d\vec{B}$ is perpendicular both to $d\hat{L}$ (which points in the direction of the current) and to the unit vector $\hat{r}$ directed from $d\hat{L}$ toward P ii The magnitude of $d\vec{B}$ is inversely proportional to r^2, where r is the distance from $d\hat{l}$ to P.

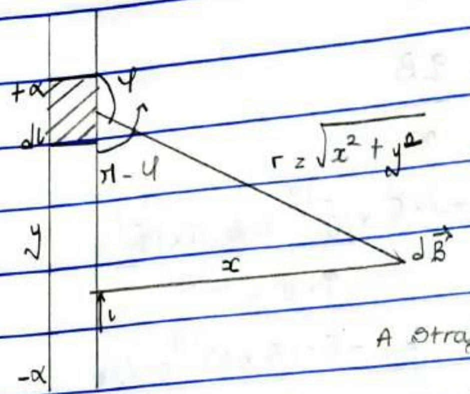
iii The magnitude of $d\vec{B}$ is proportional to the current I and to the magnitude of the length element $d\vec{l}$.

iv The magnitude of $d\vec{B}$ is proportional to $\sin\theta$, where θ is the angle between $\hat{r}$ and dl.

Biot - Savart Law

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

b



A straight current carrying conductor

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

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

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

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

From the diagram $r^2 = x^2 + y^2$

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

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

Substituting (ii) in (i)

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

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

Recall $dl = dy$

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

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

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(iii) becomes

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

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

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

when the length $2a$ of the conductor is very great in comparison to its distance x from B, it is considered infinitely long. That is, when a is much larger than x.

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

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

2a

Electric Field	Electric field intensity
This is a region of space in which an electric charge will ~~as~~ experience an electric force'	This is the force per unit charge

b $Q_1 = 8\mu C = 8 \times 10^{-9} C$

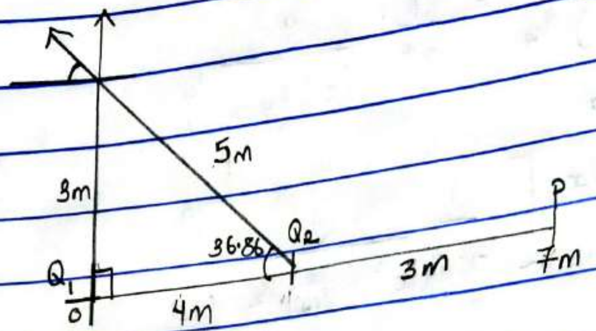
$Q_2 = 12nC = 12 \times 10^{-9}$

$x_1 = 4cm$

$\cos\theta = \frac{4}{5}$

$\theta = 36.86°$

1



1 The net electric field at point P on the x axis at x = 7m

$$E_1 = \frac{8 \times 10^{-19} \times 9 \times 10^9}{7^2}$$

$$= \cancel{1.46} = \cancel{1.49} = 1.459 N/C \simeq 1.46$$

$$E_2 = \frac{12 \times 10^{-9} \times 9 \times 10^9}{3^2}$$

$$= 12 N/C$$

$$E_{Net} = E_1 + E_2 = 12 + 1.46$$

$$= 13.46 N/C$$

$$= 13.5 N/C$$

2 $$E_1 = \frac{8 \times 10^{-19} \times 9 \times 10^9}{3^2} = 8 \times 1 = 8 N/C$$

$$E_2 = \frac{12 \times 10^{-9} \times 9 \times 10^{9}}{5^2}$$

$$= 4.32\ N/C$$

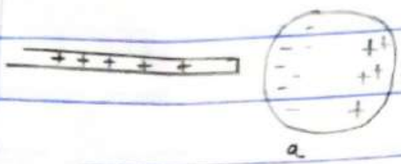
E	Angle	x-component	y-component
8 N/C	90°	$E_{x_1} = 8 \times \cos 90$	$E_{y_1} = \cancel{4.32}\ 8 \times \sin 90$
		$= 0 N/C$	$= 8\ N/C$
4.32 N/C	36.86°	$E_{x_2} = 4.32 \times \cos 36.86$	$E_{y_2} = 4.32 \times \sin 36.86$
		$= -3.45 N/C$	$= \cancel{10.58 N/C}\ 2.58\ N/C$
	Total	$E_x = -3.45 N/C$	$E_y = 10.58 N/C$

$$E = \sqrt{(-3.45)^2 + (10.58)^2}$$

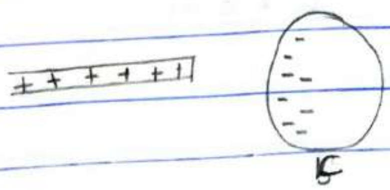
$$= \sqrt{123.8389}$$

$$E = 11.13\ N/C$$

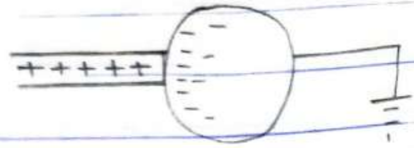
b Bring a positively charged rubber rod to a neutral conducting sphere that is isolated. The repulsive force between electrons in the rods and those in the sphere cause redistribution of charges in the sphere. The region close to the spher ~~who~~ would have excess negative charge, cause the positive charges would have moved from this location. Connect the sphere to a grounded conducting wire, some electrons leave the sphere and into the earth. Remove the wire and sphere is left with excess of induced negative charge, which later when the rod is removed become uniformly distributed in the sphere.



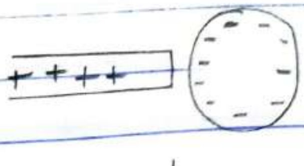
a



c



b



d

16 $q_1 + q_2 = 5\times10^{-5}C$ $\quad F = 1N$

$q_1 = 5\times10^{-5}C - q_2$ $\quad r = 2m$

$K = 9\times10^{9}$

$$F = \frac{KQ_1Q_2}{r^2}$$

$$q_1 q_2 = \frac{Fr^2}{K} = \frac{1\times4}{9\times10^9} = 4.44\times10^{-10}$$

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

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

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

Using algebraic famular

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

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

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

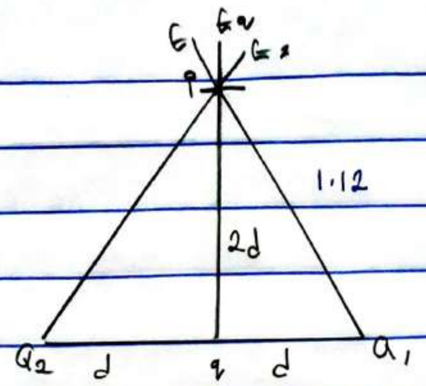
$$q_1 = 3.84\times10^{-5} \quad \text{or} \quad 1.15\times10^{-5}$$

$$q_2 = 5\times10^{-5} - 1.15\times10^{-5}$$
$$= 3.85\times10^{-5}$$

$q_1 = 1.15\times10^{-5}$

$q_2 = 3.85\times10^{-5}$ or vice-versa.

c



$d = 0.5$

$k = 9\times10^9$

$Q_1 = Q_2 = 8\mu C$

$\tan\theta = \frac{o}{a} = \frac{1}{0.5}$

$\theta = \tan^{-1}\left(\frac{1}{0.5}\right) = 63.43^\circ$

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

$E_1 = 57397.95918\ N/c$

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

Vector	Angle	x - component	Y - component
E_1: 57397.95918	63.43	-25673.58186	+51336.07808
E_2: 57397.95918	63.43	+25673.58186	+51336.07808

Total = E_x 0 , E_y = 102672.1562

$E_q = \sqrt{0^2 + (102,672.1562)^2}$

$E_q = 102672.1562$

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

$q = \frac{102,672.1562}{9\times10^9}$

$= 1.14 \times 10^{-5}$

$= 11.4\times10^{-6}\ C = \cancel{11.4\mu C}\ 11.4\mu C$