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19/MHS01/134
Phy 102 Assignment.

SECTION B

4a Magnetic Flux is defined as the number of magnetic field lines passing through a given surface area.

4b. $m = 9.11 \times 10^{-31} kg$ $r = 1.4 \times 10^{-7} m$ $\vec{B} = 3.5 \times 10^{-1}$ weber/m^2 $q = 1.6 \times 10^{-19} C$

ω = angular speed = cyclotron frequency

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

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

4c. The cyclotron frequency is 6.15×10^{10} rad/s. It is also known as angular speed. This is because the electron circulates at angular frequency in the type of accelerator called the cyclotron.

[5]

5a Biot Savart law: a statement in electromagnetism: the magnetic intensity at any point due to a steady current in an infinitely long straight wire is directly proportional to the current and inversely proportional to the distance from point to wire.

5b

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

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

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

$$r^2 = x^2 + y^2$$

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

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

Subtitutu

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

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

$dl = dy$

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

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

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

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

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

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

$(x^2+a^2)^{1/2} \cong a$ as a approches infinity

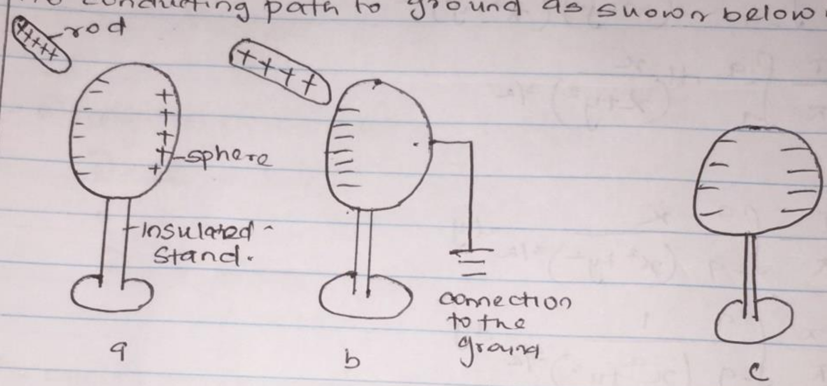
$$B = \frac{\mu_0 I}{2\pi x}$$

In physical situation, there is axial symmetry on the y-axis. Thus all points in a circle of radius around the conductor, The magnitude is $B = \frac{\mu_0 I}{2\pi r}$

∴ It defines the magnitude of the magnetic field of flux density B near along straight carrying conductor

SECTION A.

1a To produce a negative charged sphere ; you have to bring a positively charged rubber rod near a neutral conducting sphere that is insulated so that there is no conducting path to ground as shown below.



1b. $q_1 + q_2 = 5.0 \times 10^{-5} C$.

$F = 1N$ $\quad K = 9.0 \times 10^9$

$r = 2m$

$$F = \frac{K q_1 q_2}{r^2}$$

$$\cancel{1 = \frac{9.9 \times 10^{-5} \times (q_1 q_2)}{2^2}}$$

$$\cancel{4 = 9.9 \times 10^{-5} q_1 q_2}$$

$$1 = \frac{9.0 \times 10^9 \times (q_1 q_2)}{2^2}$$

$$\frac{4}{9.0 \times 10^9} = \frac{9.0 \times 10^9 (q_1 q_2)}{9.0 \times 10^{-9}}$$

$4.44\times10^{-10} = q_1 q_2$

$5.0\times10^{-5} = q_1 + q_2$.

$5.0\times10^{-5} - q_2 = q_1$

Subtitute

$(5.0\times10^{-5} - q_2)\times q_2 = 4.44\times10^{-10}$

$5.0\times10^{-5} q_2 - q_2^2 = 4.44\times10^{-10}$

$q_2^2 - 5.0\times10^{-5} q_2 + 4.44\times10^{-10} = 0$

$q_2 = 3.85\times10^{-5}$ or 1.15×10^{-5} C

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

$q_2 + q_1 \quad q_1 = 5.0\times10^{-5} - 3.85\times10^{-5}$

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

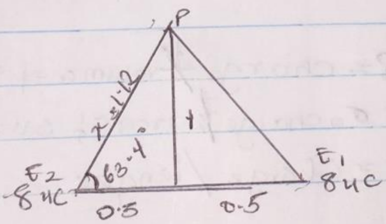
when $q_2 = 1.15\times10^{-5}$

$q_1 = 5.0\times10^{-5} - 1.15\times10^{-5}$

$q_1 = 3.85\times10^{-5}$ C //

1c $q_1 = q_2 = 8\mu C$

$d = 0.5m$



$\tan\theta = \frac{opp}{ady} = \frac{1}{0.5}$

$\tan\theta = 2$

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

$\theta = 63.4°$

using pythagoras theorem

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

$x^2 = 0.25 + 1$

$x^2 = 1.25$

$x = \sqrt{1.25}$

$x = 1.12$

$E_1 = E_2 = \frac{Kq_1}{r^2} = \frac{9.0\times10^9 \times 8\times10^{-6}}{(1.12)^2}$

$E_1 = E_2 = 57397.96$

$E_q = \frac{Kq_1}{r^2} = \frac{9.0\times10^9 \times q}{1} = 9.0\times10^9 q$

Vector	angle	x - comp	y - comp
$E_2 = 57397.96$	63.4	-25700.5	51322.6
$E_1 = 57397.96$	63.4	25700.5	51322.6
$E_q = 9.0\times10^9 q$	90°	0	$9.0\times10^9 q$
		$\Sigma x = 0$	$\Sigma y = 102645.2 + 9.0\times10^9 q$

$\text{magnitude} = \sqrt{0^2 + (102645.2 + 9.0\times10^9 q)^2}$

$0 = 102645.2 + 9.0\times10^9 q$

$\frac{9.0\times10^9 q}{9.0\times10^9} = \frac{-102645.2}{9.0\times10^9}$ $\quad q = 1.14\times10^{-5} C$ //

3

3a) Volume charge density = ρ = charge / volume of distribution q/v

(ii) Surface charge density = σ = charge / area of surface q/A

(iii) linear charge density = τ = Charge / lenght q/l

(3b) Electric potential difference can be defined as the workdone per unit charge against electrical forces when a charge is transported from one place to another.

$dW = F \cdot dl \quad \cdots (1)$

$F = -q \cdot E \quad \cdots (2)$

putting 2 in (1)

$dW = -q_0 E dL$

Total work done in moving a test charge from A to B

$$W(A \to B)_{Ag} = -q_0 \int_A^B E\,dL \quad \ldots 4$$

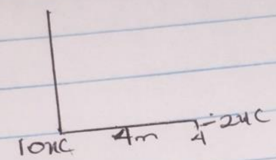
From the definition above

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

Putting Eq 4 in 5

$$V_B - V_A = \int_A^B E\,dl \quad //$$

3c $Q_1 = 10uC$ $Q_2 = -2uC$



$$V_p = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1 + Q_2}{r}\right]$$

$$0 = 9 \cdot 10^9 \left[\frac{10\times10^{-6} - 2\times10^{-6}}{r}\right]$$

$$0 = 9 \cdot 10^9 \left[\frac{8\times10^{-6}}{r}\right]$$