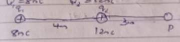
AJAYI BUKOLA PRECIOUS
NURSING
19/MHS 02/012
PHY 102 Assignment

SECTION A

2 a) Electric field: is a region of space in which an electric charge will experience an electric force. While Electric field Intensity can be defined as the force per unit charge. Mathematically, the magnitude of the field is given by: $E = \frac{F(N)}{q_0(C)}$. It is measured in (N/C)

b) $Q_1 = 8nC$ $Q_2 = 12nC$

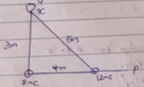


$E_{1P} = \frac{Kq_1 P}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469 N/C$

$E_{2P} = \frac{Kq_2 P}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12 N/C$

$E_{net} = (12 + 1.469) N/C$

$= 13.469 N/C$



$x^2 = 3^2 + 4^2$

$x = \sqrt{9+16}$

$x = \sqrt{25}$

$x = 5m$

$E_1 Q = \frac{Kq_1 P}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8 N/C$

$E_2 Q = \frac{Kq_2 P}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32 N/C$

Vector	Angle	x component	Y-component
E_1 Q	90°	0	8
$8\mu C$			
E_2 Q			
$4.22\mu C$	36.87°	3.456	2.592
		3.456	10.592

$$E_{Net} = \sqrt{3.456^2 + 10.592^2}$$
$$= 11.14 \mu C$$

3) a) volume charge density, $\rho = \frac{dQ}{dv} \Longrightarrow dQ = \rho dv$

b) surface charge density, $\sigma = \frac{dQ}{dA} \Longrightarrow dQ = \sigma dA$

c) linear charge density, $\lambda = \frac{dQ}{dl} \Longrightarrow dQ = \lambda dl$

b) Electrical Potential Difference

The 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 a scalar quantity. To move a test charge from A to B at constant velocity, an external force of $F = -q_0 E$ must act on the charge

$$\therefore dw = F dl$$

$$\text{But } F = -q_0 E$$

$$dw = -q_0 E dl$$

Total workdone in moving the test charge from A to B

$$W(A \to B)_{ag} = -q_0 \int_A^B E dl.$$

$$V_B - V_A = \frac{W(A \longrightarrow B)_{ag}}{q_0}$$

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

B. For point charge Q, to the left

$$V = \frac{kq}{r}$$

$$V_1 = \frac{K \times C(10\mu C)}{x}$$

$$V_2 = \frac{K \times (-24\mu C)}{4+x}$$

$$\frac{(10uc)k}{x} = \frac{(2uc)k}{4+x}$$

$$\frac{10uc}{x} = \frac{2uc}{4+x}$$

$$\frac{10}{x} = \frac{2}{4+x}$$

$$10(4+x) = 2x$$

$$40 + 10x = 2x$$

$$40 = 2x - 10x$$

$$40 = -8m$$

$$x = -5m$$

In between

$$V_1 = \frac{K_1 0}{x}$$

$$V_2 = \frac{K(-2)}{4-x}$$

where $V = 0$

$$0 = 40 - x - 2x_1$$

$$0 = 40 - 3x$$

$x = \frac{40}{3}$ Hence value is not between the points

To the Right

$$V_1 = \frac{10k}{x}$$

$$V_2 = \frac{2K}{x-4}$$

$$10(x-4) = 2x$$

$$10x - 40 = 2x$$

$$8x = 40$$

$$x = 5m$$

SECTION B

4a) Magnetic flux is the number of magnetic lines of forces set up in a magnetic circuit

b) Mass of electron $= 9.11 \times 10^{-27}$ kg

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

Mag field (B) $= 3.5 \times 10^{7}$ Wb/m^2

$$W = \frac{qB}{m_e}$$

$$W = \frac{1.60 \times 10^{-19} \times 3.5 \times 10^{7}}{9.11 \times 10^{-31}}$$

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

c) The angular speed is often regarded to as the cyclotron frequency because the charge particle (electron) travel round a circular orbit with an angular speed of 6.147×10^{10} radian per second

5)a) Biot - Savart law

- The vector $\overrightarrow{dB}$ is perpendicular both to dl (which points in the direction of the current and to the unit vector $\hat{r}$ directed from $\overrightarrow{dl}$ toward P
- The magnitude of $\overrightarrow{dB}$ is inversely proportional to r^2 where r is the distance from $\overrightarrow{dl}$ to P
- The magnitude of $\overrightarrow{dB}$ is proportional to the current I and the magnitude of the length element $\overrightarrow{dl}$
- The magnitude of $\overrightarrow{dB}$ is proportional to $\sin\theta$ where θ is the angle between $\hat{r}$ and $\overrightarrow{dl}$.

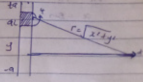
Mathematically, Biot - Savart law is expressed as

$$\overrightarrow{dB} = \frac{\mu_0 I \, \overrightarrow{dl} \times \hat{r}}{4\pi r^2}$$

where μ_0 is a constant called permeability of free space

$$\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}.$$

b Using Biot - Savart law



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

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

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

From the above diagram

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

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

From the above diagram

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

$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dL \sin(\pi - \psi)}{x^2 + y^2}$ —— (i)

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

Substituting (ii) into (i), we have

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

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

Recall $dL = dy$

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

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

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

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

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

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

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

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

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