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

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

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

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

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

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

Substituting $(**)$ into $(*)$ 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 $dl = dy$

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

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

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

Equation $(***)$ therefore becomes

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

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

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

$(x^2+a^2)^{1/2} \cong a$ as $a \longrightarrow \infty$

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

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

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

$x^2 = 9 + 16$

$\sqrt{x^2} = \sqrt{25}$

$x = 5m$

$\sin\theta = \frac{3}{5}$

$\theta = \sin^{-1} 3/5$

$\theta = 36.87^\circ$

$E_1 = \frac{kq_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-9}}{9} = 8N/C$

$E_2 = \frac{kq_2}{r_2^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32N/C$

Vector	Angle	x-comp	y-comp
$E_1 = 8N/C$	90°	$8\cos 90 = 0$	$8\sin 90 = 8$
$E_2 = 4.32N/C$	36.87°	$4.32\cos 36.87 = 3.455995$	$4.32\sin 36.87$
		3.455995	$\frac{= 2.592}{10.592}$

$E = \sqrt{\sum E_x^2 + \sum E_y^2} = \sqrt{3.455995^2 + 10.592^2}$

$E = 11.2N/C$

3a) Formulation of the following identities of charges.

(i) Volume Charge density, $\rho = \frac{dQ}{dV} \Rightarrow dQ = \rho dV$.

(ii) Surface charge density, $\sigma = \frac{dQ}{dA} \Rightarrow dQ = \sigma dA$.

(iii) Linear charge density, $\lambda = \frac{dQ}{dL} \Rightarrow dQ = \lambda dL$.

(b) Electric potential difference between two points in an electric field can be defined as the work done per unit charge against forces when a charge is transported from one point to the other.

We have different formulas depending on how the case may be.

(a) When the electric potential is in a uniform electric field

4a) Magnetic flux is defined as the strength of a magnetic field represented by the lines of force - It is represented by the symbol Φ

(b) $m_e = 9.11 \times 10^{-31}$ kg, $r = 1.4 \times 10^{-7}$ m, $B = 3.5 \times 10^{-1}$ Wb/m²
$\theta = 90^\circ$

$F_B = qvB\sin\theta$, where $\theta = 90^\circ$

$$F_B = qvB$$

$$F_B = \frac{mv^2}{r}$$

$$v = \frac{qBr}{m_e}$$

$$v = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1} \times 1.4 \times 10^{-7}}{9.11 \times 10^{-31}}$$

$$v = 8605.93 \text{ m/s}$$

Hence, the angular speed -

$$\omega = \frac{qB}{m_e} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}} = 6.147 \times 10^{10} \text{ rad/s}$$

(c) We were told to find the cyclotron frequency which is the angular speed. The formula was provided above and the values were slotted into the formula

5) State the Biot-Savart Law.

i) The vector $d\vec{B}$ is perpendicular both to $d\vec{l}$ (which points in the direction of the current) and to the unit vector $\hat{r}$ directed from $d\vec{l}$ toward P.

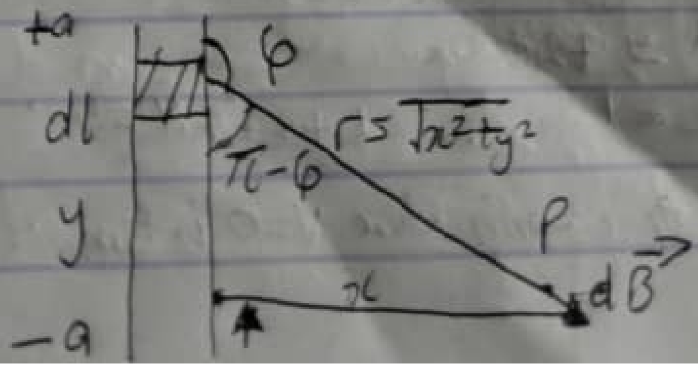
(ii) The magnitude of $d\vec{B}$ is inversely proportional to r^2.

(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 btw $\hat{r}$ and $d\vec{l}$

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

(b)



$$V_B - V_A = \frac{W_{(A \to B)}}{q_0}$$

(5) Electric potential difference is also the potential energy per unit charge

$$V_B - V_A = \frac{\Delta U}{q_0}$$

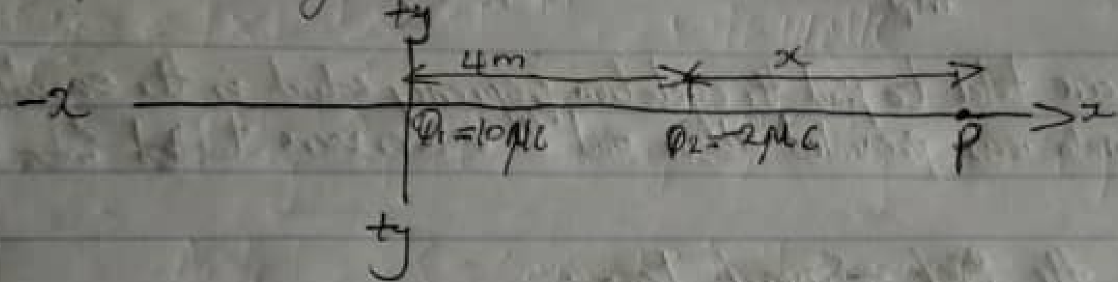
(6) We also have electric potential due to a single point charge

$$V_B - V_A = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

(7) We also have electric potential due to several point charges

$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2} + \frac{Q_3}{r_3} + \frac{Q_4}{r_4} \dots \frac{Q_n}{r_n}\right].$$

(E) $Q_1 = 10\mu C$ and $Q_2 = -2\mu C$ are along the x-axis at $x=0$ and $x=4m$ respectively. Find the position along the x-axis where $V=0$.



$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

Let $V_P = 0$

$$0 = 9\times10^{9}\left[\frac{10\times10^{-16}}{4+x} + \frac{(-2\times10^{-6})}{x}\right]$$

$$0 = \frac{9000}{4+x} - \frac{18000}{x}$$

multiply through by $(4+x)(x)$

$$(4+x)(x)0 = \frac{90000}{4+x}(4+x)(x) - \frac{18000}{x}(4+x)(x)$$

$$0 = 90000x - 18000(4+x)$$

$$0 = 90000x - 72000 - 18000x$$

$$72000 = 90000x - 18000x$$

$$72000 = 72000x$$

$$x = 1 \quad \therefore 4+x = 4+1 = 5$$

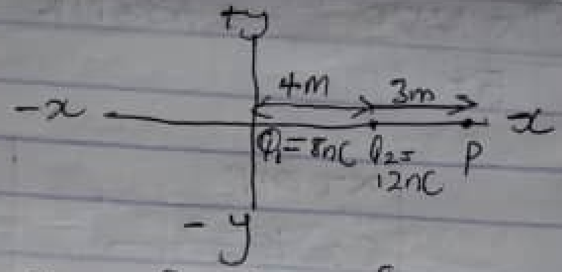
SO, the position along the x-axis where $V=0$ is 5m

-2
+3

Name: Ezekwueche Munachukwu Beholax.
Matric No: 19/MHS01/167.
Course Code: PHY102.
Department: MBBS.

2a An electric field is a region of space in which an electric charge will experience an electric force while electric field intensity E, can be defined as the force per unit charge.

(b) $Q_1 = 8nC$, $Q_2 = 12nC$ are on the x-axis at $x = 4m$. Find the net electric field at a point P on the x-axis at $x = 7m$.



$E_1 = \frac{kq_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.4694N/C$

$E_2 = \frac{kq_2}{r_2^2} = \frac{9\times10^9 \times 12\times10^{-9}}{9} = 12N/C$.

Vector	Angle	X-component	Y-component
$E_1 = 1.4694N/C$	0	$1.4694\cos 0 = 1.4694$	0
$E_2 = 12N/C$	0	$12\cos 0 = 12$	0
		13.4694	

$E = \sqrt{\sum E_x^2 + \sum E_y^2}$

$E = \sqrt{\sum E_x^2}$

$E = \sqrt{13.4694^2}$

$E = 13.4694\ NC$.

(ii) The electric field at point q on the y axis at $y = 3m$ due to the charges.