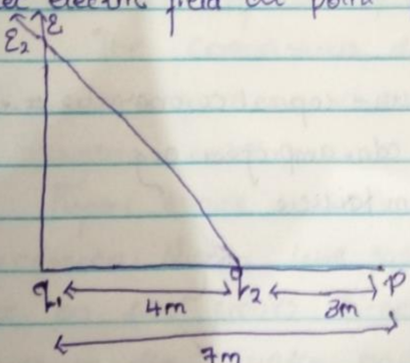
①

NAME: Aguokwu jennifer chidimma
Matric No: 19/mn/ca/112
Department: Medicine and surgery

2 Electric field is a region of space in which an electric charge will experience an electric force. while electric field intensity is the force per unit charge.

2b $q_1 = 8nC$ at origin, $q_2 = 12nC$ on x axis at $x = 4m$

(a) net electric field at point p on the axis at $x = 7m$



$$E_1 = \frac{KQ_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7^2}$$

$$= 1.46 \ N/C$$

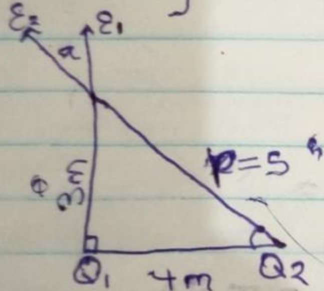
$$\simeq 1.5 \ N/C$$

- U

$$\mathcal{E}_2 = \frac{KQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12 \text{ N/c}$$

$$\mathcal{E}_{net} = \vec{\mathcal{E}_1} + \vec{\mathcal{E}_2} = (1.5 + 12)\text{ N/c} = 13.5 \text{ N/c}$$

b. Electric field at a point Q on the y axis at $y = 3m$ due to charge



$P^2 = 3^2 + 4^2$

$P^2 = 9 + 16$

$P^2 = 25$

$P = \sqrt{25}$

$P = 5$

$$\mathcal{E}_1 = \frac{KQ_1}{R^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2}$$

$$= 8 \text{ N/c}$$

$$\mathcal{E}_2 = \frac{KQ_2}{R^2} = \frac{9\times10^9 \times 1.2\times10^{-9}}{5^2}$$

$$= 4.32 \text{ N/c}$$

vector	angle	x-comp.	y-comp.
$e_1 = 8$ N/c	90°	0 N/c	8 N/c
$e_2 = 4.32$ N/c	36.9°	-3.45 N/c	2.59 N/c
		$\mathcal{E}f_x = -3.45$ N/c	$\mathcal{E}f_y = 10.59$ N/c

$$\mathcal{E}_{net} = \sqrt{\mathcal{E}F_x^2 + \mathcal{E}F_y^2}$$
$$= \sqrt{(-3.45)^2 + (10.59)^2}$$
$$= \sqrt{11.90 + 112.15}$$
$$= \sqrt{} = 11.13 \text{ N/C}$$

3 Formation of identities of charge

a) volume charge density $\cdot \rho$

$$= \frac{dQ}{dv} = dQ = \rho \, dv$$

b Surface charged density $\sigma =$

$$= \frac{dQ}{dA} = dQ = \sigma \, dA$$

c Linear charged density $dQ/dL = dQ = \lambda \, dL$

3b electric potential difference equation

• due to a single point charge

$$V_B - V_A = \frac{Q}{4\pi\mathcal{E}_0}\left[\frac{1}{R_B} - \frac{1}{r_A}\right]$$

Where V = eletric potential

Q = point charge.

R_A = distance of Q to point B

R_B = distance of Q to point A

- due to several point charges

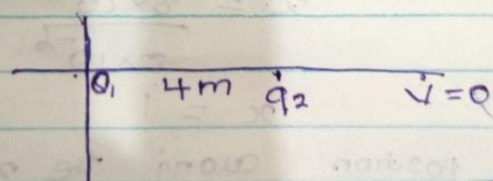
$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

Where V. electric potential

Q. point charge

r. distance of Q

3c) point charge $Q_1 = 10\mu C$, $Q_2 = -2\mu C$ along x axis $x = 0$, $x = 4m$ respectivery Find the position along the x axis where $V = 0$



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

recall $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 k$

$$V_P = K\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

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

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

$$0 = \frac{10\times10^{-6}}{4+x} + \frac{-2\times10^{-6}}{x}$$

$$\frac{2\times10^{-6}}{x} = \frac{10\times10^{-6}}{4+x}$$

$$10\times10^{-6}(x) = 2\times10^{-6}(4+x)$$

$$10\times10^{-6}x = 8\times10^{-6} + 2\times10^{-6}x$$

$$10\times10^{-6}x - 2\times10^{-6}x = 8\times10^{-6}$$

$$8\times10^{-6}x = 8\times10^{-6}$$

$$x = \frac{8\times10^{-6}}{8\times10^{-6}}$$

$$x = 1$$

$\therefore$ position along the x axis is 1m.

Where $V=0$

$$V = K\left[\frac{Q_1}{R_1} + \frac{Q_2}{R_2}\right]$$

$$\therefore 0 = \left[\frac{10\times10^{-6}}{4-x} + \frac{-2\times10^{-6}}{x}\right]\hat{j}$$

$$\frac{2\times10^{-6}}{x} = \frac{10\times10^{-6}}{x}$$

$$8\times10^{-6} - 2\times10^{-6}x = 10\times10^{-6}$$

$$8\times10^{-6} = 12\times10^{-6}x$$

$$x = \frac{8\times10^{-6}}{12\times10^{-6}}$$

$$x = 0.667\,m$$

$\therefore$ position of $V=0$ is $= 0.667\,m$

4a Magnetic flux is defined as the strength of a magnetic field which can be represented by line of Force. It is denoted as ϕ.

$$\phi = B \cdot dA$$

4b $M_e = 9.11\times10^{-31}\,kg$, $r = 1.4\times10^{-7}\,m$; $B = 3.5\times10^{-6}\,Wb/m^2$

cyclotron frequency = angular speed. $q = 1.6\times10^{-19}$

$$F_B = qVB = \frac{m_eV^2}{r}$$

$$M_eV^2 = qVBr$$

$$V = \frac{qBr}{M_e} = \frac{1.6\times10^{-19} \times 3.5\times10^{-1} \times 1.4\times10^{-7}}{9.11\times10^{-31}}$$

$$V = 8.6\times10^{3} m/s$$

$$\omega = \frac{V}{r} = \frac{qB}{M_e} = \frac{1.6\times10^{-19} \times 3.5\times10^{-1}}{9.11\times10^{-31}}$$

$$\omega = 6.14\times10^{10} S^{-1}$$

4c In 4b we were given, mass of electron = 9.11×10^{-31} kg radius = 1.4×10^{-7} meters, B = 3.5×10^{-1} w/m^2 as parameters and we were asked to find the cyclotron frequency which is same with the angular speed.

recall ω = angular speed

$$\omega = \frac{qB}{M_e}$$

the cyclotron frequency is 6.14×10^{10} having a unit of S^{-1}

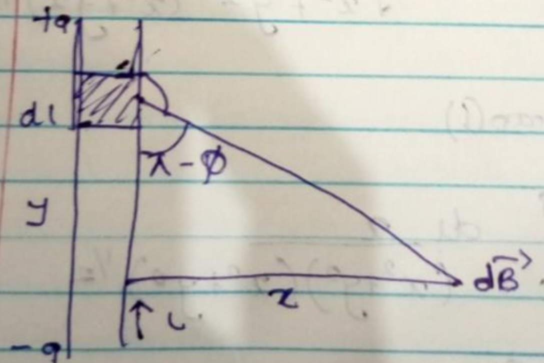
5a Biot - savart Law states that in electromagnetism the magnetic intensity at any point due to a stedy current in an infinitely long straight wire is directly proportional to the current and inversely proportional to the distance from point to wire.

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

Where μ_0 = Permeability of free space
$= 4\pi \times 10^{-7}$ T. M/A ; r = radius
$d\vec{B}$ = magnetic field
I = steady current
dl = length of wire
Unit is ω / m^2

(5b)

Magnetic field of a straight current carrying conductor



A section of a straight current carring conductor

Using Biot-savart law, we have

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

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

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

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

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

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

Substitute (ii) into (i)

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

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

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

(10)

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

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

$$(x^2+a^2)^{1/2} = a = \infty$$

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