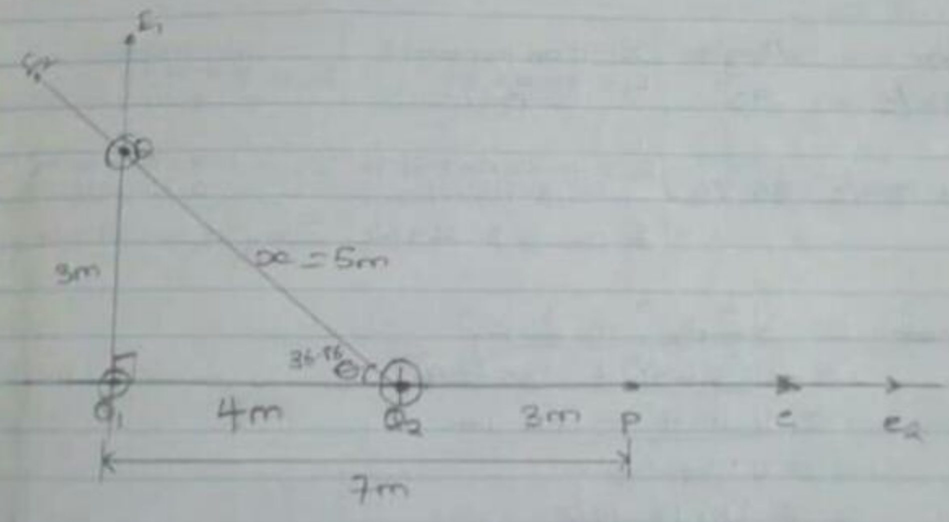
NAME: RAJI OYINDAMOLA MARIAM
MATRIC NO: 19/MHS02/110
Department: Nursing (100 level)
college: Medicine and Health sciences
course: phy 102

Section A

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

b) $Q_1 = 8nc$, $Q_2 = 12nc$



$$E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^{9} \times 8\times10^{-9}}{7^2} = \frac{72}{49}$$
$$= 1.469 \text{ N/c} \simeq 1.5\text{N/c}$$

$$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^{9} \times 12\times10^{-9}}{3^2} = \frac{108}{9} = 12\text{N/c}$$

Vector	Angle	X component	Y-component
$E_1 = 1.5$N/c	$0°$	$E_1 = 1.5\cos 0 = 1.5$N/c	$E_1 = 1.5\sin 0 = 0$N/c
$E_2 = 12$N/c	$0°$	$E_2 = 12\cos 0 = 12$N/c	$E_2 = 12\sin 0 = 0$N/c
		$\Sigma E_x = 13.5$	$\Sigma E_y = 0$

i) $E_{net} = \sqrt{\Sigma E_x^2 + \Sigma E_y^2}$
$= \sqrt{13.5^2 + 0^2}$
$= \sqrt{182.25}$
$= 13.5 N/C$

ii) $E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = \frac{72}{9} = 8 N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = \frac{108}{25} = 4.32 N/C$

Vector	Angle	X-component	Y-component
$E_1 = 8 N/C$	90^0	$E_1 = 8\cos 90^\circ = 0 N/C$	$E_1 = 8\sin 90^\circ = 8 N/C$
$E_2 = 4.32 N/C$	36.86^0	$E_2 = 4.32\cos 36.86 = 3.45 N/C$	$E_2 = 4.32\sin 36.86 = 2.59 N/C$
		$\Sigma E_x = 3.45 N/C$	$\Sigma E_y = 10.59 N/C$

$E_{net} = \sqrt{\Sigma E_x^2 + \Sigma E_y^2}$
$= \sqrt{(3.45)^2 + (10.59)^2}$
$= \sqrt{11.9 + 112.14}$
$= \sqrt{124.04}$
$= 11.13 N/C$

3 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, $\lambda = \frac{dQ}{dL} \rightarrow dQ = \lambda dL$

Where:
Q = charge, V = volume, L = Length, A = Area

b) Electric potential difference between two points in an electric field can be defined as the workdone per unit charge against electrical forces when a charge is transported from one point to the other. It is measured in Volt(V) or Joule per coulomb (J/c) and it is a Scalar Quantity.

$$V = \frac{\text{Workdone}}{\text{charge } (q)}$$

$$\text{Workdone} = q \times V$$

- due to a single point charge

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

Where; Q = point charge
V_B = distance of Q to point B
V_A = distance of Q to point A

- due to a several point charge

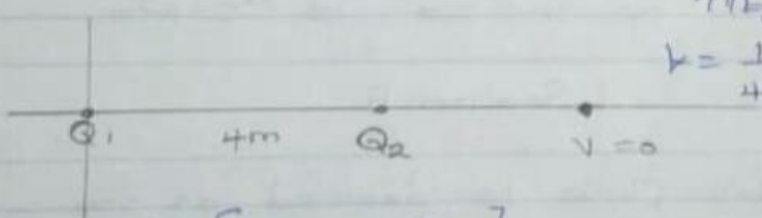
$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1}\right] + \left[\frac{Q_2}{r_2}\right]$$

Where: V = Electric potential
Q = point charge
r = distance of Q

3c)

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

$$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^{-9}$$



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

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

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

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

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

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

$$8\times10^{-6} = 10\times10^{-6}x - 2\times10^{-6}x$$
$$8\times10^{-6} = 8\times10^{-6}x$$
$$x = \frac{8\times10^{-6}}{8\times10^{-6}}$$
$$x = 1$$

$\therefore$ position along the x-axis is 1m where V = 0.

$$V = k\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$
$$0 = \left[\frac{10\times10^{-6}}{4-x} + \frac{-2\times10^{-6}}{x}\right]$$
$$\frac{2\times10^{-6}}{x} = \frac{10\times10^{-6}}{4-x}$$
$$(4-x)(2\times10^{-6}) = (10\times10^{-6})x$$
$$8\times10^{-6} - 2\times10^{-6}x = 10\times10^{-6}x$$
$$8\times10^{-6} = 10\times10^{-6}x + 2\times10^{-6}x$$
$$8\times10^{-6} = 12\times10^{-6}x$$
$$x = \frac{8\times10^{-6}}{12\times10^{-6}}$$
$$x = 0.67m$$

$\therefore$ position of V = 0 is 0.67m

Section B

4a) Magnetic flux is defined as the number of magnetic field lines passing through a given closed surface.

$$\phi_B = B\cdot A = BA\cos\theta$$

4b) Data:

$M_e = 9.11\times10^{-31}$ kg

$r = 1.4\times10^{-7}$ m

$B = 3.5\times10^{-1}$ Weber/m^2

Cyclotron frequency = Angular speed

$q = 1.6\times10^{-19}$

$$f_B = qvB = \frac{M_e v^2}{r}$$

$$m_e V = qBr$$

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

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

$$= \frac{7.84\times10^{-27}}{9.11\times10^{-31}}$$

$$= 8605.9 \simeq 8.61\times10^{3}\ m/s$$

$$W = \frac{v}{r} = \frac{qB}{m_e} = \frac{1.6\times10^{-19} \times 3.6\times10^{-4}}{9.11\times10^{-31}}$$

$$W = \frac{5.6\times10^{-20}}{9.11\times10^{-31}} \doteq 6.14\times10^{10}\ e^{-1}$$

4c) In 4b We Were given parameters: Mass of electron as 9.11×10^{-31} kg, radius as 1.4×10^{-7} m $B = 3.5\times10^{-1}$ Weber/m² Asked to find the cycloton frequency also known as angular speed. It is cycloton frequency because it is frequency of an acceleration called CYCLOTRON

Recall W = Angular speed

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

Since Cycle from frequency = Angular Speed The cycloton frequency $= 6.14\times10^{10}\ e^{-1}$ having a unit of $\frac{1}{T}$ Which is the unit of frequency dimensionally.

5a) Biot-Savart Law state that is an equation that describes the magnetic field created by a current-carrying Wire and allows you to calculate its strength at various points.

5b) Magnetic field of a straight current carrying Conductor

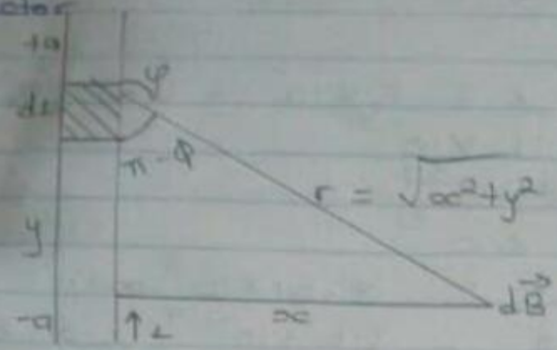


fig 1: A section of straight current carrying conductor

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

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

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

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

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

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

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

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

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