NAME: AKINKUNMI SAMUEL ADURAGBEMI
MATRIC NO: 19/MHS01/071
DEPT: MBBS

PHY 102 ASSIGNMENT

2 (a) Distinguish between the terms: electric field and electric field intensity

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

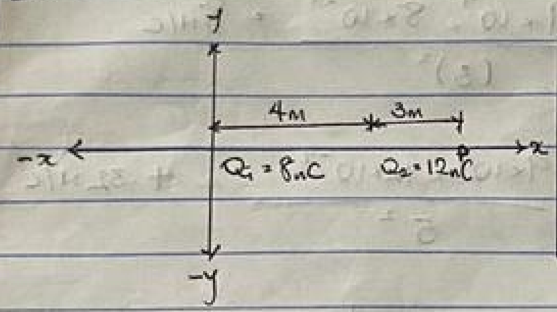
(b) A positive charge $Q_1 = 8nC$ is at the origin, and a second positive charge $Q_2 = 12nC$ is on the x-axis at $x = 4m$. find

i) the net electric field at a point P on the x-axis at $x = 7m$.

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

Sln

i)



$$E_1 = \frac{Kq_1}{(r_1)^2} = \frac{9\times10^{9} \times 8\times10^{-9}}{7^2} = 1.4694\ N/C$$

$$E_2 = \frac{Kq_2}{(r_2)^2} = \frac{9\times10^{9}\times12\times10^{-9}}{3^2} = 12\ N/C$$

Vector	Angle	x - Comp	y - Comp
$E_1 = 1.4694 N/C$	$0°$	$1.4694 \times \cos 0 = 1.4694$	0
$E_2 = 12\ N/C$	$0°$	$12 \times \cos 0 = 13.4694$	0

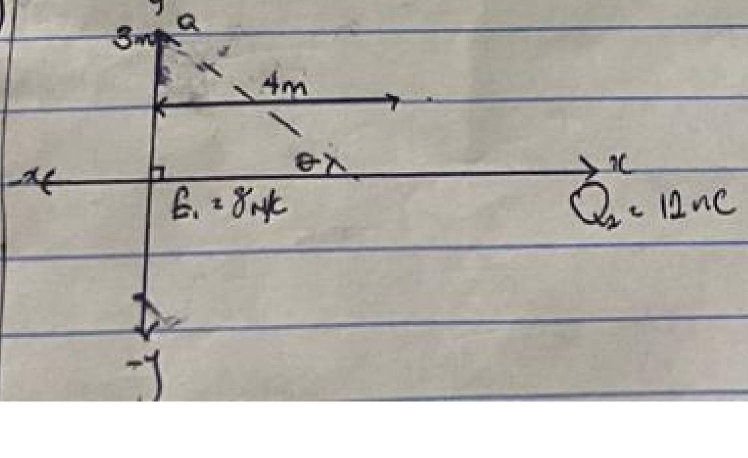
$$E = \sqrt{\sum Ex^2 + \sum Ey^2}$$

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

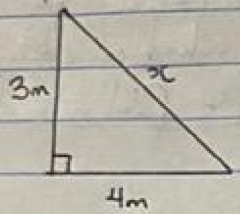
$$E = \sqrt{13.4694^2}$$

$$E = 13.4694\ N/C \simeq 13.5\ N/C$$

ii)



To find the distance between electric field of point p and Q. we use pythagoras theorem:

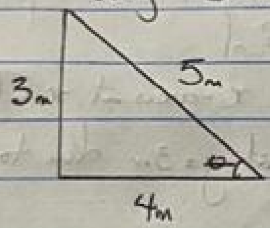


$x^2 = 3^2 + 4^2$

$x^2 = 9 + 16 = 25$

$x = \sqrt{25} = 5m$

Using Sin:



$\sin\theta = 3/5$

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

$\theta = 36.87^\circ$

$\therefore E_1 = \frac{kq_1}{(r_1)^2} = \frac{9\times10^9 \times 8\times10^{-9}}{(3)^2} = 8 N/C$

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

Vector	Angle	x - Comp	y - Comp
$E_1 = 8 N/C$	90°	$8\times\cos 90 = 0$	$8\times\sin 90 = 8$
$E_2 = 4.32 N/C$	36.87°	$4.32\times\cos 36.87 = 3.4560$	$4.32\times\sin 36.87 = 2.592$
		3.4560	10.592

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

$E = \sqrt{3.4560^2 + 10.592^2}$

$E = 11.2 N/C$

3a) State formulation of the following distribution of charge:

(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) Explain with appropriate equations, the electric potential difference

Ans

→ 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 moved from one point to another. It is measured in volt or Joules per Coulomb. It's a Scalar quantity.

Formulas for electric Potential Difference

→ Electric potential difference in a uniform electric field

$$V_B - V_A = \frac{W_{CA}}{-q_0} \rightarrow B_{2A_g}$$

→ Electric potential difference is the potential energy per unit charge

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

→ Electric potential energy due to Single point charge

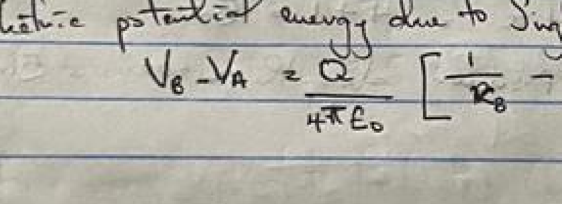
$$V_B - V_A = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{R_B} - \frac{1}{r_A}\right]$$

→ Electric potential due to Several point charge

$$V_p = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2} + \frac{Q_3}{r_3} + \frac{Q_4}{r_4}\right]$$

(c) Two point charges $Q_1 = 10\mu c$ and $Q_2 = -2\mu c$ are arranged along the x-axis at $x = 0$ and $x = 4m$ respectively. Find the position along the x-axis where $V = 0$

Soln



3 a) State formulation of the following electric field 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) Explain with appropriate equations, the electric potential difference

Ans

⇒ 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 moved from one point to another. It is measured in volt or Joules per Coulomb. It's a Scalar quantity.

Formulas for electric Potential Difference

⇒ Electric potential difference in a uniform electric field

$$V_B - V_A = \frac{W_{CA}}{q_0} \rightarrow B_{2}A_{g}$$

⇒ Electric potential difference as the potential energy per unit charge

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

⇒ Electric potential energy due to single point charge

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

... Several point charge

3b) $V_P = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$

Let $V_P = 0$

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

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

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

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

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

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

$$72000 = 90000x - 18000x$$

$$72000 = 72000x$$

$$x = 1m$$

$\therefore 4+x = 4+1 = 5m$.

$\therefore$ The position along the x-axis is 5m when $V=0$

4a) What is Magnetic flux

Ans: This is defined as the strength of a Magnetic field represented by a line of forces. It represented with the Symbol ϕ and Mathematically given as $\phi = BdA$

(b) An electron with a rest Mass of 9.11×10^{-31} Kg Moves in a Circular orbit of radius 1.4×10^{-7}m in a Uniform magnetic field of 3.5×10^{-1} weber/meter Square, perpendicular to the Speed with which electron Moves. find the Cyclotron frequency of the Moving electron

Sol

$$\omega = \frac{QB}{M_p}$$

$F_s = QV_s \sin\theta$ where $\theta = 90°$

$$F_B = QVB = \frac{Mv^2}{r}$$

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

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

$$V = -8.60593\ m/s$$

Hence, The angular Speed, $\omega = \frac{qB}{M_p}$

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

$$= 6.147\times10^{10}\ rad/s$$

4c) In 4b.) above we were given:

→ Mass of the electron $= 9.11\times10^{-31}$ kg

→ Radius $= 1.4\times10^{-7}$ m

→ Magnetic field $= 3.5\times10^{-1}$ weber / meter Square

And we were asked to find the Cyclotron frequency which is equ[al] to the angular Speed. So we find the angular Speed Using $\omega = \frac{qB}{M}$ and Substitute the parameters and Solve to get 6.147×10^{10} rads^{-1}

5a) State the Biot - Savart Law

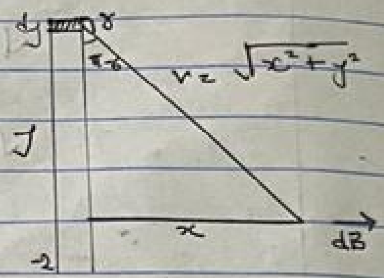
Ans: This states that the Magnetic field intensity at any point [due] to a steady Current in an infinitely long straight wire is [directly] proportional to the Current and inversely proportional to the [distance] from the point to the Wire where there is a Constant Called permeability of free Space.

5b) Using the Biot-Savart Law, show that the Magnitude of the Magnetic field of a straight Current-Carrying Conductor is given as

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

Soln

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



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

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

From the diagram, $r^2 = x^2 + y^2$ (pythagoras theorem)

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

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

Substituting (II) into (I)

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

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

Recall $dl = dy$

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