Name: Essien Blessing Ekeng
Department: Pharmacy
Matric no: 19/MHH01/033
Course code: Phy 102

19/04/2020

Section A

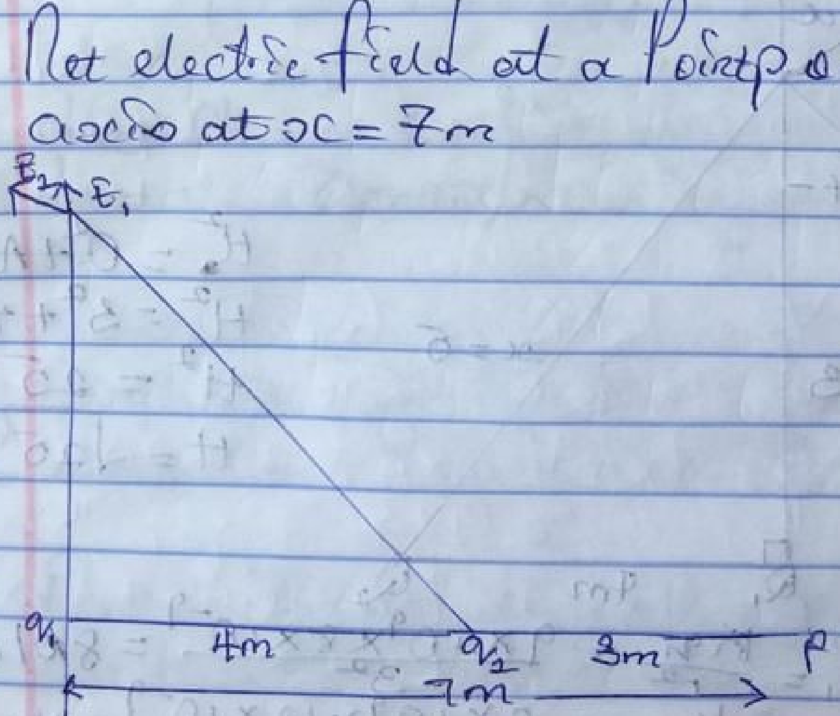
2a. Electric field is a region of space in which an electric force.

Where

Electric field Intensity can be defined as the force per unit charge. i.e $E = \frac{F(N)}{q_0(C)}$

b) $q_1 = 8nC$ at Origin, $q_2 = 12nC$, x-axis at $x = 4m$.

i) Net electric field at a Point P on the x-axis at $x = 7m$

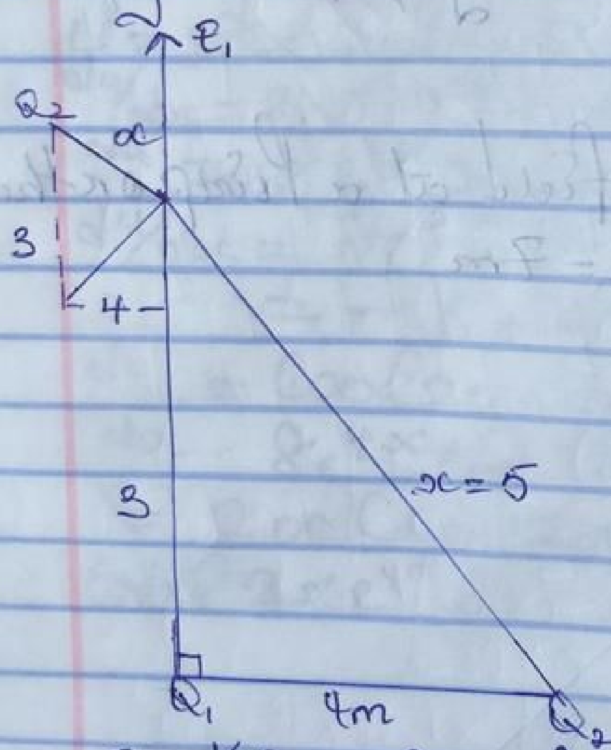


$$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\,N/C \approx 1.5\,N/C$$

$$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{7^2} = 12\,N/C$$

$$E_{net} = E_1 + E_2 = (1.5 + 12)\,N/C = 13.5\,N/C$$

i) Electric field at a Point Q on the y axis at y = 3m due to the charges.



$$H^2 = O^2 + A^2$$
$$H^2 = 3^2 + 4^2$$
$$H^2 = 25$$
$$H = \sqrt{25} = 5$$

$$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8\,N/C$$

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

Vector	Angle	x comp	Y comp
$E_1 = 8 N/C$	90°	$0 N/C$	$8 N/C$
$E_2 = 4.32 N/C$	36.87°	$-3.48 N/C$	$2.59 N/C$
Total		$E_{fx} = -3.48 N/C$	$E_{fy} = 10.59 N$

$$E_{net} = \sqrt{E_{fx}^2 + E_{fy}^2}$$

$$= \sqrt{(-3.48)^2 + (10.59)^2}$$

$$= \sqrt{12.11 + 112.15}$$

$$= \sqrt{124.26}$$

$$= 11.12 N/C$$

3a.) dQ = Charge element, dA = area element, dv = vol element, dL = length element

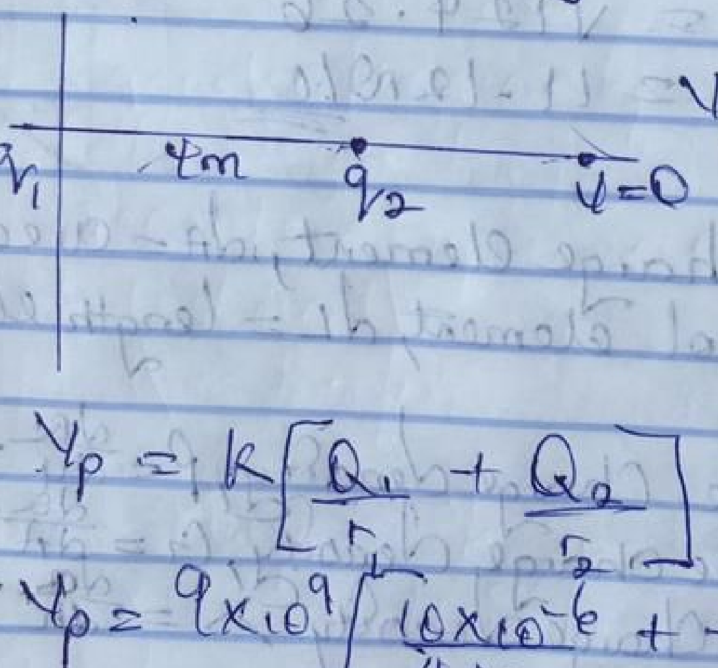
i) Volume Charge density, $\rho = \frac{dQ}{dv} \rightarrow dQ = \rho dv$
ii) Surface charge density, $\sigma = \frac{dQ}{dA} \rightarrow dQ = \sigma dA$
iii) Linear Charge density, $\lambda = \frac{dQ}{dL} \rightarrow dQ = \lambda dL$

b.) Electrical Potential difference equation due to a single point charge

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

Where Q = Point Charge
r_B = distance Q to B
r_A = distance Q to A
V = Electric Potential

3c) $Q_1 = 10\mu C$, $Q_2 = -2\mu C$, $x = 0$, $a = 4m$
Find position along 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~~ $= 9\times10^9 = K$

recall $\frac{1}{4\pi\varepsilon_0}$

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

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

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

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

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

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

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

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

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

$\cancel{x} \; \cancel{7} - 0.67 = -1$

$x = 1m$

Position along the x-axis is $-1m$

(ii) 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 4 = 0 to 0.67m

Section B.

4a.) Magnetic flux is defined as the strength of the Magnetic field which can be represented by lines of force. It is denoted as Φ

$\Phi = B \cdot dn$

b) $m_e = 9.11\times10^{-31}kg$; $r = 1.4\times10^{-7}m$; $B = 3.5\times10^{-1}$, cyclotron frequency = angular speed $= q = 1.6\times10^{-19}$ $\therefore F_B = quB = \frac{m_e v^2}{r^2} = m_e u = qBr$

$v = \frac{qBr}{m_2} = \frac{1.6\times10^{-19}\times3.5\times10^{-1}\times1.4\times10^{-7}}{9.11\times10^{-31}}$

$C_0 = 6.14 \times 10^{10} C^{-1}$

4c.) In 4b we were given Parameters, $M_e = 9.11 \times 10^{-31} kg$, $r = 1.4 \times 10^{-7} m$, $B = 3.5 \times 10^{-1} wb/m^2$

And we were asked to find the cyclotron frequency which is the same thing as angular speed, it is called cyclotron frequency because it is a frequency of an accelerator called cyclotron.

Recall ω = angular speed

$\omega = \frac{quB}{M_e}$, Since cyclotron frequency = angular speed the cyclotron frequency $= 6.14 \times 10^{-9} C^{-1}$

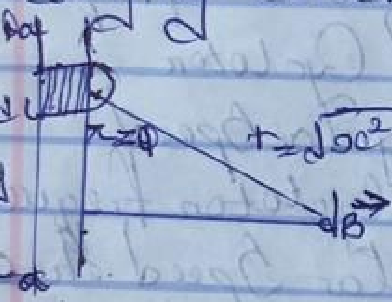
having a unit of $\frac{1}{t}$ which is the unit of frequency dimensionally.

5a) Bio-Savart law states the Magnetic field is directly Proportional to the Product Permeability of free Space (μ) the current (I), the change in length of the radius and inversely Proportional to square of radius (r^2)

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

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 w/m^2

5B. Magnetic field Of a Straight Current Carrying Conductor.



A section of a Straight Current Carrying Conductor

Applying Bio-Savart law, we find the Magnitude of the field (dB^y) from the diagram.

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

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

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

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

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

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

Substitute (ii) into (i)

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

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

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

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

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

$a = x$

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