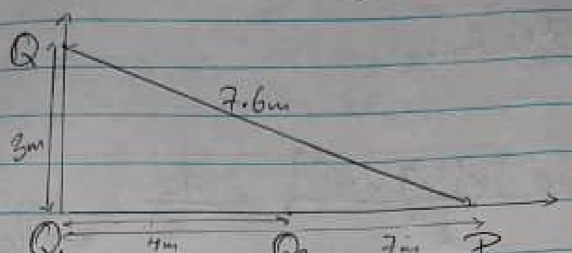
19/MHS 01/011

2 Electric field is a ~~ge~~ region around a charge in which it exerts electrostatics force on another charges while Electric field intensity is the strength of electric field at any point in space.

b



Where $Q_1 = 8nC$
$Q_2 = 12nC$

Recall $E = kq/r^2$

$\therefore E_1 = \frac{[9\times10^9 Nm^2/c]\cdot[8\times10^{-9}C]}{[7.0m]^2}$

$E_1 = 1.47 N/C$

$E_2 = \frac{[9\times10^9 Nm^2/c]\cdot[12\times10^{-9}C]}{[3.0m]^2}$

$E_2 = 12 N/C$

Vector	Angle	X Component	Y Component
$E_1 = 1.47 N/C$	$0°$	$E_{1x} = 1.47 \cos 0°$ $E_{1x} = 1.47 N/C$	$E_{1y} = 1.47 \sin 0$ $E_{1y} = 0$
$E_2 = 12 N/C$	$0°$	$E_{2x} = 12 \cos 0°$ $= 12 N/C$ $\Sigma E_x = 13.47 N/C$	$E_{2y} = 12 \sin 0$ $E_{2y} = 0$ $\Sigma E_y = 0$

$E_{net} = \sqrt{[E_x]^2 + [E_y]^2}$

$= \sqrt{[13.47]^2 + [0]^2}$

$= \sqrt{181.4409}$

$E_{net} = 13.47 N/C$

4 $E_1 = \frac{kQ_1}{r^2} = \frac{[9\times10^9]\times[8\times10^{-9}]}{3^2} = \frac{72}{9} = 8N/C$

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

Vector	Angle	x Component	Y component
$E_1 = 8N/C$	90^0	$E_1 = 8\cos 90$ $= 0$	$E_1 = 8\sin 90$ $= 8 N/C$
$E_2 = 4.32N/C$	36.86°	$E_2 = 4.32\cos 36.86$ $= 3.45 N/C$	$E_2 = 4.32\sin 36.86$ $= 2.59 N/C$

$\Sigma_{Ex} = 3.45 N/C$ $\qquad$ $\Sigma_{Ey} = 10.59 N/C$

$E_{net} = \sqrt{\Sigma_{Ex}^2 + \Sigma_{Ey}^2}$

$= \sqrt{11.9 + 112.14}$

$= 11.13 N/C$

3| Volume charge density, $\rho = q/v$
Where $\rho = \frac{dQ}{dv}$
$dQ = \rho dv$

Where ρ = volume charge density
q = Electric charge
v = Volume

ii| Surface charge density, $\sigma = q/A$
Where $\sigma = \frac{dQ}{dA}$
$dQ = \sigma dA$

Where σ = surface charge
q = electric charge
A = Area

iii| Linear charge density, $\lambda = q/L$
Where $\lambda = \frac{dQ}{dL}$
$dQ = \lambda dL$

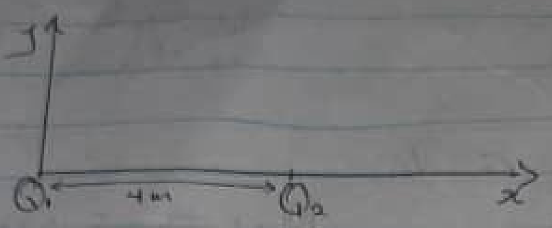
Where λ = linear charge
q = electric charge
L = Length

b- Electric Potential Difference
thus can be defined as the difference in electric potential (v) between the final and the initial position when work is done upon a charge to change its potential energy in equation

$$\Delta v = V_B - V_A = \frac{Work}{Charge} = \frac{\Delta PE}{Charge}$$

Where $1V = 1 J/C$
Unit of Potential difference are Joules per Coulomb given the name volt (v) after Alessandro Volta.

c) $Q_1 = 10\mu C \quad x = 0$
$Q_2 = -2\mu C \quad x = 4m$



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

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

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

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

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

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

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

$$x = 7$$

∴ Position along the x-axis is 1m

Where $V = 0$

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

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

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

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

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

$$x = \frac{8\times10^{-6}}{12\times10^{-6}} = 0.67m$$

$\therefore$ Position of $V = 0.67m$

Section B

7 Magnetic flux is defined as the number of magnetic field lines passing through a given close Surface.

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

6 $M_e = 9.11 \times 10^{-31} kg$

$r = 1.7 \times 10^{-7} m$

$B = 3.5 \times 10^{-1}$ weber/m²

Cyclotron frequency = Angular Speed

$q = 1.6 \times 10^{-19}$

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

$$M_eV = qBr$$

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

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

$$= \frac{7.84 \times 10^{-27}}{9.11 \times 10^{-31}}$$

$$= 8605.9 \simeq 8.61 \times 10^{3} m/s$$

$$W = V/r = \frac{qB}{M_e} = \frac{1.6 \times 10^{-19} \times 3.6 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$$\Rightarrow \underline{\underline{6.14 \times 10^{10} s^{-1}}}$$

c In 4b we were given parameters

Mass of an electron $= 9.11 \times 10^{-31} kg$

Radius $= 1.4 \times 10^{-7} m$

B $= 3.5 \times 10^{-1}$ weber/m²

It is cycloton frequency because, it is the frequency of an acceleration which is called "CYCLOTON"

Recall $H =$ Angular speed

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

Since cycle from frequency = Angular speed
The cycloton frequency $= 6.14 \times 10^{10} s^{-1}$ having a Unit of T^{-1} which is the Unit of frequency dimensionally.

5 Bu...
...
6 M...

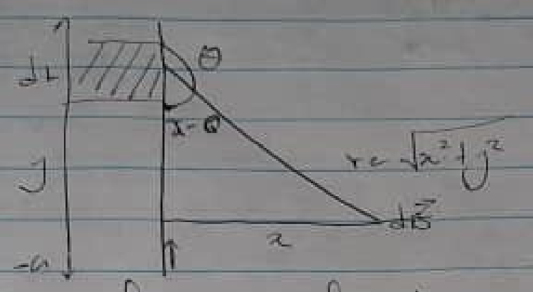
$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2} \frac{y}{(x^2+y^2)^{1/2}}$$

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

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

5 Biot - Savart law state an equation that describes the magnetic field created by a current carrying wire and allows you to calculate its strength at various points

6 Magnetic field of a straight current carrying conductor



A section of straight current carrying conductor

Applying the Biot - Savart law we find magnitude of the field $d\vec{B}$

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

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

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

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

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

Substitute II into I

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

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