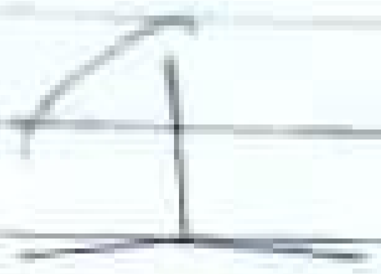
MUOGHA INALLA FAVOUR

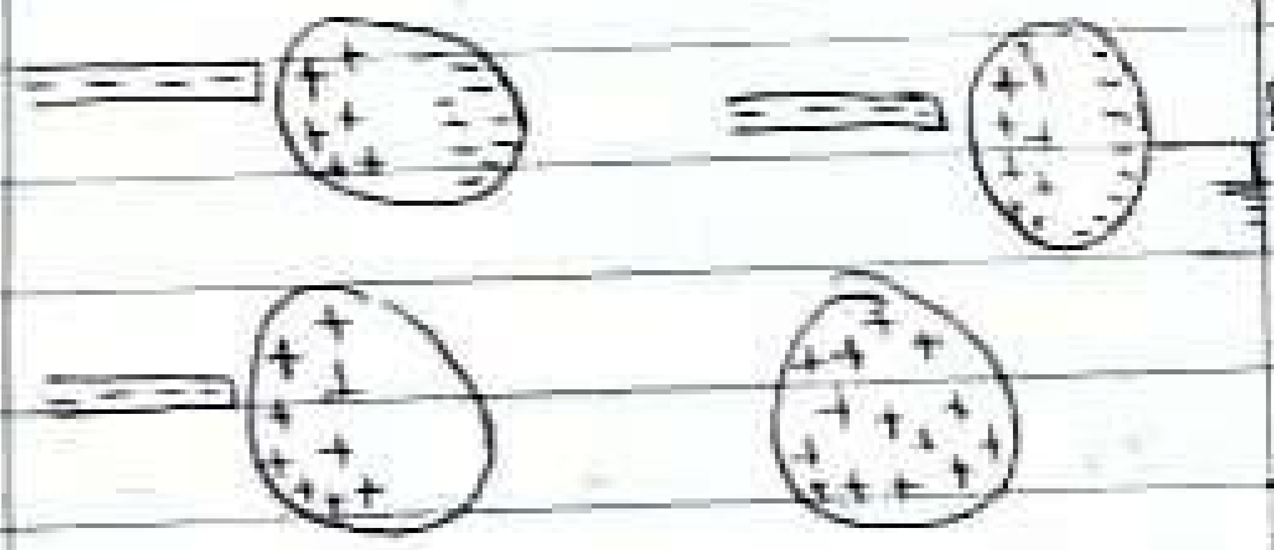
19/MRSC/1/2012

MCB3

PHY102.



1a Charging By Induction: When a negatively charged rubber rod is brought near a neutral conducting sphere as shown below. All the positively charges goes close to the rubber rod while the negative charges are at the extreme end of the rubber rod. The neutral charged sphere is then connected to an insulating or while the rod is still place close to it. The neutral sphere connected to an earth wire, all the negative charges passes through the earth wire and goes to the ground. The rubber rod is then removed, And the sphere remains positively charged.



1b $q_1 + q_2 = 5.0 \times 10^{-5} C$,

$F = 1$ $\quad$ $q_1 = q_2 - 5.0 \times 10^{-5} C$

$r = 2$

Recall that $F = \frac{K q_1 q_2}{r^2}$ $\quad (K = 9 \times 10^9)$

$1 = \frac{(9 \times 10^9) \times (q_2 - 5.0 \times 10^{-5} C) \times q_2}{4}$

$4.44 \times 10^{-10} = (q_2 - 5.0 \times 10^{-5} q_2) q_2$

$4.44 \times 10^{-10} = q_2^2 - 5.0 \times 10^{-5}$

~~$q_2 = 4.44 \times 10^{-5}$~~

~~$5.0 \times 10^{-5} - 4.44 \times 10^{-5}$~~

$q_2 = \underline{1.14 \times 10^{-5}}$

Recall that $q_1 + q_2 = 5.0 \times 10^{-5}$

$q_1 = 5.0 \times 10^{-5} - 1.14 \times 10^{-5}$

$q_1 = \underline{3.86 \times 10^{-5} C}$.

1c) $Q_1 = Q_2 = 8\mu C$

$d = 0.5m$

$\tan\theta = \text{opp}/\text{adj}$

$\theta = \tan^{-1} 1/0.5$

$\theta = \underline{63.4^{\circ}}$

$E_1 = \frac{K q_1}{r^2} = \frac{(9 \times 10^9) \times 8 \times 10^{-6}}{(1.22)^2}$

$E_1 = \underline{5732.79} C$

$E_2 = \frac{K q_2}{r^2} = \frac{(9 \times 10^9) \times (8 \times 10^{-6})}{(1.28)^2}$

$E_2 = 5739.29 C$

$E_q = K q / r^2 = \frac{(9 \times 10^9) \times q}{(1)^2} = 9 \times 10^9 q$

Vector	Angle	x-Compon	y-Compon
59504 ~~5732.79~~	63.4	-26643 ~~25700.84~~	53205 ~~5132.95~~
59504 ~~5739.29~~	63.4	26643 ~~25300.79~~	53205 ~~5132.26~~
$9 \cdot 10^9 q$	90	0	$9 \times 10^9 q$
		0	E_y =

$\Sigma E_y = 106410 + ~~105092~~ ~~22465~~$
$9 \times 10^9 q$

Magnitude.

$E_q = \sqrt{0^2 + (~~10264 + 23465~~)^2}$ $-106410 + 9 \dots$

Since $E = 0$; $0 = 9 \times 10^9 q + 106410$ ~~$\dots$~~

$q = \frac{~~52568~~}{9 \times 10^9}$ ~~$= -14 \mu C$~~ $q = \underline{-12 \mu C}$

$q = \underline{-12 \mu C}$

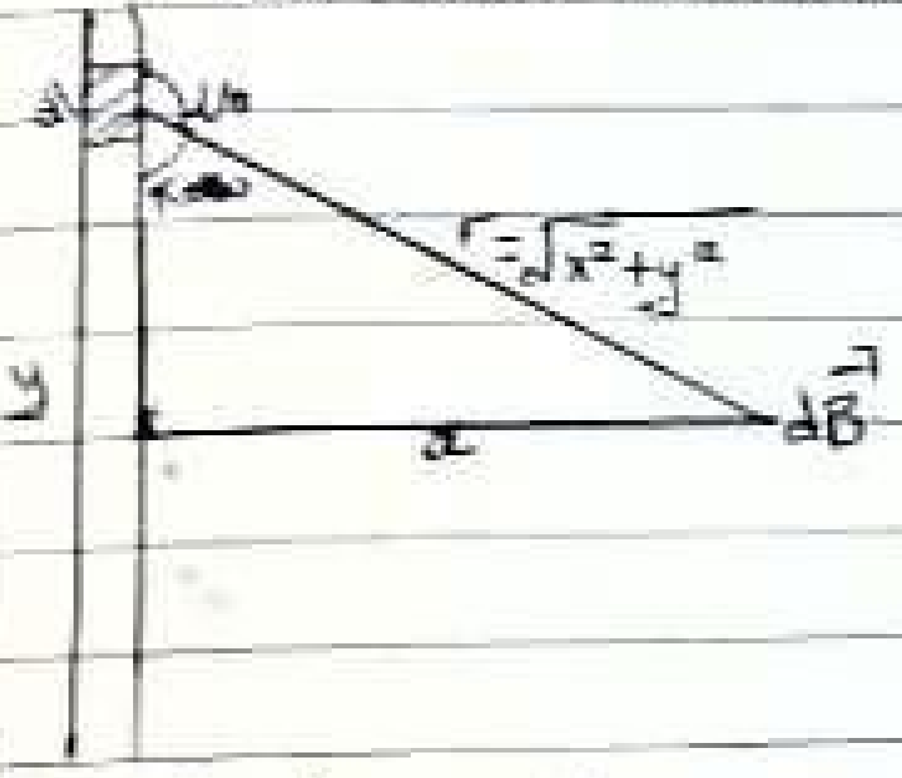
5

5a The Biot-Savart Laws This is an equation that describes the magnetic field generated by a constant electric current.

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

where μ_0 is a constant called permeability of free space

$$\mu_0 = 4\pi = 10^{-7} T\,m/A$$



A section of a straight current carry conductor. Applying the Biot Savart law, we find the magnitude of the field $d\vec{B}$

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

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

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

From Diagram:- $r^2 = x^2 + y^2$ (Pythagoras theorem)

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

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

Substituting equation (2) into (1), we have

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

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

Recall that $dl = dy$

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

Using Special Integrals:-

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

Equation (3) =>

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

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

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

When the length of 2a of the conductor is very great in comparison to the distance x from point P, we consider it infinitely long. that is when a is much larger than x.

$(x^2+a^2)^{1/2} \approx a$, as $a \to \infty$

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

At all points in a circle of radius r around the conductor, the magnitude of

$$\boxed{B \Rightarrow \frac{\mu_0 I}{2\pi r}}$$

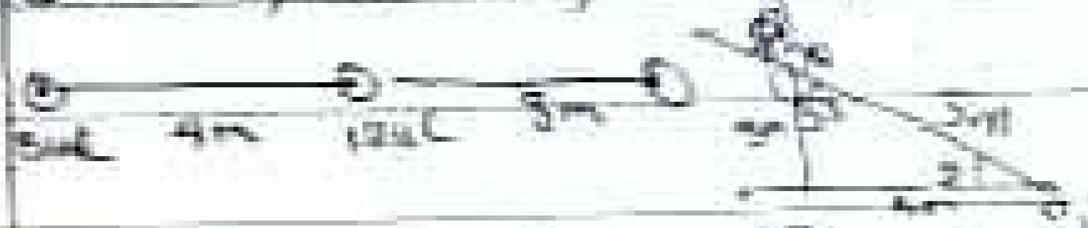
2

2a) An electric field:- This is the region of space in which an electric charge will experience an electric force while

An Electric Field Strength or Electric Field intensity :- is the force per unit charge, mathematically, it is E = F(N)/q(C)

the unit is Newton per coulomb (N/C)

b) $Q_1 = 8\mu C$, $Q_2 = 12\mu C$, $x = 4m$, $k = 9\times10^9$



$E_{1P} = \frac{kQ_1}{r^2} = \frac{(9\times10^9)\times(8\times10^{-8})}{7^2} = 1.469 N/C$

$E_{2P} = \frac{kQ_2}{r^2} = \frac{(9\times10^9)\times(12\times10^{-9})}{3^2} = 12 N/C$

$E_n = 1.469 + 12 = 13.469 = 13.5 N/C$

ii) $E_{net} = \vec{E_1} + \vec{E_2}$

$E_1 = KQ_1/r^2 = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8 N/C$

$E_2 = KQ_2/r^2 = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32 N/C$

Vector	Angle	x. com	y. com
$E_1 = 8 N/C$	90°	8 Cos 90 = 0	8 Sin 90 = 8.00
$E_2 = 4.32$	36.9	4.32 × Cos 36.9 = -3.45	4.32 × Sin 36.9 = 2.59
		$\Sigma f_x = -3.45$	$\Sigma f_y = 10.59$

$E_{net} = \sqrt{(\Sigma f_x)^2 + (\Sigma f_y)^2}$

$= \sqrt{(-3.45)^2 + (10.59)^2}$

$E_{net} =$ ~~11.14 N/C~~ $11.14 uC$

4

4a) The magnetic flux:- This is defined as the strength of a magnetic field represented by lines of force its usually represent by the symbol ϕ

4b) $m_e = 9.11\times10^{-31} kg$

$r = 1.4\times10^{-9} m$

$\theta = 90°$

magnetic field (B) = 3.5×10^{-1} weber/meter square

$Q = 1.6\times10^{-19} C$

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

$V = \frac{(1.6\times10^{-19})\times(3.5\times10^{-1})\times(1.4\times10^{-9})}{9.11\times10^{-31}}$

$V =$ ~~[illegible]~~ $= -6.15\times10^{10}$ rad/sec

Angular speed = Cyclotron frequency

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

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

$= -6.15\times10^{10}$ rad/s

c) The charge particle circulates at the angular frequency or angular speed at -6.15×10^{10} rads in the type of accelerator called cyclotron, therefore the angular speed ~~is at a [illegible]~~ is negative or opposite ~~cyclotron frequency~~ direction to that of the charge particle electrons.

5a) The ...