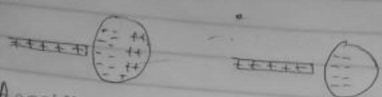
Name: Leslie David Chizi Naomi
Matric No: 19/MHS01/286
Dept: MBBS

(1)

PHY 102 ASSIGNMENT

1) Induction is the process whereby electric charges can be obtained on an object without touching it.



A positively charged rod is brought close to a neutral sphere

A grounded conducting wire is connected to the sphere which causes some of the electrons to leave the sphere and travel to the earth

When the rod is removed, the negative charge remains and then becomes evenly distributed

b) $r = 2.0m$

$F = 1.0N$

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

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

$F = \frac{kq_1 q_2}{r^2}$

$1 = \frac{(9 \times 10^9) \times q_1 \times (5.0 \times 10^{-5} - q_1)}{2^2}$

$4 = 9 \times 10^9 q_1 \times (5.0 \times 10^{-5} - q_1)$

$4 = 4.5 \times 10^5 q_1 - 9.0 \times 10^9 q_1^2$

$9.0 \times 10^9 q_1^2 - 4.5 \times 10^5 q + 4 = 0$

$q = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

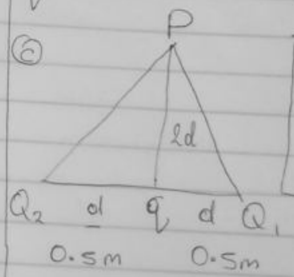
~~$q = -(-4.5 \times 10^5) \pm \sqrt{(-4.5 \times 10^5)^2 \ldots}$~~

$q = \frac{-(-4.5 \times 10^5) \pm \sqrt{(-4.5 \times 10^5)^2 - 4 \times (9 \times 10^9) \times 4}}{2 \times (9.0 \times 10^9)}$

$q = \frac{4.5 \times 10^5 \pm 241867.7}{1.8 \times 10^{10}}$

$q = 3.84 \times 10^{-5}C$ OR $1.156 \times 10^{-5}C$

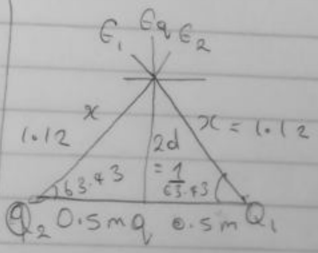
(c)



$Q_1 = Q_2 = 8\mu C$

$d = 0.5m$

$q = ?$



19/MH801/236

(2)

$x^2 = 1^2 + 0.5^2$

$x^2 = 1 + 0.25$

$x^2 = 1.25$

$x = 1.12$

$\tan\theta = \frac{1}{0.5}$

$\tan\theta = 2$

$\theta = 63.43°$ //

$E_1 = \frac{kq_1}{r^2} = \frac{(9\times10^9)\times(8.0\times10^{-6})}{(1.12)^2}$

$E_1 = 57397.96\ N/C$

$E_2 = \frac{kq_2}{r^2} = \frac{(9\times10^9)\times(8.0\times10^{-6})}{(1.12)^2}$

$E_2 = 57397.96\ N/C$

$E_q = \frac{kq}{r^2} = \frac{(9\times10^9)\times(q)}{(1.12)^2}$

$E_q = 9\times10^9 q$

~~Vector~~	~~θ~~	~~x-Comp~~	~~y-Comp~~
~~E_1~~	~~63.43~~	~~$E_1 \cos 63.43$~~	
~~E_2~~	~~63.43~~		
~~E_q~~	~~90~~		

Vector	θ	x-Comp	y-Comp
E_1	63.43	$-E_1 \cos 63.43 = -25700$	$E_1 \sin 63.43 = 51336$
E_2	63.43	$E_2 \cos 63.43 = 25700$	$E_2 \sin 63.43 = 51336$
E_q	90	$E_q \cos 90 = 0$	$E_q \sin 90 = 9\times10^9 q$
		$\Sigma x = 0$	$\Sigma y = 102672 + 9\times10^9 q$

Magnitude $= \sqrt{\Sigma x^2 + \Sigma y^2}$

~~$E_p = \sqrt{0^2 + (102672 + 9\times10^9}$~~

$E_p = \sqrt{0^2 + (102672 + 9\times10^9 q)^2}$

Since $E = 0$

$0 = 102672 + 9\times10^9 q$

$q = \frac{-102672}{9\times10^9}$

$q = -1.14\times10^{-5}$

$q = -11.4\ \mu C$ //

(2) a) Electric field is the region of space in which an electric charge will experience an electric force while electric field intensity is the magnitude of the field and it is the force per unit charge.

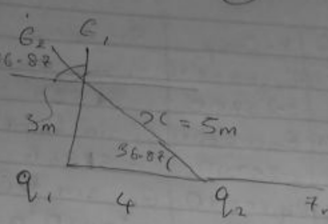
b) $Q_1 = 8nC$

$Q_2 = 12nC$

$x = 4m$

19/MAES01/236

(3)



$x^2 = \sqrt{3^2 + 4^2}$

$x^2 = \sqrt{9 + 16}$

$x = 5$

$\sin\theta = 3/5$

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

$\theta = 36.87$

$E_1 = \frac{kq_1}{r^2} = \frac{(9\times10^9)\times(8\times10^{-9})}{3^2}$

$E_1 = 8 N/C$

$E_2 = \frac{kq_2}{r^2} = \frac{(9\times10^9)\times(12\times10^{-9})}{5^2}$

$E_2 = 4.32 N/C$

Vector	θ	X-Comp	Y-Comp
$E_1 = 8$	$90°$	$E_1\cos\theta = 0$	$E_1\sin\theta = 8$
$E_2 = 4.32$	36.87	$E_2\cos\theta = -3.5$	$E_2\sin\theta = 2.59$
		$\Sigma_x = -3.5$	$\Sigma_y = 10.6$

$|E| = \sqrt{\Sigma x^2 + \Sigma y^2}$

$|E| = \sqrt{(-3.5)^2 + (10.6)^2}$

$|E| = 11.2 N/C$

$\tan\theta = \frac{\Sigma y}{\Sigma x} = \frac{10.59}{3.5}$

$\theta = 72$

(a) Magnetic flux is defined as the strength of magnetic field ~~respectively~~ represented by lines of force (ϕ)

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

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

$B = 3.5\times10^{-1}$

$\omega = \frac{qB}{m}$

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

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

(c) The cyclotron frequency is also referred to as angular speed. It is called this because the charge particle circulates at the angular speed/frequency in the type of accelerator called cyclotron

$\omega = \frac{v}{r} = \frac{qB}{m}$

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

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

$\therefore$ angular speed is also cyclotron frequency, $\therefore$ cyclotron frequency is 6.147×10^{10} rad/s

(4) a) The Biot-Savart law is an equation based on the following observations for the

19/MHS01/256

(4)

magnetic field $d\vec{B}$ at a point P associated with a length element $d\vec{l}$ of a wire carrying a steady current I.

b)

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

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

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

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

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

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

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

$$= \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}} \quad \ldots(**)$$

Substituting (**) into (*)

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

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

Recall $dl = dy$

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

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

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 (***) therefore becomes

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

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

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

When the length 2a of the condutor is very great in comparison to its distance from point P, we ~~conside~~ consider it infinetly long. That is, when a is much larger than x, $(x^2+a^2)^{1/2} \simeq a$, as $a \to \infty$

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

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