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MATRIC NO: 19/MHS01/010
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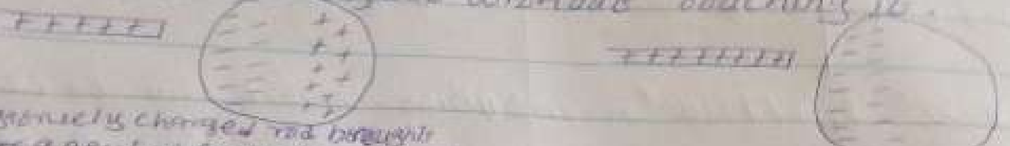
COVID-19 ASSIGNMENT

1. Charging by induction is when electric charges are obtained on an object without touching it.



negatively charged rod brought near a neutral conducting sphere

some of electron leave the sphere and transfer to the sphere

when the rod is removed in the vicinity of the sphere induced negative charge remains.

b. $q_1 + q_2 = 5.0\times10^{-5}C$ $F = 1.0N$ $d = 2m$

$q_2 = 5.0\times10\times10^{-5} - q_1$

$F = \frac{Kq_1q_2}{r^2}$

$1 = \frac{9.0\times10^9\times q_1\times 5.0\times10^{-5} - q}{2^2}$

$4 = 4.5\times10^{-5}q_1 - 9.0\times10^9 q^2$

$9.0\times10^9 q^2 - 4.5\times10^{-5}q + 4 = 0$

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

$= \frac{-(-4.5\times10^{-5}) \pm \sqrt{(4.5\times10^{-5})^2 - 4\times9.0\times10^9\times4}}{2\times9.0\times10^9}$

$= \frac{4.5\times10^{-5} + \sqrt{5.85\times10^{10}}}{1.8\times10^{10}}$

$= \frac{4.5\times10^{-5} + 241867.7}{1.8\times10^{10}}$ or

$\frac{4.5\times10^{-5} - 241867.7}{1.8\times10^{10}}$

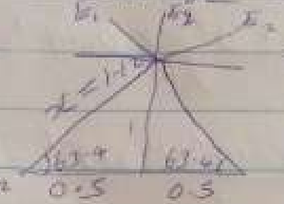
$q = 3.84\times10^{-5}C$ or $1.156\times10^{-5}C$

c. $Q_1 = Q_2 = 8.0\times10^{-6}C$ $d = 0.5$ $q = ?$

$F = E = ?$ $x^2 = 1^2 + 0.5^2$

$\sqrt{x^2} = \sqrt{1.25}$

$x = 1.12$



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

$\theta = \tan^{-1} 2$

$\theta = 63.4^\circ$

$E_1 = \frac{Kq_1}{r^2} = \frac{9.0\times10^9\times 8.0\times10^{-6}}{(1.12)^2} = 57397.96$ N/C

$E_2 = \frac{Kq}{r^2} = \frac{9.0\times10^9\times8.0\times10^{-6}}{(1.12)^2}$

$= 57397.96$ N/C

$E_q = \frac{Kq}{r^2} = \frac{9.0\times10^9\times q}{1^2} = 9.0\times10^9 q$ N/C

vector	θ°	x component	Y component
E_1	63.4	$E_1\cos63.4 = -25700.26$	$E_1\sin63.4 = 51322.63$
E_2	63.4	$E_2\cos63.4 = 25700.26$	$E_2\sin63.4 = 51322.63$
E_q	90°	$E_q\cos90 = 0$	
		$\Sigma_x = 0$	$\Sigma_y = 102645.26 + 9.0\times10^9 q$

Magnitude $= \sqrt{(\Sigma_x)^2 + (\Sigma_y)^2}$

$E = \sqrt{0^2 + (102645.26 + 9.0\times10^9 q)^2}$

Since $E = 0$

$0 = 102645.26 + 9.0\times10^9 q$

$q = \frac{-102645.26}{9.0\times10^9}$

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

$q = -11.4\mu C$

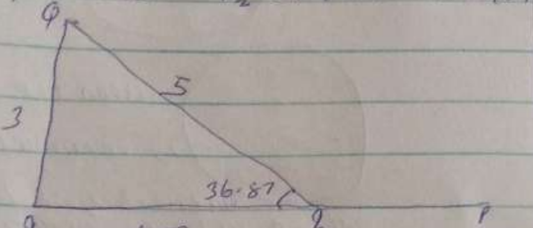
2a Electric Field

It is a region of space in which an electric charge will experience electric force.

Electric field intensity

It is force per charge. It is the magnitude of the field.

b) $q_1 = 8\times10^{-9}$ $q_2 = 12\times10^{-9}$ $x = 4m$



i. $E_1 = \frac{Kq}{r^2} = \frac{9.0\times10^{9}\times8.0\times10^{-9}}{7^2} = 1.469$ N/C

$E_2 = \frac{Kq}{r^2} = \frac{9.0\times10^{9}\times12\times10^{-9}}{3^2} = 12$ N/C

net electric field = 12 + 1.469

= 13.47 N/C

ii. $E_1 = \frac{Kq}{r^2} = \frac{9.0\times10^{9}\times8.0\times10^{-9}}{3^2} = 8$ N/C

$E_2 = \frac{Kq}{r^2} = \frac{9.0\times10^{9}\times12\times10^{-9}}{5^2} = 4.32$ N/C

vector	angle	x-component	y-component
E_1	90	$E_1\cos90 = 0$	$E_1\sin90 = 8$
E_2	36.87	$E_2\cos36.87 = 3.456$	$E_2\sin36.87 = 2.59$
		$E_x = 3.456$	$E_y = 10.59$

$|E| = \sqrt{3.456^2 + (10.59)^2} = 11.14$ N/C

$E = 11.14$ N/C $\theta = \tan^{-1}\frac{y}{x} = 71.93°$

4.) a) Magnetic flux is defined as the strength of magnetic field represented by lines of force. It is represented by the symbol ϕ

b) $m = 9.11\times10^{-31}$ $r = 1.4\times10^{-7}$ m

$B = 3.5\times10^{-1}$ $\theta = 90$

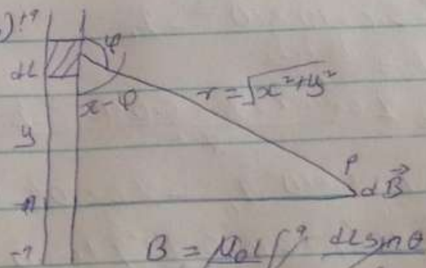
cyclotron frequency $(\omega) = \frac{qB}{m}$

$= \frac{1.6\times10^{-19}\times3.5\times10^{-1}}{9.11\times10^{-31}}$

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

5a) Biot-Savart law states that the magnetic field is directly proportional to the product permeability to free space (μ), the current (I), the change in length, the radius and inversely proportional to square to radius (r^2). It can be represented mathematically by $B = \frac{\mu_0 I}{2\pi x}$

5b)



$B = \frac{\mu_0 I}{4\pi}\int_{-9}^{9}\frac{dL\sin\theta}{r^2}$

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$\sin(x-\theta)$

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

$\therefore B = \frac{\mu_0 I}{4\pi}\int_{-9}^{9}\frac{dL\sin(x-\theta)}{r^2}$

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

$B = \frac{\mu_0 I}{4\pi}\int_{-9}^{9}\frac{dL\sin(x-\theta)}{x^2+y^2}$ --- (*)

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

substituting (**) into (*), we have

$B = \frac{\mu_0 I}{4\pi}\int_{-9}^{9} dL \frac{x}{(x^2+y^2)(x^2+y^2)^{\frac{1}{2}}}$

$B = \frac{\mu_0 I}{4\pi}\int_{-9}^{9} dL \frac{x}{(x^2+y^2)^{3/2}}$

Recall $dL = dy$

$B = \frac{\mu_0 I}{4\pi}\int_{-9}^{9}\frac{x}{(x^2+y^2)^{3/2}}dy$

$B = \frac{\mu_0 I x}{4\pi}\int_{-9}^{9}\frac{1}{(x^2+y^2)^{3/2}}dy$ --- (***)

using special integral

19/MHS011/010

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

Eqt (~~xxx~~) ∴ becomes

$$B = \frac{\mu_0 I x}{4\pi} \left[\frac{y}{x^2(x^2+y^2)^{1/2}} \right]_{-9}^{9}$$

$$B = \frac{\mu_0 I x}{4\pi} \left(\frac{2 9}{x^2(x^2+9^2)^{1/2}} \right)$$

$$B = \frac{\mu_0 I}{4\pi x} \left(\frac{2 9}{(x^2+9^2)^{1/2}} \right)$$

$$(x^2+9^2)^{1/2} \simeq 9, \quad 9 \to \infty$$

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