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Matric number 19/mhs09/004
Dentistry
MHS
PHY 102 Assignment

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~~Section A~~

1(a) Charging by induction:
Electric Charges can be Obtained on an object Without touching it, by a process called electrostatic induction. consider a positively charged rubber rod brough near a neutral (uncharged) conducting sphere that is insulated so that there Is no Conducting path to ground as shown in the diagram below. The repulsive force between the protons in the rod and those in the sphere causes a redistribution of charges On the sphere so that some protons ~~in the rod~~ move to the side of the sphere Farthest away From the rod (Fig. 1.3a). The region of the sphere nearest the posively charged rod has an excess of negative Charge because of the migration of protons

away from the location. If a grounded conducting wire is then connected to the sphere, as in (Fig. 1.3b), some of the protons leave the sphere and travel to the earth. If the wire to ground is then removed (Fig. 1.3c), then conducting sphere is left with an excess of induced negative charge. Finally when the rubber rod is removed from the vicinity of the sphere (Fig. 1.3d), the induced negatively charge remains on the ~~grou~~ ungrounded sphere and becomes uniformly distributed over the surface of the sphere

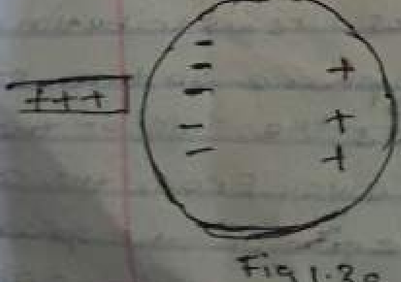


Fig 1.3a

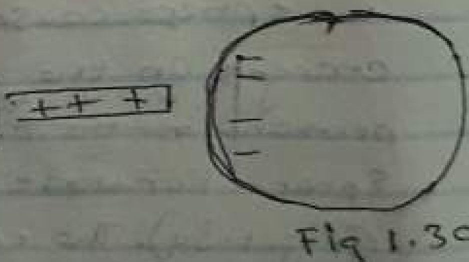


Fig 1.3c

1(5). $K = 9 \times 10^9$

$q_1 + q_2 = 5 \times 10^{-6}\,C$.

$F = 1N$.

$d = 2m$

Recall that; $K = 9 \times 10^9$

$$F = \frac{K q_1 q_2}{r^2}$$

$\cancel{1 = 9 \times 10^9 \times (q_1 q_2 \times 5 \times 10^{-6})}$

$$1 = \frac{9 \times 10^9 \times (q_1 q_2 \times 5 \times 10^{-6})}{2^2}$$

$4 = 9 \times 10^9 \times 5 \times 10^{-5} \times q_1 + 9 \times 10^9 q_2$

$4 = 4.5 \times 10^{-5} q_1 + 9 \times 10^9 q_2$

$4.5 \times 10^5 q_1 + 4 = 0$.

$9 \times 10^9 q_2 - 4.5 \times 10^5$

$0.0000111C$.

$q_1 = 0.0000038C$.

$q_2 = 0.0000038C$

$q_2 = 1.11 \times 10^{-5}\,C$.

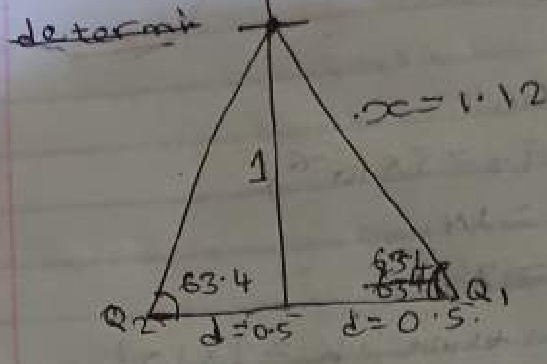
$\Rightarrow q_1 = 1.11 \times 10^{-5}\,C$.

$\Rightarrow q_1 = 3.8 \times 10^{-5}$

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

$d = 0.5\,m$

~~determi~~



using pytagora theorem

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

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

$x = \sqrt{1.25}$

$x = 1.12$

$$\tan\theta = \frac{opp}{adj}$$

$\theta = 1/0.5 = 2$

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

$\theta = 63.4$

$\cancel{E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)} = 5739.795}$

$\cancel{E_2 = \frac{kq_1}{r^2} = 9\times10^9 \times 8\times10^{-5}}$

$$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)} = 5739.795918$$

$$E_2 = \frac{kq_1}{r^2} = 9\times10^9 \times 8\times10^{-6} = 5739.795918$$

$E_q = \frac{kq}{r^2}$

vector

$E_1 = 5739.795$

$E_2 = 5739.$

$E_q = 9\times$

$E_q = \frac{Kq}{r^2} = \frac{9 \times 10^9 \times q}{1} = 9 \times 10^9 q$

	angle	x-component	y-component
~~vector~~ ~~$E_1 = 5739.79513$~~	63.4°	$E_1 \times \cos\theta = 2670043785$	5132.263939
$E_2 = 5739.79593$	63.4°	2570.045785	5132.263839
$E_q = 9 \times 10^9 q$	90°	$E_q \cos\theta = 0$	$9 \times 10^9 q$
		$\Sigma_x = 0$	$\Sigma_y = 10264.5256$

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

$E_q = \sqrt{0^2 + (10264.52568)^2}$

since $\Sigma_x = 0$

$0 = 9 \times 10^9 q + 10264.52568$

$q = -\frac{10264.52568}{9 \times 10^9}$

~~$q = 1.1405$~~ $q = 1.1405028 \times 10^{-6}$

$\pm q = 1.14C$

2(a). Electric Field is a region of space in which electric charges will experience an electric force which electric intensity is the Force per unit charge.

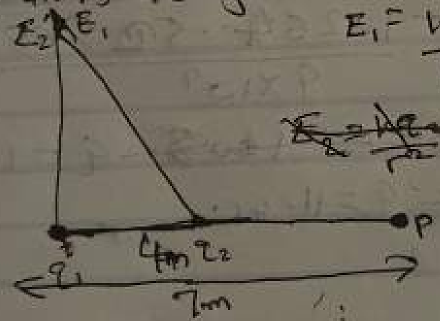
(b)i. $q_1 = 8nC$ as origin, $q_2 = 12nC$ on x-axis as $x = 4m$.

(i). net electric field at point P on the x-axis at $x = 7m$.

ii. electric field at a point Q on the y-axis at $y = 3m$ due to the charges

i. $E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2}$

$~~E_2 = \frac{kq_2}{r^2}~~ = 1.469 N/C$



$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{7^2} = 12 N/C.$

$W = E_{net} = E_1 + E_2 = 1.5 + 1.24$
$= 1.3.7$

ii.

vector

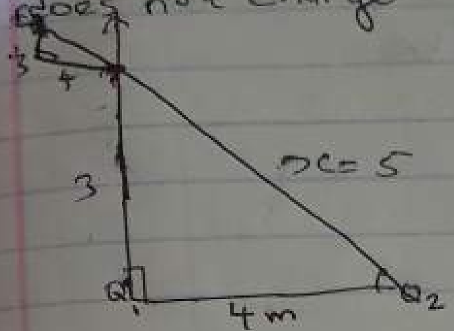
$E_1 = 3N/C$

$E_2 = 4.32$

E_{net}

E_{net}

ii. E at point Q on the y-axis at y = 3m does not charge.



$c^2 = a^2 + b^2$

$c^2 = 4^2 + 3^2$

$c^2 = 16 + 9 = 25$

$c = \sqrt{25} = 5$.

$E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2}$

$= 8 N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2}$

$= 4.32 N/C$

vector	angle	x-component	y-component
$E_1 = 8 N/C$	$90°$	$0 N/C$	$8 N/C$
$E_2 = 4.32 N/C$	$36.0°$	$-3.45 N/C$	$2.59 N/C$
		$\Sigma F_x = -3.45 N/C$	$\Sigma F_y = 10.59 N/C$

$E_{net} = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$

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

$= \sqrt{-11.90 + 112.15}$

$= \sqrt{124.05}$

$= 11.14 N/C$.

3a. Magnetic flux is defined as the strength of the magnetic field which can be represented by the line of forces. O=B.dA

b.

4b. $m = 9 \times 10^{-31}$ kg

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

~~mq~~ $B = 3.5 \times 10^{-1}$ weber / meter^2

cyclotron freavuency = angular speed

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

$$\omega = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9 \times 10^{-31}}$$

$$\omega = 62222222222.22222 \ T^{-1}$$

C

3(c) In the question we were given parameters such as;

i. mass of the electron $= \cancel{9x}\ 9.11 \times 10^{-31}$ kg

ii. radius $= 1.4 \times 10^{-7}$ m.

iii. ~~mg~~ magnetic Field $= \cancel{3.5}\ 3.5 \times 10^{-1}$ w

recall that angular speed =

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

$$\omega = v/r = \frac{qB}{m} = \cancel{1.6 \times 10^{-10} \times 3.5 \times 10^{-10}}$$

$$\frac{1.6 \times 10^{-10} \times 3.5 \times 10^{-10}}{= 9.11 \times 10^{-31}}$$

$$\frac{qB}{m} = \cancel{1\times6}\ \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$$= 622.22\ T^{1}.$$

4a Biot savavrt law states that the magnetic field is directly proportional to the product permeability of free space, the current I, the length, the radius and inversely proportional to square of radius.

It can be mathematically represented as

$$dB = \frac{\mu_0}{4\pi} \frac{I\, dl \times r}{r^2}$$

where μ_0 is constant called permeability of free space.

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

B = weber/m^2.

4b. Magnetic field a straight current carrying condutor

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

Recall dl = dy

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

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

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

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

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

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

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

$$(x^2+ a^2)^{1/2} \cong \mathbf{a}, \text{ as } a \rightarrow$$

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

In a physical situation, we have axial symmetry about the y- axis. Thus, at all points in a circle of radius r, around the conductor, the magnitude of B is

$$B = \frac{\mu_o I}{2\pi r} \qquad \ldots \qquad (\#)$$

Equation (#) defines the magnitude of the magnetic field of flux density B near a long, straight current carrying conductor.

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