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DEPT: COMPUTER ENGINEERING

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COURSE TITLE: ELECTRICITY, MAGNETISM AND MODERN PHYSICS.

COURSE CODE: PHY 102.

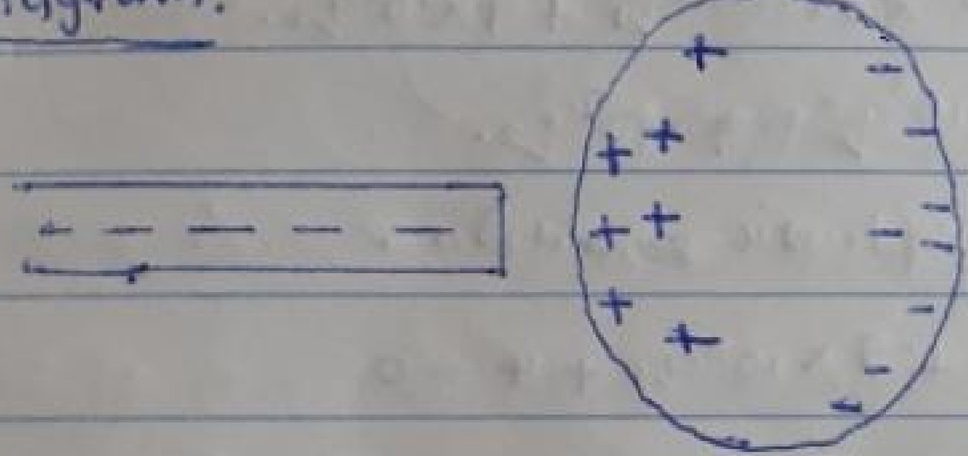
SECTION A

1a. Charging by induction.

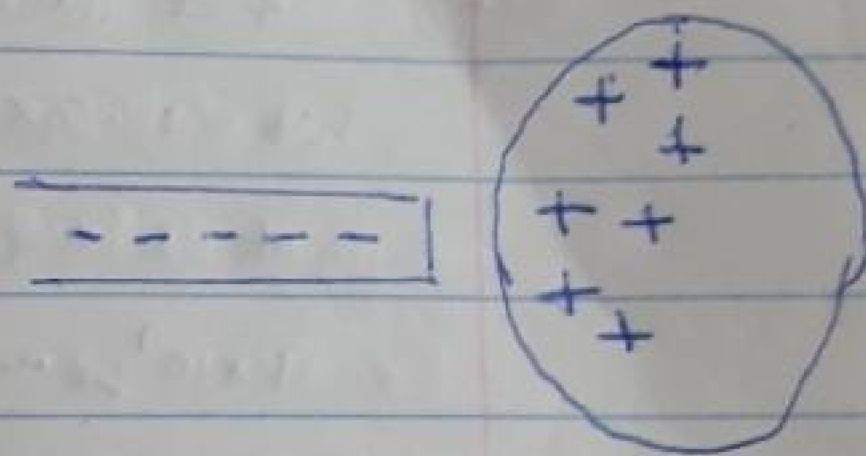
Electric charges can be obtained on an object without touching it, by a process called electrostatic induction. consider a positively charged rubber rod brought near a neutral (uncharged) conducting sphere that is insulat[ed] so that there is no conducting path to ground as sho[wn] below. The repulsive force between the protons in the rod and those in the sphere causes a redistribution of charges on the sphere so that some protons move to th[e] side farthest away from the rod. The region of the sphere nearest the positively charged rod has an excess of negative charge because of the migrat[ion] of protons away from this location. If a grounde[d] conducting wire is then connected to the sphere, ~~…~~ some of the protons leave the sphere and travel to the earth.

If the wire to ground is then removed, the conducting sphere is left with an excess of induced negative charge. Finally, when the rubber rod is removed from the ~~charge~~ ~~remains on~~ vinicity of the sphere, the induced negatively charged remains on the ungrounded sphere and becomes uniformly distributed over the surface of the sphere.

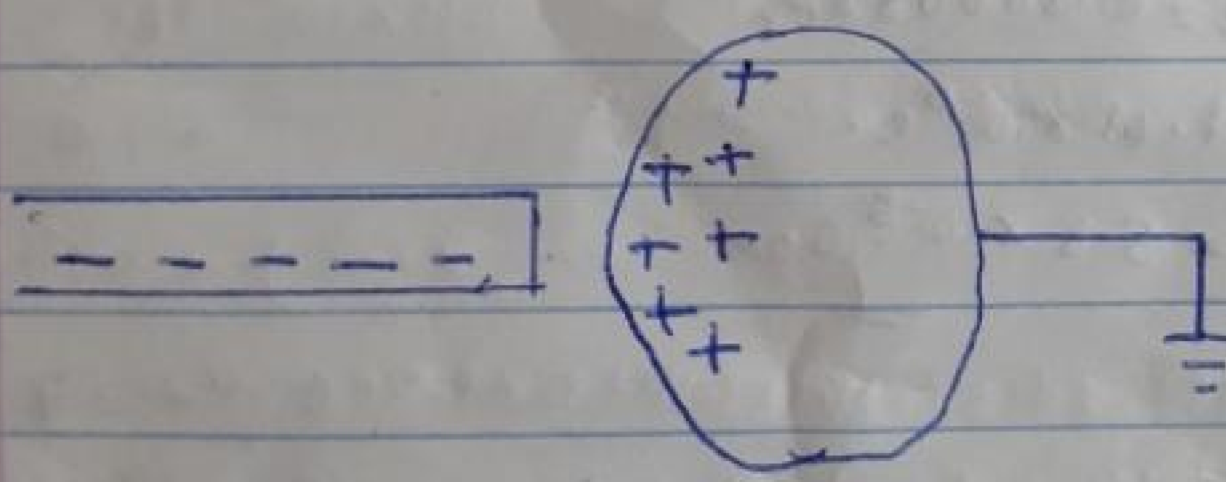
Diagram:



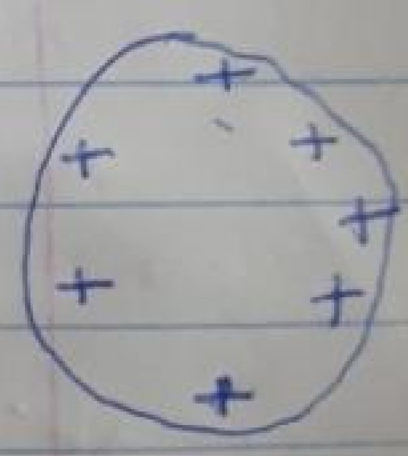
~~fig 13 a~~ a.



~~fig 13~~ c.



b.



d.

b) $K = 9 \times 10^9$

$Q_1 + Q_2 = 5 \times 10^{-5} C$.

$F = 1N$

$d = 2m$.

Calculate the charge on each sphere?

Recall that.

$k = 9 \times 10^9$

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

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

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

$4 = 4.5 \times 10^5 q_1 + 9 \times 10^9 q_2$.

It is a quadratic equation.

$9 \times 10^9 q_2 - 4.5 \times 10^5 q_1 + 4 = 0$

$q_1 = 0.0000111 c$.

$q_2 = 0.000038 c$.

$\therefore q_1 = 1.11 \times 10^{-5} c$.

$\therefore q_2 = 3.8 \times 10^{-5} c$

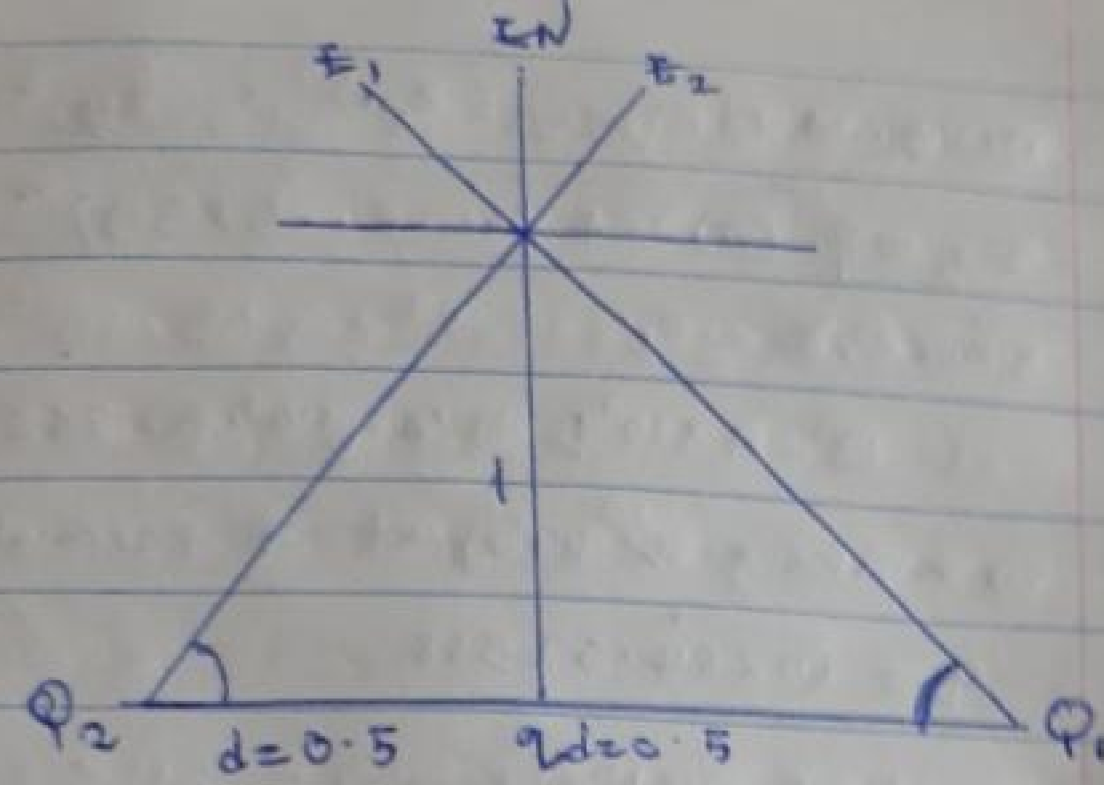
c. $Q_1 = q_2 = 8 \mu c$

$d = 0.5 m$

determine Q if electric field at a point P is zero.

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

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



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

$\theta = 63.4$

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

$\sqrt{x^2} = \sqrt{1.26}$

$x = \sqrt{1.26}$

$x = 1.12$

$$E_1 = \frac{kq_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5789.795918.$$

$$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5789.795918.$$

$$E_q = \frac{kq}{r^2} = \frac{9\times10^9 \times q}{1} = 9\times10^9 q$$

Vector	angle	x.comp	y-comp
$E_1 = 5789.795918$	63.4°	$E_1 = \cos\theta$	5132.262839
	$E_1 =$	$x = 70.045785$	
$E_2 = 5739.795918$	63.4°	$x = 70.045785$	5132.282839

$$\text{magnitude} = \sqrt{(\Sigma x)^2 + (\Sigma y)^2}$$

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

since, $E = 0$.

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

making q subject of formula.

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

$$q = 1.140502853 \times 10^{-6}$$

$$\simeq q = 11.4\mu C.$$

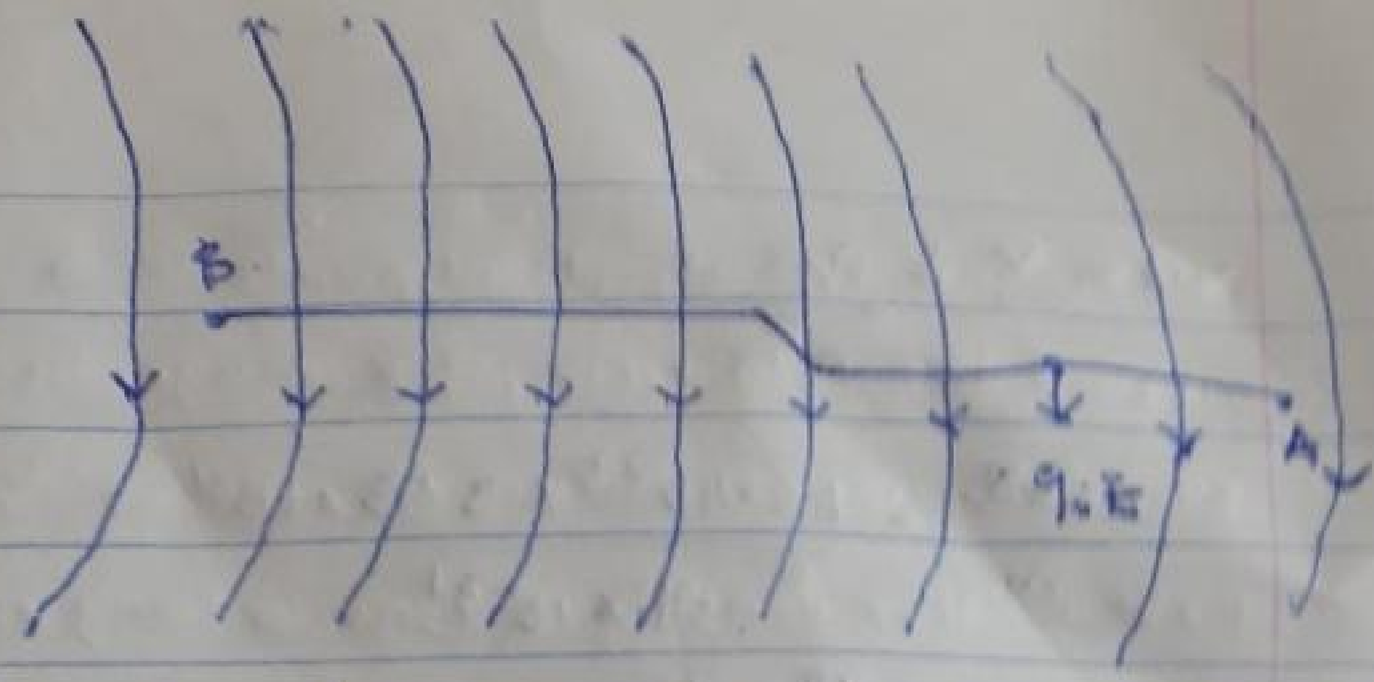
3a; volume charge density.

ii Linear charge density.

iii surface charge density.

3b ELECTRIC POTENTIAL DIFFERENCE

The electric potential difference between two points in an electric field can be defined as the workdone per unit charge against electrical forces when a charge is transported from one point to the other. It is measured in volt or joules per coloumb. Electric potential difference is a scalar quantity.



consider the diagram above, suppose a test charge is moved from point to point along an arbitrary path inside an electric field. The electric field exerts a force on the charge as shown in fig 3.1. To move the test charge from to a constant velocity, an external force of must act on the charge. Therefore, the elemental workdone is given as putting equation in yields.

4a magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol ϕ. mathematically given as $\phi = B.dA$

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

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

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

cyclotron frequency = angular speed.

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

$$\omega = \frac{qB}{m} = \frac{1.6\times10^{-19}\times 3.5\times10^{-1}}{9\times10^{-31}}$$

$$\omega = \underline{6.2\times10^{10}\,T^{-1}}$$

4c. mass of the electron = 9.11×10^{-31} kg.

A radius of 1.4×10^{-7} m.

magnetic Field of 3.5×10^{-1} weber/meter square.

Recall that angular speed is given as ω = =

substituting we have, $\omega = \dfrac{1.6\times10^{\wedge}-10 \times 3.5\times10^{\wedge}-10}{9.11\times10^{\wedge}-31}$.

$= \underline{6.2\times10^{10}T^{-1}}$.

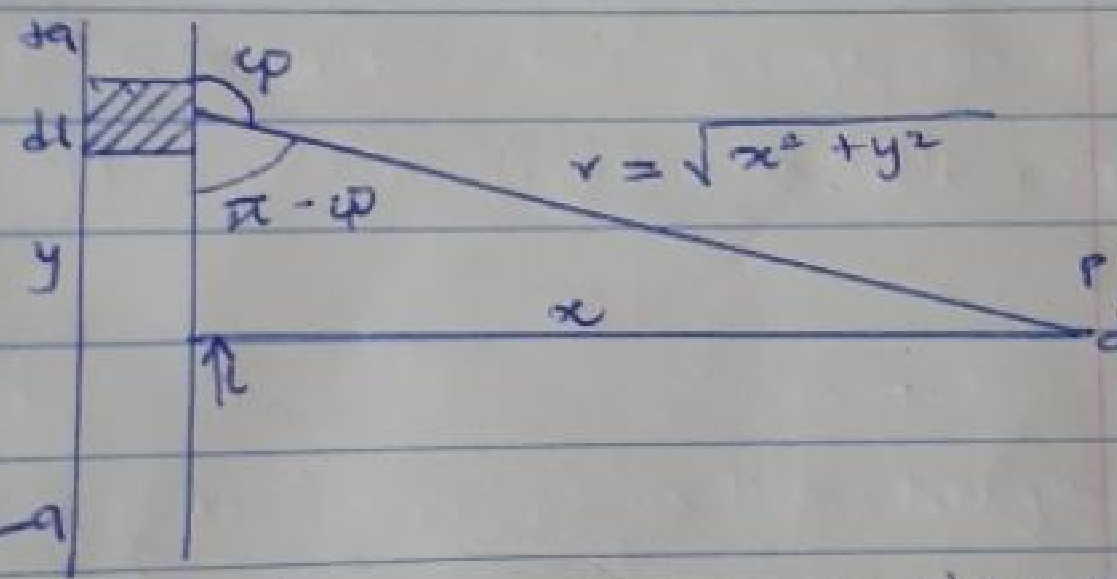
so since cyclotron frequency is equal to angular speed the cyclotron frequency is equal to 6.2×10^{10} T-1, having a unit as 1/T which is equal to the unit of frequency dimensionally.

5a. Biot-savart law states that the magnetic field is directly proportional to the product permeability of free space (μ_0), the current (i), the change in length the radius (r^2). It can be represented mathematically by.

The unit is weber / meter square.

5b. Magnetic field of a straight current carrying conductor

Fig 1: A section of a straight current carrying conductor



Applying the Biot savart law, we find the magnitude of the field. From diagram,

Recall,

using special integrals:

when the length of the conductor is very great in comparison to its distance from point P, we consider it infinitely long. That is, when is much larger than, in a physical situation, we have axial symmetry about the y-axis. Thus, at all points in a circle of radius around the conductor, the magnitude of B is

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