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MHS
MBBS
100L

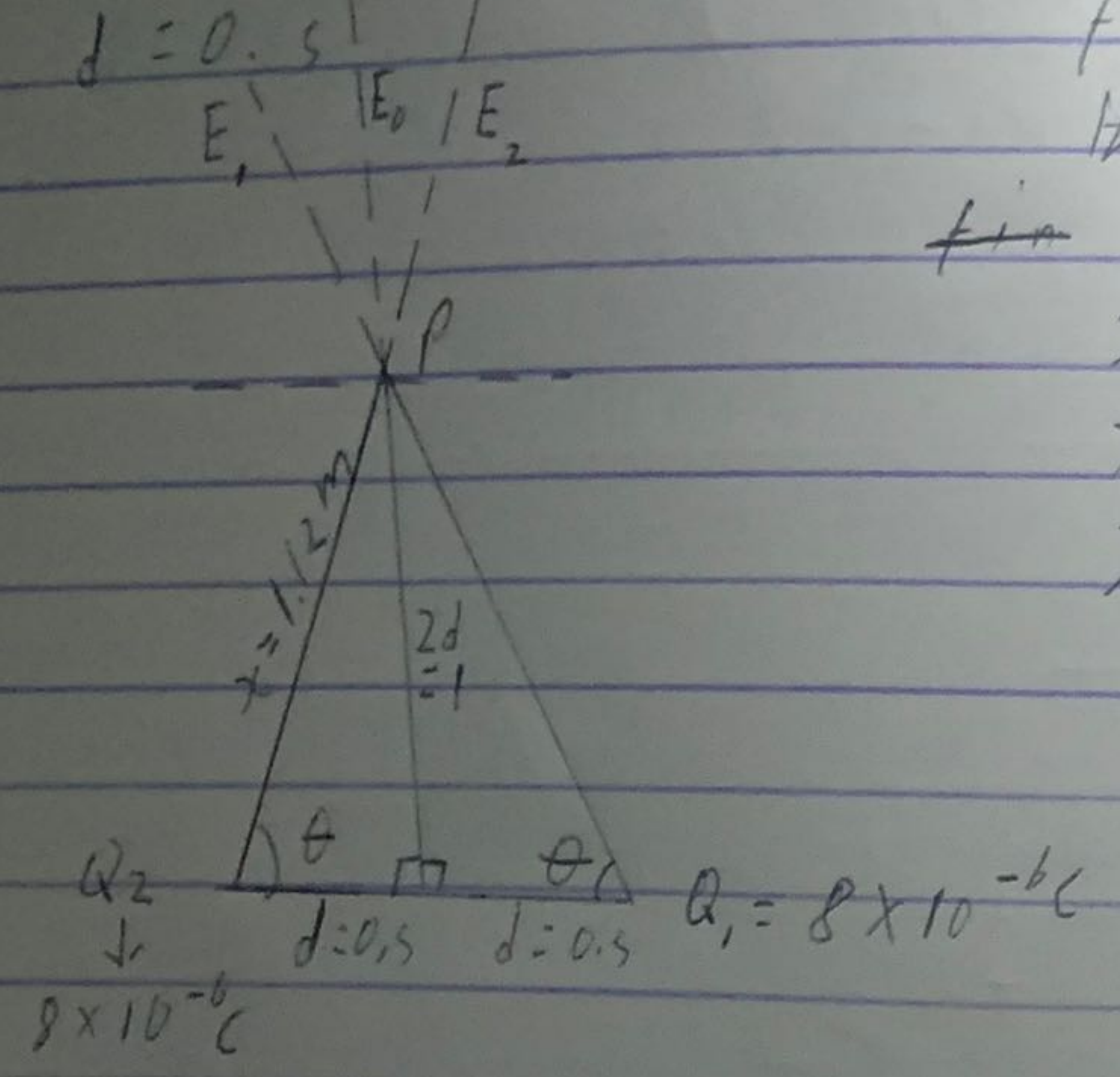
PHY 102 COVID-19
Holiday Assignment Section A

1a.) Charging by induction:
Electric charges can be obtained without touching it, by a process called electrostatic induction. Consider a positively charged rubber rod brought near a neutral (uncharged) conducting sphere that is insulated so that there is no conducting path to ground. ~~as shown below~~ The repulsive force causes a redistribution of charges on the sphere so that some protons move to the side of the sphere farthest away from the rod. The region of the sphere nearest the positively charged rod has an excess of negative charge because of the migration of protons away from this location. When the rubber rod is removed from the vicinity of the sphere, the induced negative charge remains on the ungrounded sphere and becomes uniformly distributed over the surface.

1.) b.) $K = 9 \times 10^9$
~~$q_1 + q_2$~~
$q_1 + q_2 = 5 \times 10^{-5} C$
$F = 1N$
$d = 2m$
To find the charge on each sphere
$K = 9 \times 10^9$
$F = \frac{K q_1 q_2}{r^2}$
$1 = \frac{9 \times 10^9 \times (q_1 q_2 \times 5 \times 10^{-5})}{2^2}$
$4 = 9 \times 10^9 \times 5 \times 10^{-5} q_1 + 9 \times 10^9 q_2$
$4 = 4.5 \times 10^5 q_1 + 9 \times 10^9 q_2$
it's a quadratic eqn
$9 \times 10^9 q_2 - 4.5 \times 10^5 q_1 + 4 = 0$
$q_1 = 0.0000111 C \simeq 1.11 \times 10^{-5} C$
$q_2 = 0.000038 C \simeq 3.8 \times 10^{-5} C$

1 c.)

1(c.) $Q_1, Q_2 = 8\mu C = 8\times10^{-6}C$




find $x$ using pythagoras theorem

$x^2 = 2d^2 + d^2$

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

$x = \sqrt{1^2 + 0.5^2}$

$x = 1.12m$

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

$\tan\theta = 2$

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

$\theta = 63.43°$

$E = \frac{Kq}{r^2}$

$Q_1 = Q_2 \; ; \; E_1 = E_2$

$E_1 = E_2 = \frac{9\times10^9 Nm^2C^{-2} \times 8\times10^{-6}C}{(1.12m)^2}$

$E_1 = E_2 = \frac{7200}{1.2544}$

$= 5739.796$

$E_1 = E_2 = 5.74\times10^4\ NC^{-1}$

$E_q = \frac{Kq}{r^2} = \frac{9\times10^9 Nm^2C^{-2}\times q}{1^2} = 9\times10^9 q\ NC^{-1}$

$\therefore E_q = 9\times10^9 q\ NC^{-1}$

| Forces | Angles | X-Component ($E\cos\theta$) | Y-Component ($E\sin\theta$) |
|---|---|---|---|
| $5.74\times10^4 NC^{-1}$ | $63.43°$ | $5.74\times10^4\cos63.43° = +2.57\times10^4$ | $5.74\times10^4\sin63.43° = 5.13\times10^4$ |
| $5.74\times10^4 NC^{-1}$ | $63.43°$ | $5.74\times10^4\cos63.43° = -2.57\times10^4$ | $5.74\times10^4\sin63.43° = 5.13\times10^4$ |
| $9\times10^9 q\ NC^{-1}$ | $90°$ | $9\times10^9 q\cos90° = 0$ | $9\times10^9 q\sin90° = 9.0\times10^9 q$ |
| | | $\Sigma x = 0 NC^{-1}$ | $\Sigma y = 1.026\times10^5 NC^{-1} + 9.0\times10^9 q$ |

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

$E_q = \sqrt{E_x^2 + E_y^2}$

$E_q = \sqrt{(0^2) + [(1.026\times10^5)^2 + (9.0\times10^9 q)^2]}$

$E_q = \sqrt{1.053\times10^{10} + (9.0\times10^9 q)^2}$

$0^2 = (\sqrt{1.053\times10^{10} + (9.0\times10^9 q)^2})^2$

$0 = 1.053\times10^{10} + (9.0\times10^9 q)^2$

$(-9.0\times10^9 q)^2 = 1.053\times10^{10}$

$\therefore q^2 = \frac{1.053\times10^{10}}{(-9.0\times10^9)} = \frac{1.053\times10^{10}}{8.1\times10^{19}} = 1.3\times10^{-10}C$

$q = 11.4\ \mu C$

3 a.) i.) Volume Charge density: the quantity of charge per unit volume, measured in the SI system in Coulombs per cubic meter, at any point in a volume.

ii.) Surface charge density: the measure of how much electric charge is accumulated over a surface. It is calculated as the charge per unit surface area.

iii.) Linear charge density: the quantity of charge per unit length, measured in Coulombs per meter, at any point on a line charge distribution. Charge density can be either positive or negative, since electric charge can be either positive or negative.

3 b.) Electric Potential difference: The electric potential difference between two points in ~~and~~ an electric field can be defined as the work done 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 ~~[illegible]~~ Coulomb.

3 c.) Suppose a test charge is moved from one point along an arbitrary path inside an electric field. The electric field exerts a force on the charge. To move the test charge at a constant velocity, an external force must act on the charge. ~~Therefore, the elemental work done is given as~~

Section B

4 a.) Magnetic flux is defined as the strength of the magnetic field which can be represented by lines of forces. It is represented by the symbol $\Phi$.

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

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

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

Cyclotron frequency = angular speed

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

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

$$\omega = 6.2 \times 10^{-11} \; T^{-1}$$

4c.) In the question we are given the parameters such as:
i) mass of the electron = $9.11 \times 10^{-31}$ Kg, radius, magnetic field.
We are then asked to find the cyclotron frequency which is equal to angular speed. It is called cyclotron ~~fr~~ frequency because it is a frequency of an accelerator called cyclotron.

5a.) Biot-Savart law states that the magnetic field is directly proportional to the product permeable of free space ($\mu$), the current ($I$), the change in length, the radius and inversely proportional to square of radius ($r^2$).

b.) Magnetic Field of a straight current carrying conductor
Recall using speed integral:
When the length of a conductor is very great in comparison to its distance from point $P$. We consider it uniformly long. That is, when it 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, magnitude of $B$

is equation defines the magnitude of the magnitude field of flux density $B$ near a long, straight current carrying conductor.