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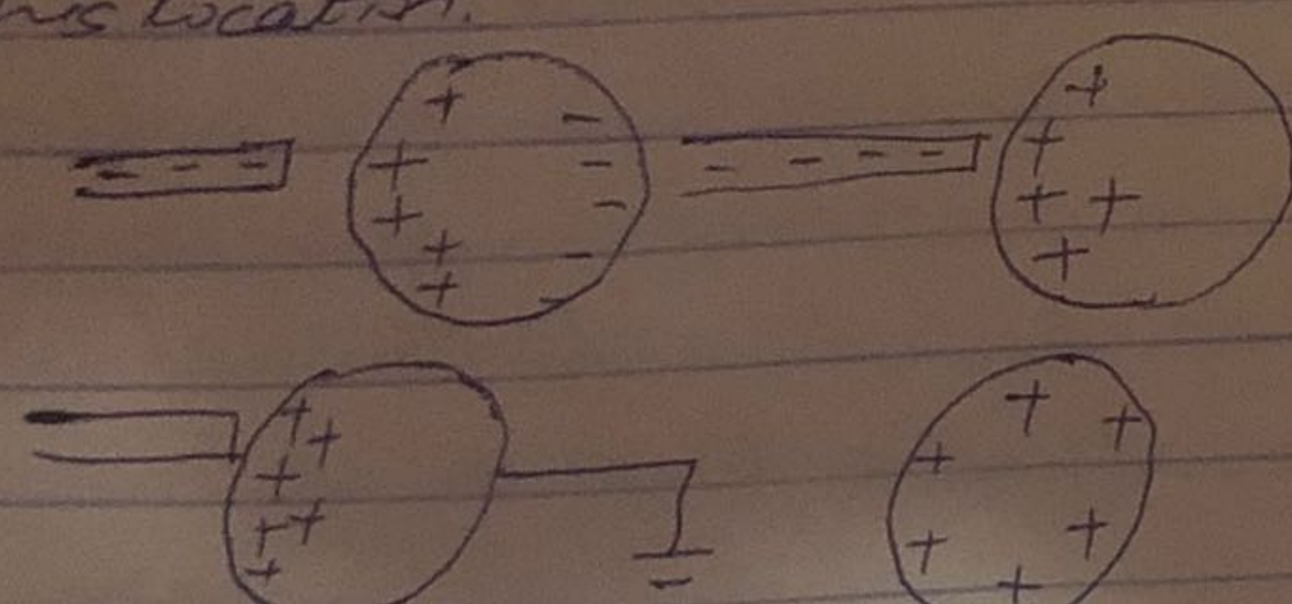
SECTION A.

1a) Charging by induction:

Electric charges can be obtained on an object without touching it, by a process called electrostatic induction. A negatively charged rubber rod brought near a neutral conducting sphere that is insulated so that there is no conducting path to ground. The repulsive force between electrons in the rod and those in the sphere cause a redistribution of charges on the sphere so that some electrons move to the side of the sphere farthest away from ~~this location~~ the rod. The region of the sphere nearest to the negatively charged rod has an excess of positive charge because of the migration of electrons away from this location.



1b ~~Charg~~ $K = 9\times10^9$

$q_1 + q_2 = 5\times10^{-5}C$

$F = 1N \quad d = 2m.$

Calculate the charge on each sphere?

Recall that

$K = 9\times10^9.$

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

$1 = \frac{9\times10^9(q_1 q_2 5\times10^{-5})}{2^2}$

$4 = 9\times10^9\times5\times10^{-5}q_1 + 9\times10^9 q_2$

$4\times4.5\times10^5 q_1 + 9\times10^9 q_2$. – It is a quadratic equation

$9\times10^9 q_2 - 4.5\times10^5 q_1 + 4 = 0$. – solving it simultaneously

$q_1 = 0.00011C.$

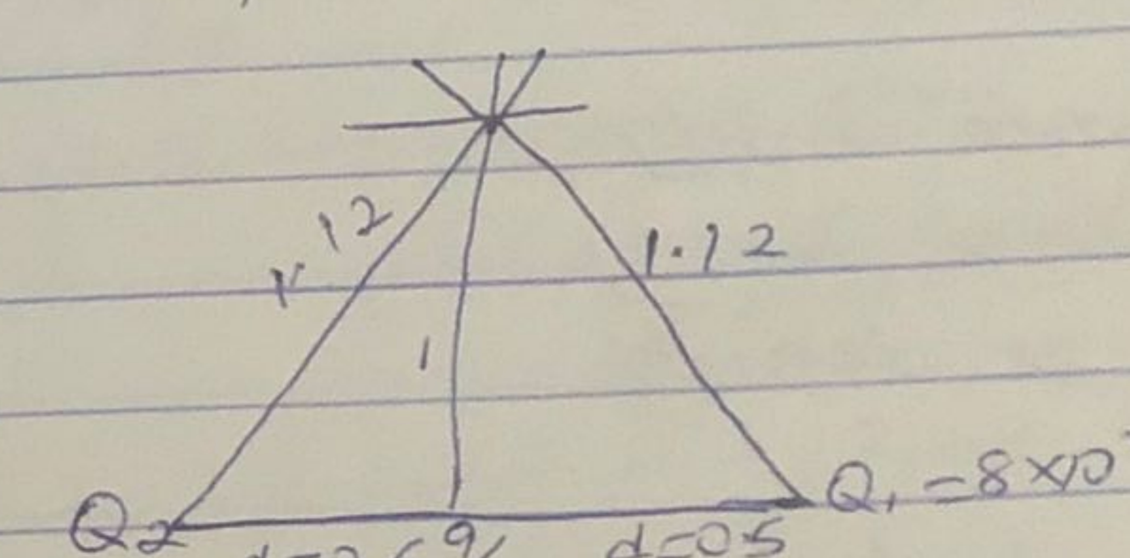
$q_2 = 0.000038C$

$\simeq q_1 = 1.11\times10^{-5}C$ and $q_2 = 3.8\times10^{-5}C$

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

$d = 0.5m$

Determine Q if electric field at point P is zero.



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

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

$\theta = 63.4.$

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

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

$x = \sqrt{1.25}$

$x = 1.12.$

$E_1 = \frac{Kq_1}{r_1} = \frac{9\times10^9\times8\times10^{-6}}{1.12^2} = 5739.7959$

$E_2 = \frac{Kq_2}{r_2} = \frac{9\times10^9\times8\times10^{-6}}{1.12^2} = 5739.7959$

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

Vector	angle	x-component	
$E_1 = 5739.7959$	$63.4°$	$E_1 \cos\theta = -2570.046$	5132.263
$E_2 = 5739.7959$	$63.4°$	2570.046	5132.263
$E_q = 9\times10^9 q$	$90°$	$E_q \cos\theta = 0.$	$9\times10^9 q$
		$\Sigma x = 0.$	$\Sigma y = 10264.526$

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

$E_q = \sqrt{(0)^2 + (10264.526)^2}$

Since $E = 0.$

$0 = 9\times10^9 q + 10264.52568$

making q subject of formulae.

$q = \frac{-10264.52568}{9\times10^9}$

$q = 1.14 \times 10^{-6}.$

$q = 1.14 uC.$

3a

1) Volume charge density.

2) Surface Charge density

3) Linear charge density.

3b) Electric potential difference.

It 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 joules per columb or volt. It is a scalar quantity.

where E = electric field.
F = force exerted by the electric field
q_0 = charge.

$dW = F \cdot dL.$

But

$F = -q_0 E.$

$dW = -q_0 E dL$

Then total work done in moving the test charge from A to B is:

$W(A \to B)_{Ag} = -q_0 \int_A^B E dL$

$V_B - V_A = \frac{W(A \to B)_{Ag}}{q_0}.$

$V_B - V_A = -\int_A^B E dL.$

SECTION B.

4a) Magnetic flux is defined as the strength of the magnetic field which is represented by line of forces. It is represented by the symbol ϕ.

4b) $m = 9\times10^{-31}$ kg. , $r = 1.4\times10^{-7}$ m, $B = 3.5\times10^{-1}$ weber/m²

cyclotron frequency = angular speed

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

$\omega = 62222222222222.222\ T^{-1}.$

$\omega = 6.2\times10^{11}\ T^{-1}.$

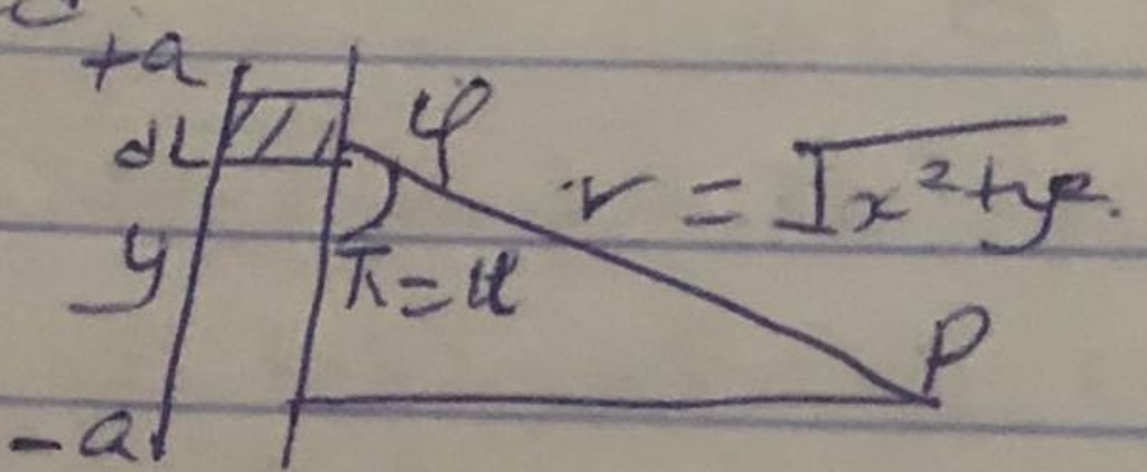
c) Since cyclotron frequency is equal to angular speed. The cyclotron frequency is equal to $6.2\times10^{11} T^{-1}$ having a unit of T^{-1} which is equal to the unit of frequency dimensionally.

5a) Biot-Savart law states that the magnetic field is directly proportional to the product permeability of free space, the current, the change of length, the radis and inversely proportional to square of radius (r^2). It can be represented mathematically by where the constant called Permeability of free space. The unit is weber/metre square

5b) Magnetic Field of a straight current carrying conductor.

Fig1: A section of a straight current carrying conductor

Applying the Biot-Savart law, we find magnitude of the field



From the diagram.