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S/n : 19/MHS01/157

PHY 102 Assignment

1. a. Charging by induction

An object can be charged with out physical contact through a process called electrostatic induction. Here;

i) A negatively charged rod is brought close to neutral sphere. (that is insulated.)

ii) Due to repulsion of like charges, there is redistribution of charges in sphere.

iii) With the rod close to the sphere, connect the sphere to earth, causing the sphere to be uniformly charged.

iv) Remove the rod ~~after~~ after you ~~disconnect~~ disconnect the sphere from ~~the rod~~ earth, your sphere is charged

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

$F = 1N$

$d = 2m$

find $q_1 = ?$, $q_2 = ?$

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

$$1 = \frac{9 \times 10^9 (5 \times 10^{-5} - q_2) q_2}{4}$$

$$1 = \frac{4.5 \times 10^5 q_2 - 9 \times 10^9 q_2^2}{4}$$

$$4 = 4.5 \times 10^5 q_2 - 9 \times 10^9 q_2^2$$

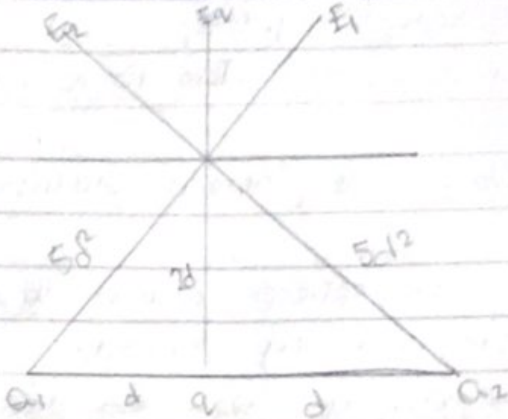
$$9 \times 10^9 q_2^2 - 4.5 \times 10^5 q_2 + 4 = 0$$

$\therefore q_1 \text{ or } q_2 = 3.84 \times 10^{-5} C$ or $1.16 \times 10^{-5} C$

c. $Q_1 = Q_2 = 8\mu C$

$d = 0.5m$

determine Q & electric field at a point P is zero



$E_1 = \frac{Kq_1}{r_2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.12^2} = 5739.795918$

$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.12^2} = 5739.795918$

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

Vector	Angle	X component	Y component
$E_1 = 5739.795918$	63.4	2570.045785	5132.262839
$E_2 = 5739.795918$	63.4	-2570.045785	5132.262839
$E_q = 9\times10^9 q$	90	0	$9\times10^9 q$

Magnitude $= \sqrt{(Ex)^2 + (Ey)^2}$

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

$E_q = 10264.52568$

$\therefore 10264.52568 = 9\times10^9 q$

$q = 1.14\times10^{-6} C \simeq 1.14\mu C$

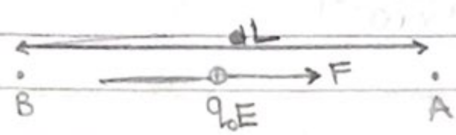
3) a. i) Volume charge density $\rho = dQ/dV$

ii) Surface charge density $\sigma = dQ/dA$

iii) Linear charge density $\lambda = dQ/dL$

b. Electric potential difference;

The electric potential difference between two points in an electric field is the workdone per unit charge



Consider the diagram above suppose a test charge is moved from point B to A. To move test charge ~~through the field a force~~ an external force, $F = -q_0E$, is exerted at charge;

$$\therefore dW = F.dL$$

$$dW = -q_0 E dL$$

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

recall from definition

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

$$\therefore V_A - V_B = -\int_B^A E dL$$

4) a. Magnetic flux is defined as the strength of magnetic field represented by lines of force. it is usually represented by symbol Φ, mathematically $\Phi = B.dA$

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

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

$B = 3.5 \times 10^{-1}$ webers/m^2

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

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

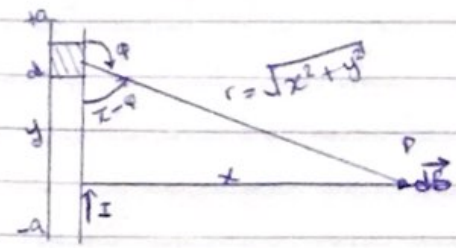
$$\omega = 6.2 \times 10^{9}\ T^{-1}$$

c. ~~mass~~ cyclotron frequency = angular speed.

5 a. The Biot Savart Law ~~is~~ ~~based~~ states that the change in magnetic field is directly proportional to the product of ~~the permeability of free space (μ_0)~~ the current (I), radius ($\hat{r}$) and change in length, and inversely proportional to square of radius (r^2).

$$B = \frac{\mu_0}{4\pi} \int \frac{I\,dl \sin\theta}{r^2}$$

b.



using Biot-savart law

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

$$\therefore \; B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl \sin(\pi-\varphi)}{r^2}$$

recall $r^2 = x^2+y^2$ and $\sin(\pi-\varphi) = \dfrac{x}{\sqrt{x^2+y^2}}$

$$\therefore \; B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} dl \cdot \frac{x}{(x^2+y^2)^{3/2}}$$

recall $dl = dy$

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

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

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

$a \longrightarrow \infty$

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