Physics Assignment

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Dept: Nursing

Matric No: [illegible]

Course: Phy102

Section A

1. Charging by Induction: Electric charges can be obtained on 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 insulated so that there is no conduction path to ground as shown 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 the side of the sphere farthest away from the rod (fig 1.3a) 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. 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), the 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 charged remains on the ungrounded sphere and becomes uniformly distributed over the surface of the sphere.

Diagram:

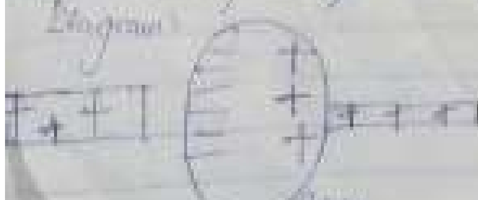


Fig 1.3a

Fig 1.3b

Vector	Angle	X-component	Y-component
$E_1 = 5739.79915$	63.4°	$E_1 = \cos\theta$ $= 2570.045785$	5130.262839
$E_2 = 5739.79988$	63.4°	$E_2 = \cos\theta$ 2570.045785	5132.262839
$E_q = 9\times10^9 q$	90°	$E_q \cos\theta = 0$ $\Sigma x = 0$	$9\times10^9 q$ $\Sigma y = 0$
			10264.52568

Magnitude: $\sqrt{(\Sigma x)^2 + (\Sigma y)^2}$

$$E_q = \sqrt{(0)^2 + (10264.525628)^2}$$

Since $E = 0$

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

Making q subject of formulae.

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

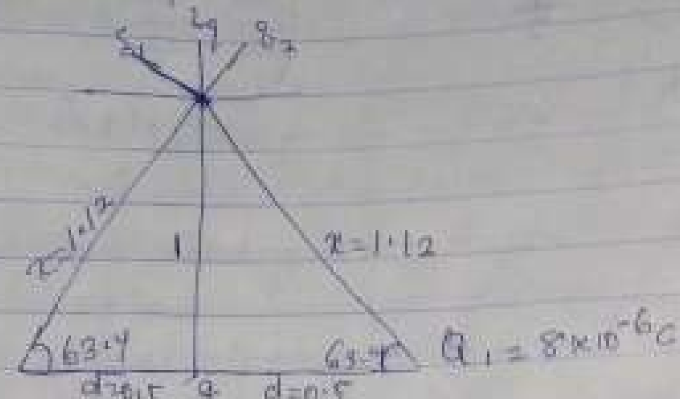
$$q = 1.1405028 53 \times10^{-6}$$

$$q \simeq 11.4\ \mu c$$

1c. $q_1 = q_2 = 8\mu C$

$d = 0.5m$

Determine a of electric field at a point P is zero



Show

$r^2 = 1^2 + 0.5^2$ [$Hyp^2 = opp^2 + adj^2$]

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

$x = 1.12$

$\tan\theta = \frac{opp}{adj}$ [SOH CAH TOA]

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

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

$\theta = 63.4$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5739.795918 = 5739.8\,N$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5739.795918$

$E_3 = \frac{kq_3}{r^2} = \frac{9\times10^9 \times q}{1} = (9\times10^9)\cdot$

Fig1.3b

Fig1.3d

1b. $K = 9\times10^9$

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

$F = 1N$

$d = 2m.$

Calculate the charge on each Sphere.

Recall that:

$k = 9\times10^9$

$F = \frac{kq_1q_2}{r^2}$

$F = 1N$

$d = 2m.\ (r)$

$$1 = 9\times10^9 \times \frac{(q_1q_2 \times 5\times10^{-5})}{2^2}$$

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

$$= 4.5\times10^5 q_1 + 9\times10^9 q_2 = 4.$$

Show Quadratic Equation:

$$9\times10^9 q_2 - 4.5\times10^5 q_2 + 4 = 0.$$

$\therefore\ q_1 = 0.0000111C$

$q_2 = 0.000038C$

$\simeq q_1 = 1.11\times10^{-5}\,C$

$\simeq q_2 = 3.8\times10^{-5}\,C$

$$W(A' \cap B)_{ny} = -q_0 \int_A^B E\,dl \ldots \text{(4)}$$

$$V_B - V_A = \frac{W(A' \cap B)_{ny}}{q_0} \ldots \text{(5)}$$

Put equation (4) in (5) yields

$$V_B - V_A = -\int_A^B E\,dl \ldots \text{(6)}$$

4a) Magnetic flux is defined as the strength of the magnetic field which can be represented by line of force. It is represented by the symbol Φ mathematically given as $\Phi = B \cdot dA$.

4b) $M = 9 \times 10^{-31}$ kg

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

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

Cyclotron frequency = angular speed.

$$W = \frac{V}{r} = \frac{qB}{M}$$

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

$$W = 62222222222.2222\,T^{-1}$$

$$\simeq 6.2 \times 10^{10}\,T^{-1}$$

4c) (1) Radius of 1.4×10^{-7} m

(2) Mass of the electron $= 9 \times 10^{-31}$ kg

(3) magnetic field of 3.5×10^{-1} Weber/meter square.

And you are asked to find the frequency of cyclotron which is equal or the same thing as Angular Speed. it is called cyclotron frequency bec

3a. (i) Volume charge Density, $\rho = \frac{dQ}{dv}$, $dQ = \rho dv$

(ii) Surface charge Density, $\sigma = \frac{dQ}{dA}$, $dQ = \sigma dA$

(iii) linear charge Density, $\lambda = \frac{dQ}{dL}$, $dQ = \lambda dL$

3b. Electric Potential Difference.

The electric potential difference between two points in an electric field can be defined as the 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 (V) or Joules per Coulomb (J/C). Electric potential difference is a scalar quantity.

fig 9.1

Consider the diagram above, a test charge q_o is moved from point A to point B along an arbitrary path inside an electric field E. The electric field E exerts a force $= q_o E$ on the charge as shown in fig 9.1. To move the test charge from A to B at constant velocity an external force of $F = -q_o E$ must act on the charge.

Therefore, the elemental work done dw is given as

$dw = F \cdot dl$ --- (1)

$F = -q_o E$ --- (2)

Substitute (2) into (1) i.e.

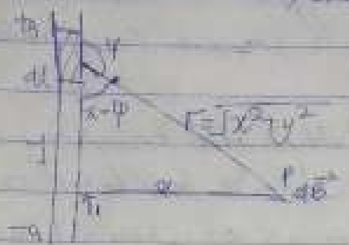
$dw = -q_o E dl$ --- (3)

The total work done in moving the test charge from A to B is;

The unit of B is weber / meter square.

1. Magnetic field of a straight current carrying conductor

Fig 1.2: Section of a straight carrying conductor. Applying the Biot-Savart law, the magnitude of the field dB



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

$$\sin(\pi - \varphi) = \sin\theta$$

from Diagram, $r^2 = x^2 + y^2$ (pythagoras theorem)

$$B = \frac{\mu_0 I}{4\pi}\int_{-a}^{a} \frac{dl \sin(\pi-\varphi)}{x^2+y^2} \quad \text{--- (1)}$$

$$\text{But } \sin(\pi-\varphi) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}} \quad \text{--- (2)}$$

Substituting (ii) into (i), we have

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

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

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

It is a frequency of an accelerator called Cyclotron.

Recall that Angular speed is given as

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

Substituting we have $\omega = \frac{v}{r} = \frac{qB}{m} = \frac{1.6 \times 10^{-10} \times 3.5 \times 10^{-10}}{9.11 \times 10^{-31}}$.

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

$$= 62222222222.2222 \ T^{-1}$$

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 (iii) therefore Becomes

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

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

When the length $2a$ of the conductor is a very great in comparison to its distance x from point P, We consider it infinitely large that it, When a is much larger than x.

$$(x^2+a^2)^{1/2} \simeq a \text{ as } a \to \infty$$

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

In a physical situation, We have axial Symmetry about the y-axis. Thus, at all points on a circle of Radius r, around the conductor, the magnitude of B is

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{——— (4)}$$

Equation (4) defines the magnitude of the Magnetic Field of flux density B near a long, Straight Current carrying Conductor.

So Sine cyclotron frequency is equal to angular speed the cyclotron frequency is equal to = 6222222222.2222 T, having a unit as Hz which is equal to the unit of frequency dimensional.

5b. 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 and inversely proportional to square of Radius (r^2) It can be represented mathematically by

$$dB = \frac{\mu_0}{4\pi} \frac{Idl \times r}{r^2}$$

Where μ_0 is Constant called permeability of free space
$$\mu_0 = 4\pi \times 10^{-7} \ T \cdot \frac{m}{A}$$