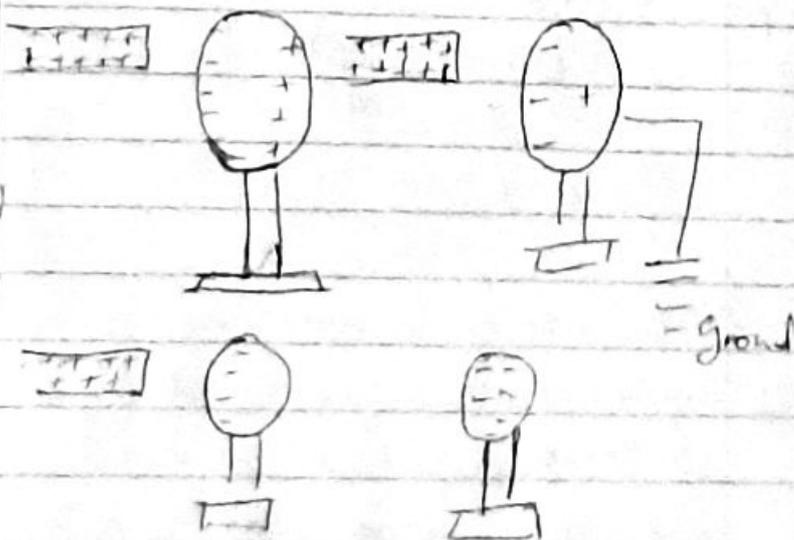


Obasi Chibankem
191mhs01269

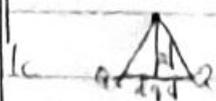
Phy 102

MBS

1. Consider a positively charged rubber rod brought near a neutral conducting sphere that is insulated so that there's no conducting path to ground. The repulsive force between the protons in the rod and those in the sphere causes a redistribution of charge on the sphere furthest away from the rod. The region of the sphere nearest the positively charged rod has an excess negative charge because of the migration of protons away from this location. If a grounded wire is 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 vicinity of the sphere, the induced negative charge is now redistributed on the sphere and becomes uniformly distributed.



$$\begin{aligned}
 (1) \quad q_1 + q_2 &= 5.0 \times 10^{-5} \text{ C} \quad (1) \quad r = 2 \text{ m} \\
 q_1 &= 5.0 \times 10^{-5} - q_2 \\
 F &= \frac{kq_1q_2}{r^2} = \frac{1.9 \times 10^9 (5.0 \times 10^{-5} - q_2)q_2}{2^2} \\
 4 &= (4.5 \times 10^{-5} - 2 \times 10^9 q_2) q_2 \\
 4 &= 4.5 \times 10^{-5} q_2 - 2 \times 10^9 q_2^2 \\
 -2 \times 10^9 q_2^2 + 4.5 \times 10^{-5} q_2 - 4 &= 0 \\
 \text{using quadratic formula} \\
 z &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\
 x &= \frac{-4.5 \times 10^{-5} \pm \sqrt{(4.5 \times 10^{-5})^2 - 4(-2 \times 10^9)(-4)}}{2(-2 \times 10^9)} \\
 x &= \frac{-4.5 \times 10^{-5} \pm \sqrt{2.025 \times 10^{-9} - 3.2 \times 10^{10}}}{-4 \times 10^9} \\
 x &= \frac{-4.5 \times 10^{-5} \pm 2.41667 \times 10^5}{-4 \times 10^9} \\
 x &= 1.5679 \times 10^{-5} \text{ C} \text{ or } 3.8437 \times 10^{-5} \text{ C} \\
 q_1 &= 1.5679 \times 10^{-5} \text{ C} \\
 q_2 &= 3.8437 \times 10^{-5} \text{ C}
 \end{aligned}$$



$$\begin{aligned}
 q_1 &= q_2 = 8 \mu\text{C} \\
 d &= 0.5 \\
 (d)^2 + d^2 &= 5^2 \\
 \sqrt{5d^2} &= d\sqrt{5} \\
 \sin \theta &= \frac{2d}{d\sqrt{5}} = \frac{2}{\sqrt{5}} \\
 \theta &= \sin^{-1} \frac{2}{\sqrt{5}} = 63.43^\circ \text{ at } 0.5 \text{ m} \\
 E_1 &= \frac{kq_1}{r^2} = \frac{9 \times 10^9 (8 \times 10^{-6})}{(0.5)^2} = 57600 \text{ N/C}
 \end{aligned}$$

$$E_2 = \frac{kQ_2}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(5/2)^2} = 57600 \text{ N/C}^{-1}$$

$$E_1 = \frac{kq}{r^2} = \frac{9 \times 10^9 \times 2}{1^2} = 1.8 \times 10^{10}$$

Q	θ	$E_x = E \cos \theta$	$E_y = E \sin \theta$
57600	63.43°	-25763.783	51516.781
57600	63.43°	25763.753	51516.781
$9.0 \times 10^9 q$	90°	0	$9.0 \times 10^9 q$

$$0 \quad 105033.562 + 9 \times 10^9 q$$

$$0 = \sqrt{(105033.562 + 9 \times 10^9 q)^2 + 10^2}$$

$$0 = 105033.562 + 9 \times 10^9 q$$

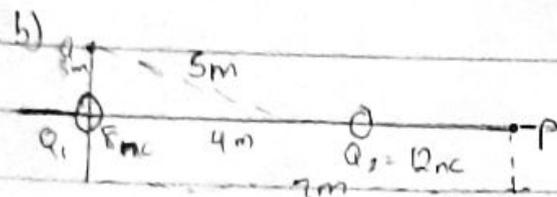
$$-9 \times 10^9 q = 105033.562$$

$$q = \frac{105033.562}{-9 \times 10^9}$$

$$-9 \times 10^9$$

$$q = -11.448 \mu\text{C}$$

2a) An electric field in a region of space in which an electric charge will experience an electric force while electric field intensity is the per unit charge experienced by a charge in an electric field.



$$At \cdot P = R_1 = \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{4^2} = 1.96937 \text{ N/C}^{-1}$$

$$E_2 = \frac{kq_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-6}}{3^2} = 12 \text{ N/C}^{-1}$$

$$R_{net} = E_1 + E_2 = 12 + 11.46937 = 23.46937 \text{ N/C}^{-1}$$

$$At \cdot Q = C, \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{3^2} = 80000$$

$$E_2 = 12 \text{ N/C} = \frac{9 \times 10^9 \times 12 \times 10^{-6}}{3^2} = 4.32 \times 10^4$$

R	θ	$R_x = E \cos \theta$	$R_y = E \sin \theta$
8	90	0	8
4.32	36.87	3.456	2.592
		3.456 N/C^{-1}	10.592 N/C^{-1}

$$E_{net} = \sqrt{E_x^2 + E_y^2}$$

$$E_{net} = \sqrt{3.456 + 10.592}$$

$$E_{net} = 11.14156 \text{ N/C}^{-1}$$

PART B

a) Magnetic flux is known as the strength of magnetic field represented by lines of force. It is usually represented by the symbol Φ .

$$b) \frac{mv^2}{2} = qvB \quad \omega = \frac{v}{r}$$

$$mv^2 = 2qvB$$

$$mv = 2qB$$

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

$$\omega = 1.6 \times 10^{-19} \times 3.5 \times 10^{-1}$$

$$9.1 \times 10^{-31}$$

$$\omega = 6.14709 \times 10^{10} \text{ rads}^{-1}$$

11) This states that an electron mass $9.1 \times 10^{-31} \text{ kg}$ and charge $1.6 \times 10^{-19} \text{ C}$ in motion in a magnetic field of $3.5 \times 10^1 \text{ Tesla}$ perpendicular with the field will have an angular frequency of $6.14709 \times 10^{10} \text{ rads}^{-1}$.

5a

- 1) The vector \vec{dB} is perpendicular to \vec{dl} (which points in the direction of the current) and to the unit vector \hat{r} directed from \vec{dl} towards P .
- 2) The magnitude dB is inversely proportional to r^2 , also in the plane from \vec{dl} to P .
- 3) The magnitude of \vec{dB} is proportional to the current and to the magnitude of the length element \vec{dl} .
- 4) The magnitude of dB is proportional to $\sin\theta$.

mathematical expression: $\vec{dB} = \frac{\mu_0 I}{4\pi} \frac{d\vec{l} \times \hat{r}}{r^2}$

(b)

$$B = \frac{\mu_0 I}{2\pi r}$$

$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{l} \times \hat{r}}{r^2}$$

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

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

$$B = \frac{\mu_0 I}{4\pi} \int \frac{dl \sin\theta}{r^2} \quad \begin{aligned} r &= \sqrt{x^2 + y^2} \\ r^2 &= x^2 + y^2 \end{aligned}$$

$$\theta = \pi - \theta$$

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

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

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

$$dl = dy$$

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

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

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

$$\text{for } x \gg a$$

$$x \gg a$$

$$B = \frac{\mu_0 I}{4\pi x}$$

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

$$B = \frac{\mu_0 I}{2\pi r}$$