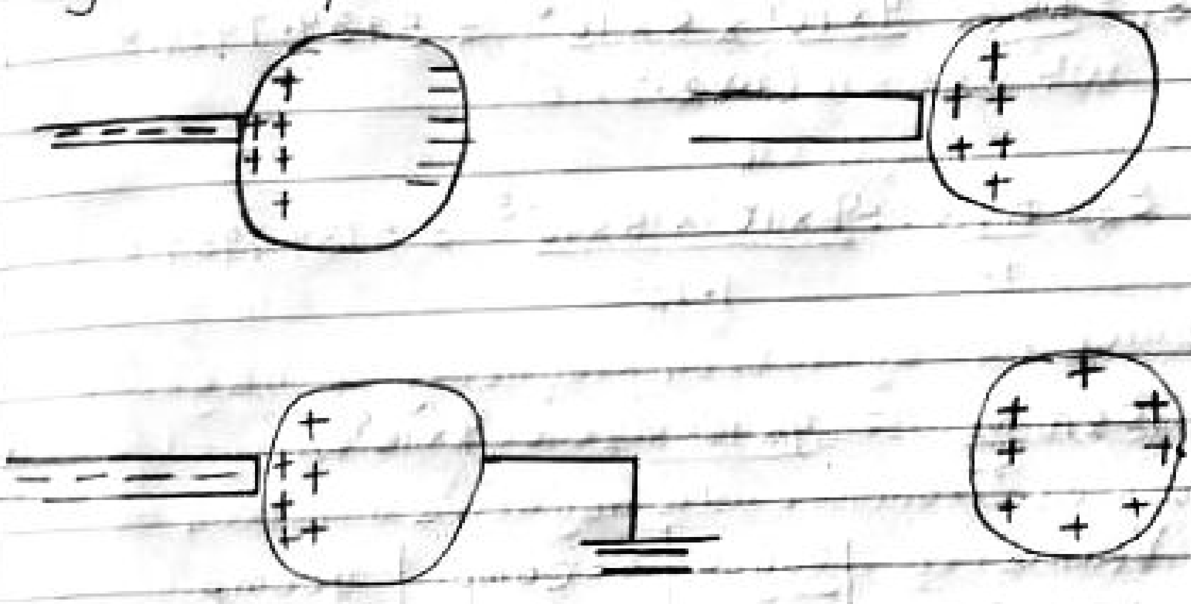
Physics 102 Answers

1) When a negatively charged rubber rod brought near a neutral conducting sphere that is insulated, so that there is no conducting path to the ground as shown below; the region of the sphere nearest the negatively charged rod has an excess of positive charge because of the migration of electrons away from this location.



1b $F = 1.0N$, $r = 2.0m$ $Q = 5.0 \times 10^{-5}$, $q_1 + q_2 = Q = 5.0 \times 10^{-5}$

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

$$1 = \frac{9 \times 10^9 \times q_1q_2}{2^2}$$

Cross Multiply

$$\frac{4}{9 \times 10^9} = \frac{\cancel{9 \times 10^9} \times q_1q_2}{\cancel{9 \times 10^9}}$$

$q_1q_2 = 4.44 \times 10^{-10}$ — eq 1

$q_1 + q_2 = 5.0 \times 10^{-5}$

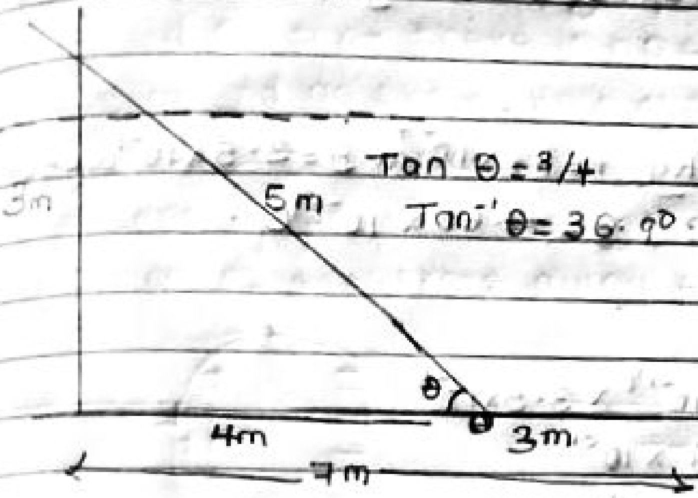
$q_1 = 5.0 \times 10^{-5} - q_2$ — eq 2

put eq 2 into eq 1

NO. 2

2a) Electric field: It is a region of space in which an electric charge will experience an electric force, while electric field intensity can be defined as the force per unit charge.

b)



$\tan\theta = 3/4$

$\tan^{-1}\theta = 36.9^{0}$

$E_p = EQ_1 + EQ_2$

$EQ_1 = \frac{KQ}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\,N/C$

$EQ_2 = \frac{KQ}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12\,N/C$

$E_{pnet} = 1.469 + 12$

$= 13.469 \approx 13.5\,N/C$

ii) $E_{net}\ Q = E_1 + E_2$

$E_1 = \frac{KQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2}$

$= 8\,N/C$

$E_2 = \frac{KQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2}$

$= 4.32\,N/C$

Vector	Angle	X com	y com
$E_1 = 8N/C$	90°	$8\cos 90 = 0$	$8\sin 90$
$E_2 = 4.32$	36.9	$-4.32\cos 36.9$	$4.32\sin 36.9$
		$E_{fx} = -3.45$	E_{fy} 2.59
			$E_{fy} = 10.59$

$E_{net} = \sqrt{(3.45)^2 + (10.59)^2}$

$$q_2 \times (5.0 \times 10^{-5} - q^2) = 4.44 \times 10^{-10}$$

$$5.0 \times 10^{-5} q_2 - q_2 = 4.44 \times 10^{-10}.$$

$$-q_2^2 + 5.0 \times 10^{-5} q_2 - 4.44 \times 10^{-10} = 0.$$

$$q^2 = 3.845 \times 10^{-5} C \text{ or } q_2 = 1.155 \times 10^{-5} C$$

$$q_1 = 5.0 \times 10^{-5} - 3.845 \times 10^{-5} \text{ or } q_1 = 5.0 \times 10^{-5} - 1.155 \times 10^{-5}$$

$$= 1.155 \times 10^{-5} C \qquad = 3.845 \times 10^{-5} C$$

$$\therefore \; q_2 = 3.845 \times 10^{-5} C, \; q_1 = 1.155 \times 10^{-5} C$$

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

$d = 0.5m$

$$E_1 = \frac{kq_1}{r_1^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2} = 57397959.8$$

$$E_2 = \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{1.12^2} = 57397959.8$$

$$E_q = \frac{kq}{r^2} = \frac{9 \times 10^9 \times q}{1} = 9 \times 10^9 N$$

Vector	angle	x = comp.	ycomp
$E_1 = 57397959.8$	63.4	$E_1 \times \cos\theta$ = 25700.45785	5132.262839
$E_2 = 57397959.8$	63.4	2570.045785	5132.262839
$E_q = 9 \times 10^9$	90	$E_x = 0$	$E_y = 10264.52568$

$$\text{Magnitude} = \sqrt{(E_x)^2 + (E_y)^2}$$

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

$$0 = 9 \times 10^9 N + 10264.52568$$

$$q = \frac{-10264.52568}{9 \times 10^9}$$

$$q = 11.4\mu C$$

$E_{net} = 11.14\,N/C$

NO. 4.

a. Magnetic flux is defined as the strength of the magnetic field represented by the Lines of force

b) Solution.

$M = 9.11 \times 10^{31}\,Kg$, $r = 1.4 \times 10^{-7}\,m$ $B = 3.5 \times 10^{-1}\,weber/m^2$

$\theta = 90°$, $w = ?$, $q = -1.60 \times 10^{-19}C$.

$$W = \frac{qB}{m_e}$$

$$W = \frac{1.60 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{31}}$$

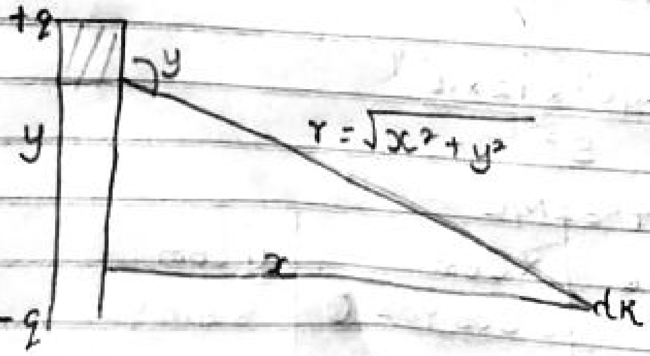
$$W = -6.15 \times 10^{10}\,rad/sec$$

c.) Since our cyclotron frequency is negative, $-6.15 \times 10^{10}\,rad/sec$, it means that the charged particle electron circulates in a negative direction at the angular frequency

NO 5

a. Biot-Savart Law is an equation that describes the magnetic field created by a current-carrying wire and allows you to calculate its strength at various forms

b)



Applying the Biot-Savart the magnitude of field dB

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

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

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

From diagram $r^2 = x^2 + y^2$

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

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

Substituting eq. 2 into 1 we have,

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

Using law of indices,

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

Recall $dl = dy$

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

Using special integrals

$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1 \quad y}{x^2(x^2+y^2)^{1/2}}$$

Equation 3 therefore becomes

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

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

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

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

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

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

In physical situation, we have axial symmetry about the y-axis. Thus, at all points in a circle of radius r, around the conductor, the magnitude of B is,

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