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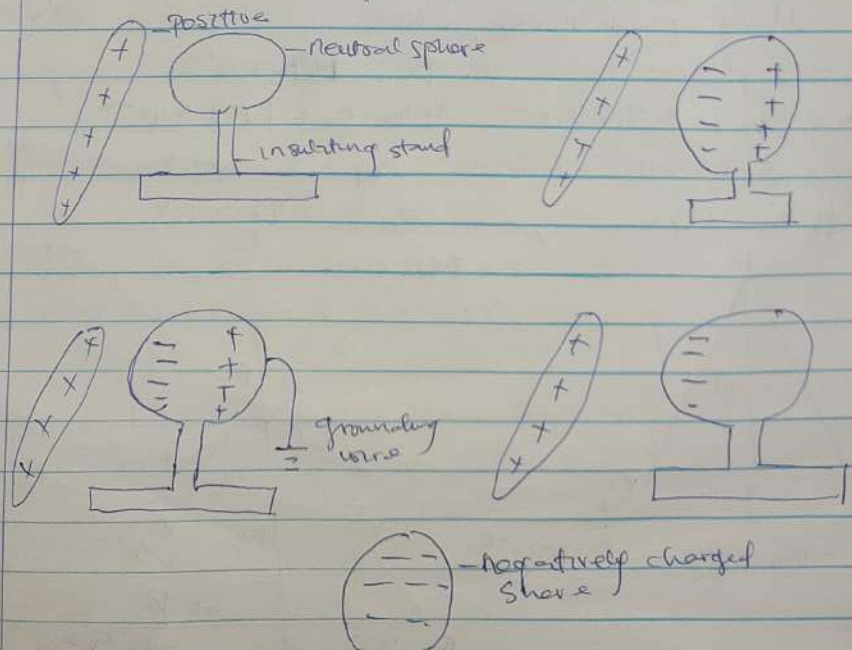
Course: PHY 102.

1a A positively charged glass rod is brought near a neutral conducting sphere that is insulated so there is no conducting path.

Repulsive force between the electrons in the rod and those in the sphere take effect it will lead to redistribution of charges in the sphere and the positive charges will move to the end away from the positive glass rod.

The region of sphere closed to the glass rod has a net excess of negative charges and the other end away from the rod has an excess of Positive charges.

A grounding wire is connected to the sphere as the positive charges from the far end travel to the ground leaving the sphere. The positive glass rod is now removed leaving the sphere with only negative charges.



1b $F = \frac{kq_1q_2}{r^2}$ $\qquad F = 1N \qquad k = 8.99\times10^{9}\ Nm^2/s^2$

$r = 2m$

$q_1 = ?$

$q_1 + q_2 = Q \qquad q_2 = ?$

$q_1 + q_2 = 505\times10^{8}c = Q$

$1 = \frac{8.99\times10^{9} \times (q_1 \times q_2)}{2^2}$

$1\times4 = 8.99\times10^{9} \times (q_1 \times q_2)$

$q_1 \times q_2 = \frac{4}{8.99\times10^{9}}$

$q_1q_2 = 4.45\times10^{-10}$ — (1)

$q_1 + q_2 = 5.05\times10^{-5}$ — (2)

from (2) $q_1 = 5.05\times10^{-5} - q_2$ — (3)

Sub (3) into equ (1)

$(5.05\times10^{-5} - q_2)(q_2) = 4.45\times10^{-10}$

$5.05\times10^{-5}q_2 - q_2^2 = 4.45\times10^{-10}$

$q_2^2 - 5.05\times10^{-5}q_2 + 4.45\times10^{-10} = 0$

Using quadratic equation.

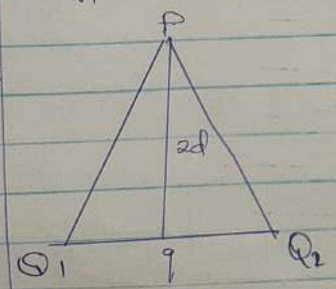
$q_2 = 3.912\times10^{-5}c$ or $q_2 = 1.137\times10^{-5}C$

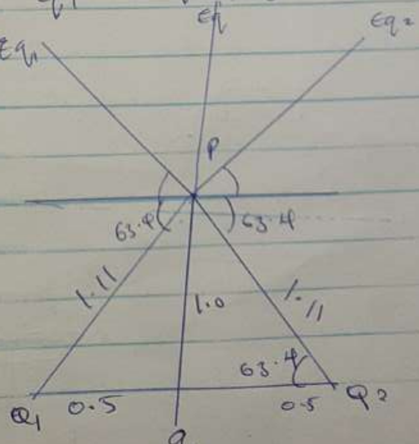
when $q_2 = 3.912\times10^{-5}$ $\qquad$ when $q_2 = 1.137\times10^{-5}$

$q_1 = 5.05\times10^{-5} - 3.912\times10^{-5}$ $\qquad$ $q_1 = 5.05\times10^{-5}$

$q_1 = 1.137\times10^{-5}c$ $\qquad$ $q_1 = 3.912\times10^{-5}$

1c





$Q_1 = Q_2 = 8nC = 8.0\times10^{-6}C$

Angle at Q_1 and Q_2 => $\tan\theta = \frac{opp}{adj}$

$$\tan\theta = \frac{1.0}{0.5}$$

$$\theta = \tan^{-1} 2 = 63.4^\circ$$

Distance of Q_1 and Q_2 to P $= \sqrt{1.0^2 + 0.5^2}$

$$= \sqrt{1 + 0.25}$$

$$= \sqrt{1.25}$$

$$= 1.11$$

$$E_{q_1} = \frac{kq_1}{r_1^2} = \frac{8.99\times10^9 \times 8\times10^{-6}}{1.1^2} = 59438.02\,NC^{-1}$$

$$E_{q_2} = \frac{kq_2}{r_2} = \frac{8.99\times10^9 \times 8\times10^{-6}}{1.1^2} = 59438.02\,NC^{-1}$$

$$E_q = \frac{kq}{r^2} = \frac{8.99\times10^9 \times q}{1^2} = 8.99\times10^9 q\,NC^{-1}$$

vector	angle	x	y
$E_{q_1} = 59438.02$	63.4	$-59438.02\cos 63.4 = -26613.9$	$59438.02 \sin 63.4 = 53146.75$
$E_{q_2} = 59438.02$	63.4°	$59438.02\cos 63.4 = 26613.9$	$59438.02 \sin 63.4 = 53146.75$
$E_q = 8.99\times10^9 q$	90	$8.99\times10^9 \cos 90 = 0$	$8.99\times10^9 q \sin 90 = 8.99\times10^9$
		$\Sigma x = 0$	$106293.5 \times 8.99 \times 10^9$

$$E_Q = \sqrt{0^2 + (106293.5 + 8.99\times10^9 q)^2}$$

$$E_Q = 106293.5 + 8.99\times10^9 q$$

E_q at $P = 0$ E_q at $P = 0$

$$106293.5 + 8.99\times10^9 q = 0$$

$$8.99\times10^9 q = -106293.5$$

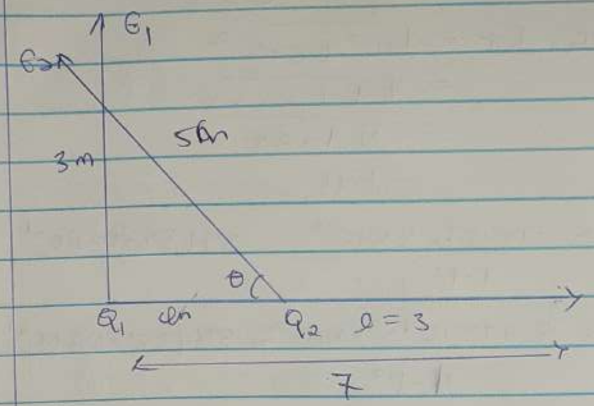
$$q = \frac{-106293.5}{8.99\times10^9}$$

$$q = -1.18\times10^{-5}$$

$$q = -11.8\,\mu C$$

2a Electric field is a region of space in which electric charge will experience an electric force while Electric field intensity is the force exerted by a single charge, ie force per unit charge

b



$F_{net}\,Q = E_{q_1} + E_{q_2}$

$E_{q_1} = \frac{kQ_1}{r^2} = \frac{8.99 \times 10^9 \times 8 \times 10^{-9}}{7^2} = 1.467\,NC^{-1}$

$E_{q_2} = \frac{kQ_2}{r^2} = \frac{8.99 \times 10^9 \times 12 \times 10^{-9}}{3^2} = 11.98\,NC^{-1}$

$E_{q_1} + E_{q_2} = 1.467 + 11.98 = 13.45\,NC$

(iii) $E_{net}\,Q = \vec{E_1} + \vec{E_2}$ ∴ $E_1 = \frac{kQ_1}{r^2} = \frac{8.99 \times 10^9 \times 8 \times 10^{-9}}{3^2}$

$E_1 = 7.99\,NC^{-1}$

$E_2 = \frac{kQ_1}{r^2} = \frac{8.99 \times 10^9 \times 12 \times 10^{-9}}{5^2} = 4.3152\,NC^{-1}$

Vector	Angle	X axis	Y axis
$E_1 = 7.99$	90°	$7.99 \cos 90 = 0$	$7.99 \sin 90 = 7.99$
E_2 4.3 N/C	36.9°	$-4.32 \cos 36.9 = -3.45$	$4.32 \sin 36.9$ 2.59
		$\Sigma f_x = -3.45$	$\Sigma f_y = 10.38$

$E_{net}\,Q = \sqrt{(-3.43)^2 + (10.38)^2}$
$= 11.14\,NC^{-1}$

4. Magnese flux is defined as the strength of the magnetic field represented by lines of force. Magnetic flux is represented by Φ

(b) $m = 9.11\times10^{-31}kg$, $r = 1.4\times10^{7}m$, $B = 3.5\times10^{-7}$

$\theta = 90^\circ$, $\omega = ?$ $q = 1.60\times10^{-17}$

$f = ?$

$f = \frac{\omega}{2r}$ but $\omega = \frac{qB}{m} = \frac{-1.60\times10^{-17}\times3.5\times10^{-7}}{9.11\times10^{31}}$

$= -6.15\times10^{10}\omega$

$f = \frac{-6.15\times10^{10}}{2e} = -9.78\times10^{9}Hz$

4c Since our cycltone frequency is negative it means the electron circulates in an opposite direction to the angular frequency.

5. The Biot - Savart law states that it is an equation ~~what~~ that describes the magnetic field generated by a constant electric current

Solution.

Applying biot - Savat law ~~into~~ to find the negative of the field $d\sigma$

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

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

$$B = \frac{\mu_0 I}{4\pi}\int_{-1}^{1} \frac{dl\sin(\pi-\alpha)}{r^2}$$

from diagram $r^2 = x^2 + y^2$ (Pythagoras theorem)

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

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

Substituting ② into ①

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

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