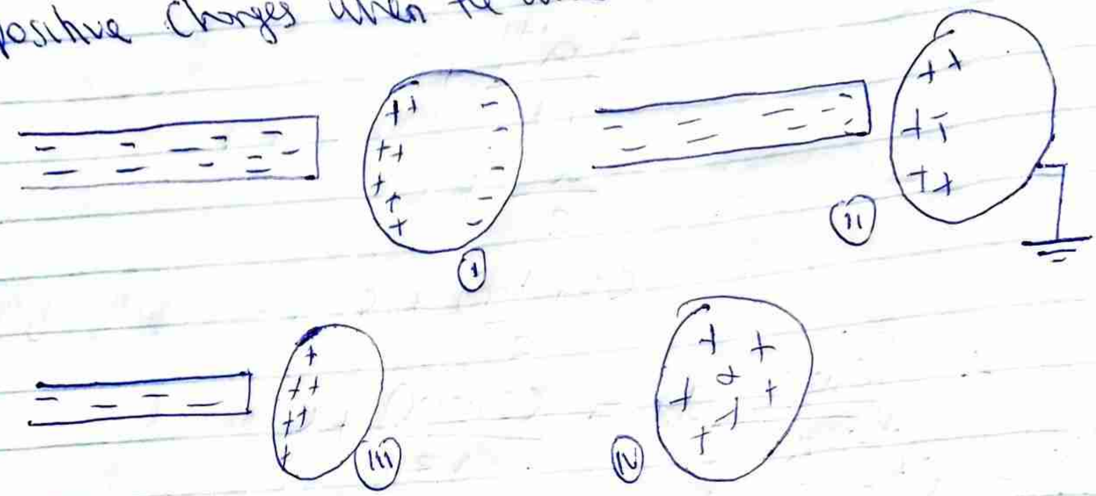
Olumide-ojo Oluwagbemi
MBBS 14/MHS01/342

1 (a) Consider a negatively charged rubber rod brought near a neutral conducting sphere which is also insulated thereby preventing loss of charges to the earth. The rod pulls towards it the positive charges and pushes away the negatively charged electrons. If the insulator is replaced with a conducting wire, the electrons leave the sphere and travel to the Earth leaving in the sphere the positive charges when the wire is removed.



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

$F = \frac{kq_1q_2}{r^2}$, $1.0 = \frac{9\times10^9 q_1 q_2}{2^2}$

$4 = 9\times10^9(5\times10^{-5} - q_1)q_2$

$4 = 4.5\times10^{-5}q_2 - 9\times10^9 q_2^2$

$-9\times10^9 q_2^2 + 4.5\times10^{-5} q_2 - 4 = 0$

Using quadratic formula, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$q_2 = \frac{-4.5\times10^{-5} \pm \sqrt{(4.5\times10^{-5})^2 - 4(-9\times10^9)(-4)}}{2(-9\times10^9)}$

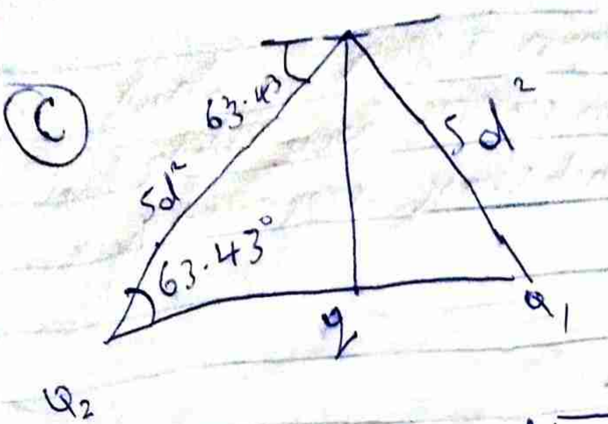
$q_2 = \frac{-4.5\times10^{5} \pm 241867}{-18\times10^9}$

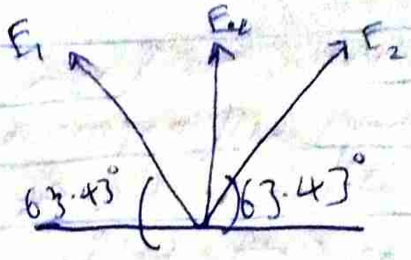
$q_2 = 1.156\times10^{-5}$ or $3.84\times10^{-5}C$

$q_1 = 1.156\times10^{-5}C$

$q_2 = 3.84\times10^{-5}C$ //

(c)





$\sqrt{2d^2 + d^2} = d\sqrt{5}$ $\tan\theta = \frac{2d}{d}$, $\tan^{-1}(2) = 63.43$

$E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times (8\times10^{-6})}{(d\sqrt{5})^2} \Rightarrow 57600 \, N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times (8\times10^{-6})}{(d\sqrt{5})^2} = 57600 \, N/C$

$E_q = \frac{kq}{r^2} = \frac{9\times10^9 \times q}{(2d)^2} = \frac{9\times10^9 q}{1^2} = 9\times10^9 q \, N/C$

Vector	θ	x-component	y-component
$E_1 = 57600 \, N/C$	63.43°	$57600\cos63.43 = -25764$	$57600\sin63.43 = 51516.8$
$E_2 = 57600 \, N/C$	63.43°	$57600\cos63.43 = +25764$	$57600\sin63.43 = 51516.8$
$E_q = 9\times10^9 q \, N/C$	90°	$9\times10^9 q \cos90 = 0$	$9\times10^9 q \sin 90 = 9\times10^{10} q$

$\Sigma f_x = 0$ $\Sigma f_y = 103033.6 + 9\times10^9 q$

$E = \sqrt{\Sigma f_x^2 + \Sigma f_y^2}$

But E at point P = 0

$0 = \sqrt{0^2 + (103033.6 + 9\times10^9 q)^2}$

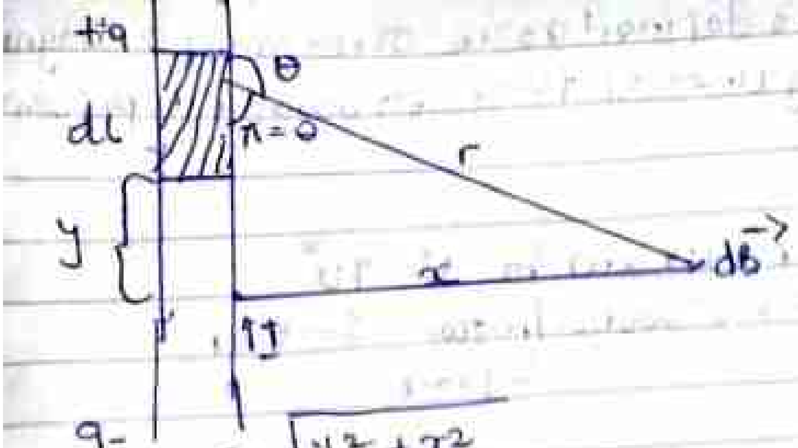
$0 = 103033.6 + 9\times10^9 q$

$q = \frac{-103033.6}{9\times10^9}$

$q = -11.4 \, nC$

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

(bi)



$r = \sqrt{y^2 + x^2}$

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

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

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

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

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

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

$(x^2 + a^2)^{1/2} \simeq a$

$a >> x$

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

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

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

tic field flux is defined as the strength of a magnetic field represented by lines of force. it's usually represent by the symbol ϕ

4b) $m_e = 9.11 \times 10^{-21}$ kg, $r = 1.4 \times 10^{-7}$m $\theta = 90°$
magnetic ~~the~~ field = 3.5×10^{-1} weber/meter square $\sin\theta = 1$

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

$$\omega = \frac{1.6 \times 10^{-19} \times (3.5 \times 10^{-1})}{9.11 \times 10^{-21}}$$

$\omega = 6.15 \times 10^{10}$ rad/s

4c) An electron of mass 9.11×10^{-31}kg and charge 1.6×10^{-19}C in motion in a magnetic field of 3.5×10^{-1} Tesla perpendicular with the field will have an angular frequency ~~by~~ of 6.15×10^{10} rad/s.

5a) The vector $d\vec{B}$ is perpendicular to $d\hat{l}$ (which points in the direction of the current) and to the unit vector $\hat{r}$ directed from $d\vec{l}$ toward P

i) The magnitude of $d\vec{B}$ is inversely proportional to r^2 where r is the distance from $d\vec{l}$ to P

ii) The magnitude of $d\vec{B}$ is proportional to the current I and to the magnitude of the length element $d\vec{l}$

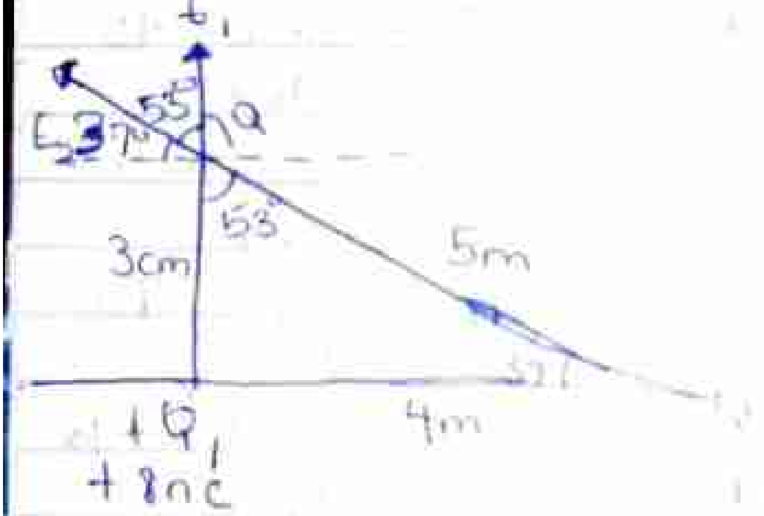
iii) The magnitude of $d\vec{B}$ is proportional to θ, where θ is the angle between $\hat{r}$ and dl

$E_1 = \frac{KQ_1}{r^2} = \frac{(9\times10^9)\times(8\times10^{-9})}{7^2} = 1.47\ N/C$

$E_2 = \frac{KQ_2}{r^2} = \frac{(9\times10^9)\times(12\times10^{-9})}{3^2} = 12\ N/C$

$E_{net} = 1.474 + 12 = 13.47\ N/C$

(11)



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

$E_2 = \frac{KQ_2}{r^2} = \frac{9\times10^9\times(12\times10^{-9})}{5^2} = 4.32\ N/C$

vector	Angle	x component	y component
$E_1 = 8\ N/C$	$90°$	$8\cos 90° = 0°$	$8\sin 90 = +8°$
$E_2 = 4.32\ N/C$	$37°$	$4.32\cos 37° = -3.45$	$4.32\sin 37° = +2.6$
		$E_{ex} = -3.45\ N/C$	$E_{ey} = 10.6\ N/C$

The Resultant E

$E = \sqrt{E_{ex}^2 + E_{ey}^2} = \sqrt{(-3.45)^2 + (10.6)^2} = \sqrt{11.903 + 112.36}$

$= \sqrt{124.263}$

$= 11.147\ N/C$