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Matric no: 19/MHS01/058

Physics 102 assignment answer:

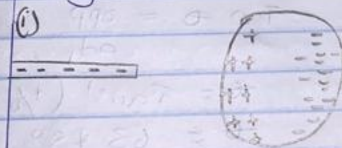
1a) consider a negatively charged rubber rod brought near a neutron conducting sphere that is insulated so that there is no conducting path to the ground as shown below. The explosive force between the electrons in the rod and those in the sphere causes a redistribution of charges on the sphere so that some of electrons move to the side of the sphere farthest away from the rod.

The region of the sphere nearest the relatively charge rod has an excess of positive charge because of the migration of electrons away from this location. If a grounded conducting wire is the connected to the sphere, some of the electrons leave the sphere and travel to the earth. If the wire to be ground is then removed, the conducting sphere is left with an excess of induced positive charge.

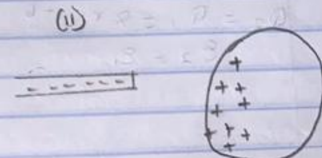
Finally, when the rubber rods is removed from the vicins of the sphere, the induced positive charge remains on underground sphere and become uniformly distributed over the surface of the sphere.

Diagrams:

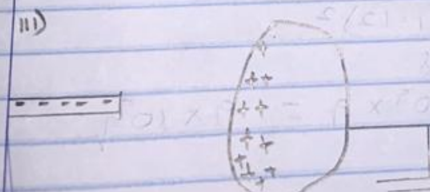
(i)



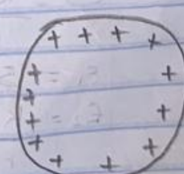
(ii)



iii)



iv)



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b) $q_1 + q_2 = 5 \times 10^{-5} C$, $q_1 = 5 \times 10^{-5} - q_2$

$F = \frac{kq_1q_2}{r^2}$, $1.0 = \frac{9 \times 10^9 q_1 q_2}{2^2}$

$4 = 9 \times 10^9 \times (5 \times 10^{-5} - q_2) q_2$

$4 = 4.5 \times 10^{-5} q_2 - 9 \times 10^9 q_2^2$

$-9 \times 10^9 q_2^2 + 4.5 \times 10^{-5} q_2 - 4 = 0$

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

$q_2 = \frac{-4.5 \times 10^{-5} \pm \sqrt{(4.5 \times 10^{-5}) - 4(9 \times 10^9)(-4)}}{2(-9 \times 10^9)}$

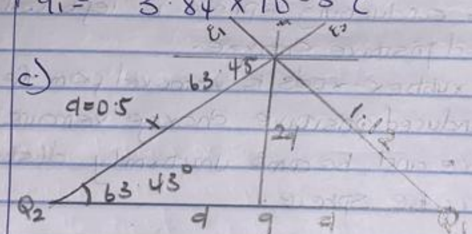
$q = \frac{-4.5 \times 10^{-5} \pm \sqrt{5.8 \times 10^{10}}}{-18 \times 10^9}$

$q = \frac{-4.5 \times 10^5 \pm 241867.7}{-18 \times 10^9}$

$q_2 = 1.156 \times 10^{-5} C$

$q_1 = 3.84 \times 10^{-5} C$

c)



$x^2 = 1^2 + 0.5^2$

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

$x = 1.12$

$Q_2 = Q_1 = 8 \times 10^{-6}$

$E_2 = E_1$

$\tan\theta = \frac{opp}{adj}$

$\theta = \tan^{-1}(1/0.5)$

$\theta = 63.43°$

$E_2 = \frac{kq_2}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2} = 57397.95918$

$E_1 = 57397.95918$

$E_2 = \frac{kq}{r^2} = 9 \times 10^9 \times q = 9 \times 10^9 q$

different on how people perce

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Vector	Angle	X - comp	Y - comp
$\varepsilon_1 = 57377.95978$	63.4	25700.45785	51322.62339
$\varepsilon_2 = 57377.95978$	63.4	-25700.45785	51322.62339
		$\varepsilon_x = 0$	$\varepsilon_y = 102645.2568$

$$\varepsilon_q = \sqrt{(0)^2 + (102645.2568)^2}$$

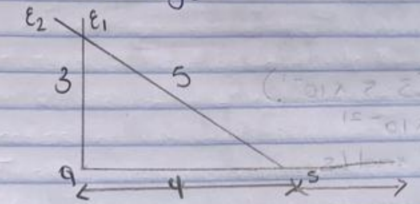
$$\varepsilon_q = 0 + 102648.2568 = 102645.2568$$

$$q = \frac{\varepsilon_q}{9\times10^9} = \frac{102645.2566}{9\times10^9}$$

$$q = 1.14\times10^{-5}\,C$$

2a) Electric field is a region or space in which an electric charge will experience an electric force.

ii) Electric field intensity can be defined as the force per unit charge.



$$\tan\theta = \frac{opp}{adj}$$

$$\theta = \tan^{-1}(3/4)$$

$$\theta = 36.9^\circ$$

$$\varepsilon_{net} = \varepsilon_1 + \varepsilon_2$$

$$\varepsilon_1 = \frac{kq}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{9^2} = 1.469\,N/C$$

$$\varepsilon_2 = \frac{kq_2}{r2} = \frac{9\times10^9\times 12\times10^{-9}}{9^2} = 12\,N/C$$

$$\varepsilon_{net} = 12 + 1.469$$

i) $\varepsilon_{net} = 13.469$ or 13.5

ii) $\varepsilon_1 = \frac{kQ_1}{r2} = \frac{9\times10^9\times8\times10^{-9}}{3^2} = 8\,N/C$

$$\varepsilon_2 = \frac{kQ_2}{r_2} = \frac{9\times10^9\times12\times10^{-7}}{5^2} = 4.32\,N/C$$

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Vector	Angle	x-comp	Y-comp
$E_1 = 8 N/C$	90	0	8
$E_2 = 4.32 N/C$	$6.9°$	-5.45	2.59

$e_x = -3.45$ $E_y = 10.59$

$E_{net} = \sqrt{(-3.45)^2 + (10.39)^2}$

$= 11.14 N/C$

$E_{net} = 11.14 N/C$

4a) Magnetic flux is defined as the strength of the magnetic field represented by lines or forces.

b) $m = 9.11 \times 10^{-11} kg$, $r = 1.4 \times 10^{-9}$, $B = 3.5 \times 10^{-1}$ weber/m²

$q = +1.6 \times 10^{-n}$

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

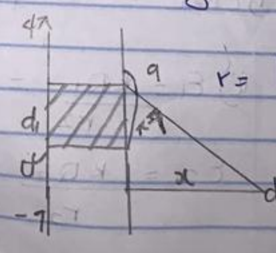
$\omega = \frac{1.6 \times 10^{-19} (3.5 \times 10^{-1})}{9.11 \times 10^{-21}}$

$\omega = 6.115 \times 10^{10}$ rad/s

4c) An electron of mass ~~9x11~~ $9.11 \times 10^{-31} kg$ and charge $1.6 \times 10^{-19} C$ in motion in a magnetic field of 3.5×10^{-1} perpendicular with the field will have an angular frequency by of 6.15×10^{10} rad/s

5a) The 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 points

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



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

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

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

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

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - a)}{x^2 + y^2} \quad --- (9)$$

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

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

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

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

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

$$a >> x$$

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

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

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