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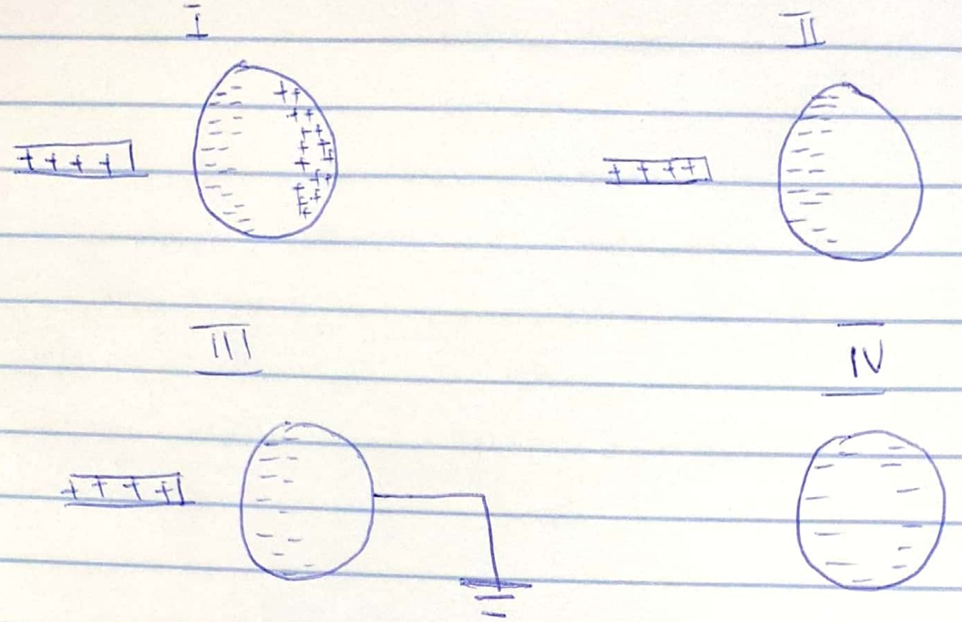
MATRIC NO: 19/MHS01/160.

1a.



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

$F = 1N$

$r = 2m$

$k = 9 \times 10^9$

$F = \frac{kq_1q_2}{r^2}$ $\frac{Fr^2}{k} = q_1q_2$

$q_1q_2 = \frac{1 \times 2^2}{9 \times 10^9} = 4.444 \times 10^{-10}$

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

$q_2 = 5.0 \times 10^{-15} - q_1$

$q_1 \times (5.0 \times 10^{-15} - q_1) = 4.444 \times 10^{-10}$

$q_1^2 - (5.0 \times 10^{-15} q_1) + 4.444 \times 10^{-10} = 0$

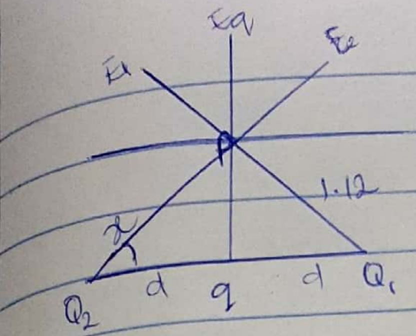
using the general quadratic formular;

$\Rightarrow \frac{5.0 \times 10^{15} + \sqrt{(5.0 \times 10^{-15} q_1) - 4(4.444 \times 10^{-10})}}{2}$

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

$q_2 = 5.0 \times 10^{-5} - 3.84 \times 10^{-5}$

$q_2 = 1.16 \times 10^{-5} C$.



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

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

$x = 1.12$

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

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

$\theta = 63.43°.$

$d = 0.5$

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

$E_2 = E_1$

$E_2 = \frac{Eq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2}$

$E_1 = 57397.95918$

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

Angle	Vector	x-component	y-component
63.4	$E_1 = 57397.95918$	25700.45785	51322.62839
63.4	$E_2 = 57397.95918$	-25700.45785	51322.62839
		$\Sigma x = 0$	$\Sigma y = 102645.2568$

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

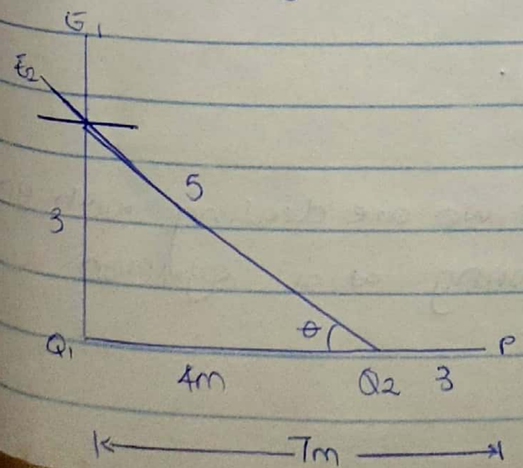
$E_q = 0 + 102645.2568$

$q = \frac{E_q}{9\times10^9} = \frac{102645.2568}{9\times10^9}$

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

Electric field – A region of space in which an electric charge will experience an electric pull.

Electric field intensity – can be defined as the force per unit charge



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

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

$\theta = 36.9°$

$E_{net} = E_1 + E_2$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\ N/C$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12\ N/C$

$E_{net} = 12 + 1.469$

(I) $E_{net} = 13.469$ or $13.5\ N/C$

(II) $E_1 = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8\ N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32\ N/C$

Vector	Angle	X-component	Y component
$E_1 = 8\ N/C$	$90°$	0	8
$E_2 = 4.32\ N/C$	$36.9°$	-3.45	2.59

$\Sigma x = -3.45$ $\Sigma y = 10.59$

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

$= 11.14\ N/C$

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

4a. Magnetic Flux is defined as the strength of the magnetic field represented by lines of force.

b. $m = 9.11\times10^{-31}\ kg$ $r = 1.4\times10^{-7}$

$B = 3.5\times10^{-1}\ weber/m^2$ $q = -1.6\times10^{-19}$

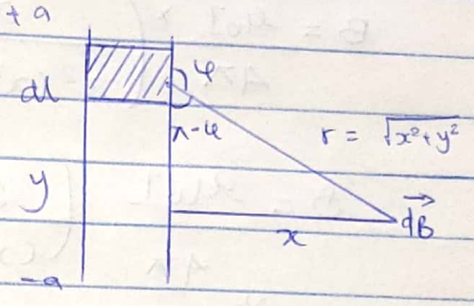
$\omega = \frac{qB}{m} = \frac{-1.6\times10^{-19} \times 3.5\times10^{-1}}{9.11\times10^{-31}}$

$\omega = -6.15\times10^{10}\ rad/s$.

c. The answer is negative because we are dealing with an electron but the electron is moving at a cyclotron frequency of 6.15×10^{10} rad/s.

5a. Biot - Savart law is an equation which describes the magnetic field created by a current - carrying wire and allows one to calculate its strength at various points.

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



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

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

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

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

but $\sin(\pi-\varphi) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}} \quad ---(2)$

Substituting (2) into (1)

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

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

recall that $dl = dy$

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

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

Using Special integrals

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

PTO.

Equation (3) becomes

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

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

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

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

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

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