Phy 102

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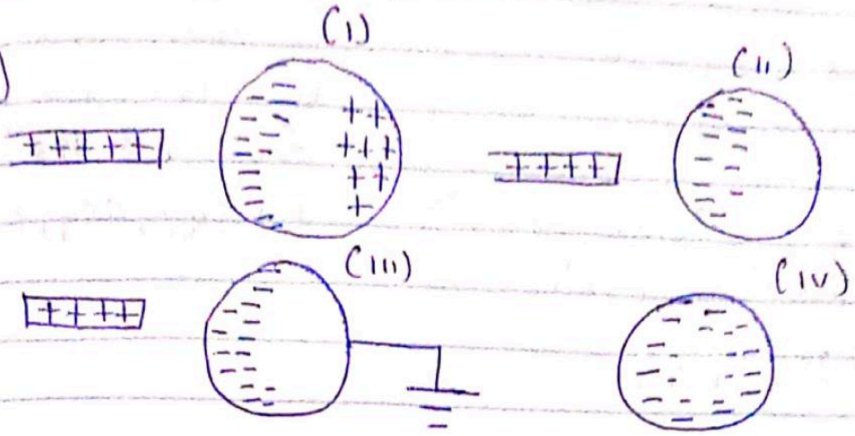
MBBS

19/MHS01/172

1 (a)



(b) $q_1 + q_2 = 5.0 \times 10^{-5}$ C $F = 1N$

$F = \frac{k q_1 q_2}{r^2}$ $\frac{Fr^2}{k} = q_1 q_2$ $r = 2m$

$k = 9 \times 10^9$

$q_1 q_2 = \frac{1 \times 2^2}{9 \times 10^9} = 4.444 \times 10^{-10}$

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

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

$q_1 (5.0 \times 10^{-5} - q_1) = 4.444 \times 10^{-10}$

$\underset{A}{q_1^2} - (\underset{B}{5.0 \times 10^{-5} q_1}) + \underset{C}{4.444 \times 10^{-10}} = 0$

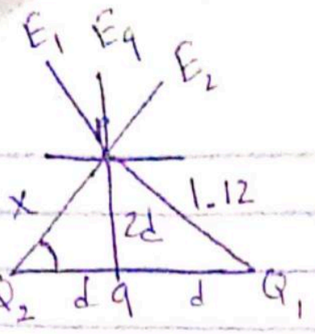
$\frac{5.0 \times 10^{-5} + \sqrt{(5.0 \times 10^{-5})^2 - 4(4.444 \times 10^{-10})}}{2}$

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

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

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

(c)



d = 0.5

$$x^2 = 1^2 + 0.5^2$$
$$\sqrt{x^2} = \sqrt{1.25}$$
$$x = 1.12$$

$$Q_2 = Q_1 = 8\times10^{-6}$$
$$E_2 = E_1$$

$$\tan\theta = \frac{opp}{adj}$$
$$\theta = \tan^{-1}\left(\frac{1}{0.5}\right)$$
$$\theta = 63.43^\circ$$

$$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.95918$$

$$E_1 = 57397.95978$$

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

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

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

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

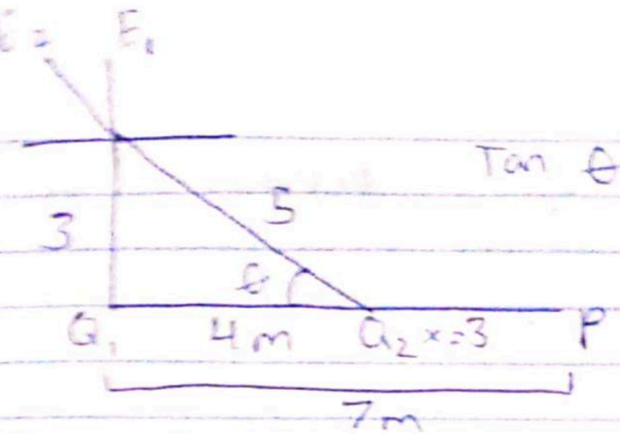
$$\boxed{q = 1.14\times10^{-5}\ C}$$

2 (a)

Electric Field - Is a region of space in which an electric charge will experience an electric field

Electric Field Intensity - Can be defined as the force per unit charge

2(b)



$\tan\theta = \frac{Opp}{Adj}$

$\theta = \tan^{-1}\left(\frac{-3}{4}\right)$

$\theta = 36.9°$

$E_{net} = E_1 + E_2$

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

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

$E_{net} = 12 + 1.469$

(i) $E_{net} = 13.469$ or $\boxed{13.5 \text{ N/C}}$

(ii)

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

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

Vector	Angle	X-comp	Y-comp
$E_1 = 8$ N/C	90°	0	8
$E_2 = 4.32$ N/C	36.9°	−3.45	2.59
		$\Sigma x = -3.45$	$\Sigma y = 10.59$

$E_{net} = \sqrt{(-3.45)^2 + (10.59)^2}$
$= 11.14 \text{ N/C}$

$\boxed{E_{net} = 11.14 \text{ N/C}}$

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

4 (b) $m = 9.11 \times 10^{-31}$ kg $r = 1.4 \times 10^{-7}$ m

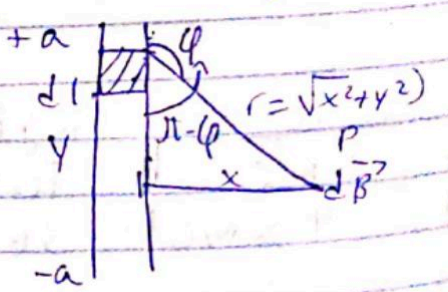
$B = 3.5 \times 10^{-1}$ weber/m^2 $q = -1.6 \times 10^{-19}$

$$\omega = \frac{qB}{m} = \frac{-1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

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

(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.

5 (a) The Biot-Savart law is used to find the total magnetic field created at some point the total magnetic field created at some point the current carrying wire or current consisting on a current carrying wire or current consisting of charges flowing through space.



5 (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 Diagram $r^2 = x^2 + y^2$

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

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

substituting (2) into (1)

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

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

recall $dl = dy$

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

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

Using special integrals

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

Equation (3) becomes

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

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

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

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

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