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MATRIC NO: 19/MHS01/174

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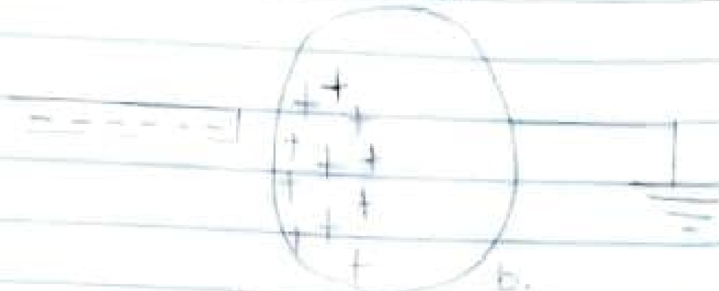
PHY 102 ASSIGNMENT

1)

a.



b.

c.

d.

b) $F = \frac{kq_1 q_2}{r^2}$

$r = 1.0\,M$

$k = 9 \times 10^9$

$q_1 = ?$

$q_2 = ?$

$r = 2$

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

$F = \frac{9 \times 10^9 \times (q_1 q_2 \; 5 \times 10^{-5})}{R^2}$

$Q_1 = 10\mu C = +10 \times 10^{-6} C$

$Q_2 = 2\mu C = -2 \times 10^{-6} C$

$V_2 = \frac{1}{4\pi E_0} = \left(\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right)$

$0 = 9 \times 10^9 \left[\frac{10 \times 10^{-6}}{4+x} + \frac{(-2 \times 10^{-6})}{x}\right]$

$0 = 9 \times 10^9 \left[\frac{10 \times 10^{-6}}{4+6} - \frac{2 \times 10^{-6}}{x}\right]$

$0 = \frac{70000}{4+x} - \frac{18000}{x}$

$0 = 70000x - 18000(4+x)$

$72000 = 90000x - 18000x$

$72000 = 72000x$

$x = 1$

$4 + x = 4 + 1$

$\Rightarrow 5\ m$

the position along the x-axis where $V = 0$ is $5m$

5a. The Biot-Savart Law states that the following observation for the magnetic field $d\vec{B}$ at a point P associated with a length element $d\hat{l}$ of a wire carrying a steady current.

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

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

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

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

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

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

$4 = 9 \times 10^{7} \times 5 \times 10^{-5} q_1 + 9 \times 10^{7} q_2$

$4 = 4.5 \times 10^{5} q_1^2 + 9 \times 10^{7} q_2$

$9 \times 10^{7} q_2 + 4.5 \times 10^{5} q^2 + 4 = 0$

$q_1 = 0.0000111C$

$q_2 = 0.0000384C$

$\Rightarrow q_1 = 1.11 \times 10^{-5} C$

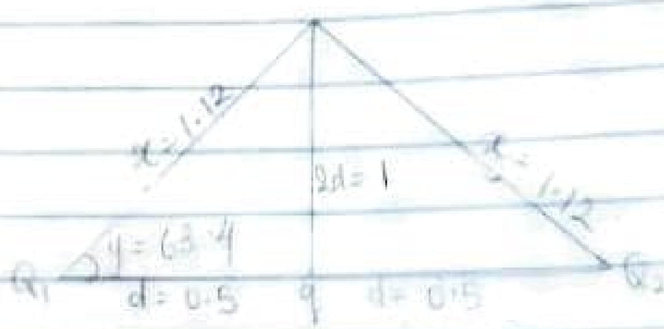
$q_2 = 3.87 \times 10^{-5} C$

q_1 & $q_2 = 1.11 \times 10^{-5} C$ & $3.84 \times 10^{-5} C$ respectively

c. $Q_1 = Q_2 = 8 \mu C$

$d = 0.5m$

Point $P = 0$



using $\tan\theta$ to find y

$y = \frac{1}{0.5}$

$y = 2$

$\tan^{-1}(y) = 63.4$

using pythagoreas theorem to find x

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

$x^2 = 1 + 0.25$

$x = \sqrt{1.25}$

$x = 1.12$

$E_1 = \frac{kq_1}{r^2} = \frac{9 \times 10^{7} \times 8 \times 10^{-6}}{(1.12)^2} = 5737.776$

$E_2 = \frac{kq_1}{r^2} = \frac{9 \times 10^{7} \times 8 \times 10^{-6}}{(1.12)^2} = 5737.776$

$E_q = \frac{kq}{r^2} = \frac{9 \times 10^{7} \times q}{1} = 9 \times 10^{7} q$

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

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

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

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

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

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

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

When $(x^2+a^2)^{1/2} = a$ & $a = \infty$

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

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

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

b. $M = 9 \times 10^{-31}$ kg

$r = 1.4 \times 10^{-7}$ m

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

Cyclotron frequency = angular speed

$\omega = \frac{V}{r} = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9 \times 10^{-31}}$

$\omega = 62222222222\ 222\ J^{-1}$

c. Each parameters were given in the above answer and we were asked to find the cyclotron frequency which is the same as angular speed. Therefore, we used the formula for finding angular speed to solve the problem. Then, we arrived at an an

Vector	Angle	x component $E_1 \cos\theta$	y component
$E_1 = 5779.776$	63.4°	2570.046	5132.263
$E_2 = 5779.776$	63.4°	2510.046	5132.263
$E_4 = 9\times10^9 q$	90°	0	$9\times10^9 q$
		$\Sigma x = 0$	$\Sigma y = 10264.526$

$$E_T = \sqrt{(\Sigma x)^2 + (\Sigma y)^2}$$

$$E_T = \sqrt{0^2 + (10264.526)^2}$$

$$E_T = 0$$

$$0 = 9\times10^9 q + 10264.526$$

$$q = \frac{-10264.526}{9\times10^9}$$

$$q = 1.1405 \times 10^{-6}\ \mu C$$

$$q = 11.4\ \mu C$$

(a) Volume charge density, $\rho = \frac{dQ}{dV} \longrightarrow dQ = \rho dV$

(b) Surface charge density, $\sigma = \frac{dQ}{dA} \longrightarrow dQ = \sigma dA$

(c) Linear charge density, $\lambda = \frac{dQ}{dL} \longrightarrow dQ = \lambda dL$

b. Electric potential difference is the work done per unit charge against electrical forces when a charge is transported from one point to the other.

$$dW = F \cdot dL \quad \text{——— (1)}$$

But, $F = -q_0 E$ ——— (2)

Substituting (2) into (1)

$$dW = -q_0 E dL \quad \text{——— (3)}$$

Total work done in moving the test charge from A to B:

$$W(A \to B)_{Ag} = -q_0 \int_A^B E dL \quad \text{——— (4)}$$

From the definition of electric potential difference

$$V_B - V_A = \frac{W(A \to B)_{Ag}}{q_0} \quad \text{——— (5)}$$

$$\therefore V_B - V_A = -\int_A^B E dL$$

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