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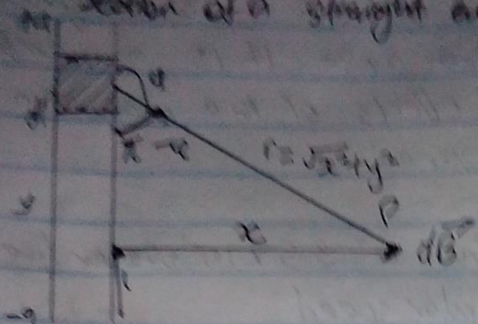
DEPT: CIVIL ENGINEERING

MATRIC NO: 19/ENG03/007

PHY 102

b) Section of a straight current carrying conductor



Applying the Biot-Savart Law, we find the magnitude of the field $\vec{dB}$

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

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

From diagram, $r^2 = x^2 + y^2$ (Pythagoras theorem)

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

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

~~Substituting (ii) into~~

Substituting (ii) into (i), we have

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

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

Recall $dl = dy$

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

Using special integrals: $\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2} \cdot \frac{y}{(x^2+y^2)^{1/2}}$

Equation (iii) therefore becomes

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

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

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

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

4 Magnetic flux is a measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effects of the magnetic force on something occupying a given area.

b) $m = 9.11 \times 10^{-31}$ kg, $r = 1.4 \times 10^{-7}$ m $B = 3.5 \times 10^{-1}$ weber/meter^2

cyclotron frequency = angular speed

$\omega = v/r = qB/m$.

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

$\omega = 62222.22 T^{-1}$

c) $M_e = 9.11 \times 10^{-31}$ kg $r = 1.4 \times 10^{-7}$ m and $B = 3.5 \times 10^{-1}$

This were the parameters given to us. We are to find cyclotron frequency because it is a frequency of an accelerator called cyclotron. Recall that angular speed is given as ω and $\omega = 62222.22 T^{-1}$

5a) Biot - Savart law is an equation describing the magnetic field generated by a constant electric current. It relates the magnetic field to the magnitude, direction, length and proximity of the electric current

where

$$\vec{dB} = \frac{\mu^{o}}{4\pi} \frac{I \, d\vec{l} \times \hat{r}}{r^2}$$

μ^o is a constant called permeability of free space

$\mu_o = 4\pi \times 10^{-7}$ T.m/A

The magnitude of the magnetic field is given as

$$B = \frac{\mu^o}{4\pi} \int \frac{I dl \sin\theta}{r^2}$$

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3:) a) i) volume charge density $\rho = \frac{dQ}{dV} \rightarrow dQ = \rho dv$

ii) surface charge density $\sigma = \frac{dQ}{dA} \rightarrow dQ = \sigma dA$

iii) linear charge density $\lambda = \frac{dQ}{dL} \rightarrow dQ = \lambda dl$

b) $dW = F \cdot dL$

$F = -q_0 E$

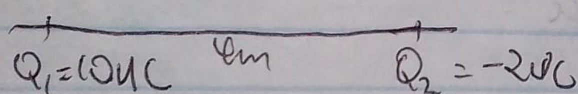
$dw = -q_0 E dl$

$W(A \rightarrow B)_{Ag} = -q_0 \int_A^B E dl$

$V_B - V_A = \frac{W(A \rightarrow B)_{Ag}}{q_0}$ · It follows the definition.

$V_B - V_A = -\int_A^B E dl$

c) ·



$Q_1 = 10 \mu C \quad Q_2 = 2\mu C$

$V = \frac{1}{4\pi\varepsilon_0} \left[\frac{Q_1}{r_1} \times \frac{Q_2}{r_2} \right]$

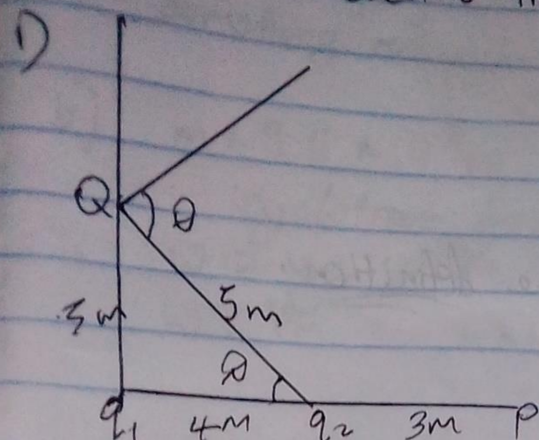
$= \frac{10 \times 10^{-6}}{r_1} \times \frac{2 \times 10^{-6}}{r_2}$

$r_1 = 5 r_2$

~~return~~ The diagram above, the position along the x-axis where $V = 0$ is 5m from $Q_1 = 10\mu C$ and 1m from $Q_2 = -2\mu C$

2 The electric field is a region around a charge in which it exerts electrostatic force on ~~another~~ other charges while the strength of electric field intensity

1)



$E_1 = \frac{kQ_i}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.47$

$E_2 = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 12.$

i ~~$PE_1 = 9\times10^9 + 8\times10^{-9} = 1.5\,N/C$~~

~~$E_2 = 9\times10^9 + 12\times10^{-9} = 12\,N/C$~~

$E_{net} = 12 + 1.5$

$= 13.5\,N/C$

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

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

θ	x cos θ	y sin θ
90	0	8
36.87	-3.46	2.56

$\Sigma x = -3.46\,N/C \quad \Sigma y = 10.59\,N/C$

$E = \sqrt{\Sigma x^2 + \Sigma y^2}$

$= \sqrt{(-3.46)^2 + (10.59)^2}$

$= 11.14\,N/C$