Recall $dl = dy$

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

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

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 (***) therefore becomes

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

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

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

When the length $2a$ of the conductor is very great in comparison to its distance x from point P, we consider it infinitely long. That is, when a is much larger than x,

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

$$\therefore B = \frac{\mu_o I}{2\pi x} \ldots (\#)$$

Equation (#) defines the magnitude of the magnetic field of flux density B near a long, straight, current carrying conductor.

unit as $^{1}/_{T}$ or rad/s which is equal to the unit of frequency dimensional

5(a) Biot-Savart law states that the magnetic field is directly proportional to the product permeability of free space (μ), the current (I), the change in length, the radius and inversely proportional to the square of radium (r^2). It can be represented mathematically by;

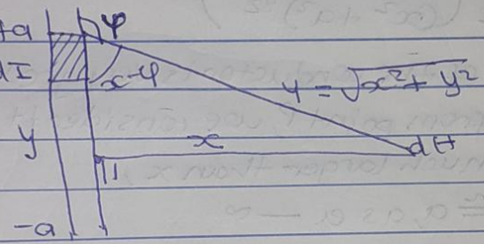
$$dB = \frac{\mu_0}{4\pi} \frac{I \, d\vec{l} \times \hat{r}}{r^2}$$

where μ_0 is a constant called permeability of free space

$$\mu_0 = 4\pi \times 10^{-7} \, T \cdot m/A$$

The unit of B = weber / meter square

b) Magnetic field of a straight current carrying conductor.



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

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

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

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

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

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

Substituting (**) into (*), we have

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

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

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

Putting equation (iv) in (v) yields

$$V_B - V_A = -\int_A^B E\,dL \quad \text{— (vi)}$$

SECTION B

4a) Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol ϕ. Mathematically given as $\phi = \oint \vec{B} \cdot d\vec{A}$

b. $M = 9 \times 10^{-31}$ kg, $r = 1.4 \times 10^{-7}$ m, $B = 3.5 \times 10^{-1}$ weber/meter^2

Cyclotron frequency = angular speed

$$W = \frac{V}{r} = \frac{qB}{m}$$

$$w = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9 \times 10^{-31}}$$

$$w = \frac{5.6 \times 10^{-20}}{9 \times 10^{-31}}$$

$$w = 0.622 \times 10^{11}$$

$$w = 6.22 \times 10^{10} \text{ rad/s}$$

c) mass of the electron $= 9.11 \times 10^{-31}$ kg

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

Magnetic field $= 3.5 \times 10^{-1}$ weber/metresquare

Cyclotron frequency = ?

Cyclotron frequency = Angular speed

Recall; Angular speed $= \frac{v}{r} = \frac{qB}{m}$

This is because it is a frequency of an accelerator called cyclotron

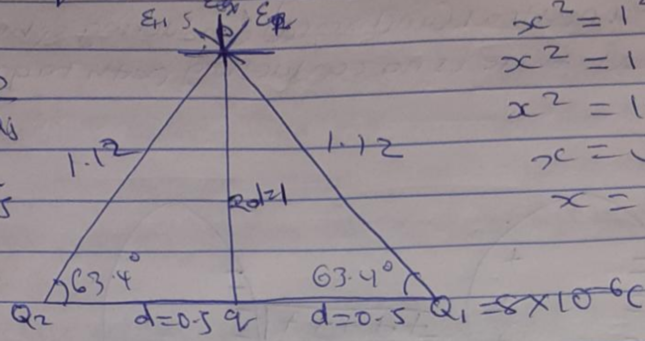
$$w = \frac{v}{r} = \frac{qB}{m} = \frac{1.6 \times 10^{-10} \times 3.5 \times 10^{-10}}{9.11 \times 10^{-31}} = 6.22 \times 10^{10} \text{ rad/s}$$

So since cyclontron frequency is equal to angular speed the cyclotron frequency is equal to $6.22 \times 10^{10}\ T^{-1}$, having a

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

$d = 0.5m$

determine q if electric field at a point p is zero



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

$\tan\theta = \frac{1}{0.5}$

$\tan\theta = 2$

$\theta = \tan^{-1}2$

$\theta = 63.4$

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

$x^2 = 1 + 0.25$

$x^2 = 1.25$

$x = \sqrt{1.25}$

$x = 1.12$

$$E_1 = \frac{KQ_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = \frac{72{,}000}{1.2544} = 57397.95918$$

$$E_2 = \frac{KQ_2}{r_2^2} = \frac{9\times10^9\times8\times10^{-6}}{(1.12)^2} = 57397.9518$$

$$E_q = \frac{Kq}{r^2} = \frac{9\times10^9\times q}{(1.12)^2} = 7.2\times10^9 q$$

Vector	Angle	x-comp	y-comp
$E_1 = 57397.9518$	63.4°	-25700.45454	51322.62179
$E_2 = 57397.9518$	63.4°	25700.45454	51322.62179
$E_q = 7.2\times10^9 q$	90°	0	$9.0\times10^9 q$
		$E_x = 0$	$E_y = 102645.2436$

$$\text{Magnitude} = \sqrt{(E_x)^2 + (E_y)^2}$$

$$E_q = \sqrt{(0)^2 + (102645.2436 + 9.0\times10^9 q)^2}$$

$$E_q = 7.2\times10^9 q + 102645.2436$$

Since $E_0 = 0$

$$0 = 9.0\times10^9 q + 102645.2436$$

$$q = \frac{-102645.2436}{9.0\times10^9}$$

$q = -1.140502853\times10^{-6}$

$q = -11.44\,\mu C$

$q = -11\,\mu C$

3(a)(i) Volum

(ii) Surfac

(iii) Linear cha

(b) Electri

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$F = -90E$

Substi

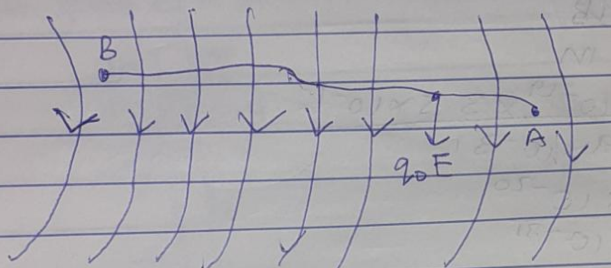
Then to

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) Electric Potential Difference: The electric potential difference between two points in an electric field can be defined as as the work done per unit charge against electrical forces when a charge is transported from one point to the other. It is measured in volt (V) or Joules per coulomb (J/C). Electric potential difference is a scalar quantity



consider the diagram above, suppose a test charge q_0 is moved from point A to point B along an arbitrary path inside an Electric field $\mathcal{E}$. The electric field, $\mathcal{E}$ exerts a force $F = q_0\mathcal{E}$ on the charge as shown in fig 3.1. To move the test charge from A to B at constant velocity, an external force of $F = -q_0E$ much act on the charge. Therefore, the elemental work done

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

$$F = -q_0E \quad \text{—— (ii)}$$

Substituting equation (2) in (1) yields

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

Then total work done in moving the test charge from A to B is:

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

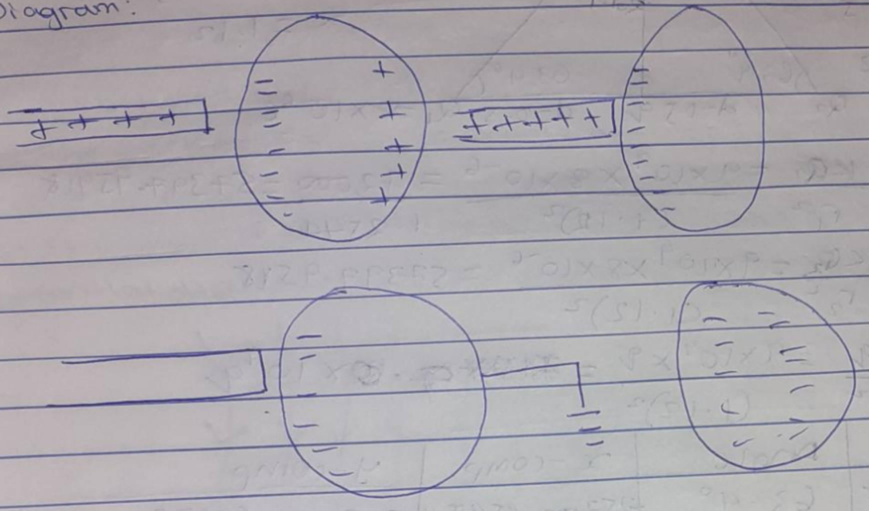
From the definition of electric potential difference. It follows:

NAME: OKEREKE MIRACLE ONYINYECHI
DEPARTMENT: MEDICINE AND SURGERY
MATRIC NUMBER: 19/MHS01/315

PHY 102 ASSIGNMENT (SECTION A)

1a) ~~K=9×10^9~~ charging by induction: Electric charges can be obtained on an object without touching it, by a process called electrostatic induction. Consider a positively charged rubber rod brought near a neutral (uncharged) conducting sphere that is insulated so that there is no conducting path to ground as below.

Diagram:



b) $K = 9\times10^9$

$q_1 + q_2 = 5.0\times10^{-5}C$

$F = 1N$

$d = 2m$

calculate the charge on each sphere

Recall; $K = 9\times10^9$

$$F = \frac{kq_1q_2}{r^2}$$

$$1 = \frac{9\times10^9 \times (q_1q_2\ 5\times10^{-5})}{2^2}$$

$$4 = 9\times10^9 \times 5\times10^{-5} q_1 + 9\times10^9 q_2$$

$$4 = 4.5\times10^5 q_1 + 9\times10^9 q_2$$

$$q_1 = 0.000011C \simeq 1.11\times10^{-5}C$$

$$q_2 = 0.000038C \simeq 3.8\times10^{-5}C$$