PHYSICS 102 ASSIGNMENT

OKE OLUWASEUN PATIENCE
MBBS
19/MHS01/310.

(a) $k = 9\times10^9$

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

$f = 1N$

$d = 2m$

Calculate the charge on each sphere.

Recall; $k = 9\times10^9$

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

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

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

$$4 = 4.5\times10^5 q_1^2 + 9\times10^7 q_2$$

$q_1 = 0.000011c$

$q_2 = 0.000038c$

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

$\simeq q_2 = 3.8\times10^{-5}c$.

infinitely long. That is, when a is much larger than x.

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

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

In a physical situation, we have axial symmetry about the y-axis. Thus, at all points in a circle of radius r, around the conductor, the magnitude of B is.

$$B = \frac{\mu_0 I}{2\pi r} \quad ---- (4)$$

Equation (4) defines the magnitude of the magnetic field of flux density B near a long, straight current carrying conductor.

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

Substituting (**) into (*):

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

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

Recall $dl = dy$.

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

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

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.

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

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

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

When the length $2a$ of the conductor is very great in comparison to its distance x from point P, we consider it

5a. 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 square of radium (r^2). It can be represented mathematically by:

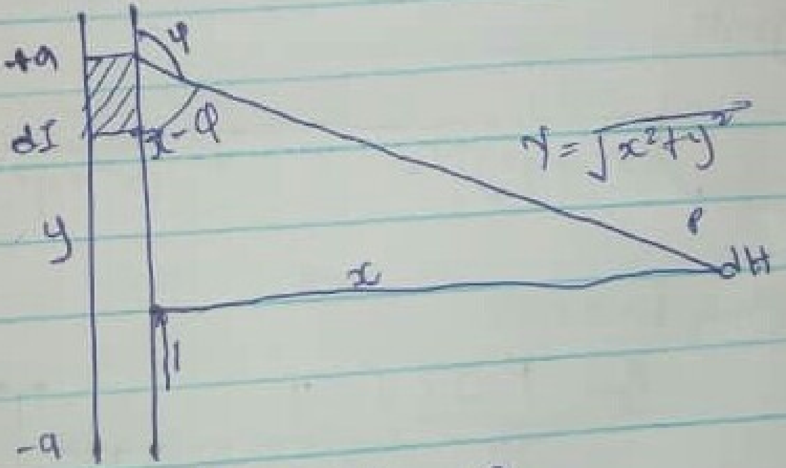
$$d \cdot B = \frac{\mu_0}{4\pi} \frac{I dL \times r}{r^2}$$

where μ_0 is a constant called permeability of free space

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

The unit of B = weber/meter square.

5b) 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).

$$B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - \varphi)}{x^2 + y^2} \quad \text{--- (7)}$$

4b. $m = 9 \times 10^{-31}$ kg
$r = 1.4 \times 10^{-7}$ m
$B = 3.5 \times 10^{-1}$ weber / meter^2.
cyclotron frequency = angular speed.

$$w = \frac{v}{r} = \frac{qB}{m}$$

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

$$w = 62222222222.22222 T^{-1}$$

4c. mass of the electron $= 9.11 \times 10^{-31}$ kg.
A radius ~~of~~ 1.4×10^{-4} m
magnetic field = 3.5×10^{-1} weber / meter square.
Cyclotron frequency = ?
Cyclotron frequency = Angular speed.
Recall; Angular speed = $\frac{v}{r} = \frac{q\beta}{m}$.

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

$$w = \frac{v}{r} = \frac{q\beta}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$$\frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}} = 62222222222.22222 T^{-1}$$

So since cyclontron frequency is equal to angular speed, the cyclotron frequency is equal to $62222222222.22222 T^{-1}$, having a unit as 1/T which is equal to the unit of frequency dimension

an external force of $F = -q_0 E$ must act on the charge.
Therefore, the elemental work done dW is given as:

$$dW = f \cdot dL \quad \text{--} \; (1)$$

But.

$$F = -q_0 E \quad \text{--} \; (2)$$

Substituting equation (2) in (1) yields.

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

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

$$W(A'nB)Aq = -q_0 \int_A^B E \, dL \quad \text{--} \; (4)$$

From the definition of electric potential difference, it follows that!

$$V_B - V_A = \frac{W(A'nB)Aq}{q_0} \quad \text{--} \; (5)$$

putting equation (4) in (5) yields

$$V_B - V_A = -\int_A^B E \, dL \quad \text{--} \; (6)$$

SECTION B.

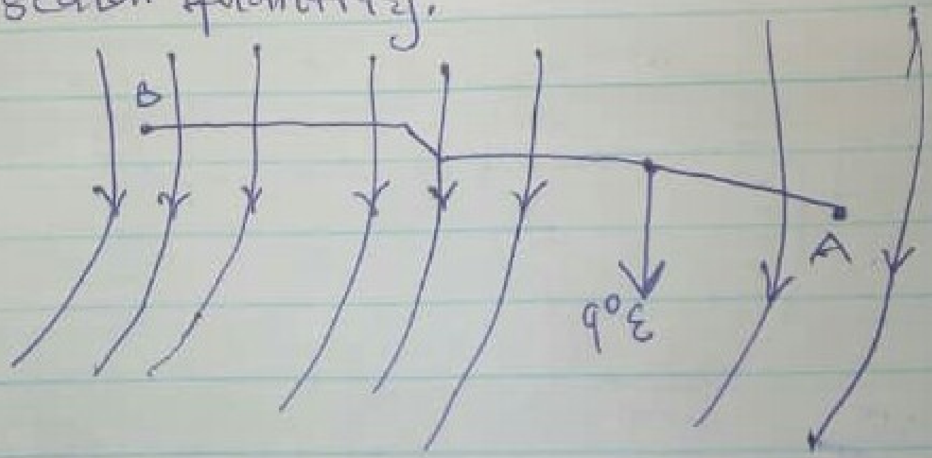
4a) Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol Φ. mathematically given as Φ =

3a. (i) Volume charge density, $\rho = \frac{dQ}{dV}$ 'n $dQ = \rho dV$.

(ii) Surface charge density, $\sigma = \frac{dQ}{dA}$ 'n $dQ = \sigma dA$.

(iii) Linear charge density, $\lambda = \frac{dQ}{dL}$ 'n $dQ = \lambda dL$.

3b. Electric Potential Difference.
The Electric potential difference between two points in an electric field can be defined 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 E. The electric field E exerts a force $F = q_0 E$ on the charge as shown in fig 3.1. To move the test charge from A to B at constant velocity, since $\varepsilon_0 = 0$

$$0 = 9\times10^{9}q + 10264.52568.$$

making q subject of formulae.

$$q = \frac{-10264.52568}{9\times10^{9}}$$

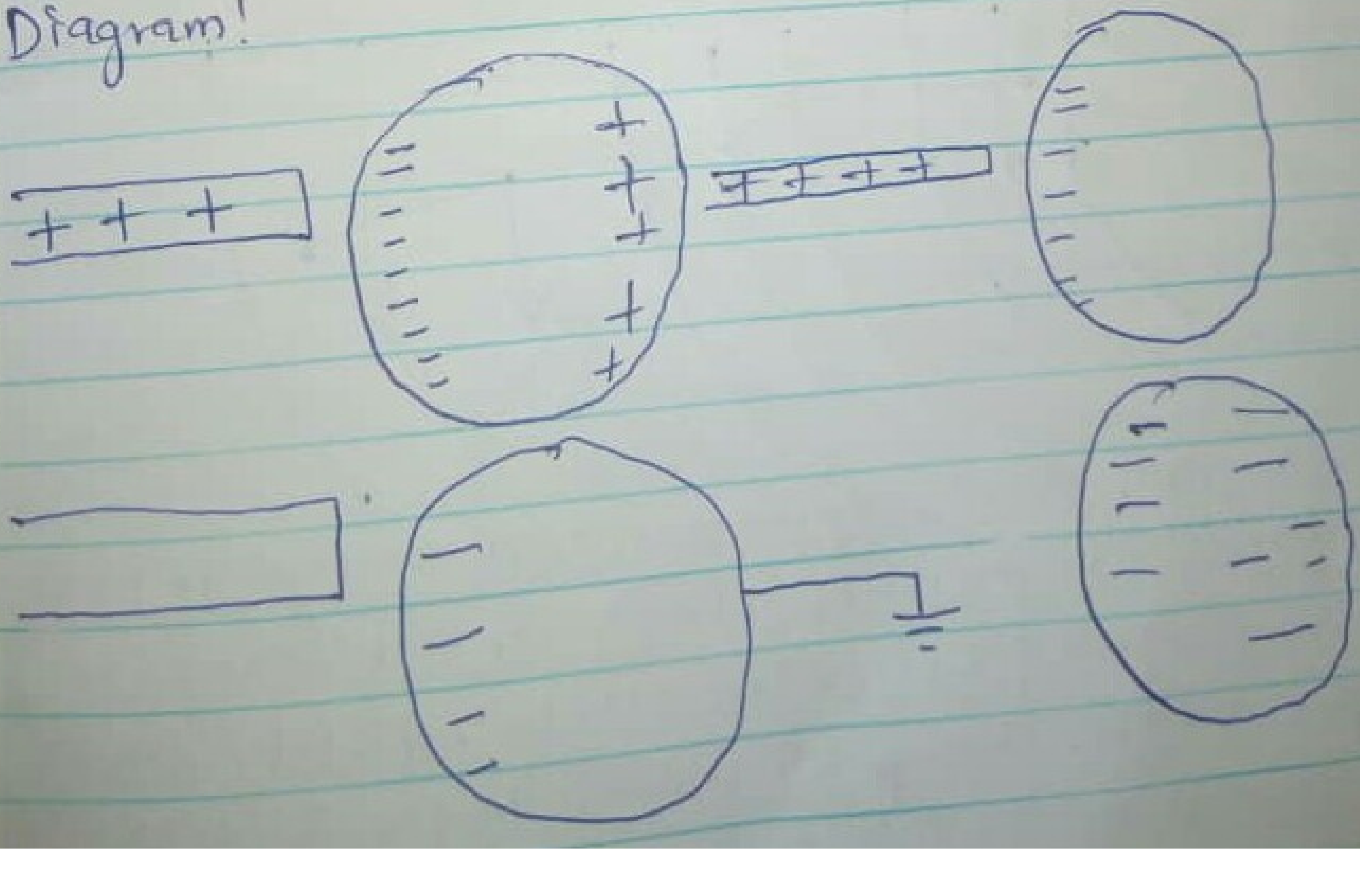
$$q = 1.140502853\times10^{-6}$$

$$\simeq q = 11.44C.$$

19. Charging by induction!

Electric charges ~~can~~ 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.

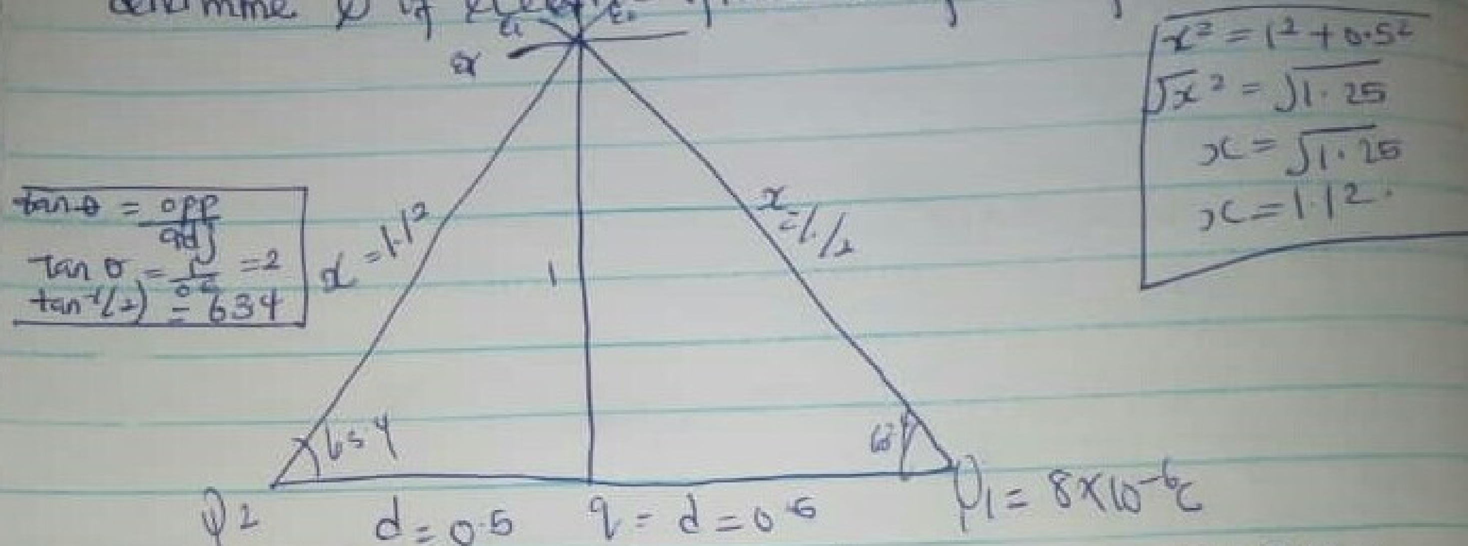
Diagram!



(c) $Q_1 = Q_2 = 8\mu C$

$d = 0.5 m$

determine Q of electric field at a point P is zero.



$$E_1 = \frac{kq_1}{r_1^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2} = 5739.795918$$

$$E_2 = \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2} = 5739.795918$$

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

Vector	angle	x-comp	y-comp
$E_1 = 5739.795918$	63.4^0	$E_1 \times \cos\theta$ $= 2570.045785$	5132.262839
$E_2 = 5739.795918$	63.4^0	2570.045785	5132.262839
$E_q = 9 \times 10^9 q$	90^0	$E_q \cos\theta = 0$ $E_x = 0$	$9 \times 10^9 q$ $E_y = 10264.52568$

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

$$E_q = \sqrt{(0)^2 + (10264.52568)^2}$$