(1)

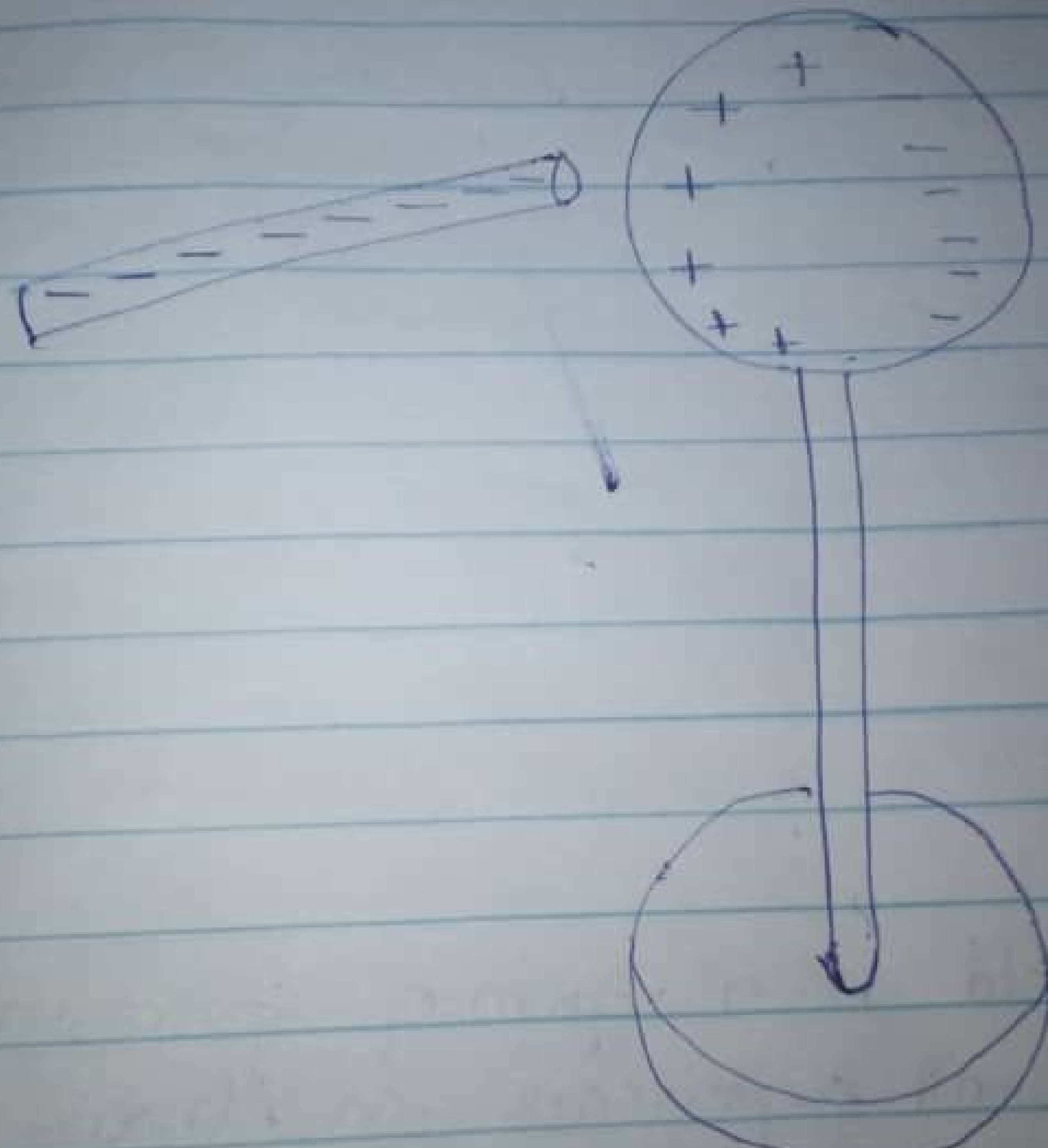
Name: Ndubuisi Ozioma Laurel
Matric No: 19/MHS01/256

ASSIGNMENT

1. Consider a negatively charge rubber rod brought near a neutral (uncharged) conducting sphere that is insultated so that there is no conducting path to ground as shown below. The repulsive force between the electrons in the rod and those in the sphere causes a redistribution of charges on the sphere so that some electrons move to the side of the sphere farthest away from the rod. The region of the sphere nearest the negatively charged rod has an excess of positive charge because of the migration of electron away from the location. a grounded conducting wire is then removed; the conducting sphere is left with an excess of induced positive charge. Finally, when the rubber rod is removed from the vicinity of the sphere. the induced positive charge remains on the ungrounded sphere and becomes uniformly distributed over the surface of the sphere.

rod brought
sphere that
path to ground
the electrons
ses a redis-
me electrons
ray from the
egatively char
ecause of
cation, If
e conducting
charge.
Vicinity of
on the Un-

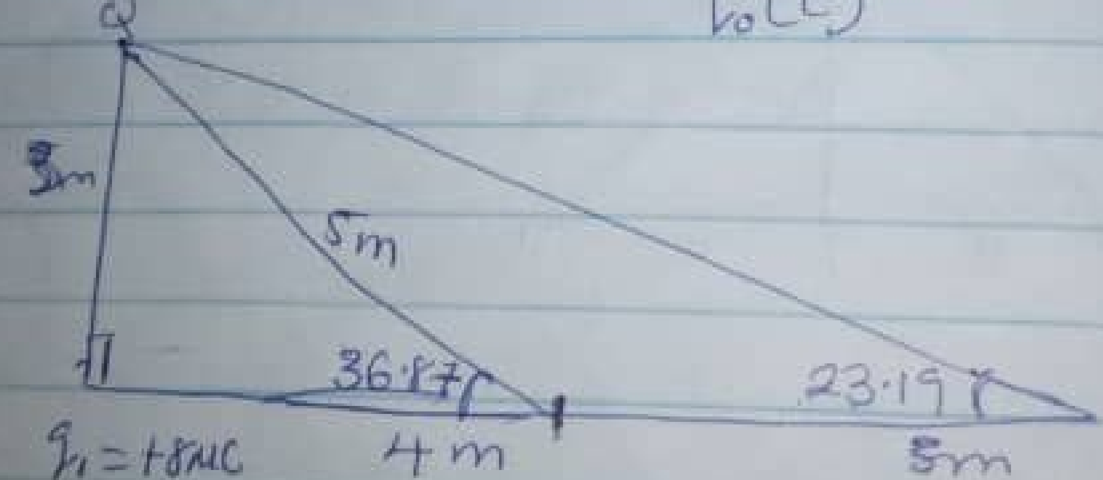
b)



c $Q_1 = Q_2 = 8\mu C$ & $d = 0.5m$. $q = ?$ $P = 0$

2) ~~A~~ Electric field is a region of space in which an electric charge will experience an electric force. While Electric field (intensity) E, can be defined as the force per unit charge. $\Rightarrow E = \frac{F(N)}{q_0(C)}$

b)

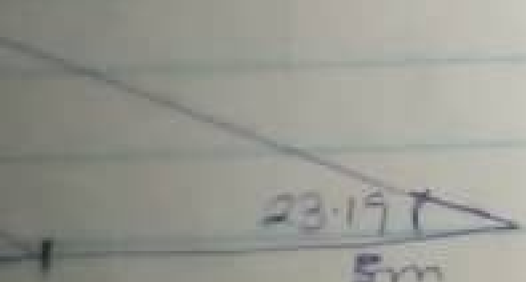


i) $E_1 = \frac{KQ_1}{r^2} = \frac{9\times10^9\times8\times10^{-9}}{7^2} = 1.47$ +

$E_2 = \frac{KQ_2}{r^2} = \frac{9\times10^9\times8\times10^{-9}}{3^2} = 13.47 N/C$

is a region of space in which an
... experience an electric force. while
...sity) E, can be defined as the force per

$$E = \frac{F(N)}{q_0(C)}$$



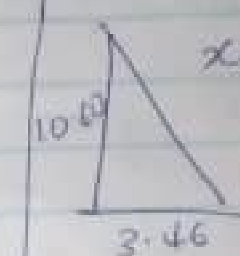
$$\frac{\ldots \times 8\times10^{-9}}{\ldots} = 1.47 \; +$$

$$\frac{\ldots 10^{9}\times 8\times 10^{-9}}{\ldots} = 13.47\,N/C$$

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

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

x	y
$8\times\cos(90)$	$8\times\sin 90$
$=0$	$=8$
$4.32\times\cos(36.87)$	$4.32\times\sin(36.87)$
$=3.46$	2.60
3.46	10.60



$x = \sqrt{10.6^2 + 3.46^2}$

$= 11.15\,N/C$

3) volume charge density $= \rho\, dV$

ii Surface " $= \sigma\, dA$

iii Line or " $= \lambda\, dL$

b The electric potential difference 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.

Suppose a test charge q_0 is moved from point A to point B along an arbitrary path inside an electric field E. The Electrifield E exerts a force $F = q_0E$ on the charge. To move the test charge from A to B

(a) at constant velocity, an external force of $F = -q_0 E$ must act on the charge. Therefore, the elemental work done dW is give as:

$$dW = F.dL \quad \text{--- (1)}$$

But

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

Substituting equation (2) in 1 yield

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

Then total work done in moving the test charge q_0 from A to B is:

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

From the difference of electric potential difference follows that:

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

b) Putting equation (4) in (5) yields

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

c) $Q_1 = 10\mu C$, $Q_2 = -2\mu C$ $x = 0$ & $x = 4m$ $x = ?$ $= V = 0$

i) 

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

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

$$\frac{0}{9\times10^{9}} = \frac{10\times10^{-6}}{r_2^2} - \frac{2\times10^{-6}}{r^2}$$

$$2r = 10r_2, \quad r_1 = 5r_2$$

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

Name Aldubuch Oziomа Laurel (7)

4) The magnetic flux is defined as the strength of magnetic field represented by lines of force. It is usually represented by the symbol ϕ

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

Cyclotron frequency = angular speed

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

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

$$w = 62222.2222 T^{-1}$$

c) We were given parameters such as

i) Mass of one electron $= 9.11 \times 10^{-31}$ kg

ii) A radius of 1.4×10^{-7} m

iii) Magnetic field of 3.5×10^{-1} weber/meters square and we were asked to find the cyclotron frequency which is equal or the same thing as angular speed. It is called cyclotron frequency because it is a frequency of an accelerator called cyclotron. Recall that angular speed is given as w = substituting we

have $w = 1.6 \times 10^{?} - 10 \times 3.5 \times 10^{-10} / 9 \times 10^{-31}$

$= 622222.222 T^{-1}$

Name: Ali Khalil Usman Lawal | Matric No: [illegible]

5 State the Biot-Savart law (6)

a) The Vector $d\vec{B}$ is perpendicular both to $d\vec{l}$ (which points to the direction of the current) and to the unit vector $\hat{r}$ directed from $d\vec{l}$ toward P.

b) The magnitude of $d\vec{B}$ is inversely proportional to r^2, where r is the distance from $d\vec{l}$ to P.

c) The magnitude of $d\vec{B}$ is proportional to the current I and to the magnitude of the lenght element $d\vec{l}$.

d) The magnitude of $d\vec{B}$ is proportional to $\sin\theta$, where θ is the angle between $\hat{r}$ and dl.

- mathematical expression=>

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

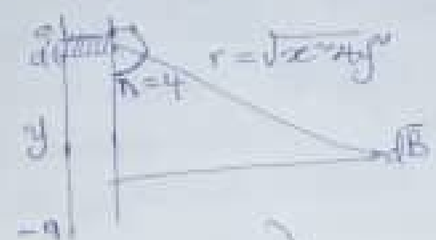
μ_0 is a constant called Permeability of free space

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

5b)

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

Sol:-



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

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

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

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

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

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{---- (1)}$$

Equation (1) defines the magnetic field of flux density B near a long straight current carrying conductor.