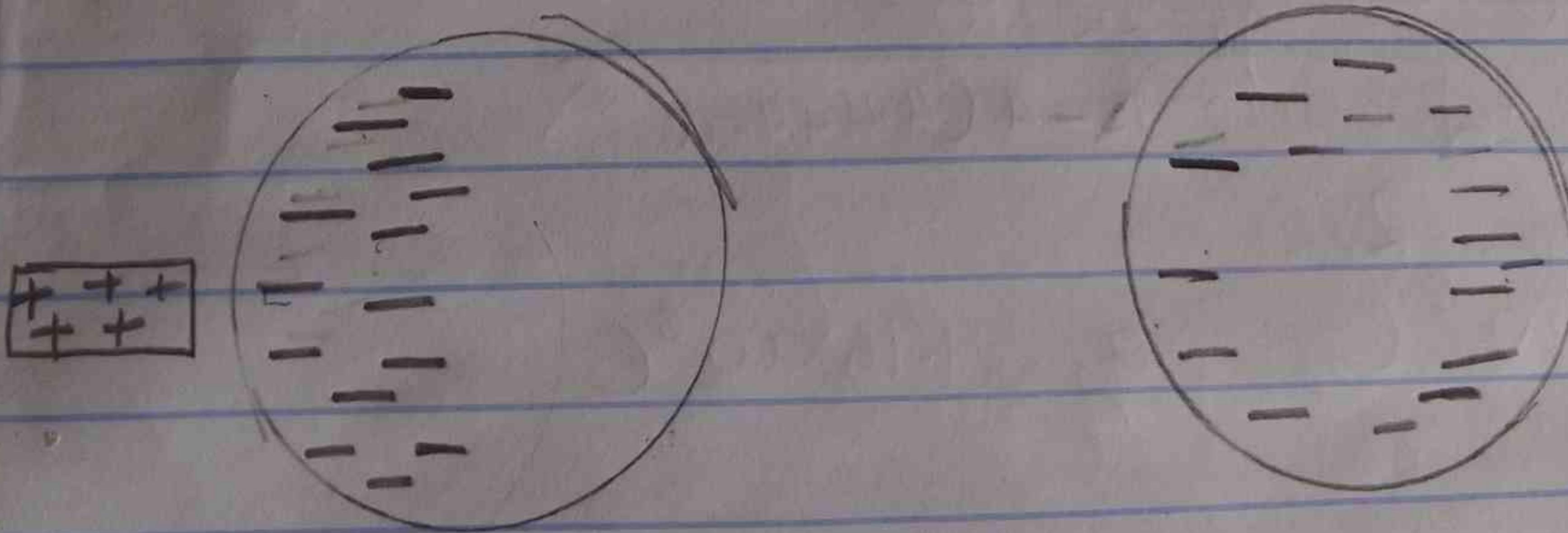
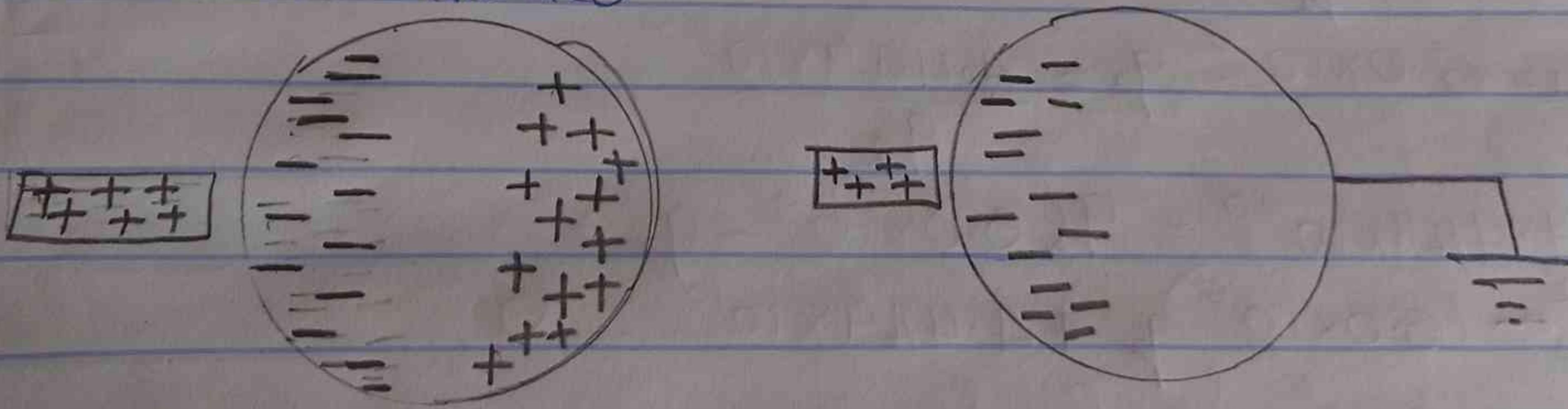


Name- Asiegbu Cynthia Ogechii  
Matric.No. 19/MHS01/106  
Department- Medicine and Surgery

- ① A sphere can become negatively charged by induction if when a positively charged rod is brought close to the sphere, the repulsive force between the protons will cause a redistribution whereby the electrons are closer to the rod and protons move further from the rod to the opposite part of the sphere. If a grounding connecting wire is short connected to the sphere, the protons are discharged to the earth and the sphere is left negatively charged after the wire has been disconnected.



$$(b) q_1 + q_2 = 5.0 \times 10^{-6} C$$

$$F = 1.0 N$$

$$r = 2.0 m$$

$$k = 8.9 \times 10^9 N m^2/C^2$$

$$F = \frac{k q_1 q_2}{r^2}$$

$$1 = \frac{8.9 \times 10^9 \times q_1 q_2}{4}$$

$$q_1 q_2 = \frac{4}{8.9 \times 10^9}$$

$$q_1 q_2 = 4.449 \times 10^{-10} C^2$$

Note that  $q_1 + q_2 = 5.0 \times 10^{-6} C$

$$q_1 = 5.0 \times 10^{-6} - q_2$$

$$q_1 = \frac{4.449 \times 10^{-10}}{q_2}$$

$$\therefore q_1 = 5.0 \times 10^{-6} - q_2 = \frac{4.449 \times 10^{-10}}{q_2}$$

$$4.449 \times 10^{-10} = q_2(5.0 \times 10^{-6} - q_2)$$

$$q_2^2 - (5.0 \times 10^{-6})q_2 + 4.449 \times 10^{-10} = 0$$

Using quadratic formula

$$q_{1,2} = \frac{(5 \times 10^{-6}) \pm \sqrt{(5 \times 10^{-6})^2 - 4(4.449 \times 10^{-10})}}{2}$$

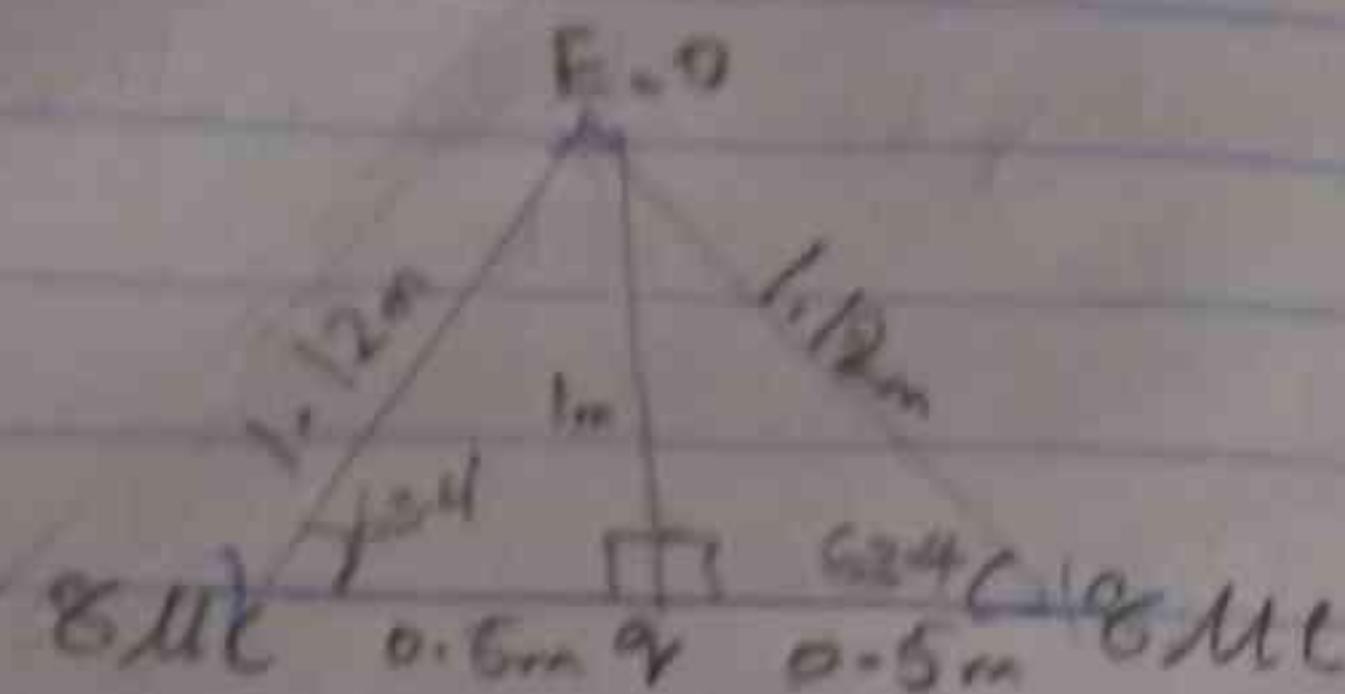
$$q_1 = 2.5 \times 10^{-5} \quad q_2 = 2.5 \times 10^{-5}$$

$$q_1 = 3.84 \times 10^{-5} C \quad q_2 = 6.16 \times 10^{-5} C$$

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

$$d = 0.6m$$

determine  $\mathbf{E}$ , if electric field at a point P  $(x, y)$ ,



$$E_1 = \frac{kQ_1}{r^2} = \frac{(9.0 \times 10^9)(8 \times 10^{-6})}{(0.5)^2} = 57397.9592$$

$$E_2 = \frac{kQ_2}{r^2} = \frac{(9.0 \times 10^9)(8 \times 10^{-6})}{(0.5)^2} = 57397.9592$$

$$E_g = \frac{kq}{r^2} = \frac{(9 \times 10^9) \times 9}{(0.5)^2} = 9 \times 10^9 \times 9$$

Vector	Angle	X-component	Y-component
$E_1 = 57397.9592$	$63.4^\circ$	+2570.045785	5132.2628
$E_2 = 57397.9592$	$63.4^\circ$	-2570.045785	5132.2628
$E_g = 9 \times 10^9 q$	$90^\circ$	0	$9 \times 10^9 q$
		$\Sigma_x = 0$	$\Sigma_y = 10264.5257 + q$

$$\text{Magnitude} = \sqrt{\Sigma_x^2 + \Sigma_y^2}$$

$$E = \sqrt{0^2 + (10264.5257 + 9 \times 10^9 q)^2}$$

$$E = 0 = 10264.5257 + 9 \times 10^9 q$$

$$q = -\frac{10264.5257}{9 \times 10^9}$$

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

$$q = -1.1 \mu C$$

3.7 Volume Charge density  $\rho = \frac{dQ}{dv}$  in  $dQ = \rho dv$

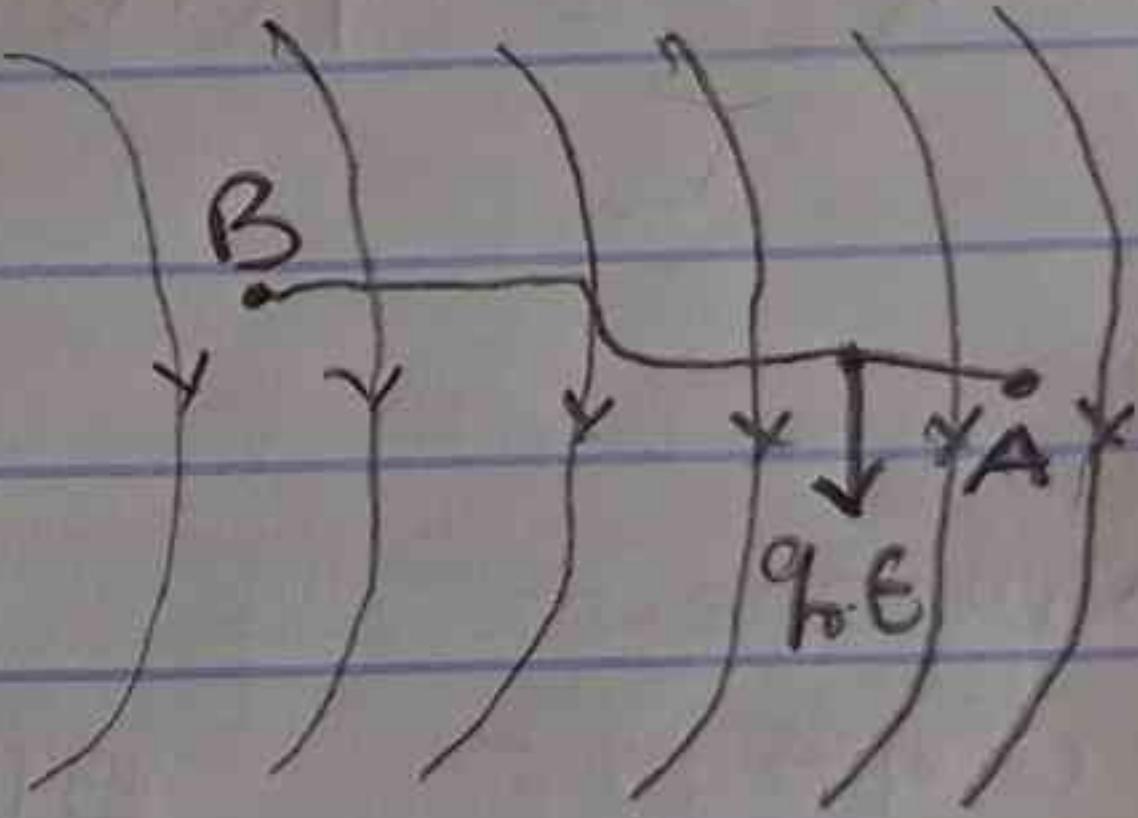
v) Surface charge density  $\sigma = \frac{dQ}{dA}$  in  $dQ = \sigma dA$

w) Surface charge density  $\tau = \frac{dQ}{dL}$  in  $dQ = \tau dL$

x) Linear charge density  $\lambda = \frac{dQ}{dL}$  in  $dQ = \lambda dL$

### 3.8 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.



Considering 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 above. To move the test charge from A to B at constant velocity, 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  $F = -q_0 E$   $\therefore dw = -q_0 E \cdot dL \quad \text{--- (2)}$

Sub eqn(2) in (1).

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

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

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

From the definition of electrical Potential difference, it follows

$$V_B - V_A = W(A \text{ to } B)_{\text{mg}} \quad \text{--- (5)}$$

or

Putting eqn (4) in (5) yields

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

## Section B

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

4b)  $M_e = 9.11 \times 10^{-31} \text{ kg}$ ,  $r = 1.4 \times 10^{-2} \text{ m}$ ,  $\theta = 90^\circ$

Magnetic field  $= 3.5 \times 10^1$  tesla

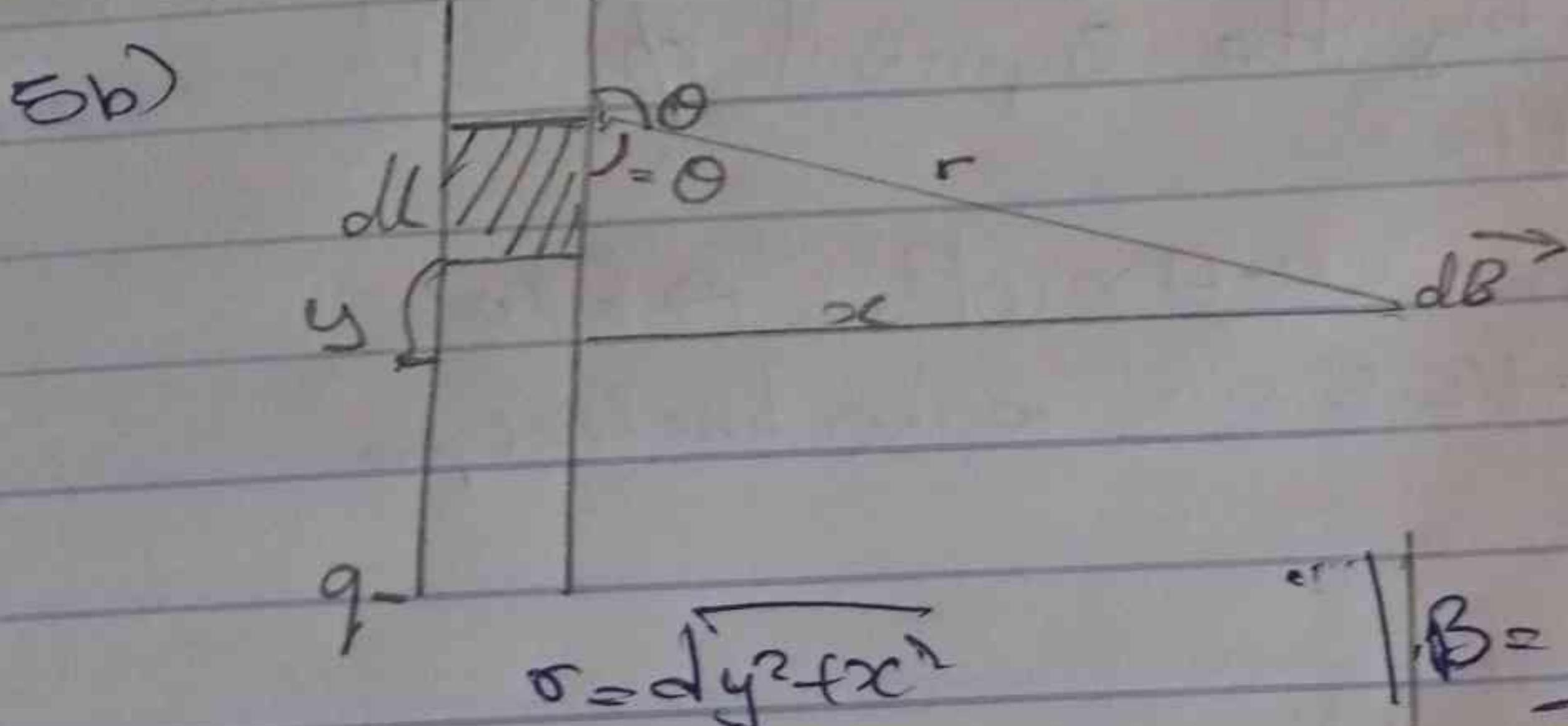
$$\omega = \frac{qB}{r}$$

$$\omega = \frac{(6.8 \times 10^{-9} \times (3.5 \times 10^1))}{9.11 \times 10^{-31}}$$

$$\omega = 6.15 \times 10^{30} \text{ rad/s}$$

4c) An electron of mass  $9.11 \times 10^{-31} \text{ kg}$  and charge  $1.6 \times 10^{-19} \text{ C}$  moves in a magnetic field of  $3.5 \times 10^1$  Tesla perpendicular to the field will have an angular frequency  $6.15 \times 10^{30} \text{ rad/s}$

- ④ The vector  $d\vec{B}$  is perpendicular to  $dl$  (which points in the direction of the current) and to the unit vector  $\hat{r}$  directed from  $dl$  towards P.
- The magnitude of  $d\vec{B}$  is inversely proportional to  $r^2$  where  $r$  is the distance from  $dl$  to P.
  - The magnitude of  $d\vec{B}$  is inversely proportional to  $r^2$  where  $r$  is the distance from  $dl$  to P.
  - The magnitude of  $d\vec{B}$  is proportional to the current I and to the magnitude of the length element  $dl$ .
  - The magnitude of  $d\vec{B}$  is proportional to  $\theta$ , where  $\theta$  is the angle between  $\hat{r}$  and  $dl$ .



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

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

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

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

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

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

$$(a^2 + x^2)^{1/2} \approx a$$

$$a \approx 2\pi x$$

$$B = \frac{N \mu_0 I}{2\pi x} \frac{a}{(2\pi x)^{1/2}}$$

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

$$\approx \frac{2\pi x}{2\pi x} x^{2/3}$$

$$B = \frac{N \mu_0 I}{2\pi x^{4/3}}$$