Physics 102 Assignment

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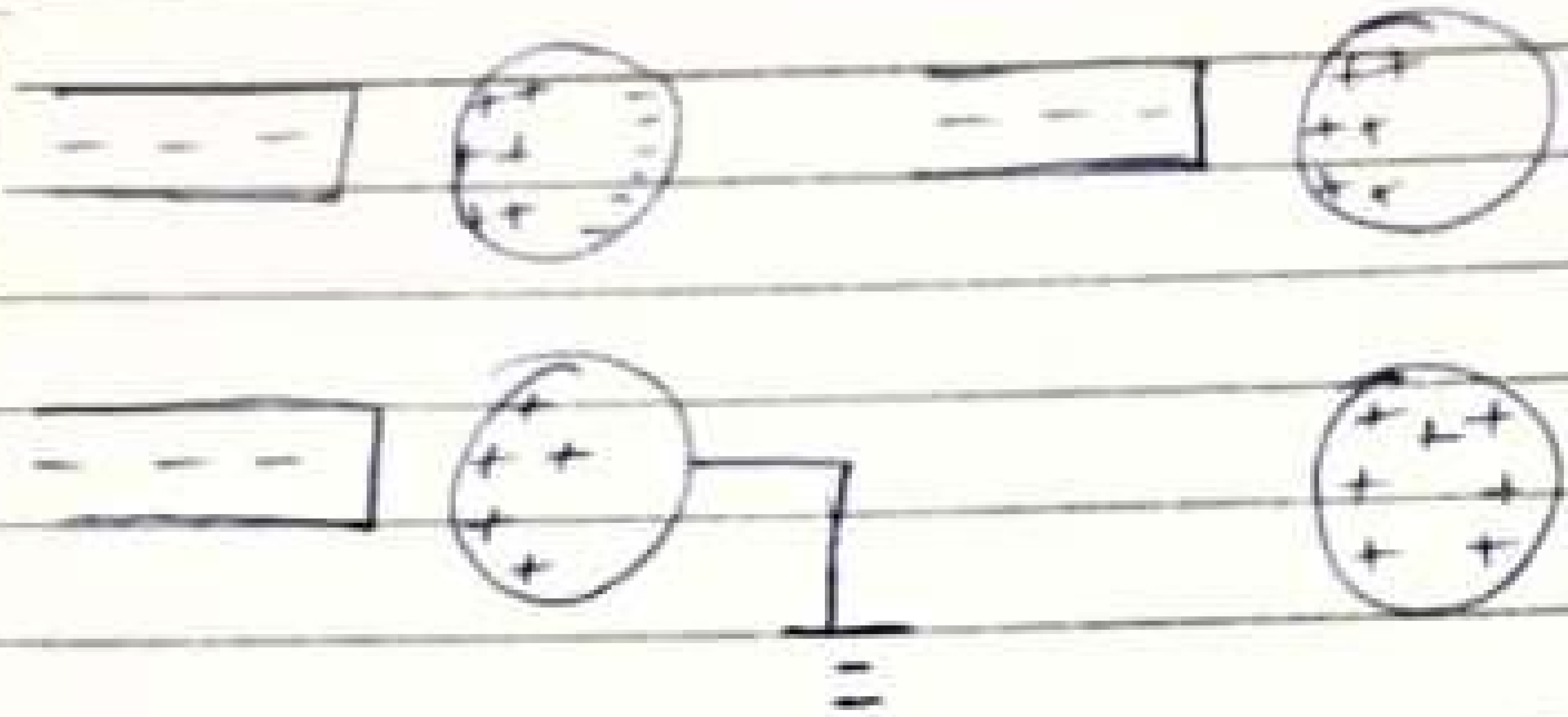
(1a) Charging by induction: A negatively charged object; rod is brought near a neutral conducting sphere that is insulated so that things in the conducting path be ground as shown below. The repulsive force between the electrons in the rod and those in the sphere causes ~~an~~ a redistribution of Changes on the Sphere so that some electrons move to the side of the sphere farthest away from the rod. A grounded conducting sphere is conducted to the sphere and some electrons leave the sphere and it is left with excess of induced positive Charge when the rubber rod is ~~[illegible]~~ removed from the vicinity of the sphere, the induced positive charge remains on the ungrounded sphere and becomes uniformly distributed over the surface of there.



(b) $q_1 + q_2 = 5.0 \times 10^{-5} C$

$F = 1$

$r = 2$

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

$1 = 9 \times 10^9 = (q_2 - 5.0 \times 10^{-5}) = q_2$

$4.44 \times 10^{-10} = (q_2 - 5.0 \times 10^{-5}) q^2$

$4.44 \times 10^{-10} = q_2^2 - 5.0 \times 10^{-5} q^2$

$q_2 = 1.14 \times 10^{-5}$

$q_1 = 5.0 \times 10^{-5} - 1.4 \times 10^{-5}$

$= 3.86 \times 10^{-5} C$

$\therefore q_1 = 3.86 \times 10^{5} C, \; q_2 = 1.14 \times 10^{-5}$

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

$d = 0.5m$

$\tan\theta = \frac{opp}{adj}$

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

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

$\theta = 63.4$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9\times8\times10^{-6}}{(1.22)^2} = 5732.79$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9\times8\times10^{6}}{(1.28)^2} = 5739.29$

$E_q = \frac{kq}{r^2} = \frac{9\times10^9\times q}{(1)^2} = 9\times10^9 q$

Vector	Angle	X.comp	Y.Comp
5732.79	63.4	25700.74	5132.26
5739.29	63.4	25700.74	5132.26
$9\times10^9 q$	90	0	$9\times10^9 q$
		0	$E_y = 10264.2365q$

$E_{2P} = \frac{kq_2 P}{r^2} = \frac{9\times10^{9} \times 12\times10^{-9}}{3^2} = 12 N/C$

$E_{net} = 12 + 1.469$

$= 13.469 N/C$

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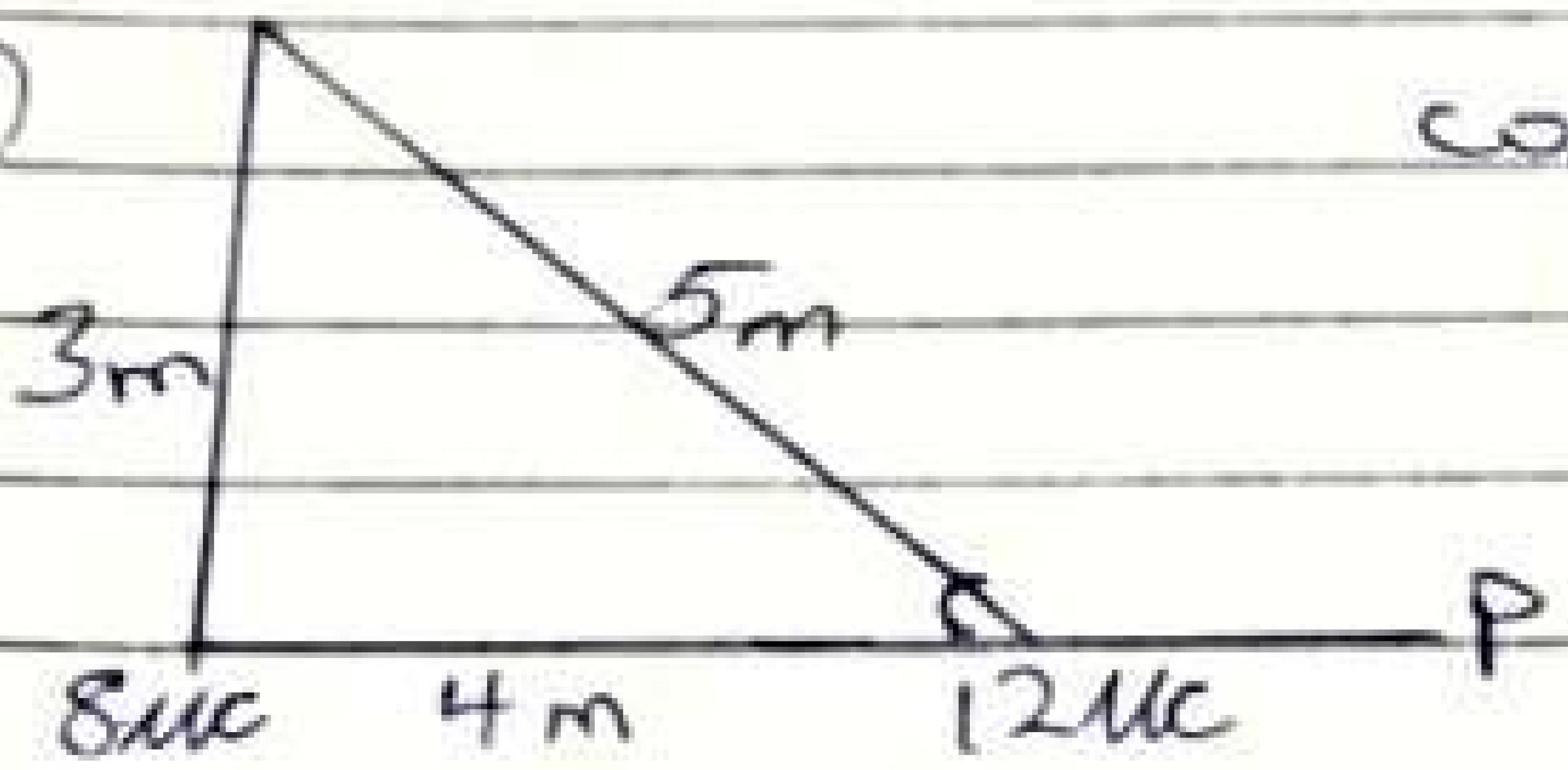

$\cos\theta = 4/5$

$\theta = 36.87^{0}$

$E_{1q} = \frac{kq}{r^2} = \frac{9\times10^{9} \times 8\times10^{-7}}{3^2} = 8 N/C$

$E_{2q} = \frac{kq_2}{r^2} = \frac{9\times10^{9} \times 12\times10^{-9}}{5^2} = 4.32 N/C$

vector	Angle	x. comp	y. comp
$E_{1q} = 8 N/C$	90^{0}	$8\cos 90 = 0$	$8\sin 90 = 8$
$E_{2q} = 4.32 N/C$	36.87^{0}	$4.32\cos 36.87 = 3.46$	$4.32\sin 36.87$
		$E = 3.46 N/C$	$E = 10.59 N/C$

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

$E_{net} = 11.14 uC$

4a) A magnetic flux is the strength of magnetic field represented by lines of force. It is usually represented by the symbol ϕ

b) $m = 9.11 \times 10^{-31}$ kg

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

$b = 3.5 \times 10^{-1}$ Wb/m^3

$q = 1.6 \times 10^{-4}$ C

$$V = \frac{qBr}{m}$$

$$V = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1} \times 1.4 \times 10^{-7}}{9.11 \times 10^{-31}}$$

$V = 8.61 \times 10^{3}$ m/s

Angular speed = Cyclotron frequency

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

$$= \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-3}}$$

$= 6.15 \times 10^{10}$ rads

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c) The charge particles circulate at the angular frequency or angular speed of 6.15×10^{10} rads in the type of accelerator called cyclotron, therefore, the angular speed is also seen as cyclotron frequency.

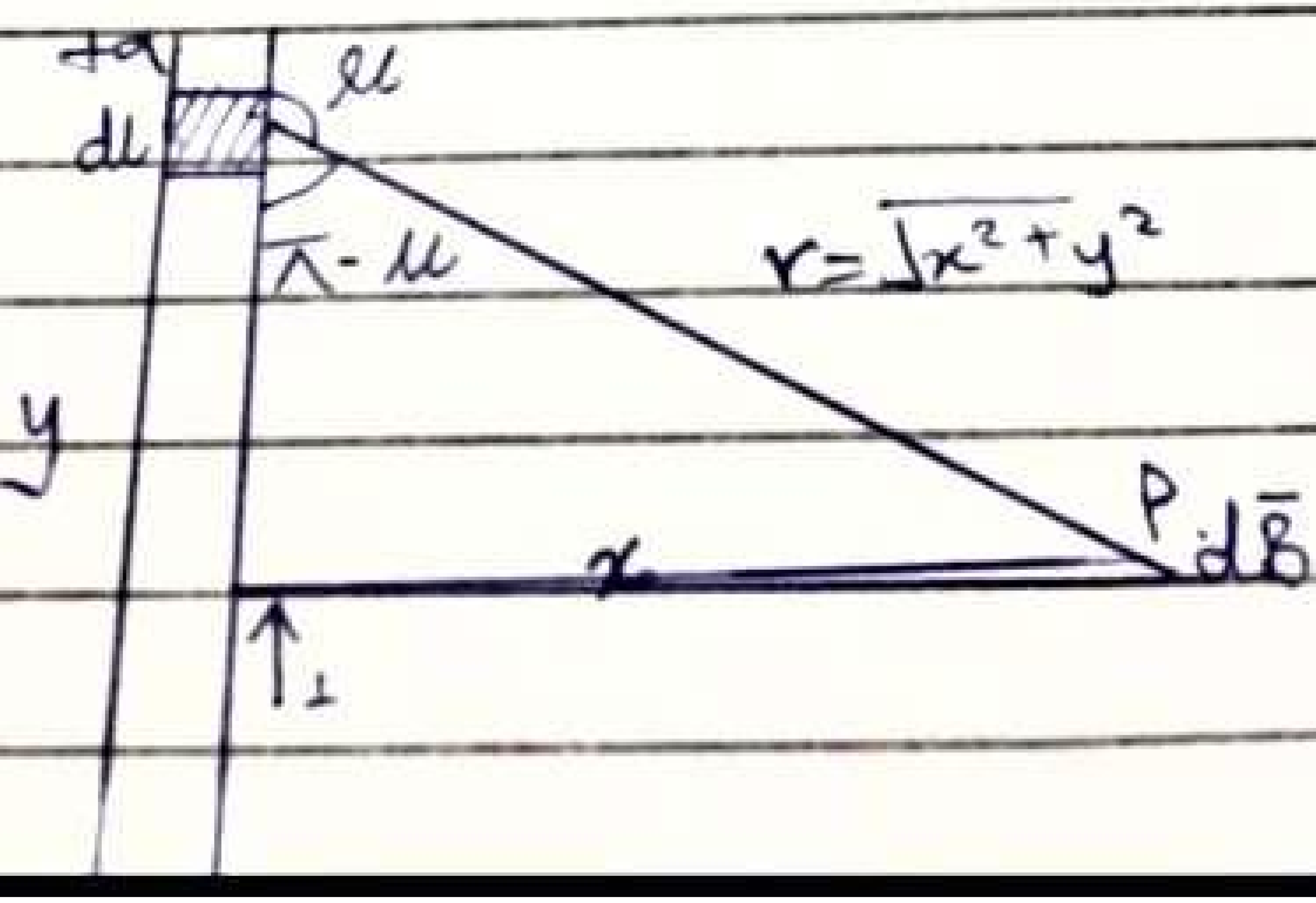
5a) The Biot-Savart law is an equation describing the magnet field generated by a constant electric current

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

where μ_0 is the constant called permeability of free space.

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

b)



A section of a straight current carrying constructor. Applying the Biot-Savart law, we find the magnitude of the field $d\vec{B}$

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

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

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

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

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

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

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

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

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

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 comparision to ~~its~~ distance x from point P, we consider it infinitely long that is, when a is much larger than x

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

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

At all points in a circle of radius r, around the conduction, the magnitude of B is $B = \dfrac{\mu_0 I}{2\pi r}$

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Magnitude

$\mathcal{E}_q = \sqrt{(0)^2 + (10264 - 2365)^2}$

Since $\mathcal{E} = 0$

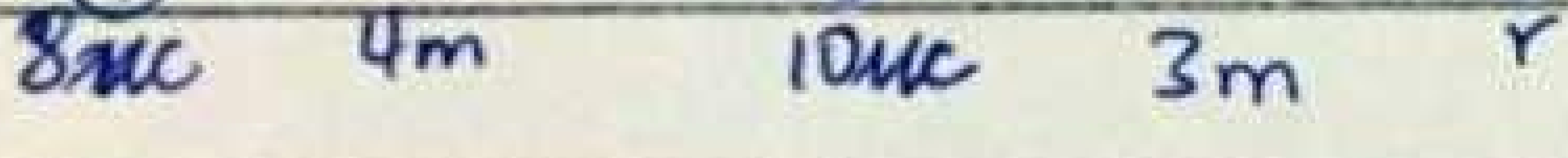
$0 = 9 \times 10^9 q + 10264 \cdot 52568$

$q = 11\mu c$

(2a) An electric field is a region of sparse in which an electric charge will experience an electric force while the electric field strength or electric field intensity can be defined as the force per unit charge. Mathematically, it is given as $\mathcal{E} = F(N)/q(c)$ which is measured in Newton coloumbs (N/c)

(b) $Q_1 = 8\mu c$, $Q_2 = 12\mu c$, $x = 4m$, $K = 9 \times 10^9$

i) $x = 7m$



$$\mathcal{E}_1 p = \frac{Kq_1 P}{r^2} = \frac{9 \times 10^9 \times (8 \times 10^{-9})}{7^2} = 1 \cdot 469 N/c$$