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Course ⟹ Phy. 102
Mat. No ⟹ 19/ENG02/061
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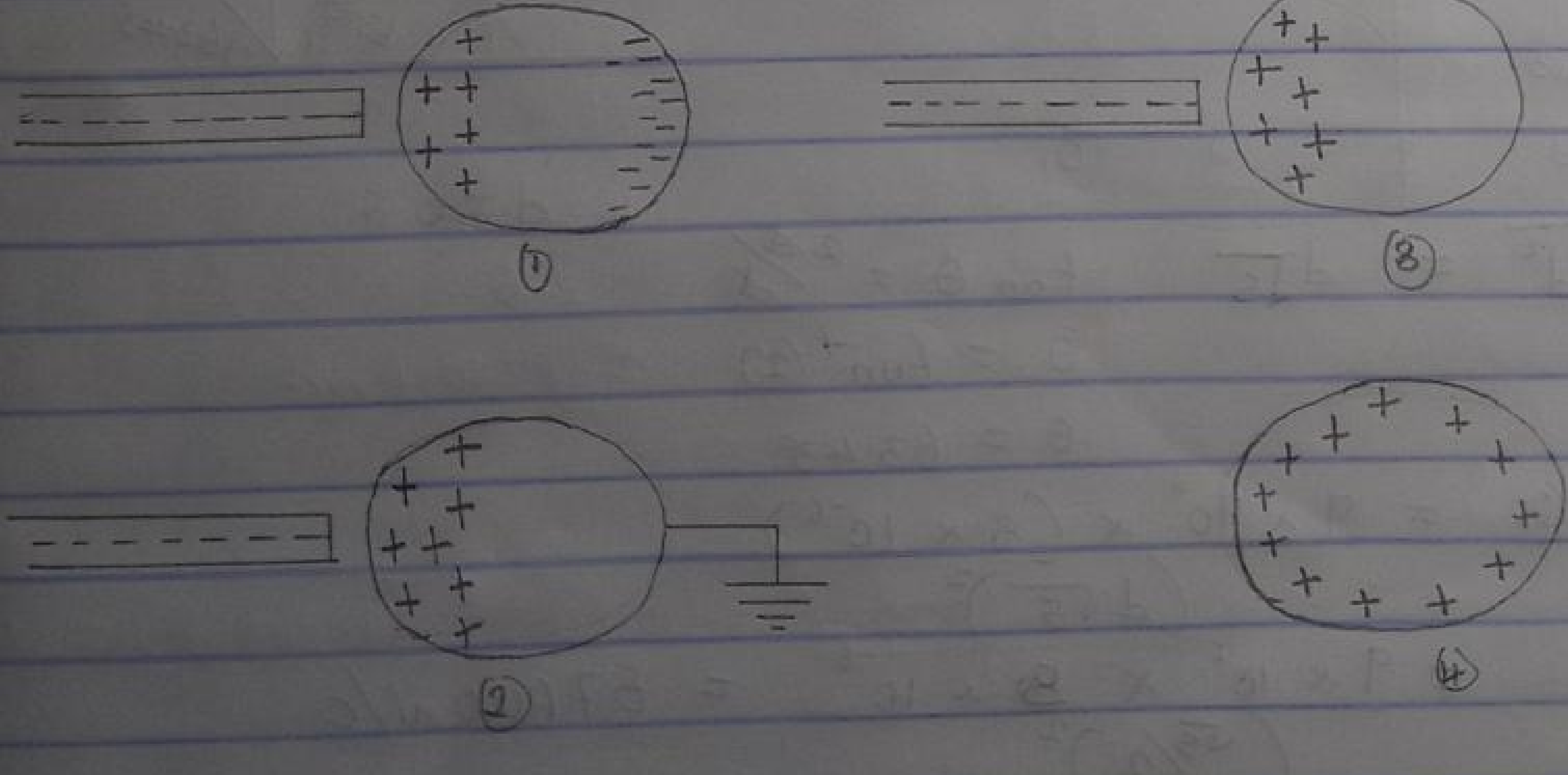
1. Consider a negatively charged rubber rod brought near a neutron (uncharged) conducting sphere. That is insulated so that there is no conducting path to the ground as shown below. The explosive force between the electrons in the rod and those in the sphere causes are distribution of charges on the sphere so that some of electrons moves to the side of the sphere farthest away from the rod.

The region of positive charge because of the migration of electrons away from this location if a grounded conducting wire is the connected to the sphere, some of the electrons leave the sphere and travel to the earth. If the wire to be grounded 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.



(1b) $q_1 + q_2 = 5 \times 10^{-5}C$, $q_1 = 5 \times 10^{-5} - q_c$

$F = \frac{kq_1 q_2}{r^2}$, $1.0 = \frac{9 \times 10^9 q_1 q_2}{2^2}$

$4 = 9 \times 10^9 \times (5 \times 10^{-5} - q) q_2$

$4 = 4.5 \times 10^{-5} q_2 - 9 \times 10^9 q_2^2$

$-9 \times 10^9 q_2^2 + 4.5 \times 10^{-5} q_2 - 4 = 0$

using the quadratic formula, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$q_2 = \frac{-4.5 \times 10^{-5} \pm \sqrt{(4.5 \times 10^{-5})^2 - 4(-9 \times 10^9)(-4)}}{2(-9 \times 10^9)}$

$q_2 = \frac{4.5 \times 10^{-5} \pm \sqrt{5.8 \times 10^{10}}}{-18 \times 10^9}$

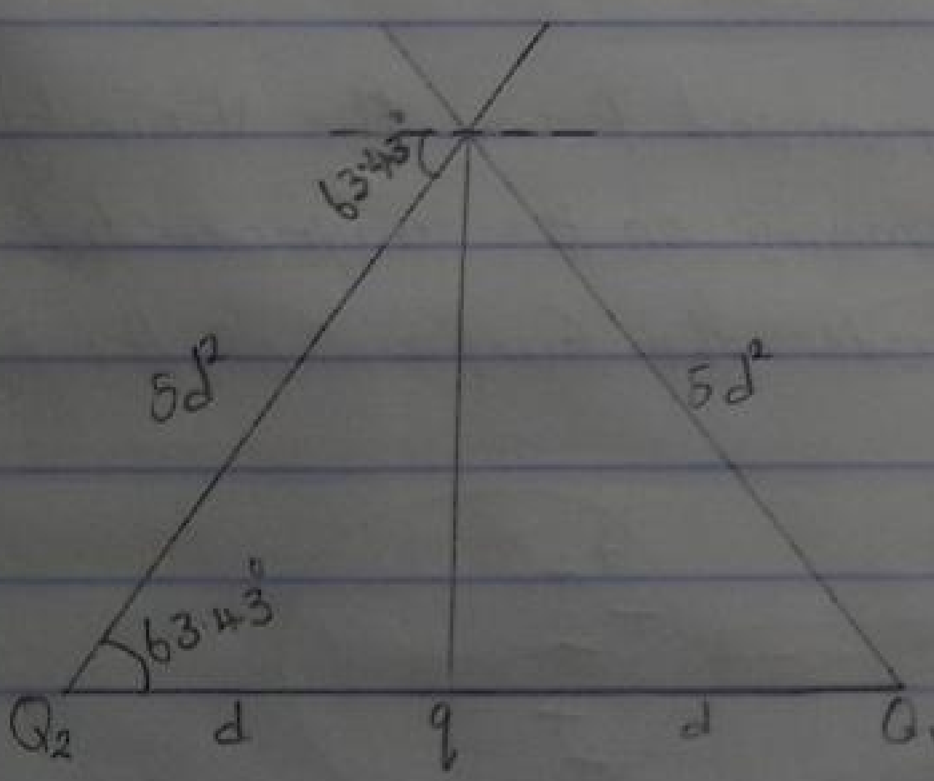
$q_2 = \frac{-4.5 \times 10^5 \pm 241867.7}{-18 \times 10^9}$

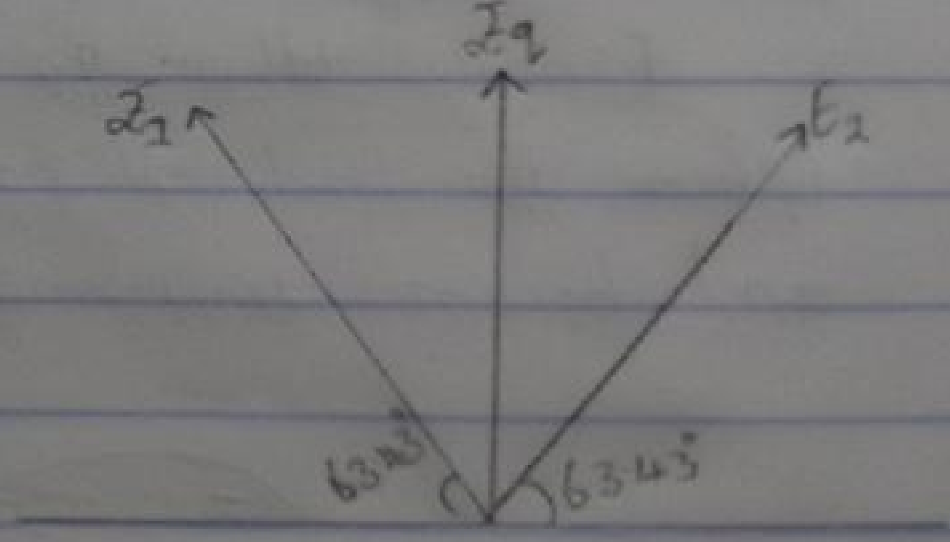
$q_2 = 1.156 \times 10^{-5}$ or $3.84 \times 10^{-5}C$

$q_1 = 1.156 \times 10^{-5}C$,,

$q_2 = 3.84 \times 10^{-5}C$,,

(1c)





$d = 0.5$

$\sqrt{2d^2 + d^2} = d\sqrt{5}$ $\tan\theta = \frac{2d}{d}$

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

$\theta = 63.43°$

$E_1 = \frac{kQ_1}{r^2} = \frac{9 \times 90^9 \times (8 \times 10^{-6})}{(d\sqrt{5})^2}$

$= \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(\sqrt{5}/2)^2} = 57600 N/C$

$$E_2 = \frac{KQ_2}{r^2} = \frac{9 \times 10^9 \times (8 \times 10^{-6})}{(d\sqrt{5})^2} = 57600 \text{ N/C}$$

$$E_q = \frac{kq}{r^2} = \frac{9 \times 10^9 \times q}{(2d)^2} = \frac{9 \times 10^9}{1^2} = 9 \times 10^9 q \text{ N/C}$$

Vector	θ	x- Component	Y- Component
$E_1 = 57600$ N/C	$63.43°$	$57600 \cos 63.43 = -25764$	$57600 \sin 63.43 = +51516.8$
$E_2 = 57600$ N/C	$63.43°$	$57600 \cos 63.43 = +25764$	$57600 \sin 63.43 = +51516.8$
$E_q = 9\times10^9 q$ N/C	$90°$	$9 \times 10^9 q \cos 90 = 0$	$q = \times 10^9 q \sin 90$ $-9 \times 10^{10} q$
		$\Sigma E_x = 0$	$\Sigma E_y = 103033.6 + 9 \times 10^9 q$

$$E_{net} = \sqrt{E_{ex}^2 + E_{ey}^2}$$

but E_{net} at point $P = 0$

$$0 = \sqrt{0^2 + (103033.6 + 9 \times 10^9 q)^2}$$

$$0 = 103033.6 + 9 \times 10^9 q$$

$$q = \frac{-103033.6}{9 \times 10^9}$$

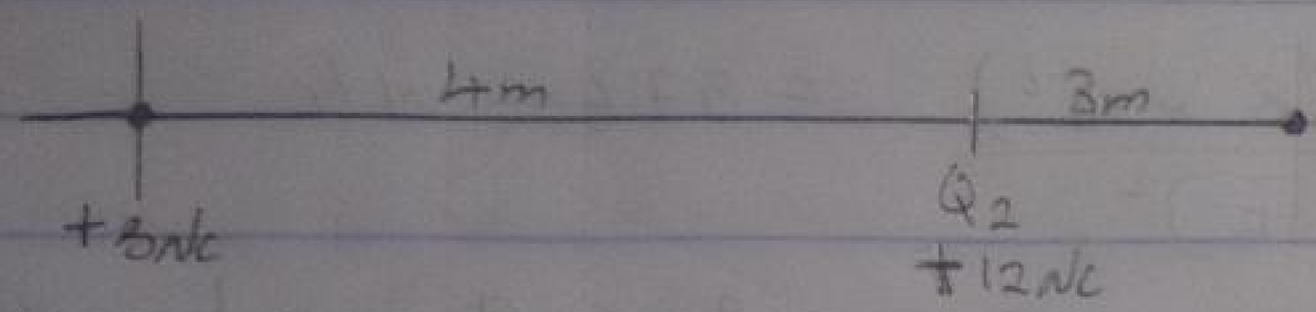
$$q = -1.144817778 \times 10^{-5}$$

$$q = -11.4 \times 10^{-6}$$

$$q = -11.4 \text{ } \mu C$$

(2) An electric field is a region of space in which an electric charge will experience an electric force while electric field intensity is the f.e unit charge unexperienced by a charge in an electric field.

(2bi)

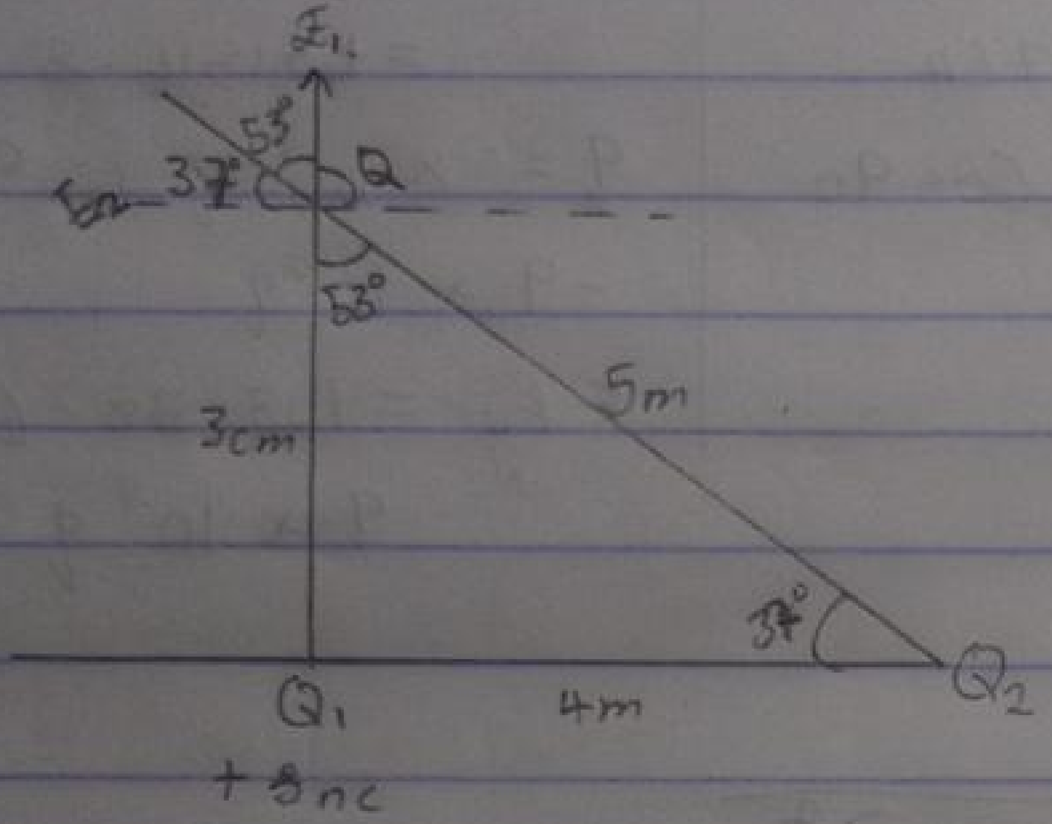


$$E_1 = \frac{kQ_1}{r^2} = \frac{(9 \times 10^{9}) \times (8 \times 10^{-9})}{7^2} = 1.47 \text{ N/C}$$

$$E_2 = \frac{kQ_2}{r^2} = \frac{(9 \times 10^{9}) \times (12 \times 10^{-9})}{3^2} = 12 \text{ N/C}$$

$$E_{net} = 1.474 + 12 = 13.47 \text{ N/C}$$

(2bii)



$$E_1 = \frac{kQ_1}{r^2} = \frac{9 \times 10^{9} \times (8 \times 10^{-9})}{3^2} = 8 \text{ N/C}$$

$$E_2 = \frac{kQ_2}{r^2} = \frac{9 \times 10^{9} \times (12 \times 10^{-9})}{5^2} = 4.32 \text{ N/C}$$

Vector	Angle	x - Component	y - Component
$E_1 = 8$ N/C	90°	$8 \cos 90°$ $= 0°$	$8 \sin 90$ $= +8°$
$E_2 = 4.32$ N/C	37°	$4.32 \cos 37°$ $= -3.45$	$4.32 \sin 37°$ $= +2.6°$
		$E_{ex} = -3.45$ N/C	$E_{ey} = 10.6$ N/C

The Resultance

$$E = \sqrt{E_{ex}^2 + E_{ey}^2} = \sqrt{(-3.45)^2 + (10.6)^2} = \sqrt{11.903 + 112.36}$$

$$= \sqrt{124.263}$$

$$= 11.147 \text{ N/C}$$

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

(4b) $M_e = 9.11 \times 10^{-21}$ kg, $r = 1.4 \times 10^{-9}$ m, $\theta = 90° = \sin\theta = 1$
Magnetic field $= 3.5 \times 10^{-1}$ Weber/meter square

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

$$w = \frac{1.6 \times 10^{-19} \times (3.5 \times 10^{-1})}{9.11 \times 10^{-21}}$$

$$w = 6.115 \times 10^{10} \text{ rads.}$$

(4c) An electron of mas 9.11×10^{31} kg and charge 1.6×10^{-19} C In motion in a magnetic field of 3.5×10^{-1} tesla perpendicular With the field will have an angular frequency of 6.15×10^{10} rads.

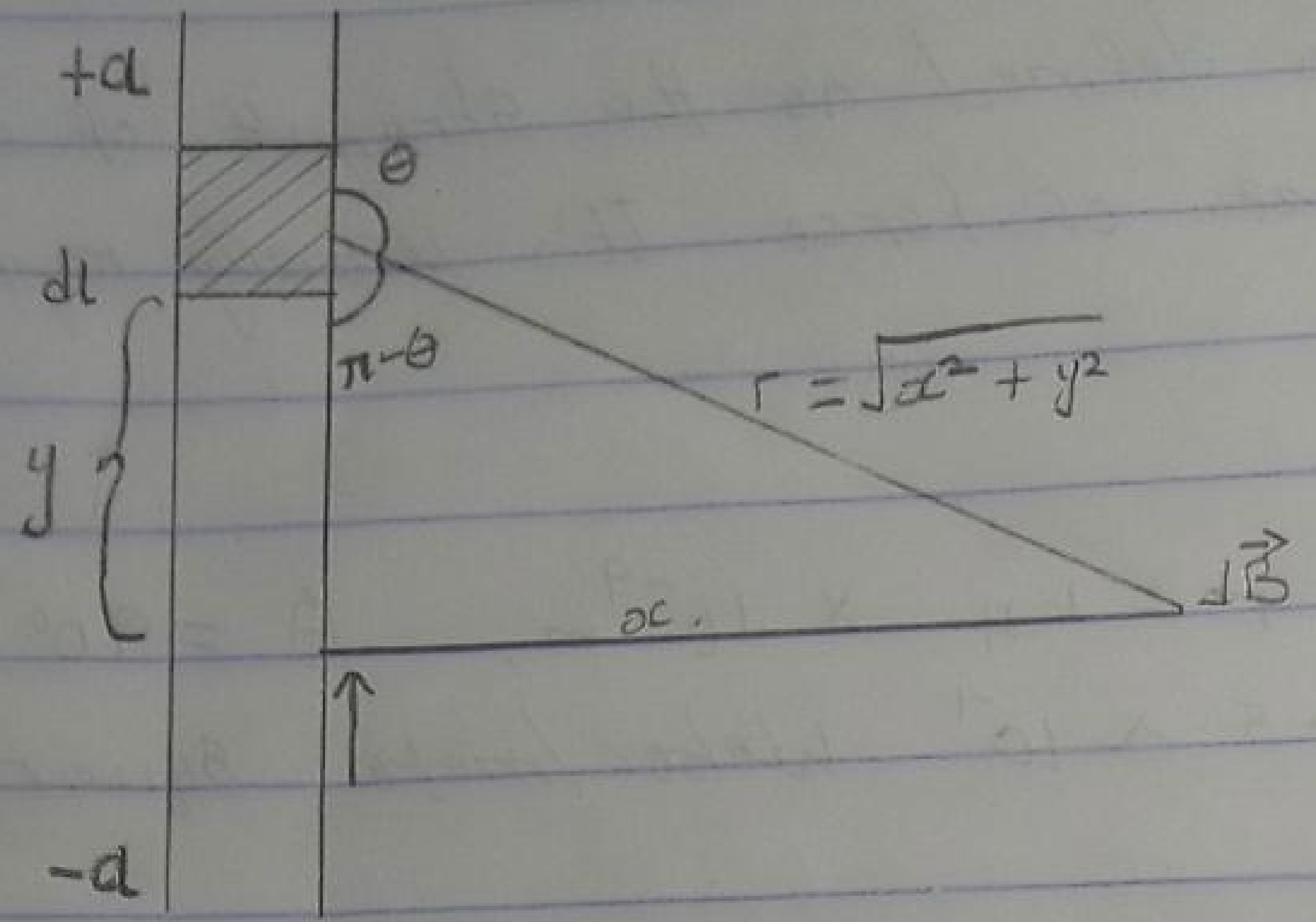
(5ai) The Vector $\vec{dB}$ is perpendicular to $d\hat{i}$ (Which points in the direction of the Current and to the unit vector $\hat{r}$ direction from $\vec{dl}$ toward P.

(5aii) The magnitude of $\vec{dB}$ is inversely Proportional to r^2 where r is the distance from $\vec{dl}$ to P.

(5aiii) The magnitude of $\vec{dB}$ is proportional to the Current I and to the magnitude of the length element $\vec{dl}$.

(5aiv) The magnitude of $\vec{dB}$ is propotional to θ, where θ is the angle between $\hat{r}$ and dl

(5b)



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

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

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

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

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

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

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

as $a \to \infty$

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

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

$$x = r$$

$$\underline{B = \frac{\mu_0 i}{2\pi r}}$$