Name: Adebayo Oluwatoyosi Matthew
College: [illegible]
Department: MLS
Matric No: 19/[illegible]/002

(1a) Magnetic flux is the strength of the magnetic field represented by lines of force. It is represented by the symbol ϕ.

(1b) An electron with a rest mass of 9.11×10^{-31} kg moves in a circular orbit of radius 1.4×10^{-7} m in a uniform magnetic field of 3.5×10^{-1} Weber/Meter square, perpendicular to the speed with which electron moves. Find the cyclotron freq. of the moving electron.

(1c) Discuss ~~Solution~~ answer in 1b above

Solution

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

$r = 1.4 \times 10^{-1}$ m

Weber $\theta = 90^\circ$

$w = ?$

$q = 1.6 \times 10^{-19}$ C

$$W = \frac{qB}{m_e}$$

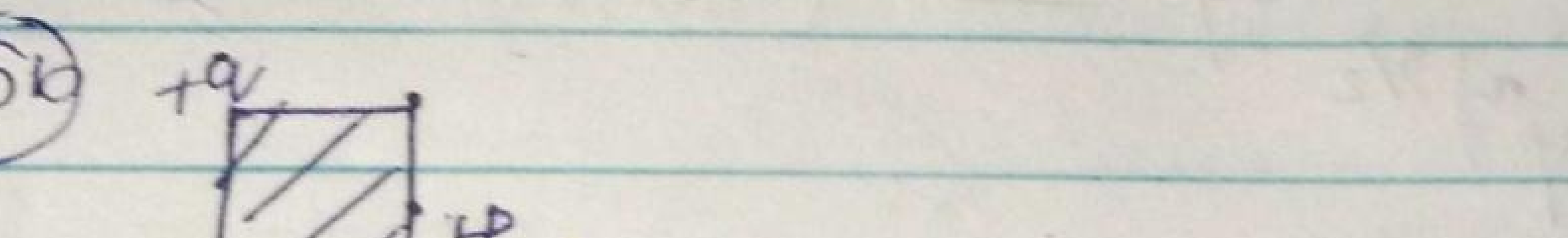
$$W = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}} = -6.15 \times 10^{10} \text{ rad/se}$$

(4i) Since Cyclotron frequency is negative, -6.5×10^{10} rad/sec. ~~It~~ means that the charge particle electron circulates in a negative or opposite direction at the angular frequency

(5a) ~~State~~ Biot-Savart law

The Biot-Savart law ~~states that~~ describes the magnetic field created by a current carrying wire and allows you to calculate the strength at various forms

(5b)



Applying the law, the magnitude of field dB

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

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

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

from the diagram $r^2 = x^2+y^2$ (Pythagoras' theorem)

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

but $\sin(\pi - \alpha) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}}$ --- (ii)

Substituting equ (ii) into (i)

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

Using law of indices

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

Recall, $dl = dy$

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

$$\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2(x^2+y^2)^{1/2}}$$

equ (iii) becomes

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

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

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

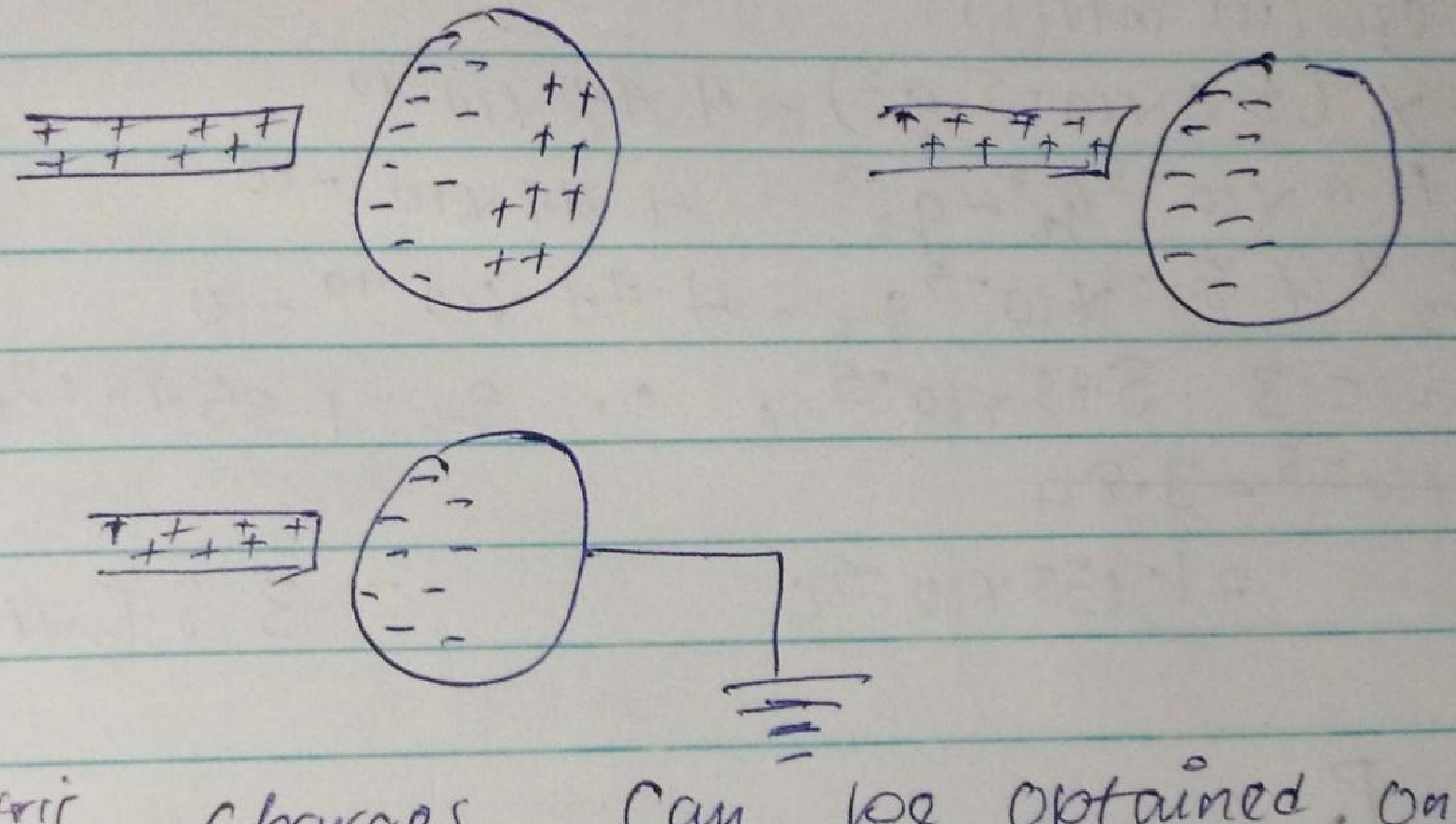
When the length $2a$ of the conductor is very great in comparison to its distance from point P. We consider ~~the~~ indefinitely long. That is when a is much longer than x

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

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

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

(i)



Electric charges can be obtained on an object without touching it by a process called Electrostatic induction

10) $F = 1.0N,\ r = 2.0m,\ Q = 5.0\times10^{-5},\ q_1+q_2 = Q =$

$$F = \frac{Kq_1q_2}{r^2}$$

$$1 = \frac{9\times10^9 \times q_1q_2}{2^2}$$

$$\frac{4}{9\times10^9} = \frac{\cancel{9\times10^9}q_1q_2}{\cancel{9\times10^9}}$$

$q_1q_2 = 4.44\times10^{-10}$ —— (i)

$q_1 + q_2 = 5.0\times10^{-5}$

$q_1 = 5.0\times10^{-5}\ q^2$ —— (ii)

put equ (ii) into (i)

$q_2 \times (5.0\times10^{-5}\ q^2) = 4.44\times10^{-10}$

$5.0\times10^{-5}q_2^2 - q_2^2 = 4.44\times10^{-10}$

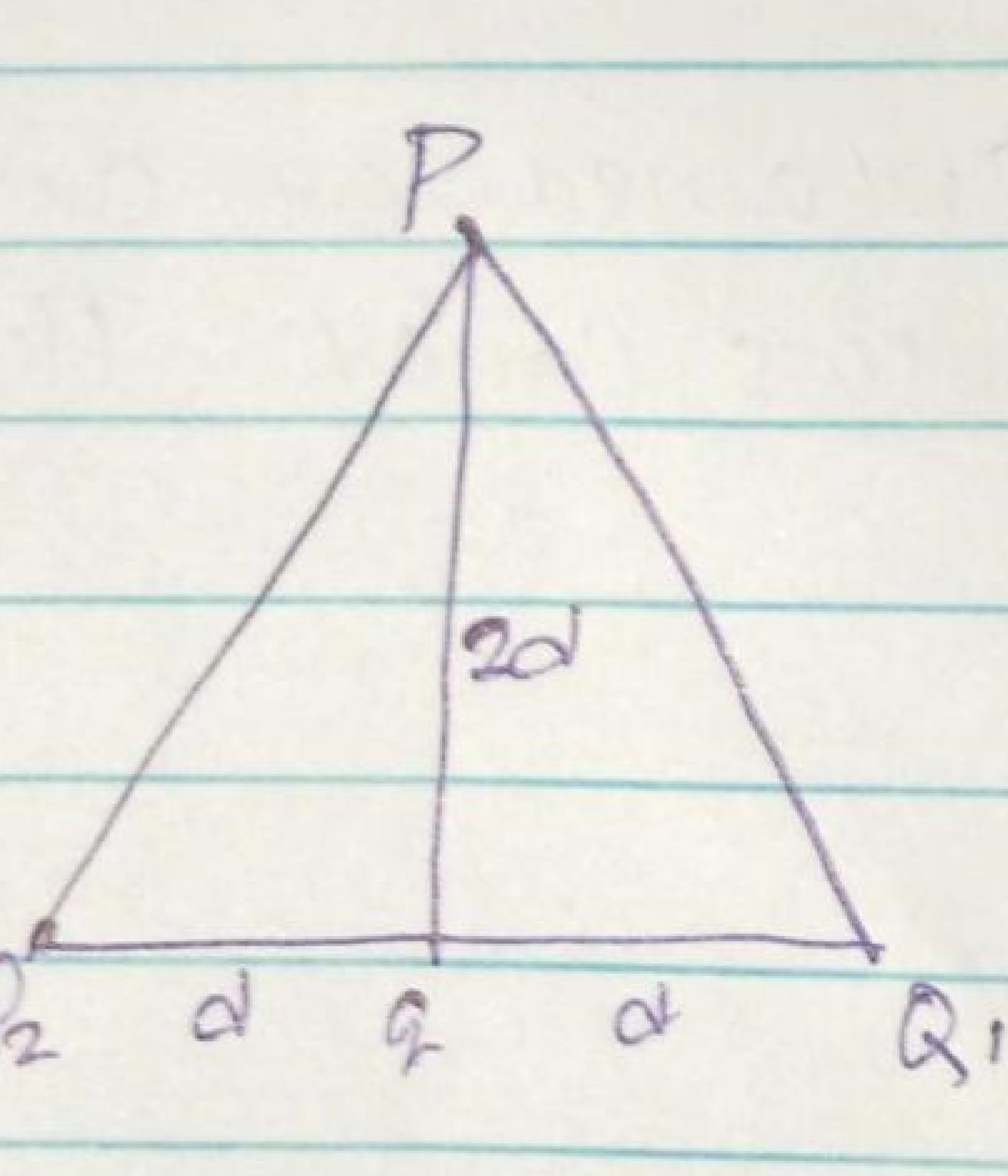
$-q_2^2 + 5.0\times10^{-5}q_2 - 4.44\times10^{-10} = 0$

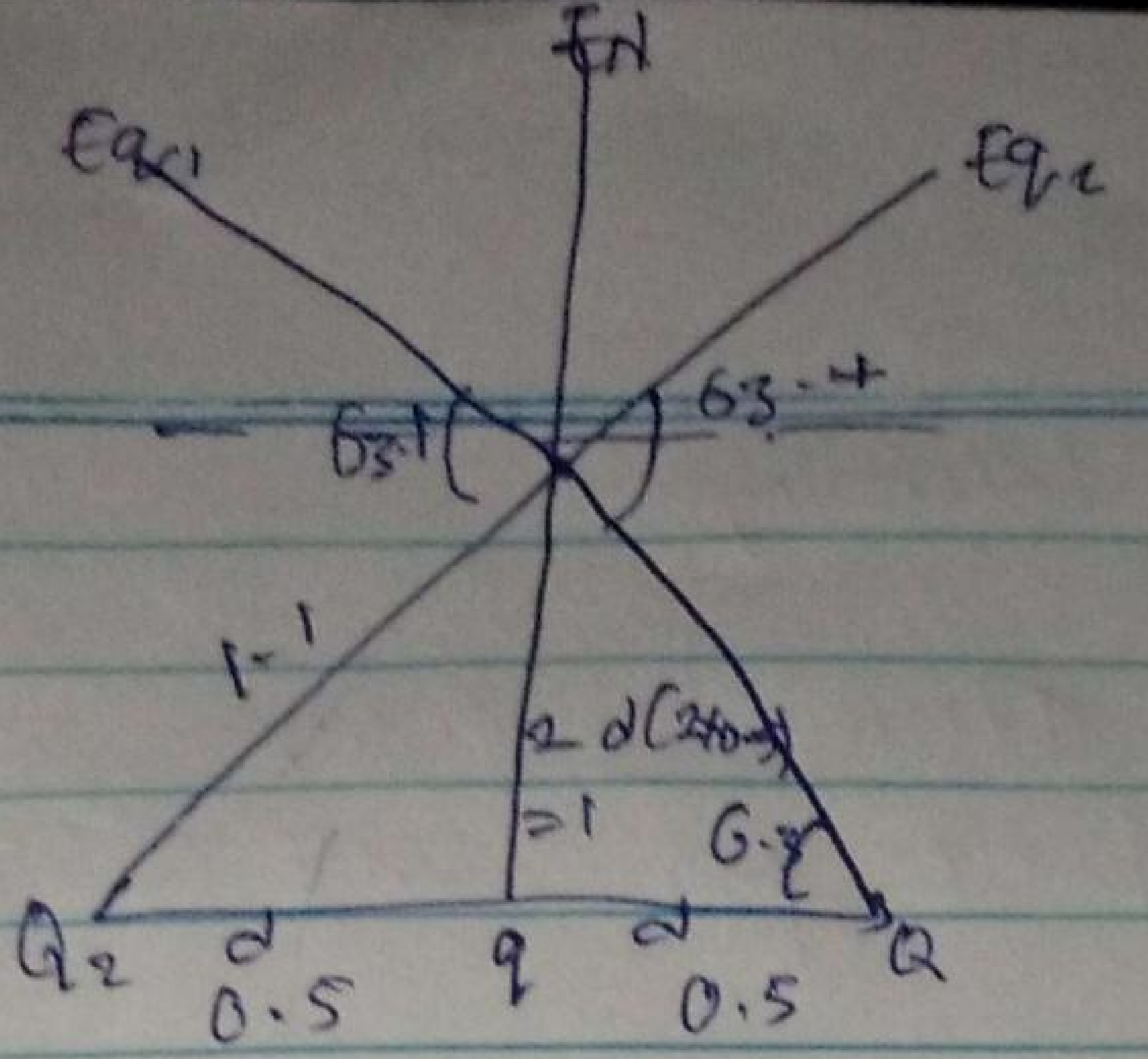
$q_2 = 3.845\times10^{-5}c$ or $q_2 = 1.55\times10^{-5}c$

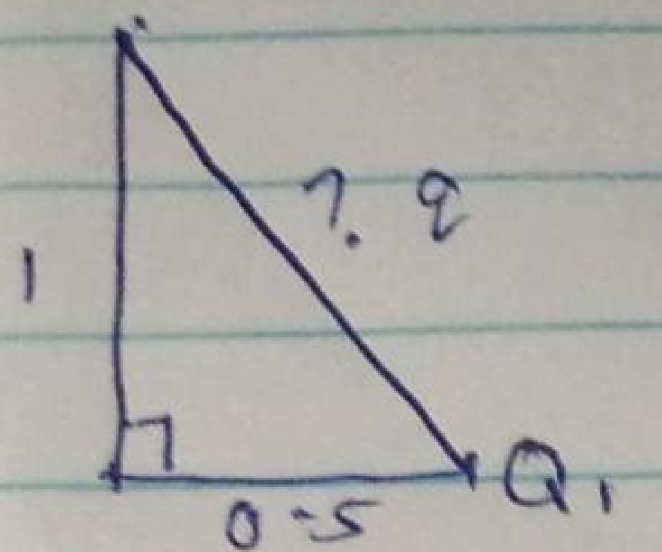
$q_1 = \cancel{5.0\times10^{-5} - 3.84}$

$= 1.155\times10^{-5}c$ $\qquad = 3.845\times10^{-5}c$

(1c)







Using Pugthagoras theorem

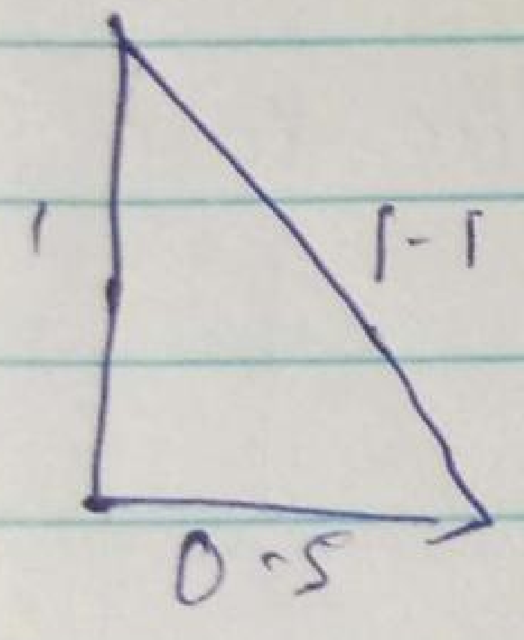
$a^2 = 1^2 + 0.5^2$

$a^2 = 1 \cdot 0.25$

$a^2 = 1.25$

$a = \sqrt{1.25}$

$a = 1.1$



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

$\theta = 63.4$

$E_p = E_{q_1} + E_{q_2} + E_q$

$E_{q_1} = \frac{kQ_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2} = 59504\ N/C$

$E_{q_2} = \frac{kQ_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2} = 59504\ N/C$

$E_q = \frac{kq}{r} = \frac{9\times10^9 \times q}{1^2} = 9\times10^9 q\ N/C$

2) Electric fields & Electric Intensity

Answer Electric field Is a region of space in which an electric charge will experience an electric force	Electric Intensity Force per unit charge

3) formulation of identities of charge

(i) Volume charge density $\rho = dQ/dv = dQ = \rho dv$

ii) Surface charge density $\sigma = dQ/dA = dQ = \sigma dA$

(iii) linear charge density $\lambda = dQ/dl = dQ = \lambda dl$

(b) Electric potential difference equation due to a single charge

$$V_B - V_A = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

where Q = point charge

V = Electric potential

r_B = distance of Q to Point B

r_A = distance of Q to point A

Due to several point charge

$$V_P = \frac{1}{4\pi\varepsilon_0}\left[\quad\right] + \left(\frac{Q_2}{}\right]$$ here ~~V = E~~

V = Electric Potential
Q = Point charge
r = distance of Q