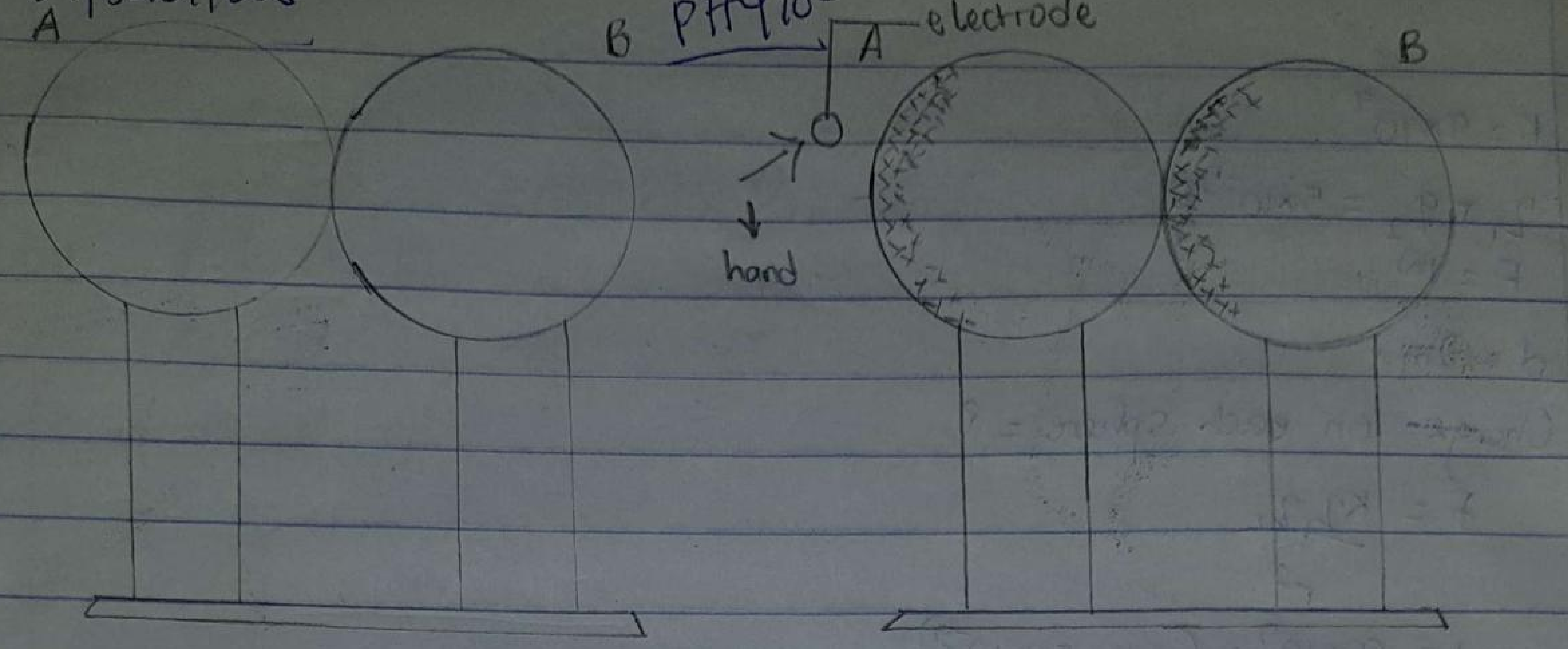
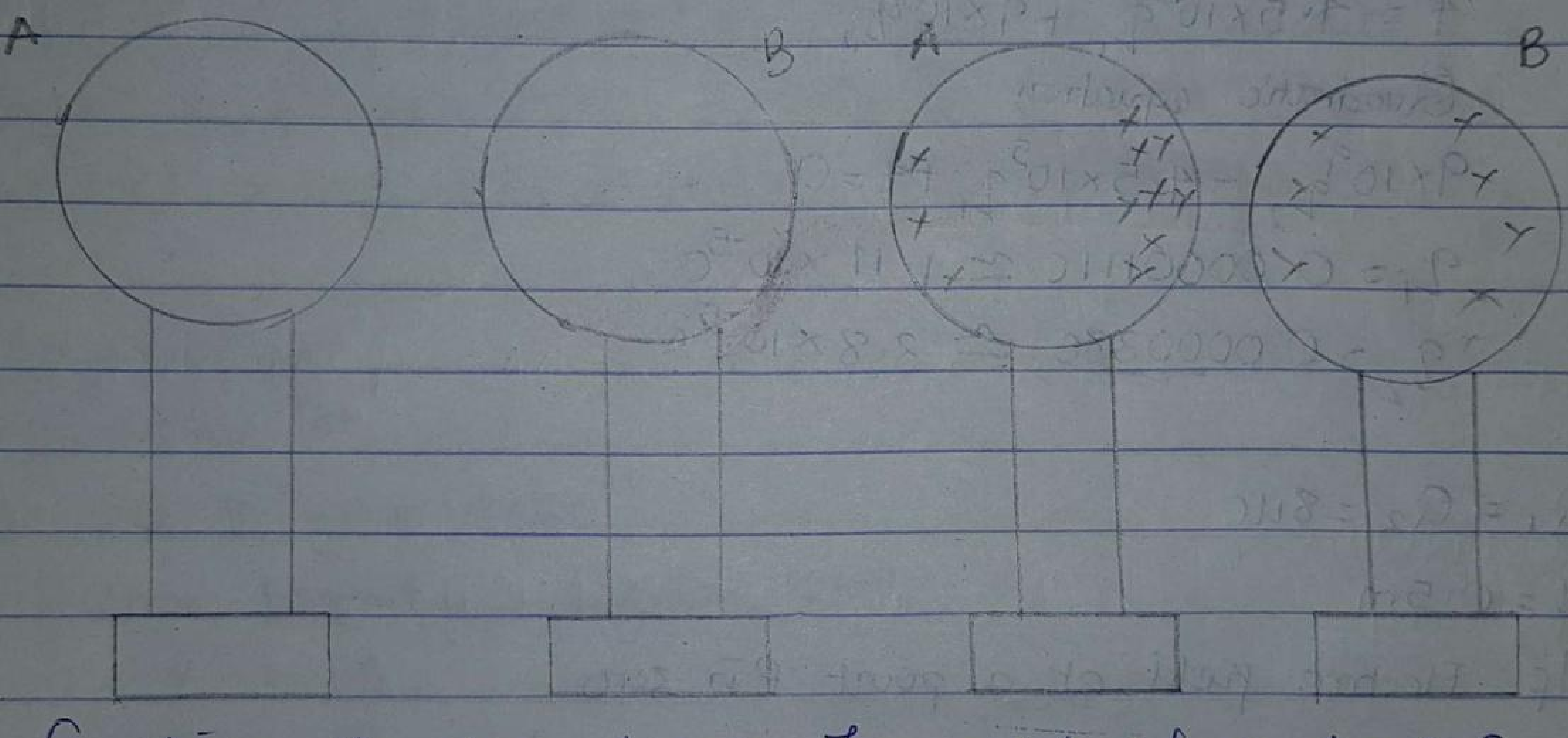
ADENIRAN OYINDAMOLA FADEKEMI

COMPUTER SCIENCE

19/SCI07/006

PHY 102





Considering the above diagram, two metal spheres A and B touching each other, A negatively charged rubber baloon is brought. If we bring the charged ballon near the spheres, electrons within two sphere system will be induced to move away from the ballon due to the repulsion between the electrons of the ballon and the spheres. Subsequently, the electrons from sphere A get transferred to sphere B. The migration of electrons causes the sphere A to become positively charged and the sphere B to be negatively charged. The overall two-sphere system is hence electrically neutral. The spheres are then seperated using an insulating cover such as gloves or a stand. When we remove the ballon, the charge gets re distributed spreading throughout the spheres.

b $K = 9\times10^{9}$

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

$F = 1N$

$d = 2m$

Charge on each sphere = ?

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

$1 = \frac{9\times10^{9}\times(q_1q_2 5\times10^{-5})}{2^2}$

$4 = 9\times10^{9}\times5\times10^{-5}q_1 + 9\times10^{9}q_2$

$4 = 4.5\times10^{5}q_1 + 9\times10^{9}q_2$

Quadratic equation

$9\times10^{9}q_2 - 4.5\times10^{5}q_1 + 4 = 0$

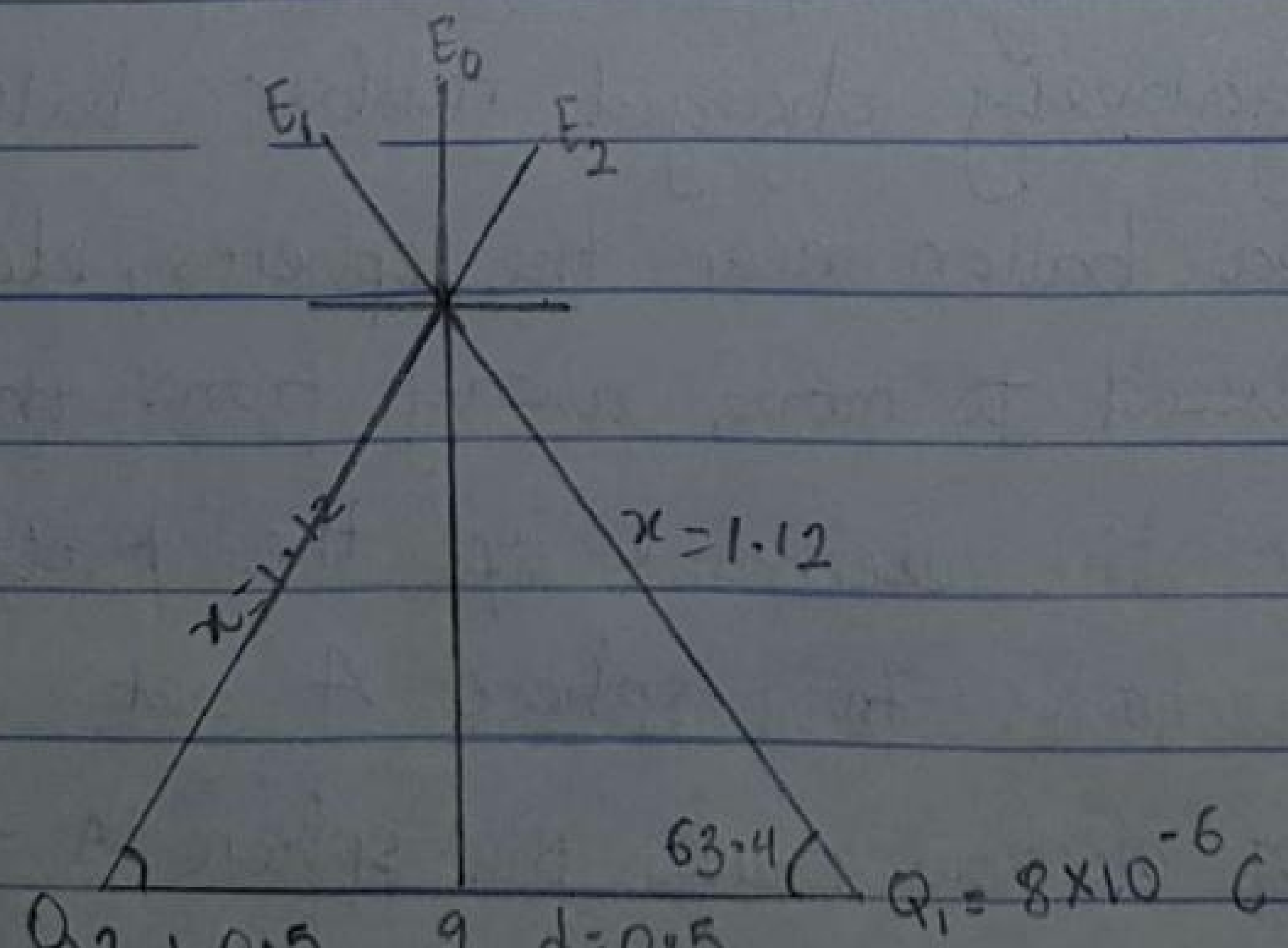
$q_1 = 0.0000111C \simeq 1.11\times10^{-5}C$

$q_2 = 0.000038C \simeq 3.8\times10^{-5}C$

c $Q_1 = Q_2 = 8uC$

$d = 0.5m$

If Electric field at a point P is zero



$x^2 = 1^2 + 0.52$

$\sqrt{x^2} = \sqrt{1.25}$

$x = \sqrt{1.25}$

$x = 1.12$

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

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

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

$\theta = 63.4$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2}$

$= 57397.9578$

P.T.O

3a Volume charge density: Formulation for the volume charge density is

$\rho = \frac{q}{v}$, where ρ is volume density

q is the charge

v is the volume of distribution

S.I unit for volume charge density is cm^{-3}

ii Surface charge density: Formulation for surface charge density is

$\sigma = \frac{q}{A}$, where σ is surface charge

q is the charge

A is the area of surface

S.I unit of surface charge density is cm^{-2}

iii Linear charge density: Formulation for linear charge density is

$\lambda = \frac{q}{l}$, where λ is linear charge

q is the charge

l is the length over which it's distributed

S.I unit of linear charge is cm^{-1}

b Electric potencial difference is the amount of work done to carry a unit charge from one point to another in an electric field. It is measured in volt (v) or Joules per coulomb (J/C). It's a scalar quantity.

Elemental works done dW is given as

$dW = F \cdot dL \ldots (1)$

But $F = -q_0 E \ldots (2)$

Substituting equation 2 in 1 = $dW = -q_0 E dL \ldots 3$

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

$W(A'nB)_{Ag} = -q_0 \int_A^B E dL \ldots 4$

From definition of electrical potential difference. It follows that:

$V_B - V_A = \frac{W(A'nB)_{Ag}}{q_0} \ldots 5$

Putting equation 4 in 5 yields $V_B - V_A = -\int_A^B E dL \ldots 6$

1c CONTINUATION

$E_2 = \frac{kq_2}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2} = 57397.95918$

$E_q = \frac{kq}{r^2} = \frac{9 \times 10^9 \times q}{1} = 9 \times 10^9 q$

Vector	Angle	x - component	y - component
$E_1 = 57397.95918$	63.4°	$E_1 \cos\theta =$ 2570.045785	$E_1 \sin\theta = 5132.262839$ –
$E_2 = 57397.95918$	63.4°	2570.045785	5132.262839
$E_q = 9 \times 10^9 q$	90	$E_q \cos\theta = 0$ $E_x = 0$	$9 \times 10^9 q$ $E_y = 10~~24~~.52568$

Scanned by TapScanner

1c Magnitude $= \sqrt{(Ex)^2 + (Ey)^2}$

$Fq = \sqrt{(0)^2 + (10264.52568)^2}$

Since $Fq = 0$

$0 = 9\times10^9 q + 10264.52568$

Make q S.O.F

$q = \frac{10264.52568}{9\times10^9}$

$q = 1.140502853\times10^{-16}$

$q = 11.4\mu C$

2a Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented by the symbol ϕ. Mathematically given as $\phi B\cdot dA$.

b $m = 9\times10^{-31} kg$

$r = 1.4\times10^{-7} m$

$B = 3.5\times10^{-1}$ weber/meter^2

cyclotron frequency = angular speed

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

$w = \frac{qB}{m} = \frac{1.6\times10^{-19}\times3.5\times10^{-1}}{\cancel{9\times10^{9}}\ 9\times10^{-31}}$

~~$q = 1.140502853\times10^{-16}$~~

~~$q = 11.4\mu C$~~

$w = 6.22\times10^{10} T^{-1}$

c Mass of electron $= 9.11\times10^{-31}$ kg

radius $= 1.4\times10^{-7} m$

magnetic field $= 3.5\times10^{-1}$ weber/meter 2

cyclotron frequency can be called angular speed

Recall angular speed $(\omega) = \frac{v}{r} = \frac{qB}{m}$

Substituting we have $\omega = \frac{v}{r} = \frac{qB}{m} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$

~~So cycloton freq~~

$= 6.22 \times 10^{10} T^{-1}$

So cycloton frequency $= 6.22 \times 10^{10} T^{-1}$, the unit is equal to the unit of frequency dimensionally.

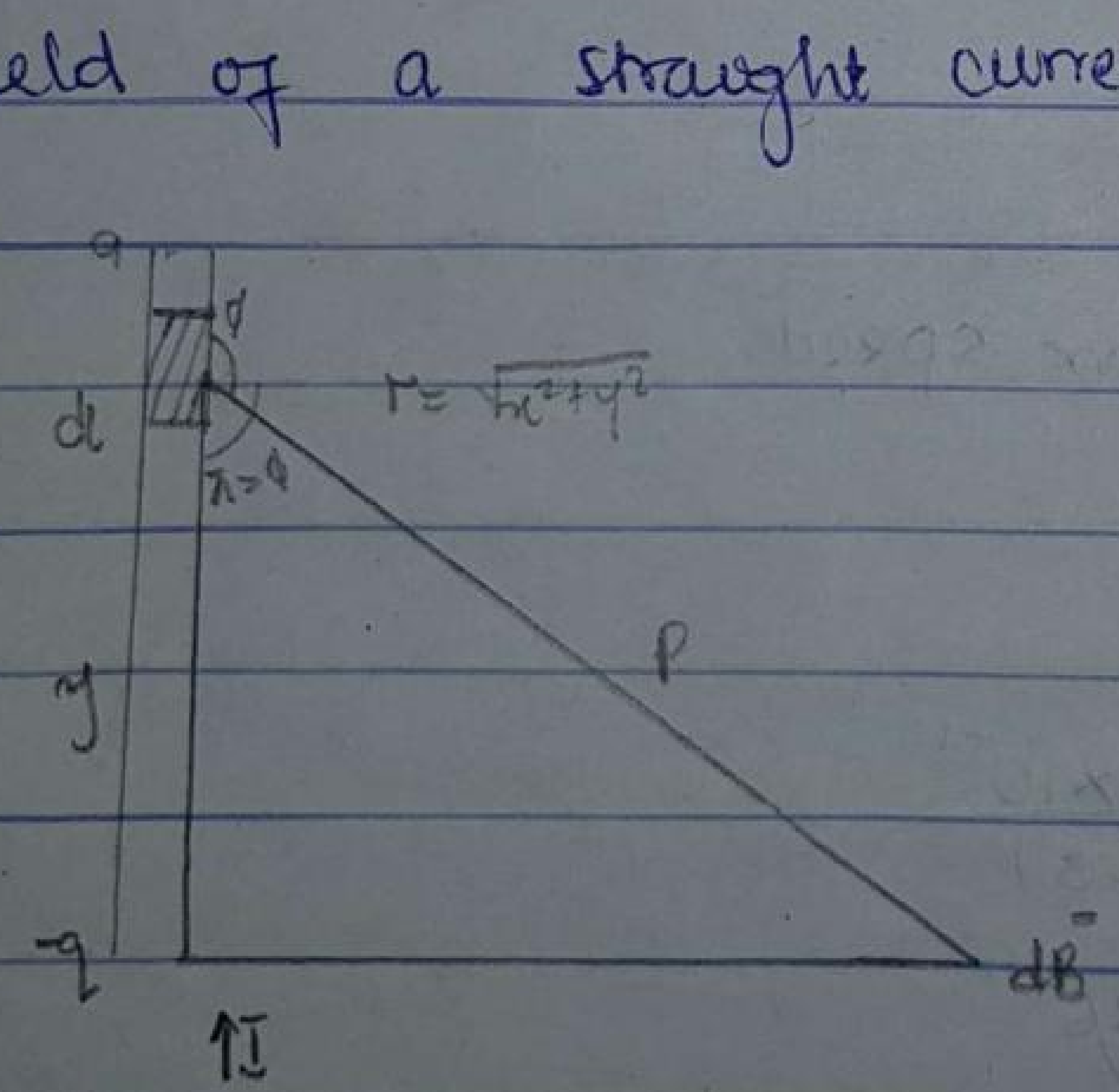
5a Biot-Savart law states that the magnetic field is directly proportional to the product permeability of free space (μ), the current (I), the change in length, the radius and inversely proportional to the square of radius (r^2). It can be represented mathematically by:

$dB = \frac{\mu_0 I dl \times r}{4\pi r^2}$ where μ_0 is a constant called Permeability of free space

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

Unit of B is weber/metre square

b Magnetic field of a straight current carrying conductor



A section of a straight current carrying conductor

Applying the Biot-Savart law, we find the magnitude of the field:

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

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

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

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

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

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

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

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

Recall $dl = dy$

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

$$B = \frac{\mu_0 I x}{4\pi}\int_{-a}^{a} \frac{1}{(x^2+y^2)^{3/2}} dy \quad \ldots 3$$

Using special integrals: $\int \frac{dy}{(x^2+y^2)^{3/2}} = \frac{1}{x^2} \times \frac{y}{(x^2+y^2)^{1/2}}$

Equation 3 becomes $B = \frac{\mu_0 I x}{4\pi}\left(\frac{2a}{x^2(x^2+a^2)^{1/2}}\right)$

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

When the length 2a of the conductor is very great in comparison to its distance from point P, we consider it infinetly. That B, when a is much larger than x, $(x^2+a^2)^{1/2} \cong a$, as $a \to \infty$

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

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

$$B = \frac{\mu_0 I}{2\pi r} \quad \ldots 4$$

Magnitude of the magnetic field of flux density B near a long, straight current carrying conductor)