PHY 102 Assignment

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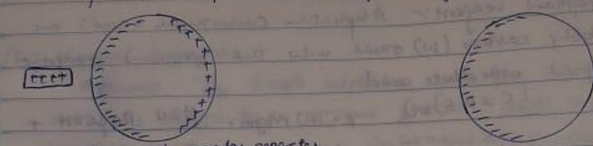
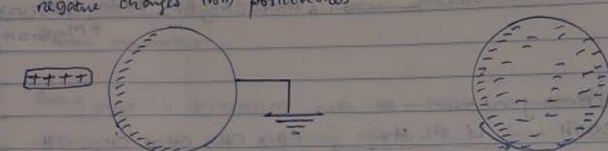
Course code: Phy 102.
Matric No: 19/Eng04/043

(1) The production of a Negatively charged sphere by induction



A +ve rod nearby separates negative charges from positive ones.

-ve electrons.



Electrons flow to the earth via wire.

Negative charged sphere

(b) $K = 9\times10^{9}\ Nm^{-2}C^{-1}$, $F = 1.0N$, $d = 2.0m$.

Soln

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

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

$$1 = \frac{9\times10^{9}(q_1 q_2)}{2^2}$$

$$\frac{4}{9\times10^{9}} = \frac{(q_1 q_2)\,\cancel{9\times10^{9}}}{\cancel{9\times10^{9}}}$$

$$q_1 q_2 = 4.44\times10^{-10} \ldots (2)$$

From equ(1)

$$q_2 = 5\times10^{-5} - q_1 \ldots (3)$$

Substitute eqn (3) into 2

$q_1(5\times10^{-5} - q_1) = 4.44\times10^{-10}$

$5\times10^{-5}q_1 - q_1^2 = 4.44\times10^{-10}$.

$-q_1^2 + 5\times10^{-5}q_1 - 4.44\times10^{-10} = 0$: multiply by (-1)

$\therefore q_1^2 - 5\times10^{-5}q_1 + 4.44\times10^{-10} = 0$

Using Quadratic formula.

$$q_1 = \frac{-(-5\times10^{-5}) \pm \sqrt{(-5\times10^{-5})^2 - 4(1)(4.44\times10^{-10})}}{2(1)}$$

$$q_1 = \frac{5\times10^{-5} \pm \sqrt{2.5\times10^{-9} - 1.776\times10^{-9}}}{2}$$

$$q_1 = \frac{5\times10^{-5} \pm \sqrt{7.24\times10^{-10}}}{2}$$

$$= \frac{5\times10^{-5} \pm 2.69\times10^{-5}}{2}$$

$q_1 = 3.84\times10^{-5}\ C$

from eqn 3

$q_2 = 5\times10^{-5} - 3.84\times10^{-5}$

$= 1.16\times10^{-5}\ C$

$\therefore q_1 = 3.84\times10^{-5}\ C$ and $q_2 = 1.16\times10^{-5}\ C$

(c) $Q_1 = Q_2 = 8\mu c$ $d = 0.5m$

$E_p = E_{q_1} + E_{q_2} + E_{q_3}$

(c) The same parameters.

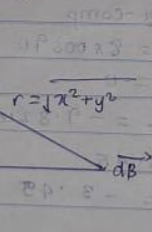
Mass of electron, Magnetic field and radius.

We were asked to find the cycloton . frequency which equal or the same thing as angular speed

$$\text{Angular speed } (\omega) = \frac{v}{r} = \frac{qB}{m}$$

(5) Biot - savart Law states that the magnetic intensity of any point due to a steady current in an infinitely long straight wire is directly proportional to the current and inversely proportional to the distance from point to wire.

(6) Magnetic field of a staight current carrying conductor.



Applying the biot - Savart Law we find the magnetude of the field $\vec{dB}$

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

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

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

From diagram $r^2 = x^2 + y^2$.

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

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

$E_{q_1} = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2} = 59504\ NC^{-1}$

$E_{q_2} = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{1.1^2} = 59504\ NC^{-1}$

$E_q = \frac{kq}{r^2} = \frac{9\times10^9}{1} = 9\times10^9\ NC^{-1}$

Vector	Angle	x-component	y-component
$E_{q_1} = 59504$	63.4°	$59504 \cos 63.4 = 26643.46$	$59504 \sin 63.4 = 53205\ NC^{-1}$
$E_{q_2} = 59504$	63.4°	$59504 \cos 63.4 = 26643.46$	$59504 \sin 63.4 = 53205\ NC^{-1}$
$E_q = 9\times10^9 q$	90	$9\times10^9 q \cos = 0$ $\Sigma f x = 0$.	$9\times10^9 q$ ~~of~~ $\sin 90 = 9\times10^9$ $\Sigma f = 106410 \times 9\times10^9$

$E_p = \sqrt{0^2 + (106\cancel{410}\times 9\times10^9)^2}$

$E_p = 106410 \times 9\times10^9 q$

At $E_p = 0$

$106410 + 9\times10^9 q = 0$

$\frac{9\times10^9 q}{9\times10^9} = \frac{-106410}{9\times10^9}$

$q = -1.18 \times 10^{-5} C$

(2) ~~Elect~~ Electric field is a region of space in which an electric charge is experienced an electric force.

Electric field intensity is defined as the force per unit charge. Electric field intensity can be expressed mathematically as $E = \frac{F(0)}{q_0(0)}$

But $\sin(\pi - \theta) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(x^2+y^2)^{1/2}}$ . . . (2)

Substitute eqn 2 in eqn 1

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

Recall $dl = dy$

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

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

Using seperate integrals

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

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

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

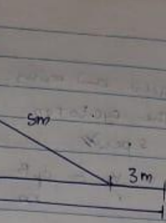
$$B = \frac{\mu_0 I}{4\pi x} \left(\frac{2a}{(x^2+a^2)^{1/2}} \right)$$

When the length 2a of the conductor is very great in comparison to its distance x from point P we consider it infinitely long.

i.e, when a is much larger than x $(x^2+a^2)^{1/2}$ a as $a \to \infty$

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

(b)



(1) $E_{nct} = EQ_1 + EQ_2$

$EQ_1 = \frac{KQ_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\ NC^{-1}$

$EQ_2 = \frac{KQ_1}{r_2^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32\ NC^{-1}$

$E_{nct} = 8 + 12$

$= 20\ N/C$

Vector	Angle.	x-comp	y-comp
$E_1 = 8N/C$	$90°$	$E_1x = 8\times\cos 90$ $= 0$	$E_1y = 8\sin 90$ $= 8$
$E_2 = 4.32N/C$	$36.9°$	$E_2x = -9.32\cos 36.9°$ $= -3.45$	$E_2y = 4.32\sin 36.9$ $= 2.59$
		$Efx = -3.45$	$Efy = 10.54$

(4) Magnetic flux through a surface is the surface integral of the normal component of the magnetic flux density passing through that surface. The SI unit is of the symbol ϕ.

(6) $\omega = \frac{qB}{m_e}$

$= \frac{-1.6\times10^{-19} \times 3.5\times10^{-1}}{9.11\times10^{-31}}$

$= -6.15\times10^{10}\ rad\,s^{-1}$