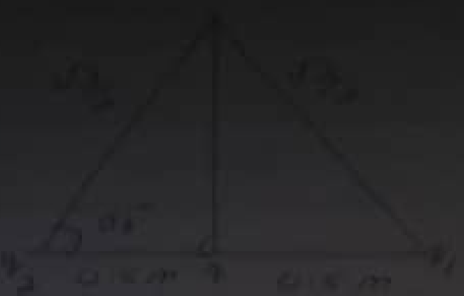


$\sin\theta = \frac{opp}{hyp}$

$\sin\theta = \frac{1}{\sqrt{5/2}}$

$\theta = \sin^{-1}(0.89)$

$\theta = 63.4^\circ \simeq 63^\circ$

$q_1 = q_2 = 8 \times 10^{-6} C$

Using Pythagoras's theorem

$c^2 = a^2 + b^2$

$c^2 = 1^2 + 0.5^2$

$c^2 = 1 + 0.25$

$c^2 = \frac{5}{4}$

$c = \sqrt{5/2}$

$$F_1 = \frac{(9 \times 10^9)(8 \times 10^{-6})}{(\sqrt{5/2})^2}$$

$F_1 = 5.76 \times 10^4 N$

$$F_2 = \frac{(9 \times 10^{-9}) \times (8 \times 10^{-6})}{(\sqrt{5/2})^2}$$

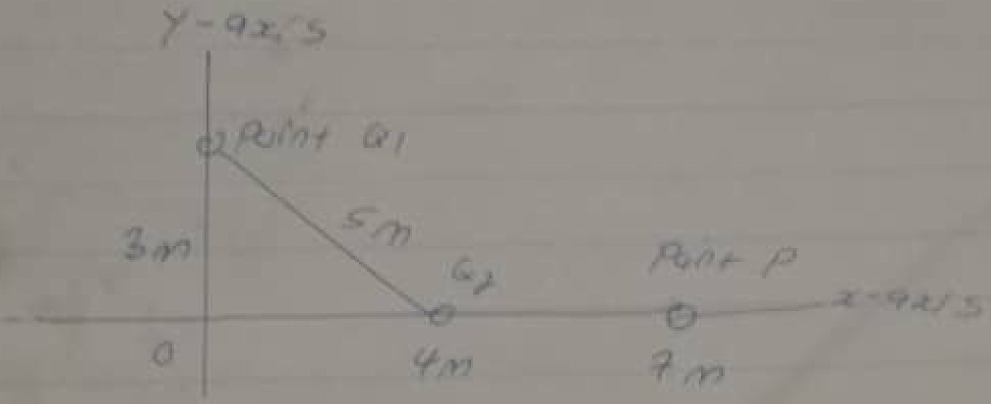
$F_2 = 5.76 \times 10^4 N$

$$F_3 = \frac{(q) \times 9 \times 10^{-9}}{(1)^2}$$

$F_3 = \cancel{9 \times 10^{-9}} \quad 9 \times 10^{-9} q$

Unit positive test charge (q) at that point.

2b.)




$q_1 = 8nC$, $q_2 = 12nC$, $r_1 = 7m$, $r_2 = 3m$, $k = 9\times10e9$ $Nm^2/C^2$

$$E_1 = \frac{k\times q_1}{r^2} = \frac{9\times10e9\times8\times10e-9}{7^2} = 1.469N/C$$

$$E_2 = \frac{k\times q_2}{r^2} = \frac{9\times10e9\times12\times10e-9}{3^2} = 12N/C$$

| vector | Angle | x-component | y-component |
|---|---|---|---|
| 1.469 | 0 | 1.469 | 0 |
| 12 | 0 | 12 | 0 |
| | | 13.469 | 0 |

$$E = \sqrt{(x-component)^2 + (y-component)^2}$$
$$E = \sqrt{(13.469)^2 + 0} = 13.47N/C$$

ii.) $q_1 = 8nC$, $q_2 = 12nC$ $r_1 = 3m$ $r_2 = 5m$, $k = 9\times10e9Nm^2/C^2$

$$E_1 = \frac{9\times10e9\times8\times10e-9}{3^2} = 8N/C$$

$$E_2 = \frac{9\times10e9\times12\times10e-9}{5^2} = 4.32N/C$$

| Strength | Angle | x-component | y-component |
|---|---|---|---|
| 8 N/C | 90° | 0 | 8 |
| 4.22 N/C | 53.16° | 2.59 | 3.46 |
| | | 2.59 | 11.46 |
| | | 2.59 | 11.46 |

$$E = \sqrt{(2.59)^2 + (11.46)^2}$$

$$E = \sqrt{138.0397} = 11.75\,N/C$$

4) Magnetic flux is defined as the strength of magnetic field represented by lines of force.

6.) $m = 9.11 \times 10e{-31}\,kg$, $r = 1.4 \times 10e{-7}\,m$,
$B = 3.5 \times 10e^{-1}$ weber/meter$^2$
$q = 1.6 \times 10e{-19}\,C$

cyclotron frequency $f = \frac{qB}{m}$

$$f = \frac{1.6 \times 10e{-19} \times 3.5 \times 10e{-1}}{9.11 \times 10e{-31}\,kg}$$

$$= \frac{5.6 \times 10e{-20}}{9.11 \times 10e{-31}}$$

$$= 6.147 \times 10e\,10\,rad/s$$

c) The cyclotron frequency is the inverse of the period which is the time taken for the accelerated electron to complete a cycle in the magnetic field.

| Vector | Angle | x-component | y-component |
|---|---|---|---|
| 8 N/C | 90° | 0 | 8 |
| 4.22 N/C | 53.13° | 2.59 | 3.46 |
| | | 2.59 | 11.46 |
| | | 2.59 | 11.46 |

$$E = \sqrt{(2.59)^2 + (11.46)^2}$$

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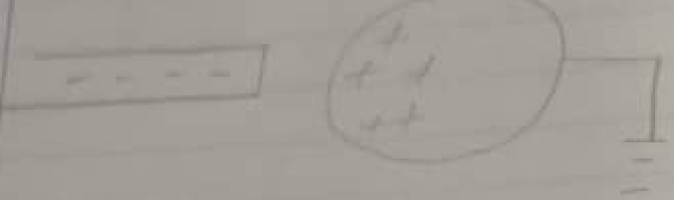
6.) The cyclotron frequency is the inverse of the period which is the time taken for the accelerated electron to complete a cycle in the magnetic field.

iii)



(v.)

b.) $q_1 = ?$ $q_2 = ?$ $q_1 + q_2 = 5.0 \times 10e{-5}$ --- equation 1

$F = 1.0N$ $d = 2.0m$

$$F = \frac{kq_1 q_2}{d^2}$$

$$q_1 q_2 = \frac{F \times d^2}{k} = \frac{1 \times 2^2}{9 \times 10e9} = 4.44 \times 10e{-10}C$$

$q_1 = 5.0 \times 10e{-5} - q_2$ --- (equation 2)

substitute equation 2 in equation 1

$(5.0 \times 10e{-5} - q_2) q_2 = 4.44 \times 10e{-10}$

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

$q_2^2 - (5.0 \times 10{-5}) q_2 + 4.44 \times 10e{-10} = 0$

$q_2 = 3.845 \times 10e{-5}C$ or $q_2 =$ $1.154 \times 10e{-5}C$

when $q_2 = 3.845 \times 10e{-5}C$, $q_1 = 1.150 \times 10e$

or when $q_2 = 1.154 \times 10e{-5}C$ $q_1 = 3.845 \times$ $-5C$

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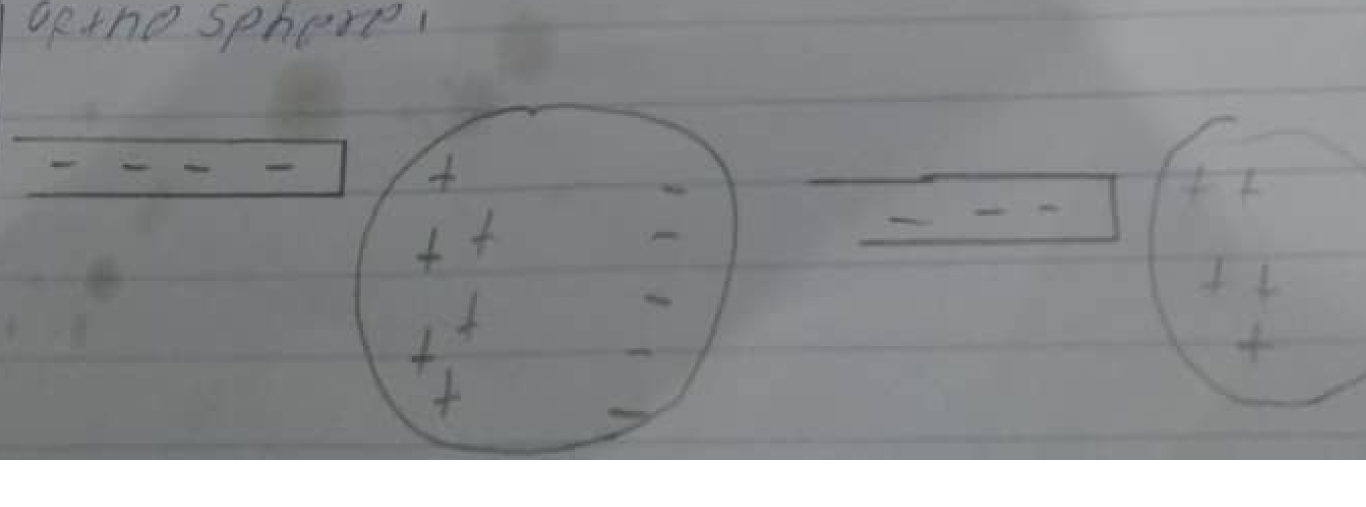
Physics

1) ~~a~~ Consider a negatively charged rubber rod brought near a neutral (uncharged) conducting sphere that is insulated so that there is ~~insulation~~ no conducting path to ground as shown below. The repulsive force between the electrons in the rod and those in the square causes a redistribution of charges on the sphere so that some electrons move to the side of the sphere farthest away from the rod.

The Region of the sphere nearest the negatively charged rod has an excess of positive charge because of the migration of electrons away from this location.

If ~~the~~ a grounded conducting wire is then connected to the square, as in some of the electrons leave the sphere and travel to the earth. If the wire to the ground 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~~ surface of the sphere.



when the length $2a$ of the conductor is very greater in comparison to its distance $x$ from point P, we consider it infinitely long. That is, when $a$ is much larger than $x$,

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

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

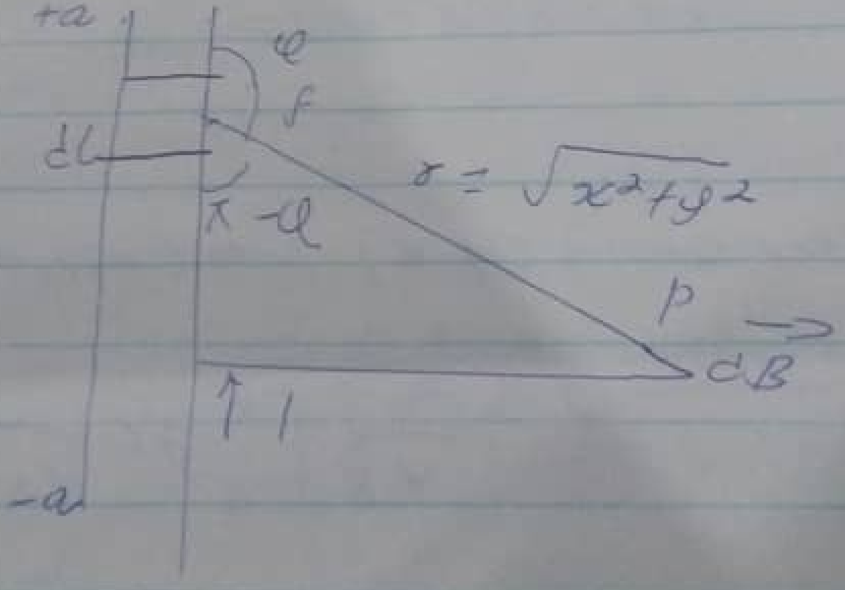
In a physical situation, we have axial symmetry about the y-axis. Thus, at all points in a circle of radius r, around the conductor, the magnitude of B is

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

Equation (#) defines the magnitude of the magnetic field of flux density B near a long, straight current carrying conductor.

5) the Biot - savart law is based on the following observations for the magnetic field $d\vec{B}$ at a point P associated with a length element $dl$ of a wire carrying a steady current I.

6) magnetic field of a straight current carrying conductor:




Applying the Bio-savart law, we find the magnitude of the field $d\vec{B}$

~~dB~~

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

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

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 (xxx) therefore becomes

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

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

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

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

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

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

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

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

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 $dl=dy$

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

| Force | Angle | Horizontal comp. | Vertical comp. |
|---|---|---|---|
| $F_1 = 5.76\times10^4$ | 62° | $-F_1 \cos 62 = $ [illegible] | $-F_1 \sin 62 = $ [illegible] |
| $F_2 = 5.76\times10^4$ | 62° | $F_2 \cos 62 = $ [illegible] | $-F_2 \sin 62 = $ [illegible] |
| $F_3 = 9\times10^9$ [illegible] | 90° | $F_3 \cos 90 = 0$ | $F_3 \sin 90 = $ [illegible] |
| | | $\Sigma F_x = 0$ | $\Sigma F_y = -1.026\times10^5$ |

The Resultant force

$$(F) = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$$

Note charge at P = 0

$$0 = \sqrt{(0)^2 + (-9\times10^9 q) - (1.026\times10^5)}$$

$$0 = \sqrt{-9\times10^9 q - 1.026\times10^5}$$

$$0 = -9\times10^9 - 1.026\times10^5$$

$$q = -\frac{1.026\times10^5}{9\times10^9}$$

$$q = -1.14\times10^{-5}C$$

$$q = -11.4\times10^{-6}C$$

$$q = -11.4\mu C$$

2) Differences between electric field and electric field intensity

| Electric field | Electric field intensity |
|---|---|
| An electric is a region or space when a stream of electric charges experience an electric force | Electric field intensity (E) also known as the strength of an electric field at any point, is defined as the force (F) experienced by a |