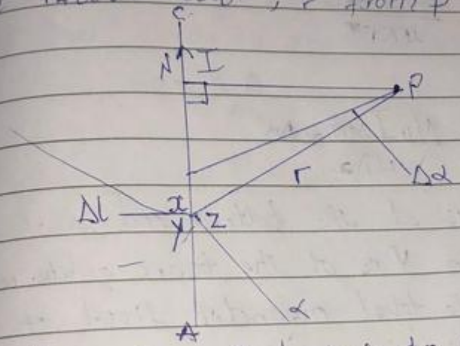
part of a long straight wire. P is taken as a point so near it that from P, the wire looks infinitely long, it subtends very nearly 180°. An element xy of this wire, of length Δl makes an angle α with the radius vector, r from P



It therefore contribute to the magnetic field at P an amount

$$\Delta B = \frac{\mu_0 I \Delta l \sin\alpha}{4\pi r^2}$$

when the wire carries a current I. If α is the perpendicular distance, PN, from P to the wire, then

$$PN = Px \sin\alpha \quad \text{or} \quad a = r \sin\alpha$$

$$\text{So} \quad r = \frac{a}{\sin\alpha} \quad \ldots (ii)$$

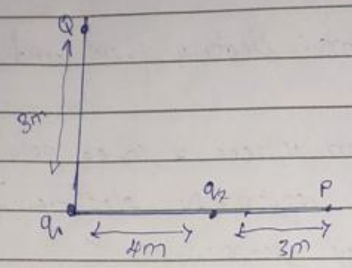
Also, if we draw xz perpendicular to py we have $XZ = xy \sin\alpha = \Delta l \sin\alpha$

bi $Q_1 = 8nC$ $Q_2 = 12nC$ at $x = 4m$

Net field at P

$$E = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{7^2} + \frac{q_2}{3^2}\right]$$

along positive x-axis



$$= 9.0\times10^{-9} C^{-2}\left[\frac{8\times10^{9}C}{(7m)^2} + \frac{12\times10^{9}C}{(3m)^2}\right]$$

$= 1.47 NC^{-1} + 12.0 NC^{-1}$ along positive x-axis

ii $\sin\theta = 4/5 = 0.8$, $\cos\theta = 3/5 = 0.6$

$$E_1 = \frac{1}{4\pi\varepsilon_0}\times\frac{q_2}{(3m)^2}$$

$$= \frac{9.0\times10^{9}\times 8\times10^{-9}}{3^2}$$

$$= 8 NC^{-1}$$

If ΔL subtends an angle $\Delta\alpha$ at r, then $XZ = r\Delta\alpha$
$= \Delta L \sin\alpha$

from (i) $\Delta B = \dfrac{\mu_0 I \Delta L \sin\alpha}{4\pi r^2}$

$$= \frac{\mu_0 I r \Delta\alpha}{4\pi r^2} = \frac{\mu_0 I \Delta\alpha}{4\pi r}$$

from (ii) $\therefore \Delta B = \dfrac{\mu_0 I \sin\alpha \Delta\alpha}{4\pi a}$

when the point Y is at the bottom end A of the wire $\alpha = 0$, and when Y is at the topic of the wire $\alpha = \pi$ ∴ therefore, the total magnetic field at p is

$$B = \frac{\mu_0}{4\pi}\int_0^{\pi} \frac{I \sin\alpha \Delta\alpha}{a}$$

$$= \frac{\mu_0 I}{4\pi a}\left[-\cos\alpha\right]_0^{\pi}$$

$\therefore B = \dfrac{\mu_0 I}{2\pi a}$, where $a = r$.

4a What is magnetic flux

b An electron with a rest mass of 9.11×10^{-31} kg moves in a circular orbic or radius 1.4×10^{-7} in a uniform magnetic field of 3.5×10^{-1} weber/meter square, perpendicular to the speed with

4 Magnetic
field r
by the

b) $m = 9$
$\theta =$

$w =$

c. In the
i Mass
ii magn
iii Drad
is
call
an

1a. for $q_2 = 3.84 \times 10^{-5}$

$q_1 = 5.0 \times 10^{-5} - 3.8 \times 10^{-5}$

$q_1 = 1.16 \times 10^{-5}$ C

for $q_2 = 1.16 \times 10^{-5}$

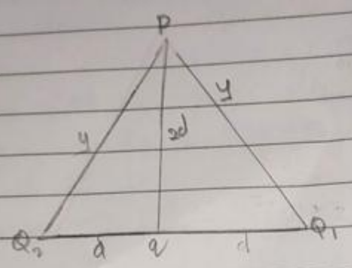
$q_1 = 5.0 \times 10^{-5} - 1.16 \times 10^{-5}$

$q_1 = 3.84 \times 10^{-5}$ C

$\therefore q_1\ 1.16 \times 10^{-5}$ C and $q_2\ 3.84 \times 10^{-5}$ C

or vice versa.

C



using pythagoras

$PQ_2^2 = PQ_1^2 = 1^2 + 0.5^2$

$PQ_1 = \sqrt{1.25}$

$PQ_1 = 1.12$ m

$E_P = E_{Q_1} + E_{Q_2} + E_{Q_q}$ ——— (i) but $E_P = 0$

$E_{Q_1} = E_{Q_2} = \frac{kQ}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2} = 57397.96\ NC^{-1}$

$E_{Q_q} = \frac{kq}{r^2} = \frac{9 \times 10^9 \times q}{(1)^2} = 9 \times 10^9 q\ NC^{-1}$

from eqn i $= 0 = 57397.96 + 57397.96 + 9 \times 10^9 q$

$-9 \times 10^9 q = 114795.92$

$\therefore q = 1.3 \times 10^{-5}$ C $= -1.3 \times 10^{-5} \times 10^{6}$

$\therefore q = -13$ C.

out touching
der a
utral Conch.
here is no
repulsive
the sphere
so that
e farther
sphere
xcess of
lectrons
oire is
some
the earth.
sphere
finally;
of the
surface

fig 1.3c

fig 1.3d

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

$r = 2\,cm$

$f = 1.0\,N$

$q_1 = ?$ and $q_2 = ?$

But $f = \frac{kq_1q_2}{r^2}$

$$r = \frac{9\times10^9 \times q_1q_2}{(2)^2}$$

$$4 = 9\times10^9\times q_1q_2$$

$$q_1q_2 = 4.44\times10^{-10}$$

$$\therefore q_1 = \frac{4.44\times10^{-10}}{q_2}$$

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

$$\frac{4.44\times10^{-10}}{q_2} + q_2 = 5\times10^{-5}$$

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

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

Using formula method $q_2 = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$$q_2 = \frac{-(5\times10^{-5}) \pm \sqrt{(-5\times10^{-5})^2 - 4(1)(4.44\times10^{-10})}}{2(1)}$$

$$q_2 = \frac{5\times10^{-5} \pm 2.68\times10^{-5}}{2}$$

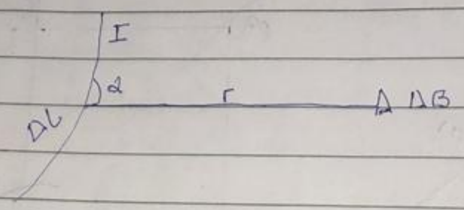
$$q_2 = \frac{5\times10^{-5} + 2.68\times10^{-5}}{2} \quad \text{or} \quad \frac{5\times10^{-5} - 2.68\times10^{-5}}{2}$$

$q_2 = 3.84\times10^{-5}\,C$ or $1.16\times10^{-5}\,C$

5a State the Biot - Savart Law

Law of Biot and Savart: this law state that the flux density ΔB at a point p due to a conductor carrying or current is given by $\Delta B \propto \frac{I \Delta L \sin\alpha}{r^2}$

Where r is the distance from the point p to the element and α is the angle between the element and the line going it top.



b. Using the Biot - Savart law. Show that the magnetic field of a straight current - carrying conductor is given as

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

- To show that the magnitude of the magnetic field B due to long straight wire is given by $B = \frac{\mu_0 I}{2\pi r}$, using the Savart law.

Let us consider the figure below, AC represents

Magnetic flux is defined as the strength of magnetic field represented by lines of forces. It is usually represented by the $\sin\phi$

$m = 9.11 \times 10^{-31}$ kg ; $r = 1.4 \times 10^{-2}$ m ; $B = 3.5 \times 10^{-1}$ weber/m²

$\theta = 90^\circ$; $\omega = ?$; $q = -1.6 \times 10^{-19}$ C

$$\omega = \frac{qB}{m_c}$$

$$\omega = \frac{-1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$$\omega = -6.15 \times 10^{10} \text{ rad/sec.}$$

c. In the equation, we were given some parameters such as:

i. mass of the electron $= 9.11 \times 10^{-31}$ kg

ii. magnetic field of 3.5×10^{-1} weber/m²

iii. A radius of 1.4×10^{-7} m

And we are asked to find the cyclotron frequency which is equal or the same thing as angular speed. It is called cycloton frequency because it is a frequency of an acceleration called cyclotron.

Recall: Angular speed is equal to $\omega = v/r = qB/m$

1a) Eletric Charge can be obtained on an object without touching it, by a process called electrostatic Induction. consider a negatively Charched rubber rod brought near a neutral (uncharged) Conducting sphere that is insulted so that there is no conducting path to ground as shown below : the repulsive force between the electron in the rod and those in the sphere causes a redistribution of charges on the sphere so that some electrons more to the side of the sphere further away from the rod (fig 1.3a). 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 a grounded conducting wire is then connected to the sphere, as in (fig 1.3b) some of the electrons leave the sphere and travel to the earth. if wire is then removed (fig 1.3c), 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 and becomes uniformly distributed over the surface of the sphere.

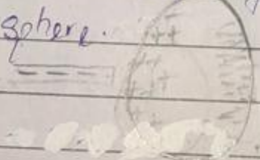


fig 1.3a

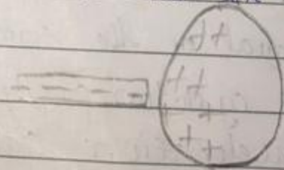


fig 1.3c

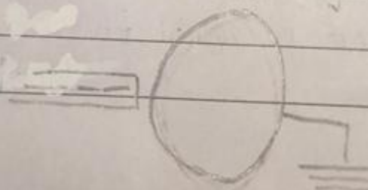


fig 1.3b

fig 1.?

b) $q_1 + q_2 =$
$r = 2cm$
$f = 1.0N$
$q_1 = ?$
But
Using
$q_2 =$
$q_2 = 5$
$q_2 = 3$

field E_2 at Q, due to q_2 has magnitude

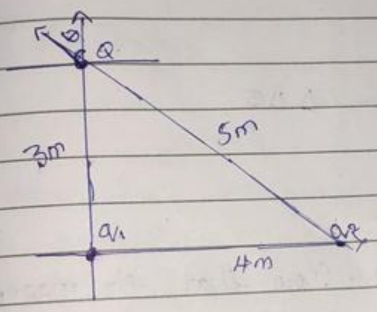
$$E_2 = \frac{1}{4\pi\epsilon_0} \times \frac{q_2}{(5m)^2}$$

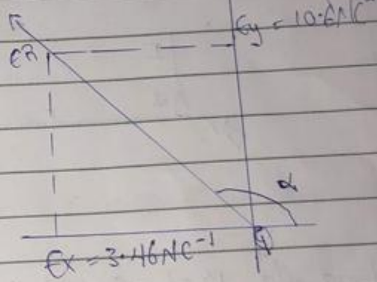
$$= \frac{9.0\times10^{9} \times 12\times10^{-9}}{5^2}$$

$$= 4.32\,NC^{-1}$$

Resultant field at Q in the x-direction = $E_2 \sin\theta$

$$= -4.32 \times 0.8 = -3.46\,NC^{-1}$$





Resultant field at Q in the y-direction = $E_1 + E_2 \cos$

$$\theta = 7.99 + -4.32 \times 0.6$$

$$= 10.6\,NC^{-1}$$

The resultant E_R makes and angle α with x-axis a shown in the diagram [figure 1.14 c] given by $\tan\alpha$

$$= \frac{E_y}{E_x} = \frac{10.6}{3.46} = 3.06$$

$$\alpha = \tan^{-1}(3.06) = 71.9^\circ$$

Ishaq Fatimah Isah
19/MHS01/207
Medicine and Health science
Medicine and Surgery
Electricty Magnetism and modern physics (PHY 102)

COVID-19 Holiday Assignment.

2a) Distinguish between the terms: electric field and eletric field intensity.

An electric field is a region where a force acts on a charged body placed in the region. An electric field can be represented by line of force.

The electric field, E at a point in an electric field is the force per unit charge acting on a positive test charge placed at that point. Electric field intensity

$$E = \frac{\text{force}}{\text{charge}} = \frac{f}{q}$$

, it units is newton per coulomb (NC^{-1}) or volt per metre (Vm^{-1}).

b) A positive charge $Q_1 = 8nC$ is at the origin, and a second positive charge $Q_2 = 12nC$ is on the x-axis at $x = 4m$. find (i) the net electric field at a point p on the x axis at $x = 7m$

ii) the electric field at a point Q on y axis at $y = 3m$ due to the charge.