5a) Bot-savart law is a statement in electromagnetics

The magnetic intensity at 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

4 | Magnetic flux through a surface is the surface integral of the normal component of the magnetic field flux density B passing through the surface. The SI unit of Magnetic flux is weber

b | $f = \frac{q \times B}{(2\pi m)}$

f = Cyclotron frequency = ?
q = Charge of particle = -1.60×10^{-19}
B = strength of magnetic field = 3.5×10^{-1} weber/meter
m = mass of the particle = 9.11×10^{-31} kg

$f = \frac{-1.60 \times 10^{-19} \times 3.5 \times 10^{-1}}{(2 \times 9.11 \times 10^{-31})}$

$= -3.073 \times 10^{10}$

c | The cyclotron frequency is the frequency of a charged particle moving perpendicular to the direction of a uniform magnet B with constant magnitude and direction

Pythagoras theorem gives us that side $QQ_1 = 5$m
and $\tan\theta = \frac{Opp}{Adj}$

$$\theta = \tan^{-1}\left(\frac{3}{4}\right)$$
$$\theta = 36.9$$

i net electric field at P = Charge by q_1 and Charge by q_2 and

$$E = \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7^2} = 1.469 \text{ N/C}$$

$$E = \frac{kq_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{3^2} = 12 \text{ N/C}$$

net electric field $= 1.469 + 12$
$= 13.469$ N/C

ii Electric field at Q

$$E = \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{3^2} = 8 \text{ N/C}$$

$$E = \frac{kq_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{5^2} = 4.32 \text{ N/C}$$

Vector	Angle	x component ($E\cos\theta$)	y component ($E\sin\theta$)
$E_1 = 8$ N/C	90°	$E_{1x} = 8\cos 90 = 0$	$E_{1y} = 8\sin 90 = 8$
$E_2 = 4.32$ N/C	36.9	$E_{2x} = 4.32\cos 36.9 = 3.455$	$E_{2y} = 4.32\sin 36.9 = 2.593$
		$\Sigma E_x = 3.455$	$\Sigma E_y = 10.593$

$E = 57397.959$

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

Vector	Angle	X-Component	Y-Component
$E_1 = 57397.959$	63.4	25700.45785	51322.62839
$E_2 = 57397.959$	63.4	-25700.45785	51322.62839
		$E_x = 0$	$E_y = 102645.2568$

$E_q = \sqrt{0^2 + (102645.2568)^2}$

$E_q = 102645.2568$

$q = \frac{E_q}{9\times10^9} = 102645.2568$

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

2 Electric field is a region or space where the effect of an electric charge can be felt or will experience an electric force

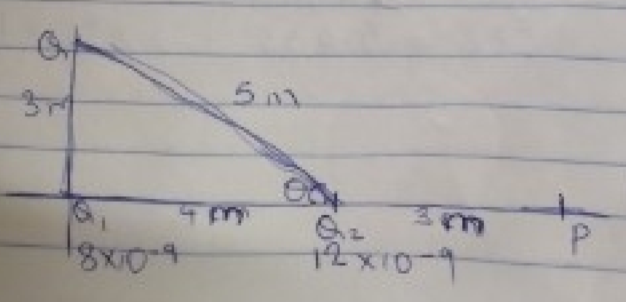
While

Electric field intensity is the force per unit charge

Mathematically the magnitude of field is given by

$$E = \frac{F(N)}{q_o(C)}$$

b



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

$k = 9\times10^9 Nm^2C^{-2}$

$F = \frac{kq_1q_2}{r^2} \Rightarrow 1.0 = \frac{9\times10^9 \times (q_1 q_2)}{(2.0)^2}$

$q_1 q_2 = 4.44\times10^{-10}$ —— (1)

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

recall $q_1 + q_2 = 5.0\times10^{-5}$ —— (11)

Substituting

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

multiply through by q_2

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

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

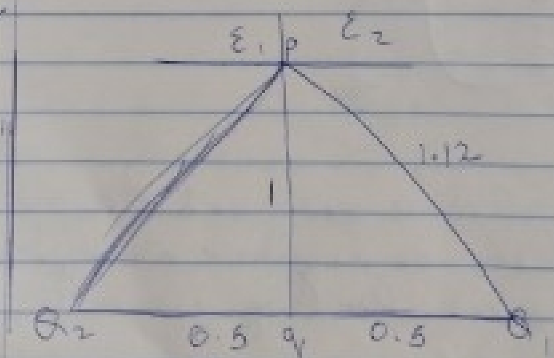
Solving quadratically

$q_2 = 3.845\times10^{-5}C$ or $1.154\times10^{-5}C$

substituting q_2 values in equ (11)

$q_1 = 1.154\times10^{-5}C$ or $3.845\times10^{-5}C$

C



$x^2 = 1^2 + 0.5^2$

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

$x = 1.12$

$Q_2 = Q_1 = 8\times10^{-6}$

$\varepsilon_2 = \varepsilon_1$

$\tan\theta = \frac{opp}{adj}$; $\theta = \tan^{-1}\left(\frac{1}{0.5}\right)$

$\theta = 63.43°$

$\varepsilon = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2}$

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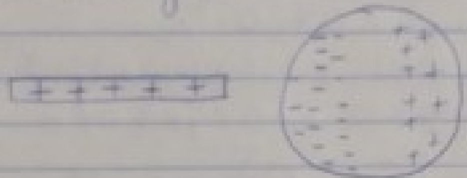
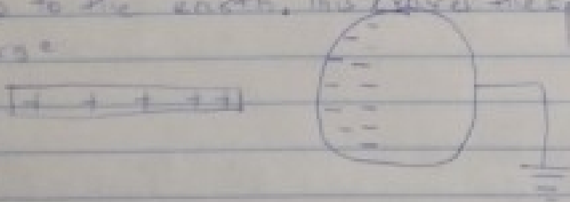
b) To produce a negatively charged sphere by induction first we would need a positively charged material (metal rod), a neutral sphere and a grounding wire

i The positively charged rod is brought close but not touching the neutral sphere. This attracts the electrons in the sphere closer to the rod and repels the positive charges



ii Then a grounded conducting wire is connected to the sphere. This makes some of the electrons in the sphere flow to the earth. This leaves the sphere with excess negative charge



iii When the wire to the ground is removed the sphere is then left with an excess of negative charge and then the rod is removed leaving you with a negatively charged sphere.