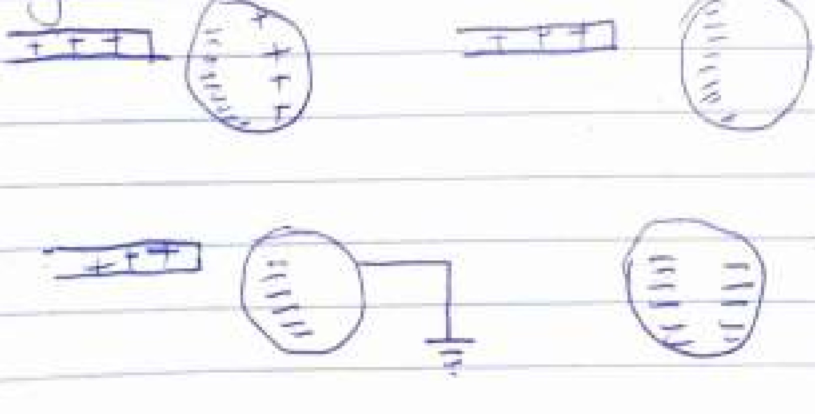
Sandy, Okuyakabasi. U.
19/MHS01/395
PHY 102
MBBS

1a) Charging by induction
Electric charges can be obtained on an object without touching it, by a process called electrostatic induction. Consider a positively charged rubber rod brought near a neutral conducting sphere that is insulted so that there is no conducting path to ~~the~~ ground as to be shown below. The repulsive force between the protons in the rod and those in the sphere causes a redistribution of charges of the sphere so that some protons move to the side of the sphere farthest away from the rod. The region of sphere nearest the protons away from this location. ~~If a proton leaves the sphere and travel to the earth.~~ If a grounded conducting wire is then connected to the sphere ~~as a~~ some of the protons leaves the sphere and travel to the earth. If the wire to ground is then removed, the conducting sphere is left with an excess of induced negative charge and when the rubber rod is removed from the vicinity of the sphere, the induced negatively charge remains on the ungrounded sphere and becomes ~~it~~ uniformly distributed over the surface of the sphere

Diagram:



b) $q_1 + q_2 = 5.0 \times 10^{-5} C$

$F = 1N$
$r = 2m$
$K = 9 \times 10^9$

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

$q_1 q_2 = \frac{1 \times 2^2}{9\times10^{9}} = 4.444\times10^{-10}$

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

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

$q_1(5.0\times10^{-5} - q_1) = 4.444\times10^{-10}$

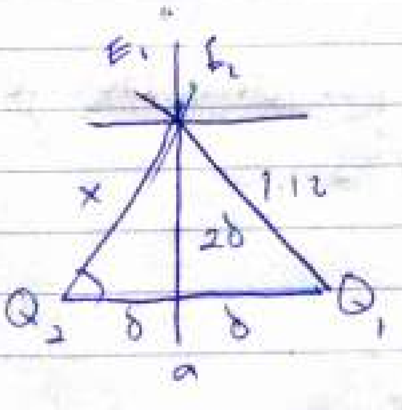
$q_1^2 - (5.0\times10^{-5}\, q_1) + \sqrt{(5.0\times10^{-5})^2 - 4(4.444\times10^{-10})}$

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

$q_2 = 5.0\times10^{-5} - 3.84\times10^{-5}$

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

c)



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

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

$x = 1.12$

$\delta = 0.5$

$Q_2 = Q_1 = 8\times10^{-6}$ $\tan\theta = \frac{Opp}{Adj}$ $\theta = \tan^{-1}(\frac{1}{0.5})$

$f_2 = f_1$ $\theta = 63.43^\circ$

$f_2 = k\frac{q_2}{r^2} = \frac{9\times10^{9} \times 8\times10^{-6}}{(1.12)^2} = 57397.959$

$f = 57397.959$

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

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

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

$E_q = 0 + 102645.2568$

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

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

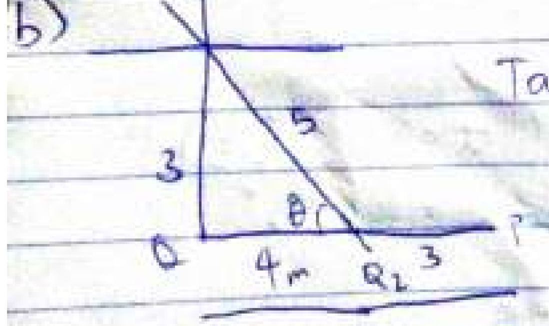
2a) Electric field – is a region in space in which an electric charge will exprience ~~an~~ an electric force

b) Electric field intensity – This is the force per unit charge: Mathematically the magnitude of the field is given by

$E = \frac{F(N)}{q_0(C)}$

$E_2 E_1$

b)



$\tan\theta = \frac{Opp}{Adj}$

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

$\theta = 36.9$

$E_{net} = E_1 + E_2$

$E_1 = \frac{Kq}{r^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\ N/C$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12\ N/C$

$E_{net} = 12 + 1.469$

$E_{net} = 13.469$ or $13.5\ N/C$

ii) $E_1 = \frac{kQ_1}{r^2} = 9\times10^9 \times \cancel{8} 8\times10^{-9} = 8\ N/C$

$E_2 = \frac{k_1 Q_2}{r^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32\ N/C$

vector	Angle	x - comp	y - comp
$E = 8\ N/C$	$90°$	0	8
$E_2 = 4.32\ N/C$	$36.9°$	-3.45	2.59
		$E_x = -3.45$	$E_y = 10.59$

$E_{net} = \sqrt{(3.45)^2 + (10.59)^2}$
$= 11.14\ N/C$

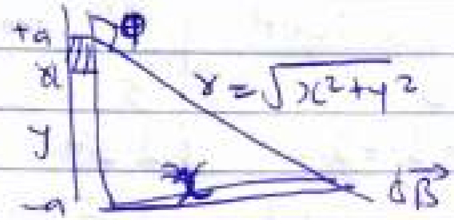
4a) Magnetic flux is Defined as the strength of the magnetic field represented by lines of force. It is represented by symbol Φ.

b) $M = 9.11\times10^{-31}\ kg$ $r = 1.4\times10^{-7}\ m$
$B = 3.5\times10^{-1}\ w/m^2$ $q = 1.6\times10^{-19}$
$w = \frac{qB}{m} = \frac{-1.6\times10^{-19} \times 3.5\times10^{-1}}{9.11\times10^{-31}}$
$W = -6.15\times10^{10}\ rad/s$

c The answer is negetive because we are dealing with an electron moving at a cyclotron prequency of 6.15×10^{10} rad/s

5a) The Biot - Savart law is used to find the total magnetic field Created at Some point on a Current Carrying wire or Current Consisting of changes flowing in ~~Sap~~ Space

5b) $B = \frac{\mu_0 I}{4\pi}$



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

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

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

~~From~~ $r^2 = x^2 + y^2$ (Pythagoras theorem)

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

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

Substituting $(**)$ into $(*)$

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

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

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

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

equation($\ast\ast\ast$) becomes

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

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

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

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

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