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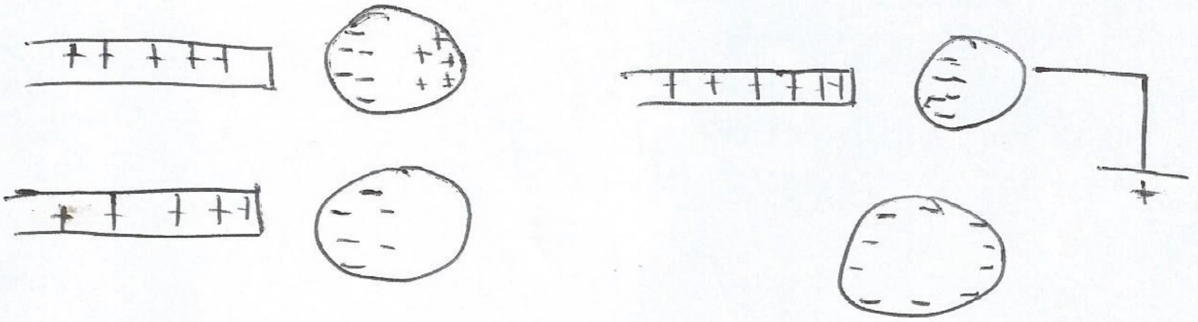
Matric No: 19/ENG02/004.
Computer Engineering

1a Positively charged rod is brought near a neutral charged conducting sphere that is insulated so there is no conducting path to the ground as shown ~~above~~ below. The repulsive force between the positive charge in the rod and that positive charge in the sphere causes the positive charge in the sphere to move farther away from the rod. If a ground conducting wire is connected to the sphere the positive charges leave the sphere and travel to the earth



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

$F = 1N$

$d = 2m$

Recall that $k = 9\times10^{9}$

$$F = \frac{kq_1q_2}{r^2}$$

$$1 = \frac{9\times10^{9} \times (q_1q_2\, 5\times10^{-5})}{2^2}$$

$$4 = 9\times10^{9} \times 5\times10^{-5} q_1 + 9\times10^{9} q_2$$

$$4 = 4.5\times10^{5} q_1 + 9\times10^{9} q_2$$

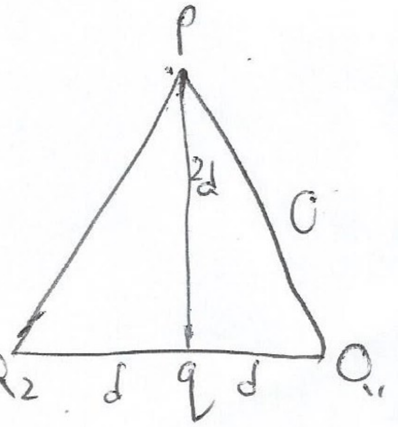
It is a quadratic equation

$$q_1 \times10^{9} q_2 - 4.5\times10^{5} q_1 + 4 = 0$$

$q_1 = 0.0000111C$
$q_2 = 0.000038C$

$\Rightarrow q_1 = 1.11 \times 10^{-5}C$
$q_2 = 3.8 \times 10^{-5}C$

1c



$Q_1 = Q_2 = 8\mu C$
$d = 0.5$

$$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5739.795918$$

$$E_2 = \frac{kq_1}{r^2} = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 5739.795918$$

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

Vector	angle	x comp	y - comp
$E_1 = 5739.795918$	$63.4°$	$E_1 \times \cos\theta$ $= 2570.045785$	$E_1 \times \sin\theta$ $= 5132.262859$
$E_2 = 5739.795918$	$63.4°$	$E_2 \times \cos\theta$ $= 2570.045785$	$E_2 \times \sin\theta$ $= 5132.262859$
$E_q = 9\times10^9 q$	$90°$	$E_q \times \cos\theta$ $= 0$	$9\times10^9 q$
		0 ~~5140.0915~~7	10264.525687 $9\times10^9 q$

$$P = \sqrt{Ex^2 + Ey^2}$$

$$= \sqrt{0^2 + 10{,}264.52568}$$

Sin $E = 0$

$$0 = 9\times10^9 q + 10264.52568$$

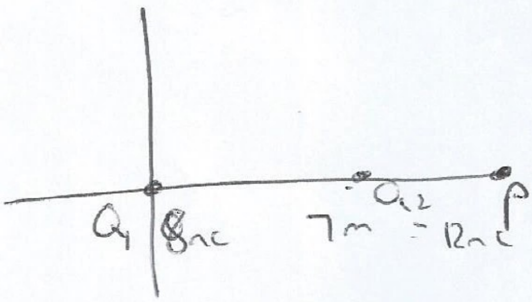
making q subject of formula

$$q = \frac{10264.52568}{9\times10^9}$$

$$q = 1.140502853\ 10^{-6}$$

$$= 11.4\mu C$$

2a



$$q_1 = \frac{8\times10^{-9}\times9\times10^9}{(7.)^2} = 1.4694$$

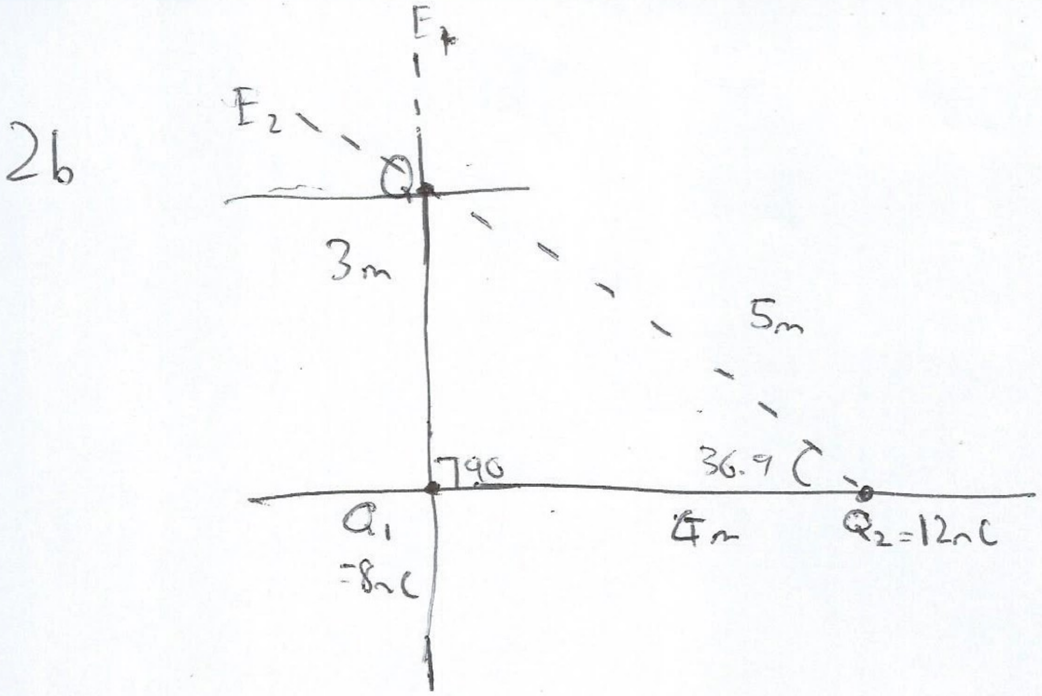
$$q^2 = \frac{12\times10^{-9}\times9\times10^{-9}}{(3)^2}$$

$$= 12$$

Horizontal	Vertical
1.4694 Sin 90	1.4694 Cos 90
12 Sin 90	~~1.4694~~ 12 Cos 90

$$E = \sqrt{(13.4694)^2} = 13.4694$$

2b



$$Q_1 = \frac{kq_1}{r^2} = \frac{8\times10^{-9} \times 9\times10^{9}}{(3)^2} = 8N$$

$$Q_2 = \frac{kq_2}{r^2} = \frac{12\times10^{-9} \times 9\times10^{9}}{(5)^2} = 4.32N$$

Vector	angle	Horizontal Comp	Vertical Component
8	90	8 Cos 90	8 Sin 90
4.32	36.9	4.32 Cos 36.9	4.32 Sin 36.9
		−3.45	10.59

$$\sqrt{\Sigma x^2 + \Sigma y^2}$$

$$= \sqrt{(-3.45)^2 + (10.59)^2}$$

$$= \sqrt{11.9025 + 112.7481}$$

$$E = 11.378 N/C$$

a. Magnetic flux is defined as the strength of the magnetic field which can be represented by line of forces. It is represented mathematically as $\Phi = B \cdot A$

b $w = v/r \div qB/m$

$m = 9.11 \times 10^{-31}$ kg $r = 1.4 \times 10^{-7}$ m, $B = 3.6 \times 10^{-1}$ tesla

$w = qB/m_e$ $q_e = 1.6 \times 10^{-19}$ C

where m_e = mass or electron $= 1.6 \times 10^{-19}$ kg

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

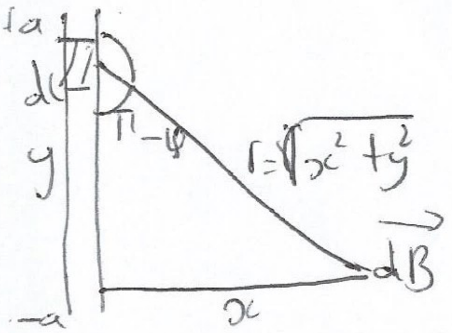
$=$

$w = 6.15 \times 10^{10}$ rad/s

c Cyclotron frequency is equal to angular speed. It is cyclotron frequency because it is a frequency of an accelerator called cyclotron.

5 Biot Savart Law states that the magnetic field is directly proportional to the product permeability of free space (μ), the current (I), the change in length, the radius and inversely proportional square of radius(r^2);

b



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

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

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

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

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

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

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

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

Using Special Integers.

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

$$B = \frac{N_0 I x}{4\pi}\left(\frac{y}{x^2(x^2+y^2)^{1/2}}\right)_{-a}^{a}$$

$$B = \frac{N_0 I x}{4\pi}\left(\frac{2a}{x^2(x^2+a^2)^{1/2}}\right)$$

$$B = \frac{N_0 I}{4\pi x}\left(\frac{2a}{(x^2+a^2)^{1/2}}\right)$$

$(x^2+a^2)^{1/2}$ _ as

$$B = \frac{N_0 I}{2\pi x}$$