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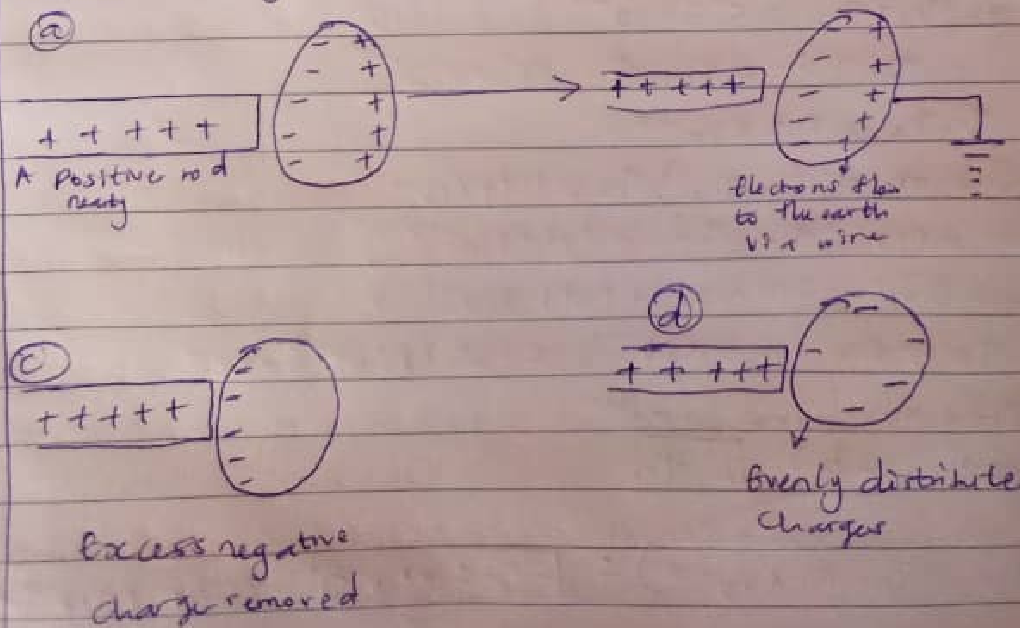
19/MHS06/001
Medical Laboratory science
PHY 102

Assignment.

1) Consider a positively charged rubber rod brought near an uncharged (neutral) conducting sphere that is insulated. The repulsive force between the electrons in the rod and those in the sphere causes a redistribution of charges on the sphere so that some electrons of the same charge with the rod moves to the side farthest away from the rod. The region of the sphere nearest to the positively charged rod has an excess of negative charge. If a grounded conducting wire is then connected to the sphere, some of electrons (negative) leaves the sphere to the earth. If the wire is then removed, the conducting wire is left with an excess of induced negative charge. the induced negative charge remains and becomes evenly distributed on the surface of the sphere.



16(c) $F = \frac{k q_1 q_2}{(r_{1-2})^2}$

$k = 9 \times 10^9$

$F = 10N$

$q_1 = ?$

$q_2 = ?$

$q_1 q_2 = 5.0 \times 10^{-5}$

$F = \frac{k q_1 q_2}{(r_{1-2})^2}$

$F \times (r_{1-2})^2 = k q_1 q_2$

$q_1 q_2 = \frac{F(r_{1-2})^2}{k}$

$= \frac{1 \times (0.2)^2}{(9 \times 10^9)}$

$= 4/9 \times 10^9 = 4.44 \times 10^{-10}$

$q_1 q_2 = 4.4 \times 10^{-10}$

Since $q_1 + q_2 = 5.0 \times 10^{-5}$

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

$\therefore q_1 q_2 = 4.4 \times 10^{-10}$

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

$5.0 \times 10^{-5} q_2 - q_2^2 = 4.44 \times 10^{-10}$

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

$a = 1,\ b = -5.0 \times 10^{-5},\ c = 4.44 \times 10^{-10}$

Using quadratic formular

$x^2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{-(-5.0 \times 10^{-5}) \pm \sqrt{-(-5.0 \times 10^{-5})^2 - 4(1 \times 4.44 \times 10^{-10})}}{2 \times 1}$

$= \frac{5.0 \times 10^{-5} \pm \sqrt{2.5 \times 10^{-9} - 1.78 \times 10^{-9}}}{2}$

$\frac{6.0 \times 10^{-5} \pm \sqrt{7.2 \times 10^{-10}}}{2}$

$= \frac{6.0 \times 10^{-5} \pm 2.68 \times 10^{-5}}{2}$

$\frac{5.0\times10^{-5} + 2.68\times10^{5}}{2}$ or $\frac{5.0\times10^{-5} - 2.68\times10^{-5}}{2}$

$= \frac{7.68\times10^{-5}}{2}$ or $\frac{2.32\times10^{-5}}{2}$

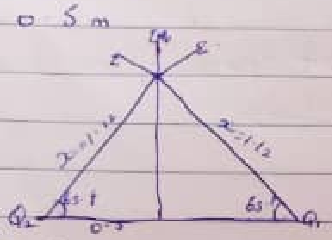
$= 3.84\times10^{5}$ $\quad 1.16\times10^{-5}$

$q_1 = 3.84\times10^{-5}$ or 1.16×10^{-5}

$q_2 = 3.84\times10^{-5}$ or 1.16×10^{-5}

(c) $Q_1 = Q_2 = 8.46$

$d = 0.5\,m$



$d^2 = t^2 + c^2$

$a^2 = 1^2 + 0.5^2$

$a^2 = 1 + 0.25$

$a^2 = 1.25 = a = \sqrt{1.25},\ a = 1.12$

$a = x \therefore x = 1.12$

$\tan\theta = \frac{opp}{adj}$

$\tan\theta = \frac{1}{0.5}$

$\theta = \tan^{-1}(2) = 63.4^\circ$

$E_1 = \frac{kq_1}{r^2} = \frac{9\times10^{9}\times8\times10^{6}}{(1.12)^2} - 5739.779591r$

$E_2 = \frac{kq_2}{r^2} = \frac{9\times10^{9}\times8\times10^{6}}{(1.12)^2} - 5739.7795911r$

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

Vector	Angle	x-Component	y-Components
$E_1 = 5739.779518$	63.4°	-2570.045785	5132.262839
$E_2 = 5739.779518$	63.4°	$+2570.045785$	5132.262839
$E_q = 9\times10^{9}q$	90°	$\cos 90 = 0$	9×10^{9}
		$E_x = 0$	$E_y = 10264.5256$

magnitude $= \sqrt{(E_x)^2 + (E_y)^2}$
$= \sqrt{0^2 + (1026t \cdot 32568)^2}$

Since $E = 0$

$0 = 9\times10^9 q + 1026t \cdot 52568$

making q subject of formular

$q = \dfrac{-1026t \cdot 52568}{9\times10^9}$

$q = -1.1405\times10^{-6}$

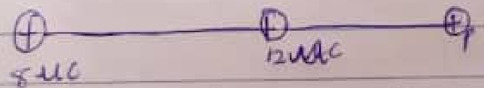
$q = -11.4\mu C$

2a) Electric field is a region of space in which an electric intensity in the force for unit charge.

2b) $q_1 = 8\mu C$

$q_2 = 12\mu C$

$x = 4m$



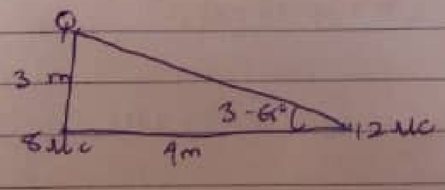
$E_{1P} = \dfrac{kq_1P}{r^2} = \dfrac{(9\times10^9)\times(8\times10^{-7})}{7^2}$

$= 1.467 \mu C^{-1}$

$E_{2P} = \dfrac{kq_2P}{r_2} = \dfrac{(9\times10^9)\times(12\times10^{-7})}{3^2} = 12 \mu C^{-1}$

$E_{net} = 12 + 1.467 = 13.469 \simeq 13.5 \mu C^{-1}$

(ii)



using pythagoras theorem

$a^2 = b^2 + c^2$, $a^2 = 3^2 + 4^2$

$a^2 = 9 + 16$

$a^2 = 25$

$a = \sqrt{25}$

$a = 5$

$\theta = \sin^{-1} 0.6$

$\theta = 36.87$

$E_q = \frac{kq}{r^2} = \frac{(9\times10^9)\times(8\times10^{-9})}{3^2}$

$= 8$

$E_{sr} = \frac{kq}{r_2} = \frac{(9\times10^9)\times(12\times10^{-9})}{5^2}$

$= 4.32$

Vector	Angle	$X (\cos\theta)$	$Y (\sin\theta)$
8	90	0	8
4.32	36.87	3.46	2.592
		$\Sigma_x = 3.46$	$\Sigma_y = 10.592$

Magnetic field

$= \sqrt{3.46^2 + 10.592^2}$

$= \sqrt{124.162}$

$= 11.14\ NC^{-1}$

$= 11.2\ NC^{-1}$

4a) Magnetic flux is defined as the strength of the magnetic field which is represented by lines of force. It is denoted as $\phi = B \cdot dA$.

4b. $B = 3.5\times10^{-1}$

$r = 1.4\times10^{-1} m$

$m = 9.11\times10^{-31} kg$

$v = ?$

$V = \frac{qBr}{m} = \frac{1.6\times10^{-19}\times3.5\times10^{-1}\times1.4\times10^{-1}}{9.11\times10^{-31}}$

$= 8.61\times10^{3} ms^{-1}$

$w = \frac{V}{r} = \frac{8.6\times10^3}{1.4\times10^{-7}} = 6.15\times10^{10}$ rad/s

ⓒ Cyclotron frequency is often referred to as ~~angular~~ angular speed "w" because the charged particle circulates at the angular frequency in the type of accelerator called cyclotron. After getting the angular velocity" the "w" can be gotten.

5a) Biot - savart law states that magnetic field is directly proportional to the product permeability of free space (μ_0) vs current, the change in length the radius and inversely proportional to the square of the radius (r^2)

$$d\hat{B} = \frac{\mu_0 I \, d\hat{l} \times \hat{r}}{4\pi r^2} \Rightarrow W/m^2$$

μ_0 = permeability of free space = $4\pi \times 10^{-7}$ T.m/A

r = radius

$d\hat{B}$ = magnetic field

I = steady current

dl = Length of wire

5b) $B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{d\tan\theta}{r^2}$

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

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

Since $r^2 = x^2 + y^2$

$\therefore B = \frac{\mu_0 I}{4\pi} \int_{-a}^{a} \frac{d\sin(\pi - \theta)}{x^2 + y^2}$ — ①

But $\sin(\pi - \psi) = \frac{x}{\sqrt{x^2+y^2}} = \frac{x}{(\sqrt{x^2+y^2})^2}$ — (2)

Substituting ~~Substituting~~ ② into ①

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

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

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

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

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 3 becomes

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

y is therefore changed to a because of integration

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

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

$(x^2 + a^2)^{1/2} \simeq a$, as a tends to ∞

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

$x = r$

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