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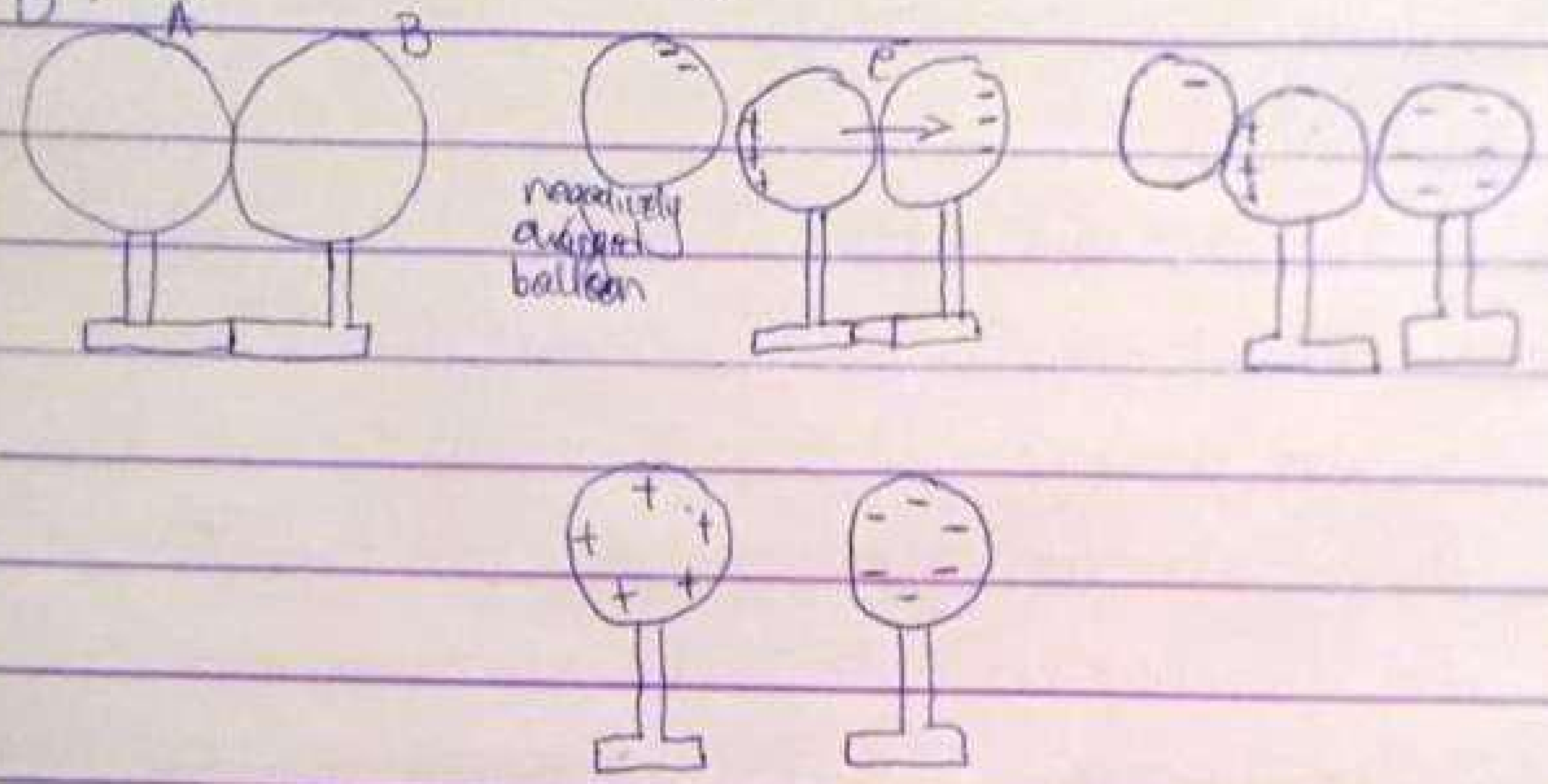
Physics 102 Assignment.
Medicine and Surgery.

1) Consider two metal spheres supported by insulating stands so that any charge acquired by the spheres cannot travel to the ground. The spheres are placed side by side so as to form a two sphere system. Being made of metal, electrons are free to move between spheres from sphere A to B and vice versa.
If a rubber balloon is negatively charged and brought near the spheres, electrons within the two sphere system will be induced to move away from the balloon. This is simply the principle that like charges repel. Being present in a conductor, they are free to move about the surface of the conductor. Subsequently, there is a mass migration of electrons from sphere A to sphere B. The electron migration cause the two-sphere system to be polarized. The movement of electrons out of shere A and into sphere B separates the negative charge from the positive charge.
Looking at the spheres individually, it would be accurate to say that sphere A has an overall positive charge and sphere B has an overall negative charge. Once the two sphere system is polarized, sphere B is physically separated from Sphere A using

The insulating stand. Having been pulled further from the balloon the negative charge likely redistributes itself uniformly about sphe
B.



1b) From Coulomb's law; $f = \frac{k q_1 q_2}{r^2}$

$$0.1 = \frac{9\times10^{9} q_1 q_2}{2^2}$$

$0.1 = 2.25\times10^{9}\, q_1 q_2$ — (1)

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

$q_1 = 5.0\times10^{-5} - q_2$ — (11)

Sub eqn 11 in eqn 1.

$0.1 = 2.25\times10^{9}(5.0\times10^{-5} - q_2)\,q_2$

$0.1 = (112500 - 2.25\times10^{9} q_2)\,q_2$

$0.1 = 112500\, q_2 - 2.25\times10^{9} q_2^2$

Quadratic $-2.25\times10^{9}q_2^2 + 112500q_2 - 0.1 = 0$.

Applying quadratic formula.

$$q_2 = \frac{-112500 \pm \sqrt{(112500)^2 - 4(-2.25\times10^{9})(-0.1)}}{2(-2.25\times10^{9})}.$$

$$q_2 = \frac{-112500 \pm 116431.3}{-4.5\times10^{9}}.$$

$\therefore q_2 = -8.736\times10^{-7}$ or 5.1×10^{-5}.

Sub q_2 when negative in eqn 11.

$\therefore q_1 = 5.0\times10^{-5} - (-8.736\times10^{-7})$

$q_1 = 5.087\times10^{-5}$.

To prove $q_1 + q_2$ has $\ell_0 = 5\times10^{-5}$.

$5.087\times10^{-5} + -8.736\times10^{-7}$

It is $= 5\times10^{-5}$

$\therefore q_1 = 5.087\times10^{-5}$ and

$q_2 = -8.736\times10^{-7}$.

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1c). $P = 0$

$x^2 = 0.5^2 + (2 \times 0.5)^2$

$x^2 = 0.25 + 1$

$x^2 = 1.25$

$x = \sqrt{1.25}$

$x = 1.12$.

$E_1 = \frac{kq_1}{r^2}$

$E_1 = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{(1.12)^2}$

$E_1 = 5.74 \times 10^4$ N/C.

$\tan\theta = \frac{2d}{d}$

$\theta = \tan^{-1} 1/0.5$

$\theta = 63.4^\circ$.

$E_1x = 5.74 \times 10^4$ N/ $\cos 63.4$

$E_1x = 2.57 \times 10^4$ N/C.

$E_1y = 5.74 \times 10^4$ N/C $\sin 63.4$

$E_1y = 5.13 \times 10^4$ N/C.

$E_2x = -2.57 \times 10^4$ N/C.

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$E_y = 5.13 \times 10^4$ N/C.

$E_q = \frac{kq_1}{r^2} = 9 \times 10^9 \times q$

$E_{qx} = 0$

$E_{qy} = 9 \times 10^9 q$

$E_{net} = 0$.

$q = -1.4 \times 10^{-6}$ C.

2a.)

An electric field is a region or space in which an electric charge will experience and electric force.

Electric field intensity is the force per unit charge.

b)

i. $E_{net} = E_1 + E_2$

$E_1 = \frac{kq_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7^2} = 1.469$ N/C.

$E_2 = \frac{kq_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{3^2} = 12$ N/C

$E_{net} = 12 + 1.469 = 13.469$ or 13.5 N/C.

ii) $E_1 = \frac{KQ_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{3^2} = 8 N/C$.

$E_2 = \frac{KQ_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{5^2} = 4.32 N/C$.

Vector	Angle	x - Comp	y Comp
$E_1 = 8 N/C$	$90°$	0	8
$E_2 = 4.32 N/C$	$36.9°$	-3.45	2.5
		$E_x = -3.45$	$E_y = 10.59$.

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

$= 11.14 N/C$.

$E_{net} = 11.14 N/C$.

(4a) Magnetic flux is the measure of the strength of a magnetic field in a given area.

b) Cyclotron frequency = Angular speed = ω

Recall, $r = \frac{mv}{qB}$ and $\omega = \frac{v}{r}$

$\omega = v \div \left[\frac{mv}{qB}\right]$

$\omega = v \times \frac{qB}{mv}$

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

Sub (2) into (1)

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

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

Recall $dl = dy$.

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

Using special integrals

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

Eqn (3) therefore becomes

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

$$w = \frac{qB}{m}$$

$$w = \frac{1.60 \times 10^{-19} \times 3.5 \times 10^{-1}}{9.11 \times 10^{-31}}$$

$$w = 6.14 \times 10^{10} \ rad/s.$$

5)

Biot Savart's law states that 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.

b) Applying biot-savart law, we find the magnitude of the field

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

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

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

From Pythagoras theorem $r^2 = x^2 + y^2$

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

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

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

When the length 2a of the conductor is very great in comparison to its dist x from point P, we consider it infinitely long. That is, when a is much larger than x,

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

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

In a physical situation, we have axial symmetry about the y-axis. Thus at all points in a circle of radius r, around the conductor, the magnitude of B is

$$B = \frac{\mu_0 I}{2\pi r} \quad \dots (\#)$$

Eqn (# defines the magnitude of the magnetic field of density B near a long, straight current carrying conductor