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PHY 102 Assignment.

1 a) 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 (uncharged) conducting sphere that is insulated so that there is no conducting path to ground. 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 move to the side of the sphere farthest away from the rod (fig a). The region of the sphere nearest the positively charged rod has an excess of negative charge because of the migration of electrons away from its location. If a grounded wire is then connected to the sphere (fig b), some of the electrons leave the sphere and travel to the earth. If the wire to ground is then removed (fig c), the conducting sphere is left with an excess of induced negative charge. Finally, when the rubber rod is removed from the vicinity of the sphere (fig d), the induced positive charge remains on the ungrounded sphere and becomes uniformly distributed over the surface.

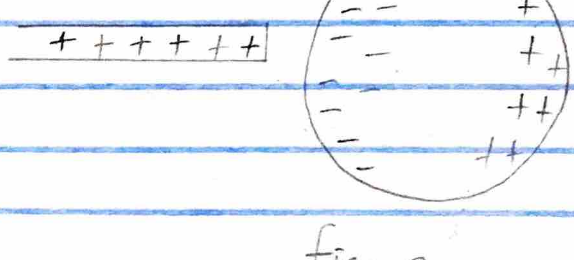


fig a.

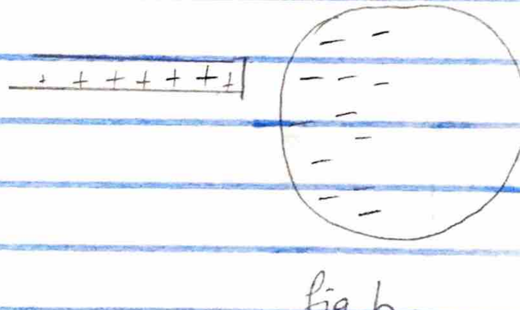
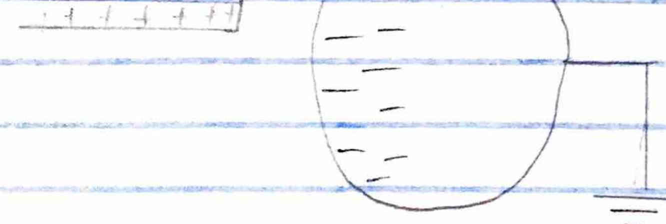
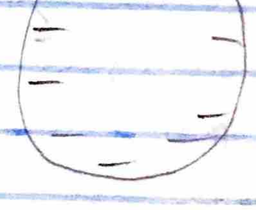


fig b.





$$E_1 = \frac{9\times10^9 \times 8\times10^{-6}}{(1.12)^2} = 57397.96$$

$$E_2 = \frac{Kq_2}{r^2} = \frac{9\times10^9\times8\times10^{-6}}{(1.12)^2} = 57397.96$$

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

Vector	Angle	x - comp	y - comp
$E_1 = 57397.96$	$63.4°$	-25700.46	51322.63
$E_2 = 57397.96$	$63.4°$	25700.46	51322.63
$E_q = 9\times10^9 q$	$90°$	$0.$	$9\times10^9 q$
		$\Sigma x = 0$	$\Sigma y = 102645.26$

magnitude $= \sqrt{(\Sigma x)^2 + (\Sigma y^2)}$

$E_q = \sqrt{0^2 + (102645.26)}\ x$

since $E = 0$

$0 = 9\times10^9 q + 102645.26$

making q subject of formula

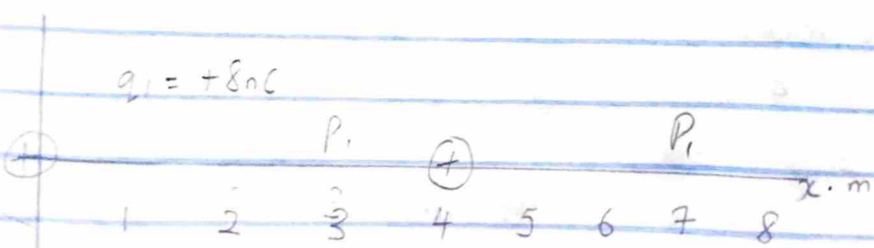
$$\frac{9\times\cancel{10^9}q}{9\times\cancel{10^9}} = -\frac{102645.26}{9\times10^9}$$

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

$q = -11\mu C$

2)a The electric field is a region around a charge in which it exerts electrostatic force on other charges while the strength of electric field at any point in space is called electric field intensity. It is a vector quantity. The electric field is a vector and electric field intensity is the magnitude of the vector.

b)



$$E = \frac{Kq}{r^2}$$

$$= \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = \frac{72}{49}$$

$E = 1\cdot47$ v/m. away from $8nC$.

Now due to $12nC$ it will be 12 V/m.

This is because the distance of point right from $12nC$ is $(7-4) = 3$.

ii $$= \frac{9\times10^9 \times 12\times10^{-9}}{3^3} = 12 \text{ v/m}.$$

Then total electric field $= 12 + 1-47$

$= 13-47$ V/m along positive x-axis.

ii) $E = \frac{Kq}{r^2}$

~~$= 9\times10^9 \times 18 \times 10^{-9}$~~

4) Magnetic flux is what generates the field around a magnetic material. It consists of photons, however, unlike the light we receive from the sun, It is at a much lower frequency. This is why magnetic lines are not visible to the naked eye.

The SI unit of magnetic flux is Weber (wb) - The CGS unit the Maxwell. It is defined as the strength of the magnetic field. It is represented by symbol Φ, mathematically given as $\Phi = B$.

b) $m = 9-11\times10^{-31}$ kg

$w = \frac{v}{r}$

$f = $

c.) In the g of electron, asked to same they $w =$

d) The B to the p change radius C

whose

the u

$$\omega = \frac{v}{r} \quad f = \frac{q \times B}{(2\pi m)} = \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1}}{2 \times 3.14 \times 9.11 \times 10^{-31}}$$

$$f = 9785245318 \; T^{-1}$$

In the question we were given parameters such as the mass of electron, radius, magnetic field of 3.5×10^{-1} and was asked to find the cyclotron frequency which is equal to the same thing as angular speed, recall angular speed is ω

$$\omega = \frac{v}{r} = \frac{qB}{m}.$$

$$f = \frac{\omega}{2\pi} = \frac{qB}{2\pi m}$$

The Biot-savart law states 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 to square of radius (r^2). It can be represented mathematically by

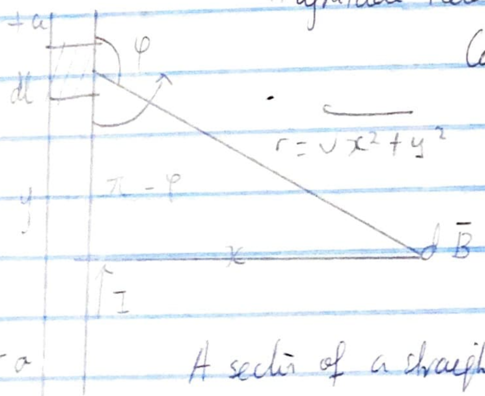
$$d\vec{B} = \frac{\mu_0 I \, d\vec{l} \times \hat{r}}{4\pi r^2}.$$

where μ_0 is a constant called permeability of free space.

$$\mu_0 = 4\pi \times 10^{-7} \; T \cdot m/A.$$

the unit is weber/metre square.

Magnitude Field of a Straight Current Carrying Conductor.



A section of a straight Current carrying conductor.

Applying the Biot - Savart Law, we find the magnitude of field $d\vec{B}$

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

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

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

From diagram $r^2 = x^2 + y^2$ {pythagoras theorem}

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

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

Substituting (2) into (1) we have

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

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

Recall $dl = dy$

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

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

Using special integers.

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

Equation (3) becomes.

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

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

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

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

$(x^2+a^2)^{1/2} \simeq a$, 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

$$B = \frac{\mu_0 I}{2\pi r} \quad -(4)$$

Equation 4 defines the magnitude of the magnetic field of flux density B near a long, straight, carrying conductor.