Collins Sarima Lennenda

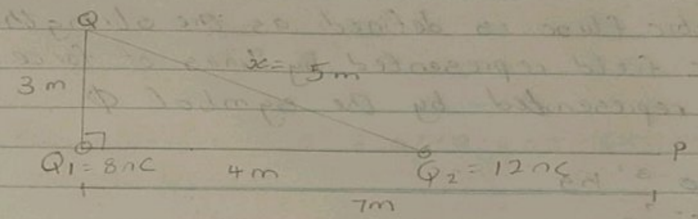
19/sci01/034

Computer Science

Collins Sarima Lennenda
19/sci01/034

2a An electric field is a region of space in ~~what~~ which an electric charge will experience an electric force while The electric field intensity (E), can be defined as the force per unit charge

b)



$x^2 = 3^2 + 4^2$

$x^2 = 9 + 16$

$x = \sqrt{25}$

$x = 5$

1) At point P

$E_1 = \frac{kq_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-9}}{7^2} = 1.469\ N/C$

$E_2 = \frac{kq_2}{r_2^2} = \frac{9\times10^9 \times 12\times10^{-9}}{3^2} = 12\ N/C$

$E_{net} = 1.469\ N/C + 12\ N/C$

$= 13.469\ N/C$

$\simeq 13.5\ N/C$

(ii) At point Q

$E_1 = \frac{kq_1}{r_1^2} = \frac{9\times10^9 \times 8\times10^{-9}}{3^2} = 8\ N/C$

$E_2 = \frac{kq_2}{r_2^2} = \frac{9\times10^9 \times 12\times10^{-9}}{5^2} = 4.32\ N/C$

vector	Angle	x - component	y - component
E_1 = 8N/C	90°	0	8 N/C
E_2 = 4.32N/C	36.87°	$-\cos 36.87 \times 4.32$ $= -3.4559$	$\sin 36.87 \times 4.32$ $= 2.592$

Scanned by CamScanner

$\Sigma E_x = -3.4559$

$\Sigma E_y = 10.592$

$E = \sqrt{(\Sigma E_x)^2 + (\Sigma E_y)^2}$

$= \sqrt{(-3.4559)^2 + (10.592)^2}$

$= 11.14$

$\simeq 11.1\ N/C$

4) a) The magnetic flux is defined as the strength of magnetic field represented by lines of force. It is usually represented by the symbol ϕ

b) $m = 9.11 \times 10^{-31}\ kg$

$r = 1.4 \times 10^{-7} m$

$B = 3.5 \times 10^{-1}\ T$

$q = 1.6 \times 10^{-19} C$

Linear speed $v = \frac{qBr}{m}$

$= \frac{1.6 \times 10^{-9} \times 0.35 \times 1.4 \times 10^{-7}}{9.11 \times 10^{-31}}$

$= 8605.93\ m/s$

angular speed $(\omega) = \frac{v}{r} = \frac{8605.93}{1.4 \times 10^{-7}} = 6.147 \times 10^{10}\ rad/s$

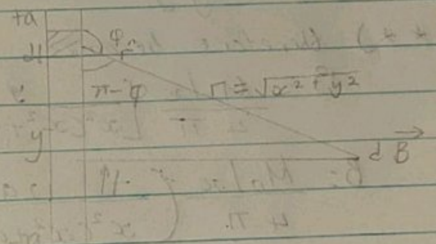
$\therefore$ cycloton frequency $= 6.147 \times 10^{10}\ rad/s$

c The angular speed ω is often referred to as the ~~8~~ cycloton frequency because the charge particule circulates at this angular frequency or angular speed in the type of accelerator called cyclotron. Therefore, the charged particule in the question (electron) has a cyclotron fregency of 6.147 rad/s ~~bas~~ because ~~it~~ it circulates at 6.147 rad/s in the cyclotron.

5) Biot - Savart law states the magnetic field is directly proportional to the product of permeability of free space (μ), the current (I), the change in length, the radius and inversely proportional to the square of radius (r^2). It can be represented mathematically by

$$dB = \frac{\mu_0 \, I \, dl \times r}{4\pi \, r^2}$$

5) Magnetic field of a straight current carrying conductor



Applying the Biot - Savart laws we find the magnitude of the 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, $r^2 = x^2 + y^2$

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

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

Substituting (**) into (*), we have

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

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

Recall $dl = dy$

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

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

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 (***) therefore becomes

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

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

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

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

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

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

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

$B = \frac{M_o I}{2\pi r}$ (#) Equation (#) defines the magnitude of the magnetic field of flux density B near a long straight current carrying.

Scanned by CamScanner

1) a) Charging by induction

Consider a negatively charged rubber rod brought near the neutral conducting sphere which is insulated so that there is no conducting path to ground asshown below. 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. 1.3a). The region of the sphere nearest the negatively charged rod has an excess of positive charge because of the migration of electrons away from this location. If a grounded conducting wire is then connected to the sphere, as in (fig. 1.3b), some of the electrons leave the sphere and travel to the earth. If the wire to the ground is then removed (fig 1.3c), the conducting sphere is left with an excess of induced positive charge.

Finally, when the rubber rod is removed from the vicinity of the sphere (fig 1.3d), the positive charge still remains on the ungrounded sphere and becomes uniformly distributed over the surface of the sphere.

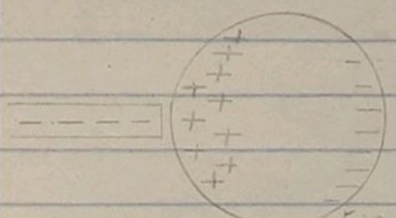


Fig. 1.3a

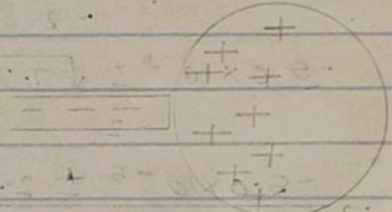


Fig 1.3c

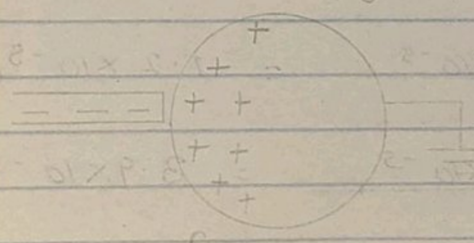


fig 1.3b

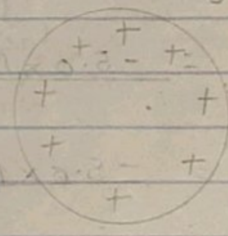


fig 1.3d

1b) $K = 9 \times 10^{9}\ Nm^{2}C^{2}$

$F = 1.0N$

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

$r = 2.0m$

$F = \frac{Kq_1 q_2}{r^2}$

$1 = \frac{(9\times10^{9})q_1 \cdot q_2}{4}$

$4 = 9\times10^{9} q_1 q_2$

$4.44\times10^{-10} = q_1 q_2$

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

$q_1 \cdot q_2 = 4.4\times10^{-10}$

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

$(5.0\times10^{-5} - q_2)\,q_2 = 4.44\times10^{-10}$

$5.0\times10^{-5} q_2 - q_2^{2} = 4.44\times10^{-10}$

$\therefore\ \cancel{5\times10}\ -q^2 + 5.0\times10^{-5} q - 4.44\times10^{-10}$

Using formula method

$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $\quad a = -1$, $b = 5.0\times10^{-5}$, $c = -4.44\times10^{-10}$

$= \frac{-5.0\times10^{-5} \pm \sqrt{2.5\times10^{-9} - 4(-1)(-4.44\times10^{-10})}}{-2}$

$= \frac{-5.0\times10^{-5} \pm \sqrt{2.5\times10^{-9} - 1.776\times10^{-9}}}{-2}$

$= \frac{-5.0\times10^{-5} \pm \sqrt{7.24\times10^{-10}}}{-2}$

$= \frac{-5.0\times10^{-5} \pm 2.7\times10^{-5}}{-2}$

$q_1 = \frac{-5.0\times10^{-5} + 2.7\times10^{-5}}{-2} = 1.2\times10^{-5}C$

$q_2 = \frac{-5.0\times10^{-5} - 2.7\times10^{-5}}{-2} = 3.9\times10^{-5}C$

1c $Q_1 = Q_2 = 8\,\mu C = 8 \times 10^{-6} C$

$d = 0.5m$

∴

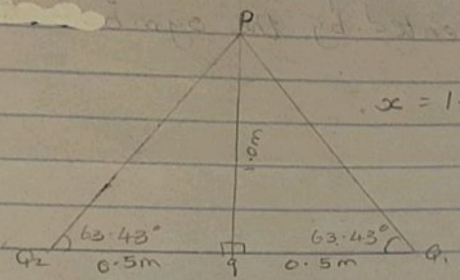
$x^2 = 1^2 + 0.5^2$

$x^2 = 1 + 0.25$

$x^2 = 1.25$

$x = \sqrt{1.25}$

$= 1.12$



$E_1 = \frac{Kq}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-6}}{1.12^2} = 5.74 \times 10^4\ N/C$

$E_2 = 5.74 \times 10^4\ N/C$

$E_3 = \frac{9 \times 10^9 \times q}{1.0^2} = 9 \times 10^9 q$

Vector	Angle	x-component	y-component
E_1	63.43°	2.57×10^4	-5.13×10^4
E_2	63.43°	-2.57×10^4	-5.13×10^4
E_3	90°	0	$9 \times 10^9 q$

$\Sigma E_x = 0$ $\Sigma E_y = -1.02 \times 10^5 + 9 \times 10^9 q$

$E_{net} = \sqrt{(\Sigma E_x)^2 + (\Sigma E_y)^2}$

$0 = \sqrt{0^2 + (-1.02 \times 10^5 + 9 \times 10^9 q)^2}$

$0 = -1.02 \times 10^5 + 9 \times 10^9 q$

$1.02 \times 10^5 = 9 \times 10^9 q$

$q = 1.13 \times 10^{-5}$

$= 11.3 \times 10^{-6} C$