YOUGHA PRAISE
19/MHS01/441
MBBS

32 Electric field is a ~~property~~ region of space around an electrically charged particle in which an electric charge would feel force

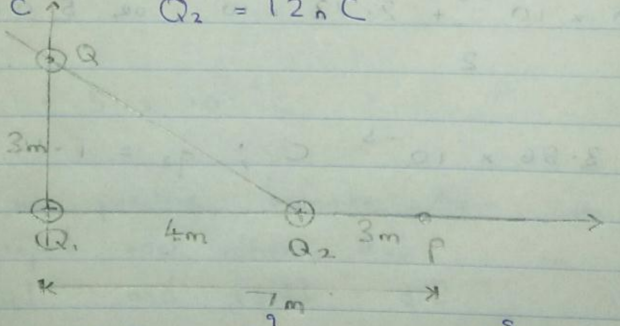
ii The magnitude of electric field is given by

$$E = F/q$$

where E = electric field strength
F = electric force
q = the test charge being used to feel the electric field

iii Electric field intensity measures the strength of an electric field at any point

b $Q_1 = 8nC$ $Q_2 = 12nC$



$$E_1 = \frac{KQ_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{7^2} = \frac{72}{49}$$

$$= 1.469\ N/C \simeq 1.5\ N/C$$

$$E_2 = \frac{KQ_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{3^2} = \frac{108}{9} = 12\ N/C$$

Vector	Angle	x - Component	Y - Component
$E_1 = 1.5$	0°	$= 1.5 \cos 0$ $= 1.5 N/C$	$= 1.5 \sin 0$ $= 0 N/C$

$E_2 = 12\ N/C \quad 0°$ $\qquad E_2 = 12 \cos 0 \qquad = 12 \sin 0$

$= 12\ N/C \qquad\qquad = 0\ N/C$

$\Sigma E_x = 13.5 \qquad \Sigma E_y = 0$

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

$= \sqrt{13.5^2 + 0^2}$

$= \sqrt{182.25}$

$= 13.5\ N/C$

ii $E_1 = \frac{kQ_1}{r^2} = \frac{9 \times 10^9 \times 8 \times 10^{-9}}{3^2} = \frac{72}{9} = 8\ N/C$

$E_2 = \frac{kQ_2}{r^2} = \frac{9 \times 10^9 \times 12 \times 10^{-9}}{5^2} = \frac{108}{25} = 4.32\ N/C$

Vector	Angle	x - Component	Y - component
$E_1 = 8\ N/C$	$90°$	$E_1 = 8 \cos 90$ $= 0$	$E_1 = 8 \sin 90$ $= 8\ N/C$
$E_2 = 4.32\ N/C$	$36.86°$	$E_2 = 4.32 \cos 36.86$ $E_2 = 3.45\ N/C$	$E_2 = 4.32 \sin 36.86$ $= 2.59$

$E_{Ex} = 3.45\ N/C \qquad E_{Ey} = 10.59\ N/C$

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

$= \sqrt{11.9 + 112.14}$

$= \sqrt{124.04}$

$= 11.13\ N/C$

3 Volume charge density, $\rho = \frac{dQ}{dv} \longrightarrow dQ = \rho dv$

ii Surface charge density, $\sigma = \frac{dQ}{dA} \longrightarrow dQ = \sigma dA$

iii Linear charge density, $\lambda = \frac{dQ}{d_L} \longrightarrow dQ = \lambda dL$

where

Q = charge, V = Volume, L = length, A = Area

b Electric potential difference b/w two points in an electric field can be defined as the work done per unit charge against electrical forces when a charge is transferred from one point to the other.

It is measured in Volt or Joule per coloumb and it is a scalar quantity

$$V = \text{Work done} / \text{Charge}$$

$$\text{Workdone} = q \times V$$

c

$$V_p = k\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

$$V_p = 9 \times 10^9 \left[\frac{10 \times 10^{-6}}{4 + x} + \frac{-2 \times 10^{-6}}{x}\right]$$

$$0 = 9 \times 10^9 \left[\frac{10 \times 10^{-6}}{4 + x} + \frac{-2 \times 10^{-6}}{x}\right]$$

$$0 = \frac{10 \times 10^{-6}}{4 + x} + \frac{(-2 \times 10^{-6})}{x}$$

$$= (10 \times 10^{-6})\, x = (4 + x)(-2 \times 10^{-6})$$

$$= 8 \times 10^{-6} = 10 \times 10^{-6} x - 2 \times 10^{-6} x$$

$$x = \frac{8 \times 10^{-6}}{8 \times 10^{-6}}$$

$$x = 1$$

$\therefore$ position along the x-axis is 1m

Where $V = Q$

$$V = k\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$$

$$0 = \left[\frac{10 \times 10^{-6}}{4 - x} + - \frac{2 \times 10^{-6}}{x}\right]$$

$$= \frac{2 \times 10^{-6}}{x} = \frac{10 \times 10^{-6}}{4 - x}$$

$$(4 - x)(2 \times 10^{-6}) = (10 \times 10^{-6})\, x$$

$$8 \times 10^{-6} - 2 \times 10^{-6} x = 10 \times 10^{-6} x$$

$$x = \frac{8 \times 10^{-6}}{\overset{2}{1\cancel{0}} \times 10^{-6}} = 0.67\text{m}$$

$\therefore$ position of $V = 0.67$m

SECTION B

4 Magnetic Flux is defined as the number of magnetic field lines passing through a given closed surface

$$\Phi_B = B \cdot A = BA \cos\theta$$

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

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

$B = 3.5 \times 10^{-1}$ Weber/m^2

Cycloton frequency = Angular speed

$q = 1.6 \times 10^{-9}$

$$F_B = qVB = \frac{M_e V^2}{r}$$

$$M_e V = qBr$$

$$V = \frac{qBr}{M_e}$$

$$= \frac{1.6 \times 10^{-19} \times 3.5 \times 10^{-1} \times 1.4 \times 10^{-7}}{9.11 \times 10^{-31}}$$

$$= \frac{7.84 \times 10^{-27}}{9.11 \times 10^{-31}}$$

$$= 8605.9 \simeq 8.61 \times 10^{3}\ m/s$$

$$W = V/r = \frac{qB}{M_e} = \frac{1.6 \times 10^{-19} \times 3.6 \times 10^{-4}}{9.11 \times 10^{-31}}$$

$$= 6.14 \times 10^{10}\ e^{-1}$$

c In 4b, We were given parameters

Mass of an electron $= 9.11 \times 10^{-31}$ kg

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

B $= 3.5 \times 10^{-1}$ Weber/m^2

It is cycloton frequency because, it is the frequency of an acceleration which is called 'CYCLOTON'

Recall w = Angular speed

$$= \frac{qB}{M_E}$$

Since cycle from frequency = Angular speed

The cycloton frequency $= 6.4 \times 10^{10} e^{-1}$ having a unit of $1/T$ which is the unit of frequency dimensionally.

5a Biot - Savart law states ~~that~~ an equation that describes the ~~magnitude~~ magnetic field erected by a current - carrying wire and allows you to calculate its strength at various points

6 Magnetic field of a straigt current carrying conductor

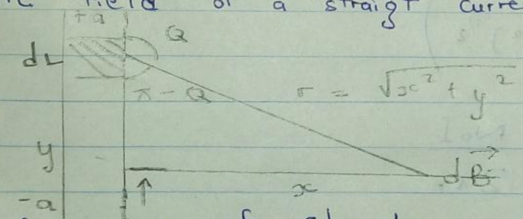


Fig: A section of straigt current carrying conductor

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

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

$$\sin(\pi - 4) = \sin\theta$$

$$B = \frac{N_o I}{4\pi} \int_{-a}^{a} \frac{dl \sin(\pi - 4)}{r^2} \quad \text{--- (i)}$$

From the diagram $r^2 = x^2 + y^2$

But $\sin(\pi - 4) = \dfrac{x}{\sqrt{x^2+y^2}} = \dfrac{x}{(x^2+y^2)^{1/2}}$ — (ii)

Substitute (ii) into (i)

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

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

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

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

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

$$B = \frac{N_o I}{2\pi x} = \frac{N_o I}{2\pi r}$$