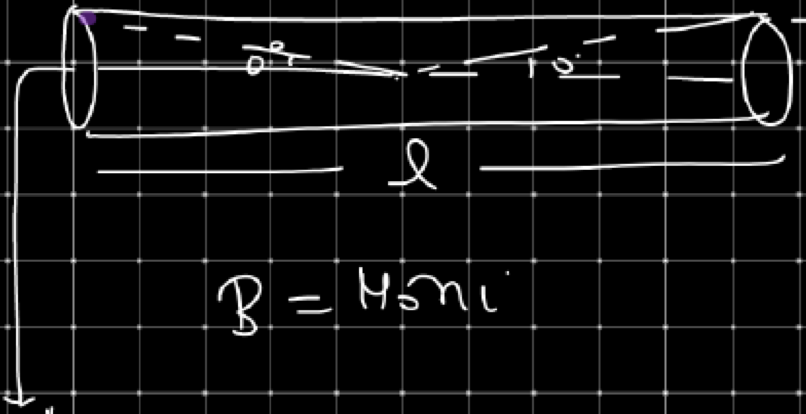
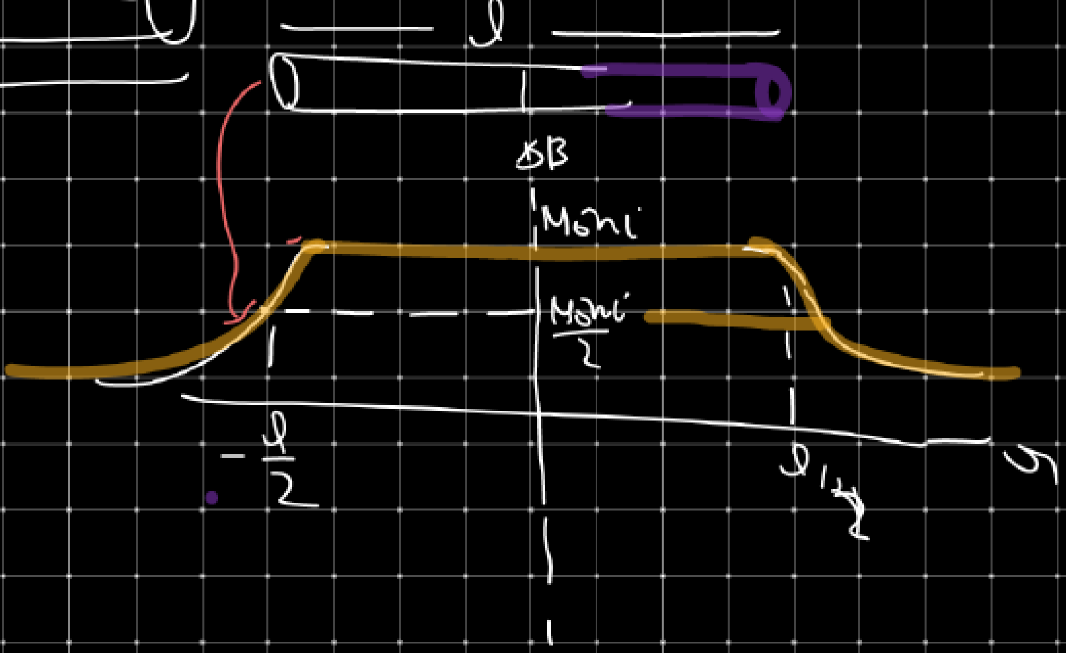
$r << l$



$B = \mu_0 n i$

$\frac{\mu_0 n i}{2}$



Q1: Magnetic field at inside of a solenoid having 10000 turn & length of solenoid is 5m & radius is 2mm. [current in wire of solenoid is 2A]

[Infinite $r << l$]
$(2\times10^{-3}m << 5m)$

$[B = \mu_0 n i]$

Solve:

$$B = \mu_0 n i$$

$$= 4\pi\times10^{-7}\times2\times10^{3}\times2$$

$$n = \frac{N}{l} = \frac{10000}{5} = 16\pi\times10^{-4}\ \text{Tesla}$$

$= 2000$
$= 2\times10^{3}$

$$\frac{\mu_0}{4\pi} = 10^{-7}\ \frac{T\text{-}m}{A}$$

$$\mu_0 = 4\pi\times10^{-7}$$

$$B = \frac{\mu_0}{4\pi}\frac{i\,dl\sin\theta}{r^2}$$

$$\frac{\mu_0}{4\pi} = 10^{-7}\ \frac{\text{Tesla-m}}{\text{Amp}}$$

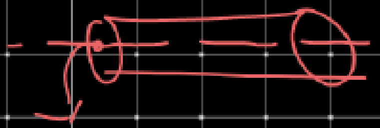
Q2) A solenoid having 1000 turn per unit length & length of solenoid is 10m & current in wire is ___ 2Amp. find. find magnetic field just outside on the axis of solenoid

OR magnetic field at end of solenoid. [having radius 2mm]

Sol

Sol) $n = 10^3$

$n = \frac{N}{l}$



$\frac{\mu_0 n i}{2}$

$l = 10m$ $\quad$ $10m >> 2mm$

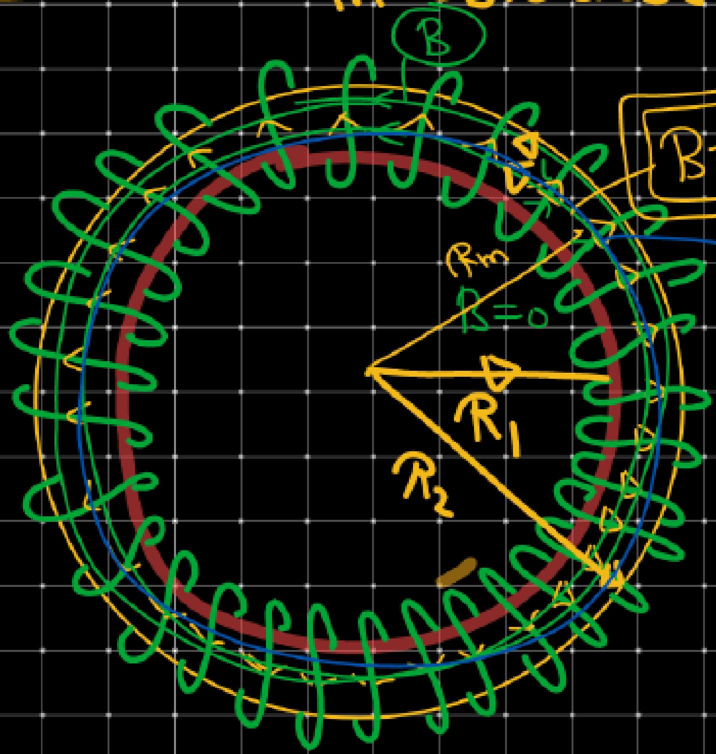
$B = \frac{\mu_0 n i}{2} = \frac{4\pi \times 10^{-7} \times 10^3 \times 2}{2}$

$= 4\pi \times 10^{-4}$ Tesla

Use of Solenoid :-

With help of solenoid, we find Uniform magnetic field inside the solenoid.

Toroid :- It produce uniform magnetic field in circular form



$l_n = Ni$

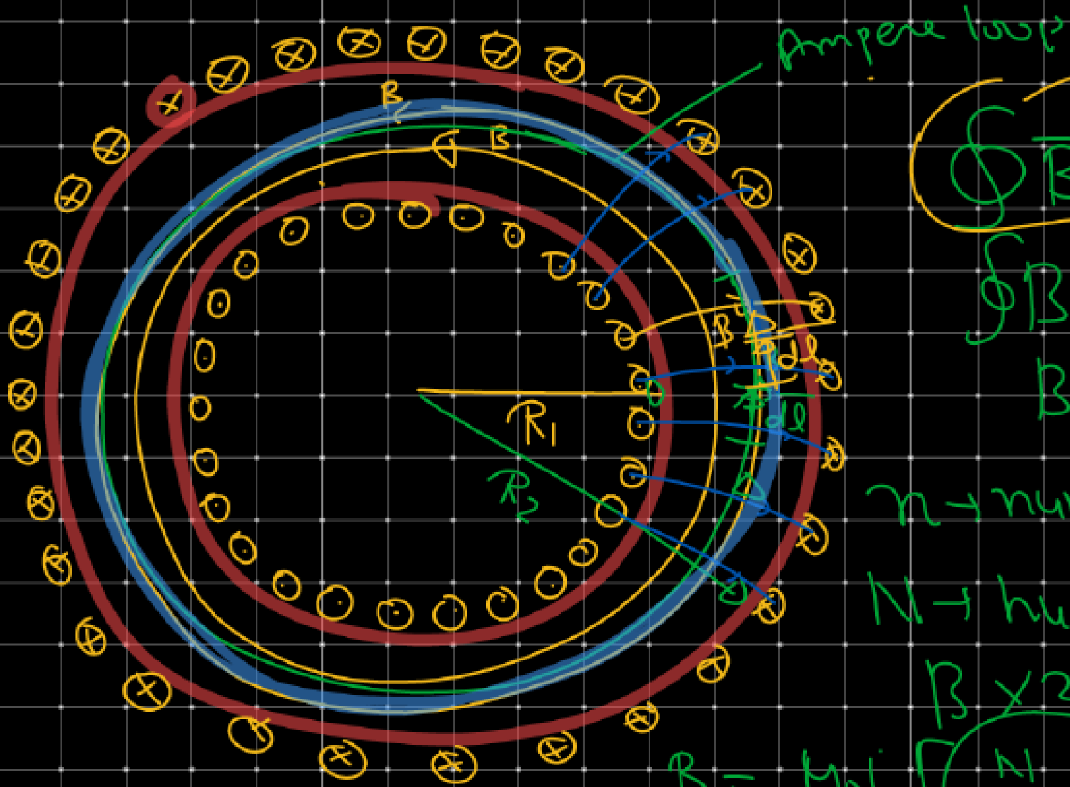
$$R_{mean} = \frac{R_1 + R_2}{2}$$

$$R_m = \frac{R_1 + R_2}{2}$$

N → number of turn.

n = number of turn per unit length

$$n = \frac{N}{2\pi R_m}$$



$$\oint \vec{B} \cdot \vec{dl} = \mu_0 i_{in}$$

$$B = \mu_0 n i$$

$$\oint B \, dl \cos 0 = \mu_0 i_{in}$$

$$B \times 2\pi R_m = \mu_0 N i$$

$n \to$ number of turn / length

$N \to$ number of turn

$$B \times 2\pi R_m = \mu_0 i N$$

$$B = \mu_0 i \left[\frac{N}{2\pi R_m} \right] \to n$$

$$B = \mu_0 n i$$

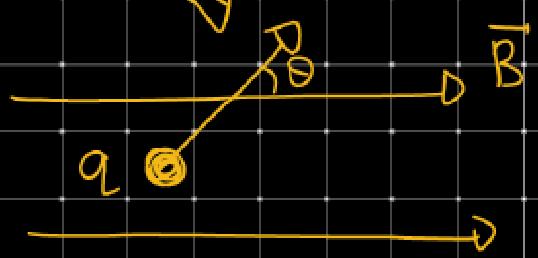
When a charge at rest it produce Electric field.

⟹ When a charge move with constant velocity it produce magnetic & electric field

⟹ When a charge accelerate, deaccelerate or Oscilate, it produce, Electric field, magnetic field as well as E.M.W.

⇒ Magnetic force:-

When a charge move in uniform magnetic field, it experience a force, which is called magnetic force & is equal to $\vec{F}_m = q(\vec{v} \times \vec{B})$



magnetic force on charge

$$\vec{F}_m = q\,vB\sin\theta\,\hat{n}$$

$$\vec{F}_m = q(\vec{v} \times \vec{B})$$

#

A charge of 2C move in magnetic field: $\vec{B} = (2\hat{i} + 3\hat{j} + 2\hat{k})\,T$, with velocity of $\bar{v} = (3\hat{i} - 2\hat{j} + \hat{k})\,m/s$

Find Magnetic force on charge particle.

$\bar{F}_m = q\left[\bar{v} \times \bar{B}\right]$

$\bar{v} \times \bar{B} = ?$

$\bar{v} \times \bar{B} = -7\hat{i} - 4\hat{j} + 13\hat{k}$

$\bar{F}_m = q\left[\bar{v} \times \bar{B}\right]$

$\bar{F}_m = 2\left(-7\hat{i} - 4\hat{j} + 13\hat{k}\right)$

$$\boxed{\bar{F}_m = \left(-14\hat{i} - 8\hat{j} + 26\hat{k}\right) N}$$

$$\bar{F}_m = q\left[\bar{v} \times \bar{B}\right]$$

$$\bar{B} = 2i + 3j + 2k$$

$$\bar{v} = 3i - 2j + k$$

$$\bar{v} \times \bar{B} = \begin{vmatrix} i & j & k \\ 3 & -2 & 1 \\ 2 & 3 & 2 \end{vmatrix} = i\begin{vmatrix} -2 & 1 \\ 3 & 2 \end{vmatrix} - j\begin{vmatrix} 3 & 1 \\ 2 & 2 \end{vmatrix} + k\begin{vmatrix} 3 & -2 \\ 2 & 3 \end{vmatrix}$$

$$= i\left[(-2\times 2) - (3\times 1)\right] - j\left[(3\times 2) - (2\times 1)\right] + k\left[(3\times 3) - (2\times -2)\right]$$

$$= i\left[-4-3\right] - j\left[6-2\right] + k\left[9+4\right]$$

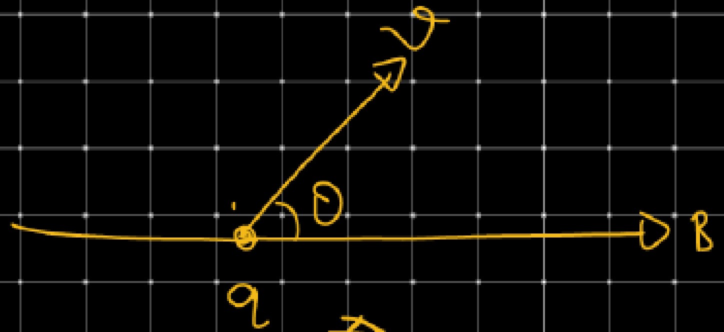
$$\bar{v} \times \bar{B} = -7i - 4j + 13k$$

$$\Rightarrow \quad \vec{F}_m = q[\vec{v} \times \vec{B}]$$

$$\boxed{\vec{F}_m \perp \vec{v}}$$

$$\boxed{\vec{F}_m \perp \vec{B}}$$

To find dirn of force using right hand rule.



$\vec{F}_m \perp \otimes$

* $\vec{F}_m = q[\vec{v} \times \vec{B}]$

$\vec{F}_m \perp \vec{v}$ & $\vec{F}_m \perp \vec{B}$

↳ Power $P = \vec{F} \cdot \vec{v}$

$P = 0$

↳ $W = 0$ $\quad \vec{F}_m \perp \vec{v}$

$\vec{F}_m \perp \vec{S}$

$W = \vec{F}_m \cdot \vec{S} = 0$

Power delivered by charge in magnetic field is zero.

$\bar{P} = 0$

$\vec{F} \perp \vec{v}$

$\vec{F} \perp \vec{B}$

$\vec{F} \perp \vec{S}$

$\Rightarrow \vec{F} \cdot \vec{v} = 0$

$\Rightarrow \vec{F} \cdot \vec{B} = 0$

$\vec{F} \cdot \vec{S} = 0$

Q1) A Charge particle move in magnetic field $\vec{B} = (2i + 3j + k)$ T & magnetic force on charge is $\vec{F}_m = (2i - 3j + \alpha k)$ N then find the Value of α.

Sol)

$\vec{B} = (2i + 3j + 1k)$ T

$\vec{F}_m = (2i - 3j + \alpha k)$ N

$\vec{F}_m \perp \vec{B}$

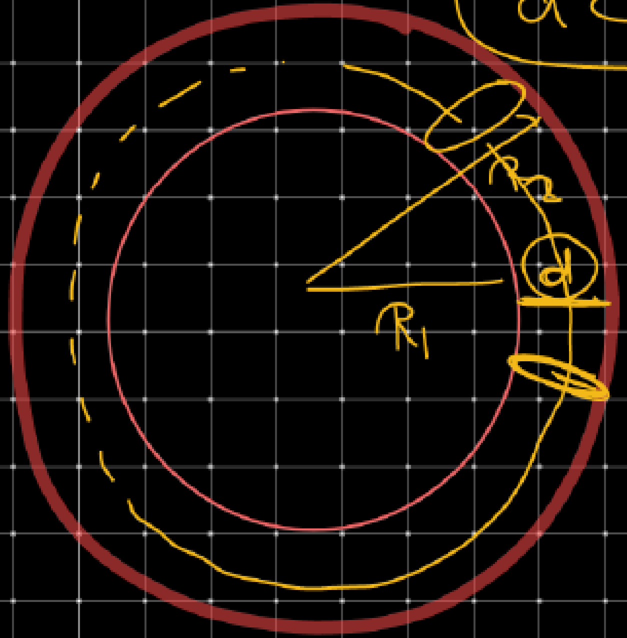
$\vec{F}_m \cdot \vec{B} = 0$

$(2i - 3j + \alpha k) \cdot (2i + 3j + 1k) = 0$

$4 - 9 + \alpha = 0$

$-5 + \alpha = 0$

$\boxed{\alpha = 5}$



$$d << R_1$$
$$d << R_2$$

$$2\pi R_1$$
$$2\pi R_2$$

$$R_{mean} = \frac{R_1 + R_2}{2}$$

$$L = 2\pi R_m$$

N

$$n = \frac{N}{2\pi R_m}$$