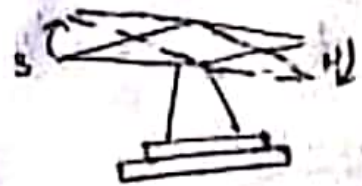
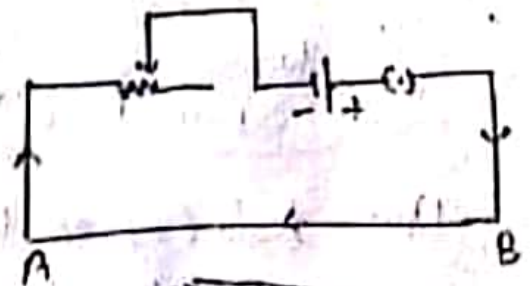
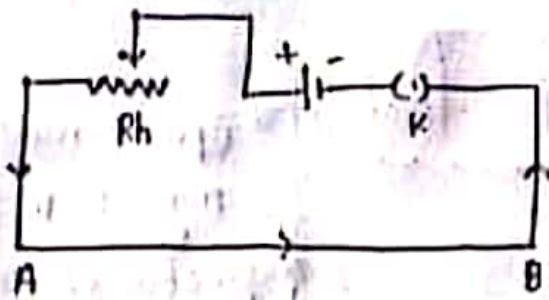


⇒ Magnetic effect of current & Magnetism ⇐

### Oersted's Experiment :-

Take a magnetic needle NS, which can rotate freely about a vertical axis. Hold a conducting wire AB parallel to it.



After closing key, it will be found that the N-pole of the magnetic needle gets deflected towards the west. If the direction of current in the wire is reversed (B to A), the north pole of magnetic needle gets deflected towards east. Since magnetic needle can be deflected only by another magnetic field it means the current in the wire must producing a magnetic field.

Maxwell's Ampere's Swimming Rule :- "Acc. to this rule, if we imagine a man swimming along the wire in the direction of current so that current enters through his feet and leaves at his head, then the N-pole of the magnetic needle will be deflected towards his left hand."

Trick :- SNOW  $\Rightarrow$  [Note: South to North in a wire over the magnetic needle, the N-pole is deflected towards West]

Physics by :-  
Pankaj Sharma

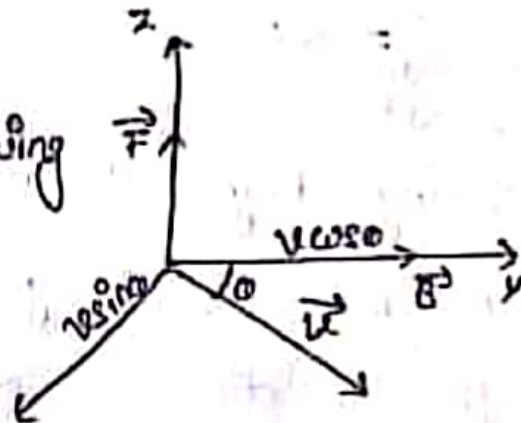
Magnetic field

space around magnet in which magnetic effect can be experienced

Unit - tesla (T) OR  $W/m^2$   
D.F.  $[M^1 A^{-1} T^{-2}]$

Expression :-

Consider a positive charge 'q' moving in a uniform magnetic field  $\vec{B}$  with a velocity  $\vec{v}$ . Let



the angle b/w  $\vec{v}$  and  $\vec{B}$  be ' $\theta$ '.

Experimentally it has been found that the mag. of force  $\vec{F}$  experienced by the moving charge

(1) is directly proportional to a

In SI unit  $k = \frac{\mu_0}{4\pi}$  and In CGS system  $k = 1$

$\mu_0 \rightarrow$  absolute magnetic permeability of free space

$$\mu_0 \rightarrow 4\pi \times 10^{-7} \text{ Wb A}^{-1} \text{ m}^{-1}$$

Imp Formulae.

$$dB = \frac{\mu_0}{4\pi} \frac{I dl \sin\theta}{r^2}$$

\* Magnetic field due to a str. wire carrying currents-

Acc. to Biot-Savart's law

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l} \times \vec{r}}{r^3}$$

$$dB = \frac{\mu_0}{4\pi} \frac{I dl \sin\theta}{r^2}$$

In  $\Delta POC$ ,

$$\theta + \phi = 90^\circ$$

$$\theta = 90^\circ - \phi$$

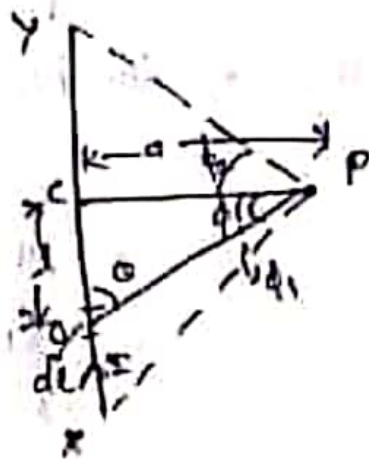
$$\sin\theta = \sin(90^\circ - \phi)$$

$$\sin\theta = \cos\phi$$

$$dB = \frac{\mu_0}{4\pi} \frac{I (a \sec^2 \phi d\phi) \cos\phi}{\left(\frac{a^2}{\cos^2 \phi}\right)}$$

$$dB = \frac{\mu_0}{4\pi} \frac{I}{a} \cos\phi d\phi$$

$$B = \int_{\phi_1}^{\phi_2} \frac{\mu_0}{4\pi} \frac{I}{a} \cos\phi d\phi$$



$$\Rightarrow \cos\phi = \frac{a}{r}$$

$$\therefore r = \frac{a}{\cos\phi}$$

$$\Rightarrow \tan\phi = \frac{l}{a}$$

$$l = a \tan\phi$$

$$dl = a \sec^2 \phi d\phi$$

$$B = \frac{\mu_0 I}{4\pi a} (\sin\phi_1 + \sin\phi_2)$$

⇒ Sp. Case ① when  $\phi_1 = \phi_2 = 90^\circ$

$$B = \frac{\mu_0 I}{2\pi a}$$

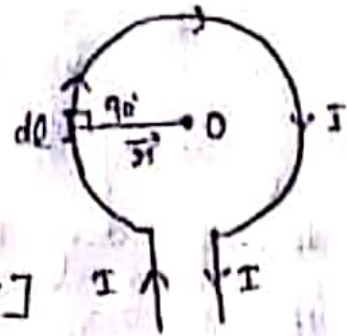
② when  $\phi_1 = 90^\circ, \phi_2 = 0^\circ$

$$B = \frac{\mu_0 I}{4\pi a}$$

\* Magnetic field at the centre of the circular coil carrying current :-

Acc. to Biot-Savart's law

$$dB = \frac{\mu_0 I dl \sin\theta}{4\pi r^2} \quad \text{--- (1)}$$



$$dB = \frac{\mu_0 I dl}{4\pi r^2} \quad [\theta = 90^\circ]$$

Integrating both sides

$$B = \int \frac{\mu_0 I dl}{4\pi r^2} = \frac{\mu_0 I}{4\pi r^2} \int dl$$

$$B = \frac{\mu_0}{4\pi} \times \frac{I}{r^2} \times 2\pi r = \frac{\mu_0}{4\pi} \times \frac{2\pi I}{r}$$

If the circular coil consist of 'n' turns, then

$$B = \frac{\mu_0}{4\pi} \times \frac{2\pi n I}{r}$$

\* Magnetic field at a point on the axis of a circular coil carrying current :-

Acc. to Biot-Savart's law, the magnitude of magnetic field induction at point P, due to current element at c is given by