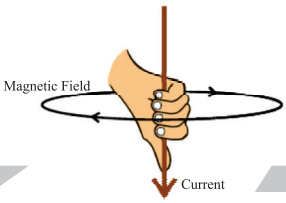


Chapter - 13

Magnetic Effects Of Electric Current

Magnet is any substance that attracts iron or iron-like substances.

Properties of Magnet

(i) Every magnet has two poles *i.e.,* North and South.

(ii) Like poles repel each other.

(iii) Unlike poles attract each other.

(iv) A freely suspended bar magnet aligns itself in nearly north-south direction, with its north pole towards north direction.

Magnetic Field : The area around a magnetic in which its magnetic force can be experienced.

- Its SI unit is Tesla (T).
- Magnetic field has both magnitude and direction.
- Magnetic field can be described with help of a magnetic compass.
- The needle of a magnetic compass is a freely suspended bar magnet.

Characteristics of Field Lines

(i) Field lines arise from North pole and end into South pole of the magnet.

(ii) Field lines are closed curves.

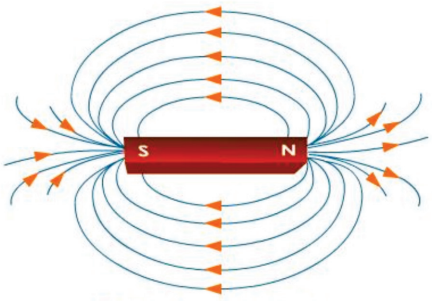
(iii) Field lines are closer in stronger magnetic field.

(iv) Field lines never intersect each other as for two lines to intersect, there must be two north directions at a point, which is not possible.

(v) Direction of field lines inside a magnet is from South to North.

(vi) The relative strength of magnetic field is shown by degree of closeness of field lines.

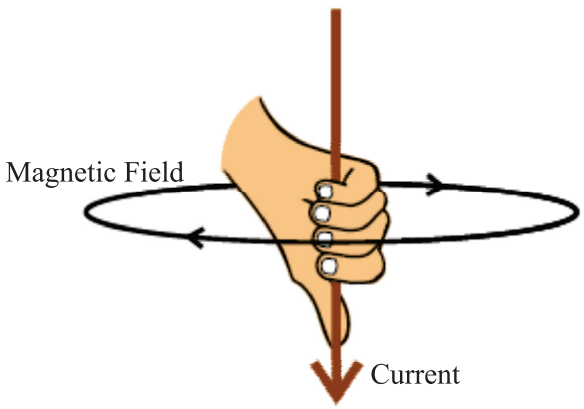
Magnetic Field of a Bar Magnet



- H. C. Oersted was the first person to state that electric current has magnetic field.

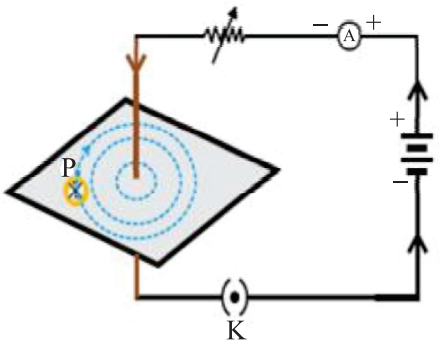
Right Hand Thumb Rule

Imagine you are holding a current carrying straight conductor in your right hand such that the thumb is pointing towards the direction of current. Then the fingers wrapped around the conductor give the direction of magnetic field.



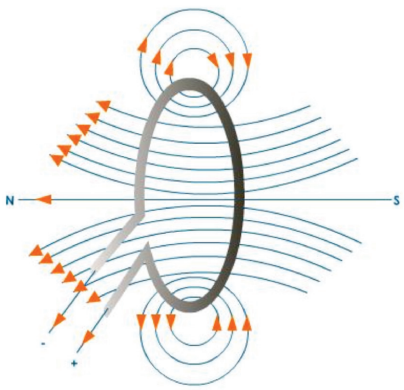
Magnetic Field Due to Current Through a Straight Conductor

- It can be represented by concentric circles at every point on conductor.
- Direction can be given by right hand thumb rule or compass.
- Circles are closer near the conductor.
- Magnetic field Strength of current
- $\text{Magnetic field} \propto \frac{1}{\text{Distance from conductor}}$



Magnetic Field Due to Current Through a Circular Loop

- It can be represented by concentric circle at every point.
- Circles become larger and larger as we move away.
- Every point on wire carrying current would give rise to magnetic field appearing as straight line at centre of the loop.
- The direction of magnetic field inside the loop is same.



Factors affecting magnetic field of a circular current carrying conductor

- Magnetic field Current passing through the conductor
- Magnetic field $\propto \frac{1}{\text{Distance from conductor}}$
- Magnetic field No. of turns in the coil

Magnetic field is additive in nature *i.e.,* magnetic field of one loop adds up to magnetic field of another loop. This is because the current in each circular turn has some direction.

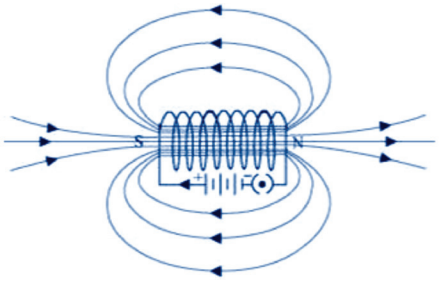
Solenoid

A coil of many circular turns of insulated copper wire wrapped closely in a cylindrical form.

- Magnetic field of a solenoid is similar to that of a bar magnet.
- Magnetic field is uniform inside the solenoid and represented by parallel field lines.
- Direction of magnetic field

  (i) Outside the solenoid : North to South

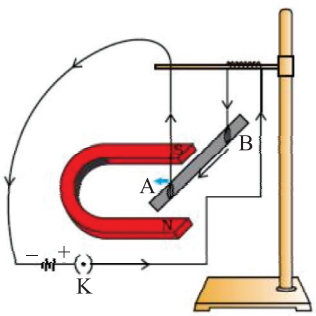
  (ii) Inside the solenoid : South to North
- Solenoid can be used to magnetise a magnetic material like soft iron.



Electromagnet	Permanent Magnet
1. It is a temporary magnet, so, can be easily demagnetised.	1. Cannot be easily demagnetised.
2. Strength can be varied.	2. Strength is fixed.
3. Polarity can be reversed.	3. Polarity cannot be reversed.
4. Generally strong magnet.	4. Generally weak magnet.

Force on a Current carrying Conductor in a Magnetic Field

Andre Marie Ampere suggested that the magnet also exerts an equal and opposite force on a current carrying conductor.

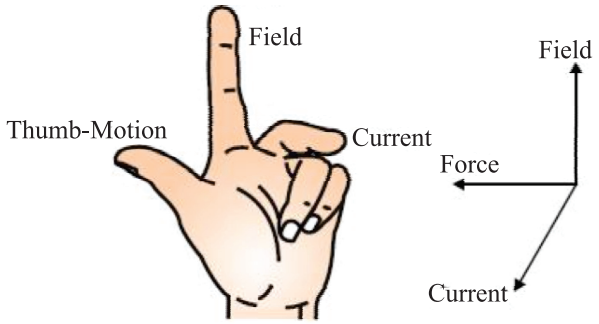


The displacement in the conductor is the maximum when the direction of current is at right angle to the direction of magnetic field.

Direction of force is reversed on reversing the direction of current.

Fleming's Left Hand Rule

Stretch the thumb, fore finger and middle finger of your left hand such that they are mutually perpendicular. If fore finger points in the direction of magnetic field, middle finger in the direction of current then thumb will point in the direction of motion or force.



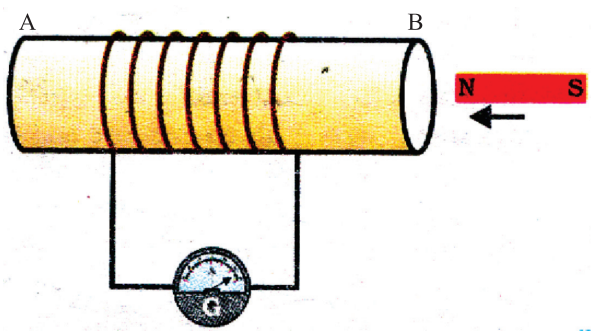
- Heart and brain in the human body have significant magnetic field.
- **MRI (Magnetic Resonance Imaging) :** Image of internal organs of body can be obtained using magnetic field of the organ.

Galvanometer : Instrument that can detect the presence of current in a circuit. It also detects the direction of current.

Electro Magnetic Induction

When a conductor is placed in a changing magnetic field, some current is induced in it. Such current is called induced current and the phenomenon is called electromagnetic induction.

Activity No. 1

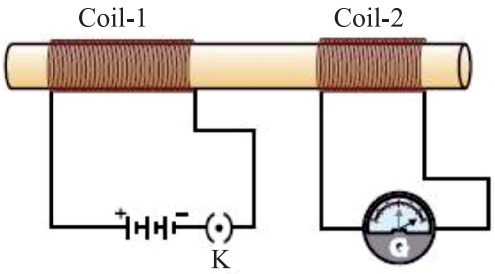


(i) **Magnet moved into the coil :** Momentary deflection in G indicating presence of current.

(ii) **Magnet kept stationary inside the coil :** No deflection.

(iii)**Magnet is withdrawn :** Momentary deflection in G but in opposite direction of first case.

Activity No. 2



Primary Coil **Secondary Coil**

(i) **Switched on :** Momentary deflection in G.

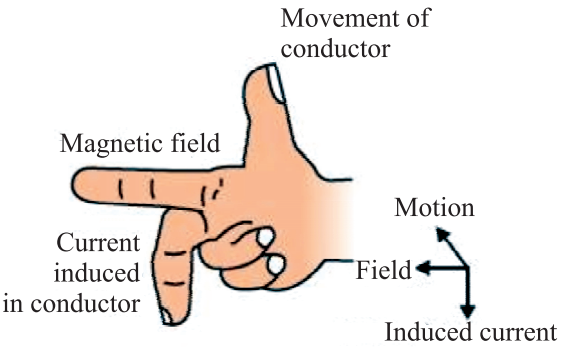
(ii) **Steady current :** No deflection.

(iii)**Switched off :** Momentary deflection in G but in opposite direction of the first case.

Fleming's Right Hand Rule

Hold the thumb, the fore finger and the middle finger of right hand at right angles to each other. If the fore finger is in the direction of magnetic field and the thumb points in the direction of motion of conductor, then the direction of induced current is indicated by middle finger.

- Working principle of electric generator.
- Used to find direction of induced current.



Alternate Current (A. C.) : The current which reverses its direction periodically.

- In India, A. C. reverses its direction in every $\frac{1}{100}$ second.

$$\text{Time period} = \frac{1}{100} + \frac{1}{100} = \frac{1}{50}\text{s}$$

$$\text{Frequency} = \frac{1}{\text{Time period}}$$

$$= \frac{1}{1/50} \qquad 50 \text{ Hz}$$

Advantage

- A. C. can be transmitted over long distance without much loss of energy.

Disadvantage

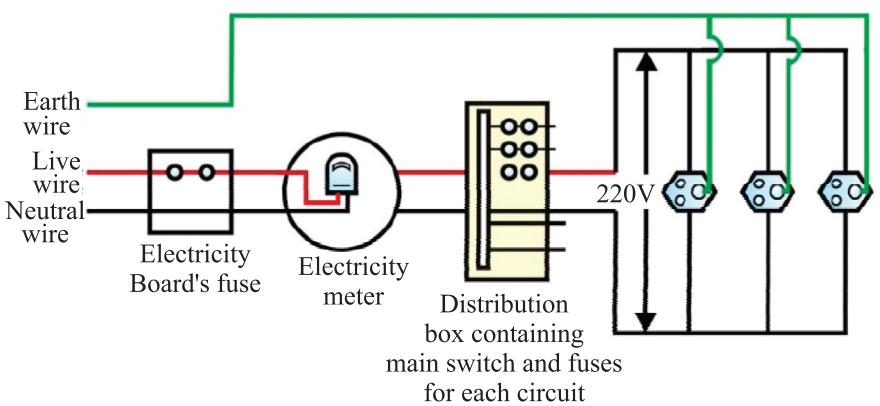
- A. C. cannot be stored.

Direct Current (D. C.) : The current which does not reverse its direction.

- D. C. can be stored.
- Loss of energy during transmission over long distance is high.
- Sources of D. C. : Cell, Battery, Storage cells.

Domestic Electric Circuits

- There are three kinds of wires used :
  (i) Live wire (positive) with red insulation cover.
  (ii) Neutral wire (negative) with black insulation cover.
  (iii)Earth wire with green insulation cover.
- The potential difference between live and neutral wire in India is 220 V.
- Pole Main supply Fuse Electricity meter Distribution box To separate circuits



Earth Wire : Protects us from electric shock in case of leakage of current especially in metallic body appliances. It provides a low resistance path for current in case of leakage of current.

Short Circuit : When live wire comes in direct contact with neutral wire accidently.

- Resistance of circuit becomes low.
- Can result in overloading.

Overloading : When current drawn is more than current carrying capacity of a conductor, it results in overloading.

Causes of overloading :

(i) Accidental hike in voltage supply.

(ii) Use of more than one appliance in a single socket.

Safety devices :

(i) Electric fuse

(ii) Earth wire

(iii)MCB (Miniature Circuit Breaker)

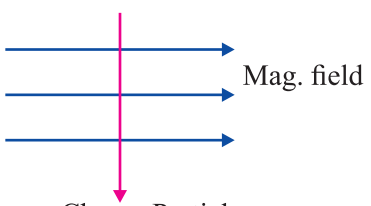
QUESTIONS

VERY SHORT ANSWER TYPE QUESTIONS (1 Mark)

1. Define magnetic field lines.
2. What is the frequency of a.c. in India ?
3. Who discovered the electromagnetic induction ?
4. What is short circuit ?
5. Why does two magnetic field lines not intersect ?

SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. A charged particle enters at right angle into a uniform magnetic field. What is the nature of charge particle if it experiences a force in a direction pointing vertically out of page.



Use Fleming's Left Hand Rule

2. When does short circuit occur ?
3. Write the three ways to produce magnetic field.

4. What is overloading ?
5. Write the use of safety device used in electric circuit.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. What is solenoid ? Where the magnetic field is uniform in solenoid ?
2. Draw the pattern of magnetic field lines due to current carrying straight conductor.
3. What is earth wire ? How it works in our domestic circuit ?

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. What is electromagnetic induction ? Explain with an activity. Write its one application.
2. Draw the schematic diagram of domestic circuit. Write the colour and nature of neutral wire, live wire and earth wire.
3. What is an electromagnet ? What material are used to make electromagnet ? Can we use steel to make electromagnet ?

VALUE BASED QUESTION

In the birthday party of Bharat, his parents gave slinky to each friend as a return gift. The next day during the school, their teacher explained them about the production of magnetic fields using current carrying coils and also said that they can make permanent magnet using such coils by passing high current through them. Teacher also explained the uses of solenoid.

(a) What values did Bharat's parents exhibit towards his son ?

(b) What type of field is produced by solenoid ?

Hints to Long Answer Type Questions

1. The process by which a changing magnetic field in a conductor induces a current in another conductor is called electromagnetic induction.

   See Fig. 15.17 NCERT

2. Refer to given diagram
3. A strong magnetic field produced inside a solenoid can be used to magnetise a piece of magnetic material, like soft iron, when placed inside the coil. The magnet so formed is called an electromagnet.

   Yes, steel can be used to make electromagnet.