

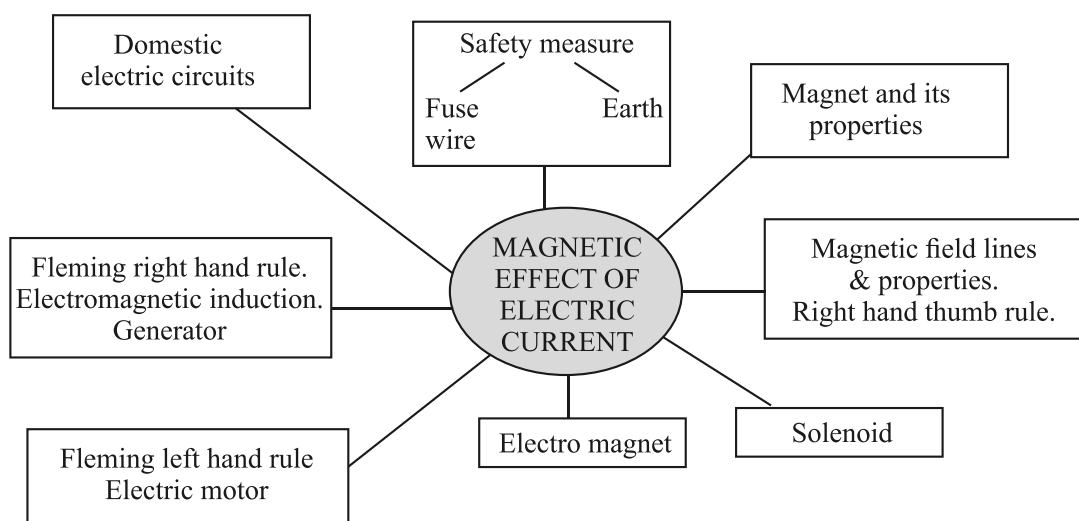
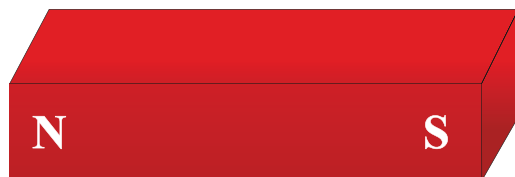
## Chapter -12

# 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.



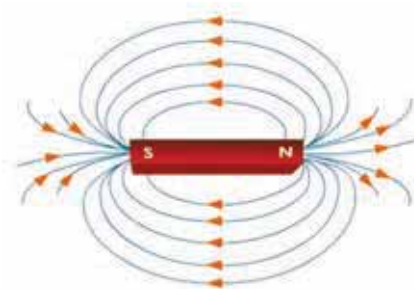
**Magnetic Field :** The area around a magnetic in which its magnetic force can be experienced.

- 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.

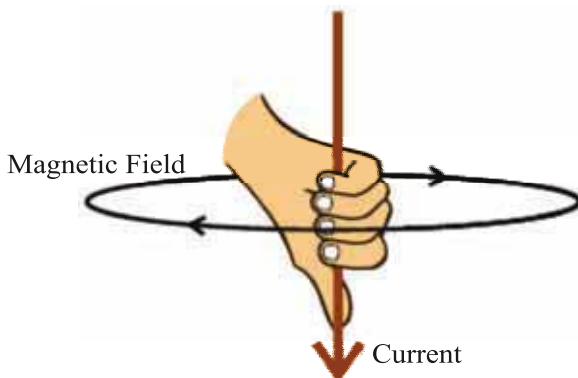
### Magnetic Field of a Bar Magnet



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

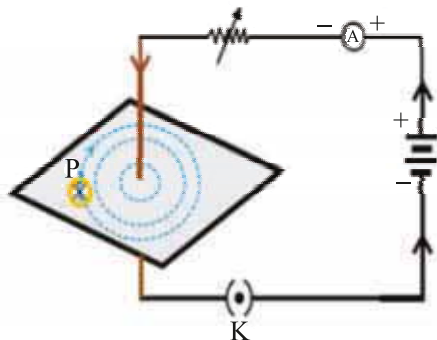
## Right Hand Thumb Rule

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.



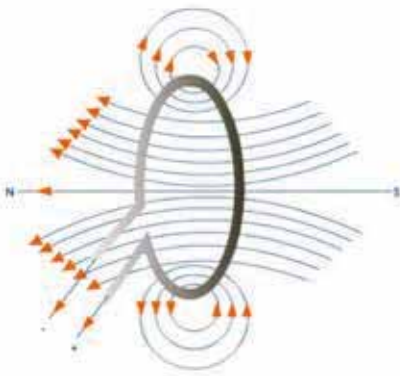
### Magnetic Field Due to Current Through a Straight Conductor

- 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  $\propto$  Strength of current
- Magnetic field  $\propto \frac{1}{\text{Distance from conduction}}$



### 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

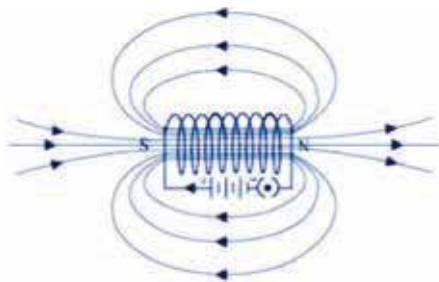
- Magnetic field  $\propto$  Current passing through the conductor
- Magnetic field  $\propto \frac{1}{\text{Distance from conduction}}$
- Magnetic field  $\propto$  No. of turns in the coil

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

1. It is a temporary magnet, so, can be easily demagnetised.
2. Strength can be varied.
3. Polarity can be reversed.
4. Generally strong magnet.

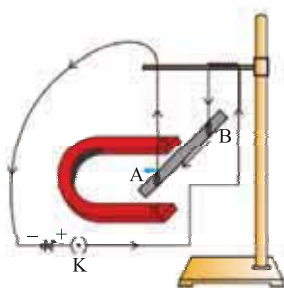


### Permanent Magnet

1. Cannot be easily demagnetised.
2. Strength is fixed.
3. Polarity cannot be reversed.
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.

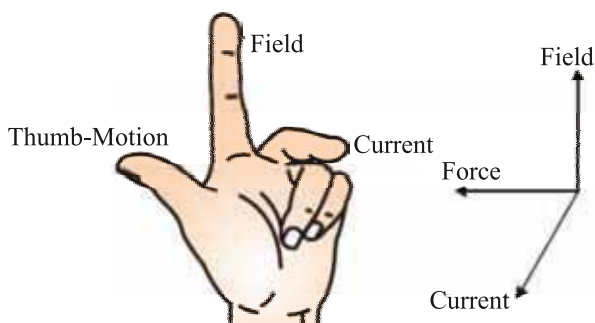


The displacement in the conductor is the maximum when the direction of current is at right angle to the direction of magnetic field.

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

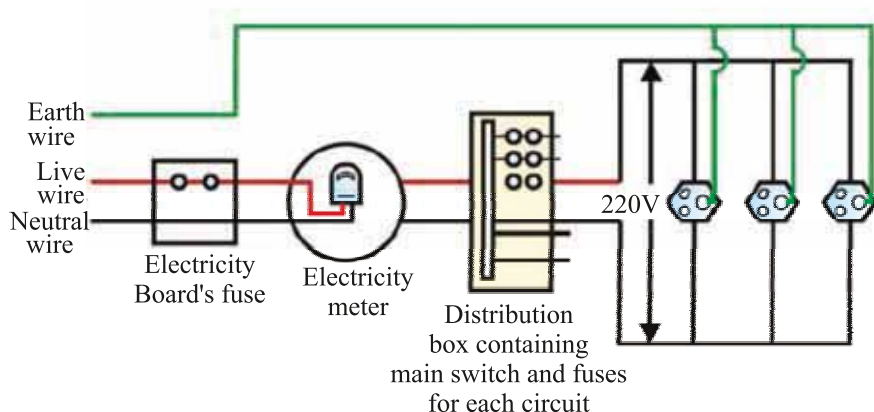
### Fleming's Left Hand Rule

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.



## 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 accidentally.

- 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. Define magnetic field lines.
2. What is the frequency of a.c. in India ?
3. What is short circuit ?
4. Why do two magnetic field lines not intersect ?
5. What should be the core of an electromagnet?
  - a) Soft iron
  - b) Hard iron
  - c) Rusted iron
  - d) None of above
6. Who has stated the Right hand Thumb Rule?
  - a) Oersted
  - b) Fleming
  - c) Einstein
  - d) Maxwell
7. In all the electrical appliances, the switches are put in the
  - a) Live wire
  - b) Earth wire
  - c) Neutral wire
  - d) All of above
8. What is the condition of an electromagnetic induction?
  - a) There must be a relative motion between the coil of wire and galvanometer
  - b) There must be a relative motion between the galvanometer and a magnet
  - c) There must be a relative motion between the galvanometer and generator
  - d) There must be a relative motion between the coil of wire and a magnet
9. No force acts on a current carrying conductor when it is placed—
  - a) Perpendicular to the magnetic field
  - b) Parallel to the magnetic field
  - c) Far away from the magnetic field
  - d) Inside a magnet

10. What is that instrument which can detect the presence of electric current in a circuit?
  - a) Galvanometer
  - b) Motor
  - c) Generator
  - d) None of above
11. Which device produces the electric current?
  - a) Generator
  - b) Galvanometer
  - c) Ammeter
  - d) Motor
12. What happens to the current in short circuit?
  - a) Reduces substantially
  - b) Does not change
  - c) increase heavily
  - d) Vary continuously
13. An alpha particle is diverted towards west is deflected towards north by a field. The field is magnetic. What will be the direction of field?
  - a) Towards south
  - b) Towards east
  - c) Downward
  - d) Upward
14. **Very Short Answer Type Questions:**
  1. What is a magnet?
  2. What is a permanent magnet?
  3. What is a temporary magnet?
  4. What is an electromagnet?
  5. What is the direction of magnetic field lines?
  6. What is the shape of magnetic field lines due to a straight current-carrying conductor?
15. Assertion (A): Magnetic field lines never intersect each other.  
Reason (R): There must not be two north directions at a point.
  - (a) (A) is incorrect and (R) is correct.
  - (b) (A) is correct and (R) is incorrect.
  - (c) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
  - (d) Both (A) and (R) are correct but (R) is the correct explanation of (A).



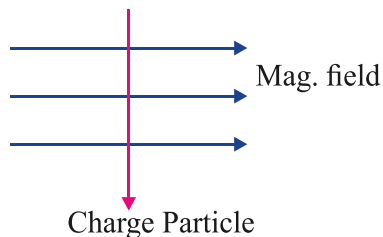
16. Assertion (A): As the speed of the coil in the motor increases, there is reduction in the current flowing through it.

Reason (R): During rotation in electric motor, some induced current is produced.

- (a) (A) is incorrect and (R) is correct.
- (b) (A) is correct and (R) is incorrect.
- (c) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
- (d) Both (A) and (R) are correct but (R) is the correct explanation of (A).

## SHORT ANSWER TYPE QUESTIONS

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

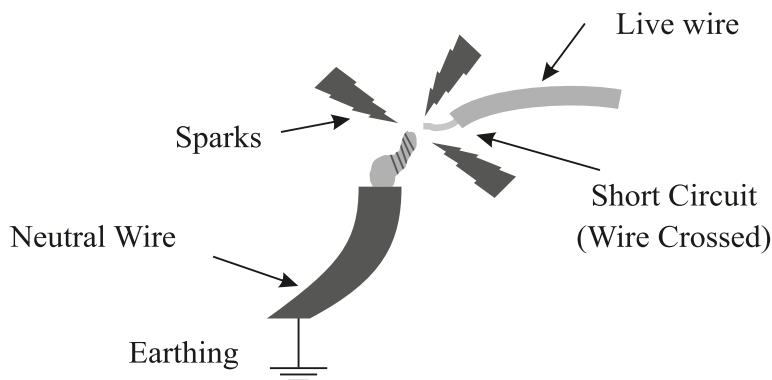
2. When does short circuit occur ?
3. Write the three ways to produce magnetic field.
4. What is overloading ?
5. Write the use of safety device used in electric circuit.
6. What is solenoid ? Where the magnetic field is uniform in solenoid ?
7. Draw the pattern of magnetic field lines due to current carrying straight conductor.
8. What is earth wire ? How it works in our domestic circuit ?
9. Draw the schematic diagram of domestic circuit. Write the colour and nature of neutral wire, live wire and earth wire.
10. What is an electromagnet ? What material are used to make electromagnet ? Can we use steel to make electromagnet ?
11. (a) State Fleming's left hand rule.  
(b) Write the principle of working of an electric motor.  
(c) Explain the function of the following.  
(i) Armature    (ii) Brushes    (iii) Split ring.

(CBSE 2018)

## Competency Based Questions

By nature, electricity seeks to return to ground, and in a properly functioning circuit, this means that the current flows through the established wiring circuit back to the service panel, and onward back through the utility wires. However, if the connections within the wiring loosen or break, electrical current may "leak." In this instance, the electrical current instantly seeks to flow back to ground by a shorter pathway. That pathway may very well be through flammable materials or even through a human being, which is why a short circuit presents the danger of fire or lethal shock.

The reason this happens is that these other materials offer a pathway of lesser resistance than is present in the copper wiring of a circuit.



Short circuit is prevented by using a device known as fuse.

- At the time of short circuit, the current in the circuit  
a) Reduces substantially      b) Does not change  
c) Increases heavily      d) Varies continuously
- During short circuit, live wire and neutral wire come in direct contact with each other. What may be the reason behind this?  
i) faulty circuit wire insulation  
ii) loose wire connections  
iii) faulty appliance wiring  
a) (i) and (ii) only      b) (ii) and (iii) only  
c) (i) and (iii) only      d) (i), (ii) and (iii) all.
- (a) What is a fuse?  
(b) On what principle does it work?
- To an electric device how a fuse is connected?