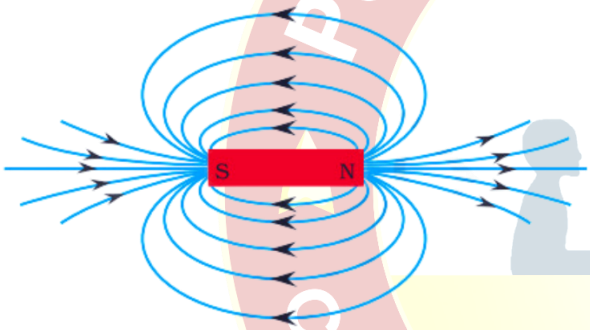
Chapter 13
Magnetic Effects of Electric Current

- A **magnet** is any material that has the ability to attract iron or iron-like materials.
- Every magnet has two poles: **North** and **South.**
- Like poles repel, while opposite poles attract.
- A freely suspended bar magnet aligns itself in a nearly north-south direction.

Magnetic Field: A region around a magnetic material within which the force of magnetism acts.

Magnetic field lines are imaginary lines, which shows the strength and direction of the magnetic field.

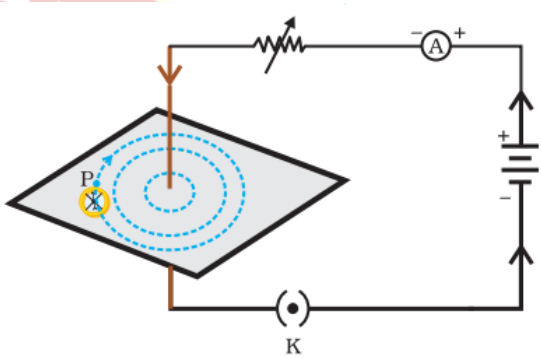


Characteristics of magnetic field lines

- Magnetic field lines go from the north pole to south pole, outside the magnet.
- Inside a magnet, the direction of field lines is from south to north.
- Magnetic field lines form closed curves.
- Field lines are closer in a stronger magnetic field. Magnetic field is stronger at the poles because the field lines are denser near the poles.
- Magnetic field lines never intersect with each other. **Why?** because if they do there will be two directions of the field at the same point, which is impossible.

H. C. Oersted first stated that an electric current produces a magnetic field. When an electric current flows through a conductor, it produces a magnetic field around it.

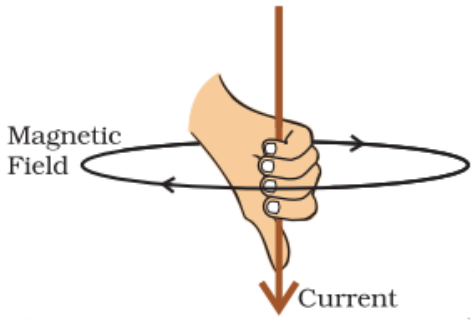
Magnetic Field due to Current through a Straight Conductor



- The magnetic field can be represented by concentric circles around the conductor.
- The magnetic field is stronger near the conductor.
- The magnetic field is proportional to the strength of the current and inversely proportional to the distance from the conductor.

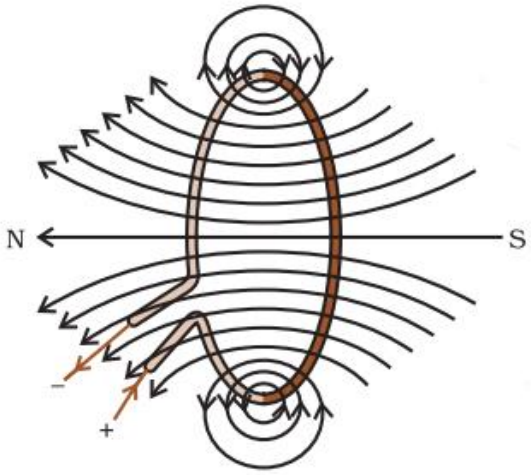
Magnetic field a current carrying wire using iron filings

Right-Hand Thumb Rule is used to determine the direction of the magnetic field around a current-carrying conductor.



If we imagine that we are holding a current-carrying straight conductor in our right hand such that the thumb points towards the direction of current. Then our fingers will wrap around the conductor in the direction of the field lines of the magnetic field

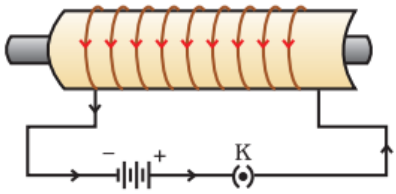
Magnetic Field due to Current through a Circular Loop

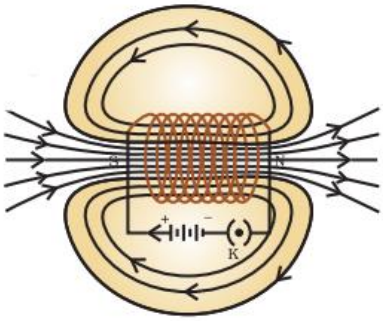


- The magnetic field is represented by concentric circles, with larger circles as one moves away from the loop.
- Every point on the wire carrying current contributes to a magnetic field that appears as a straight line at the centre of the loop.
- Factors affecting the magnetic field: **the current, distance from the conductor, and the number of turns in the coil**.

Solenoid

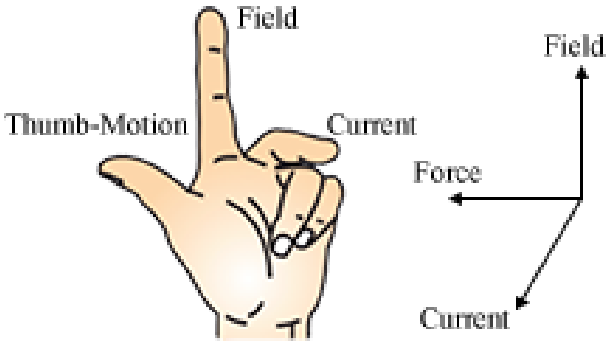
- A solenoid is a coil of insulated copper wire with many circular turns.
- The magnetic field of a solenoid is similar to that of a bar magnet and is uniform inside the solenoid.
- The direction of the magnetic field is from North to South outside the solenoid and from South to North inside the solenoid.





Electromagnet

- An electromagnet is a solenoid with a soft iron core.
- It is a temporary magnet that can be easily demagnetized.
- Its strength can be adjusted, and its polarity can be reversed.
- Electromagnets are generally strong magnets.



Force on a Current-Carrying Conductor in a Magnetic Field:

- A magnet exerts a force on a current-carrying conductor.
- The maximum force is applied when the current is at a right angle to the magnetic field.
- The direction of force reverses with a change in the direction of the current.

Fleming's Left Hand Rule

- Fleming's left-hand rule states that if we hold the forefinger and the middle finger and the thumb of our left hand at right angles to each other such that:

Forefinger points in the direction of **magnetic field**,
Middle finger in the direction of the **current** then
Then the direction which the thumb points gives the direction of the **force/motion** of the conductor.

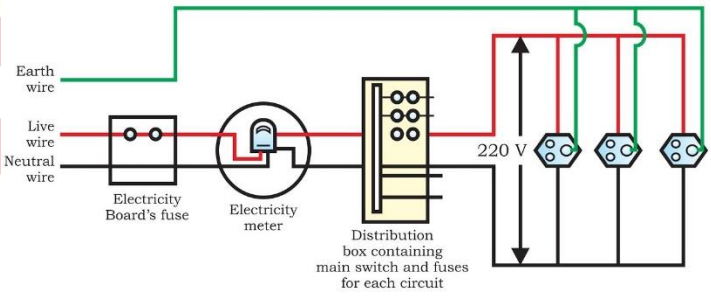
Alternating Current (A.C.)

- A.C. periodically reverses its direction.
- In India, A.C. reverses direction every 1/100 second, resulting in a frequency of 50 Hz.
- A.C. can be transmitted over long distances with minimal energy loss.

Direct Current (D.C.)

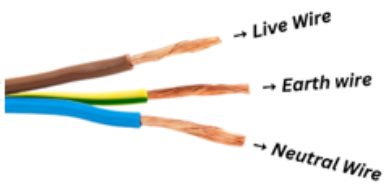
- D.C. does not reverse its direction.
- D.C. can be stored.
- Energy loss during long-distance transmission is high.
- Sources of D.C. include cells, batteries, and storage cells.

Domestic Electric Circuits

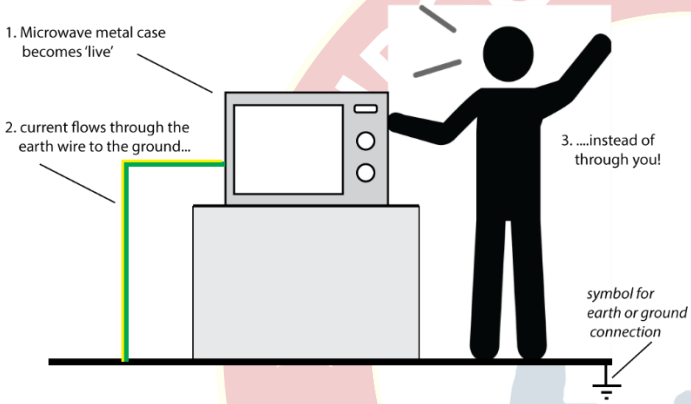


- Three types of wires are used in domestic circuits: live wire (red), neutral wire (black), and earth wire (green).
- The potential difference between live and neutral wires in India is 220 V.

- Safety measures include the use of an electric fuse, earth wire, and MCB (Miniature Circuit Breaker).



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. The resistance of circuit becomes low which can result in overloading.

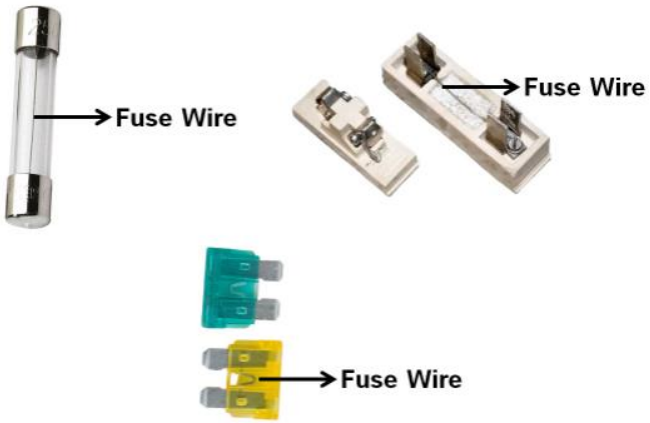
Overloading: When current drawn is more than current carrying capacity of a conductor, it results in overloading.

Causes of overloading

(i) Accidental hike in voltage supply.

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

Electric Fuse: A fuse is a safety device that protects an electrical circuit from excessive current. It consists of a metal wire or strip that melts when the current exceeds a certain level, breaking the circuit and preventing damage to connected devices.



MCB : Miniature Circuit Breaker is an electrical switch that automatically interrupts the electrical flow in a circuit in case of an overload or a short circuit. MCBs are commonly used in residential, commercial, and industrial electrical installations to protect electrical circuits and devices from damage caused by excessive current.