Electricity:

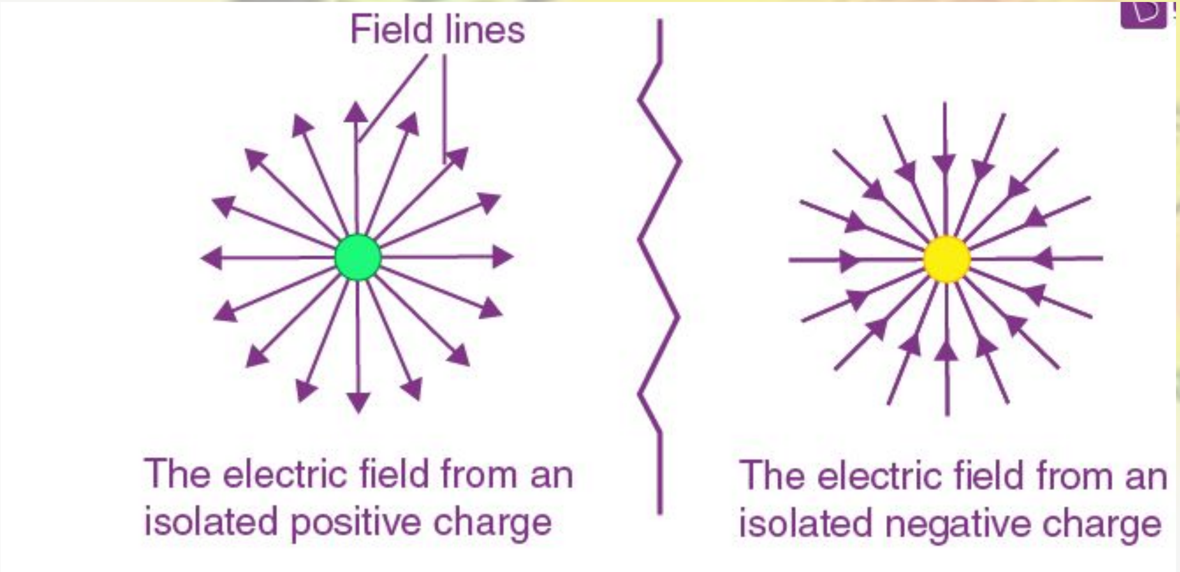
- Study of the motion of electric charges.
- Electric charge: Scalar quantity, measured in Coulombs (C).
- Static Electricity: Electricity produced by friction (e.g., rubbing a comb on hair).

Coulomb's Law:

- Describes the force between two point charges.
- Force is directly proportional to the product of the charges.
- Force is inversely proportional to the square of the distance between the charges.
- Formula: $F = k (q_1 q_2/r^2)$
    - F: Force between the charges
    - k: Coulomb's constant (8.99×10^9 N m^2/C^2)
    - q_1 and q_2: Magnitudes of the charges
    - r: Distance between the charges

Electric Field (E):

- **Definition:** The space around a charge where its influence can be felt by other charges.
- **Electric Field Intensity:** Force per unit positive test charge at a point.
  - Formula: $E = F/q$ (F = force, q = charge)
  - Unit: Newton/Coulomb (N/C)
- **Electric Field Lines:** Imaginary lines showing the direction of the electric field.
  - Never intersect.
  - Start from positive charges and end on negative charges.

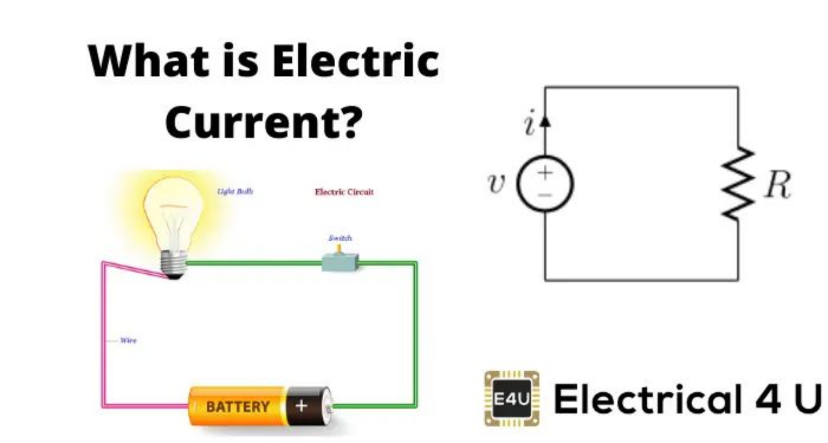


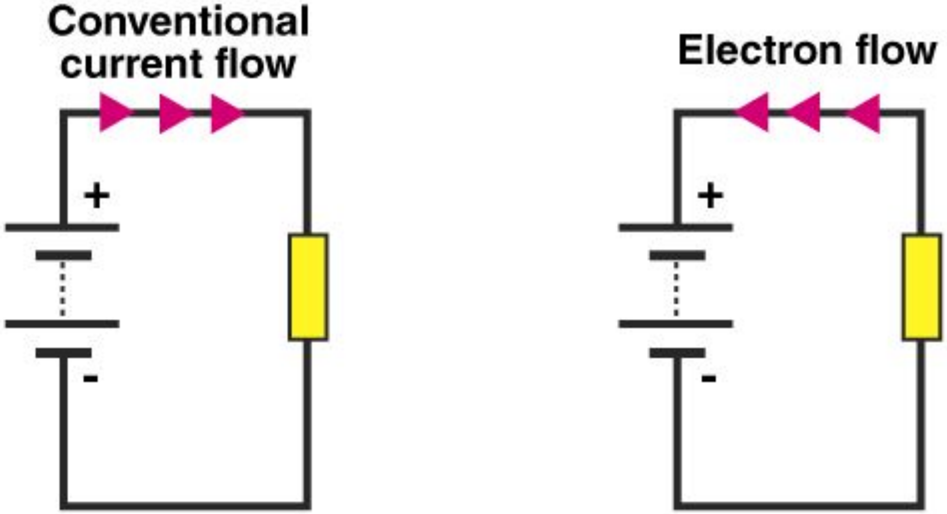
Electric Potential (V):

- **Definition:** Work done per unit charge to bring a test charge from infinity to a point in the field.
- **Unit:** Joule/Coulomb (J/C) or Volt (V)
- **Potential Difference:** Work done per unit charge to move a charge between two points.
  - Determines the flow of charge (from higher to lower potential).
- **Inside a Conductor:** Electric field is zero.

Electric Current (I):

- **Definition:** Flow of electric charge over time.
- **Formula:** I = q/t (q = charge, t = time)
- **Unit:** Ampere (A) (1 A = 1 C/s)
- **Types:**
    - Direct Current (DC): Constant direction.
    - Alternating Current (AC): Direction changes periodically.
- **Carriers:**
    - Solids: Electrons
    - Liquids: Ions and electrons
    - Semiconductors: Electrons and Holes

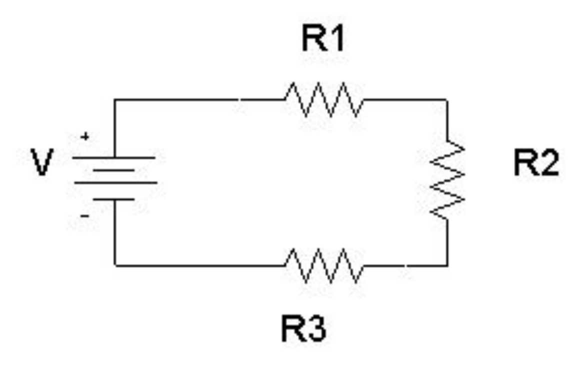




Electron and conventional current flow

Resistance (R):

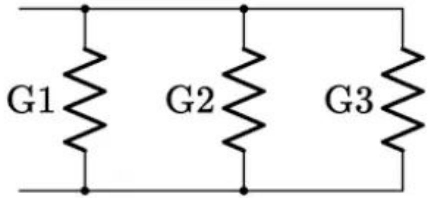
- Definition: A material's opposition to the flow of electric current.
- SI Unit: Ohm (Ω)
- Formula: $R = \rho L/A$
  - ρ: Resistivity of the material
  - L: Length of the conductor
  - A: Cross-sectional area of the conductor

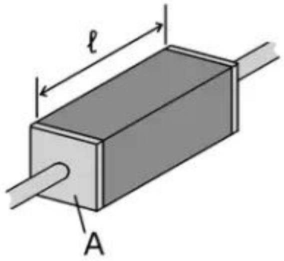


Conductance (G):

- Definition: The reciprocal of resistance (ease of current flow).
- SI Unit: Siemens (S) or mho (℧)
- Formula: $G = 1/R$

What is Conductance?

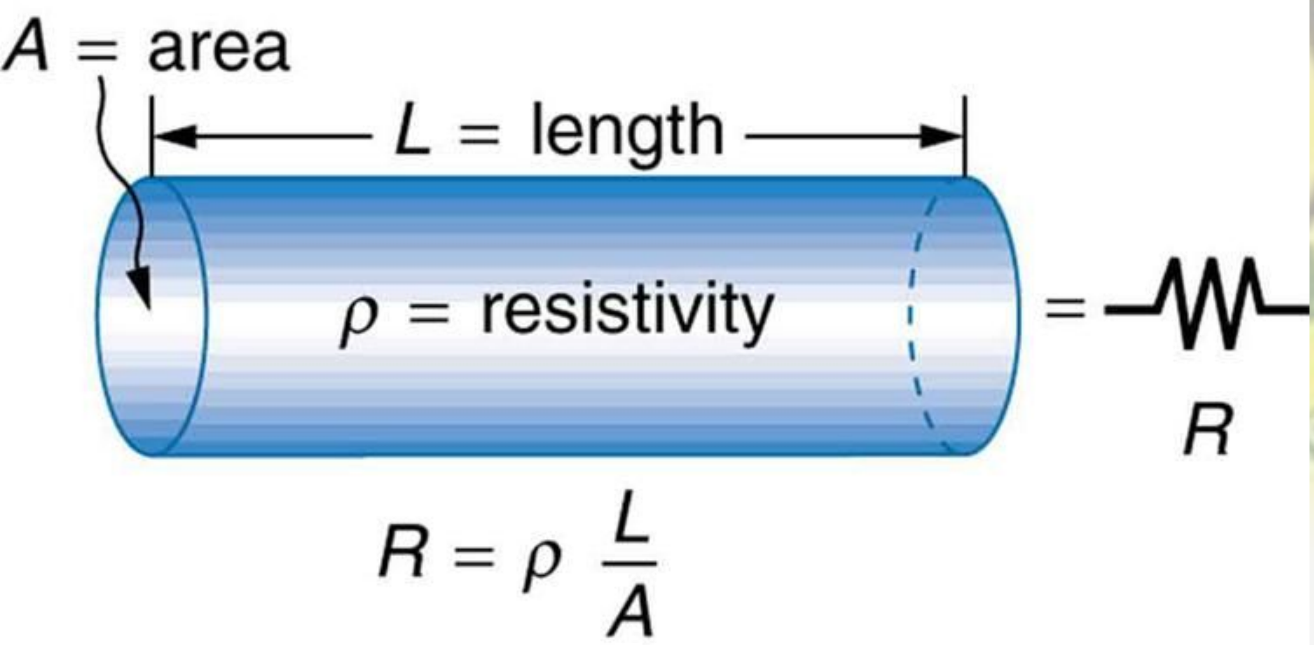




$$G = \frac{1}{R} = \frac{i}{v}$$

Resistivity (ρ):

- Definition: Resistance of a material with unit length and unit cross-sectional area.
- SI Unit: Ohm-meter (Ωm)
- Depends on:
    - Temperature (increases for metals)
    - Nature of the material (low for metals, high for alloys)
- Independent of: Dimensions of the conductor (length and area)

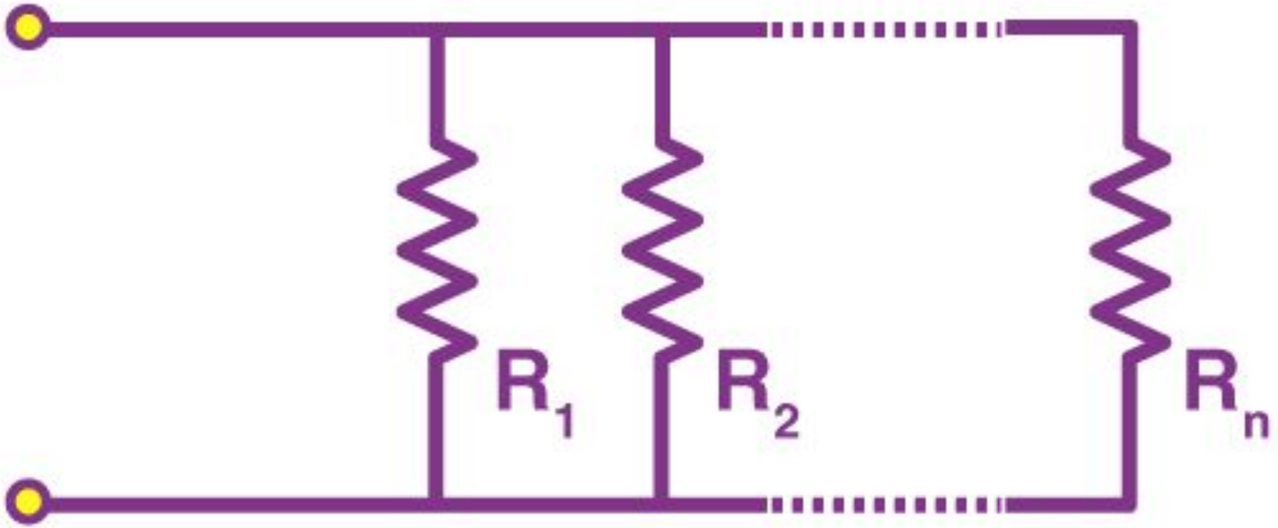


Combination of Resistances:

- **Series:**
  - Resistors connected end-to-end.
  - Same current flows through each resistor.
  - Total resistance: $R = R_1 + R_2 + R_3 + \dots$
- **Parallel:**
  - Resistors connected with common endpoints.
  - Same voltage across each resistor.
  - Total resistance: $1/R = 1/R_1 + 1/R_2 + 1/R_3 + \dots$

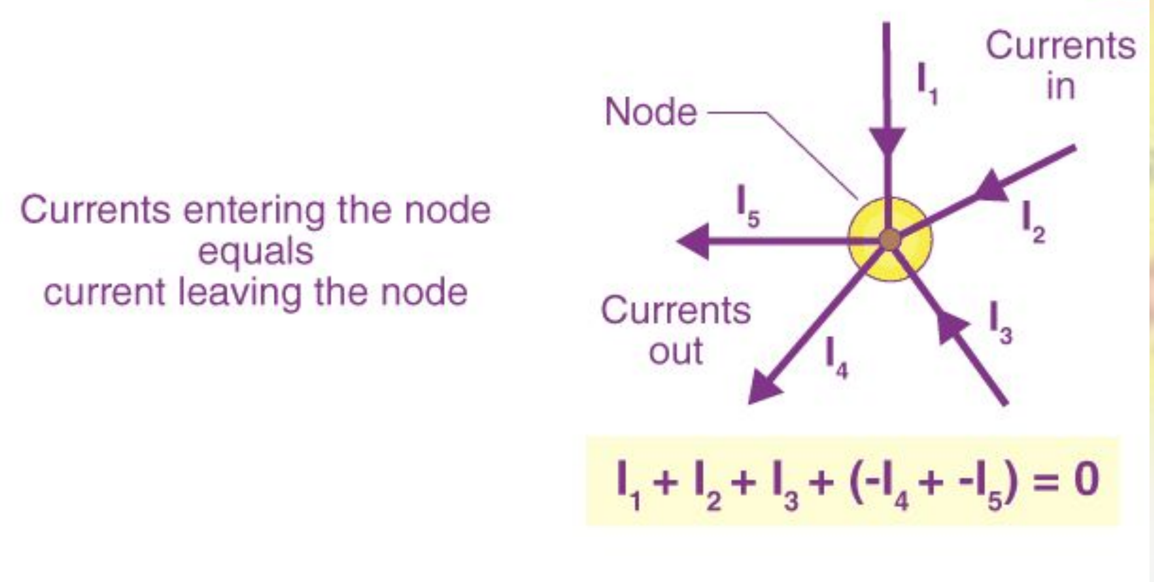
Ohm's Law:

- Relationship between voltage (V), current (I), and resistance (R).
- Formula: $V = IR$
- Conditions: Valid only if physical conditions (temperature, pressure, etc.) remain constant.


R_1
R_2
R_n

Kirchhoff's Laws:

- **Kirchhoff's Current Law (KCL):**
  - At any junction in a circuit, the sum of currents entering the junction equals the sum of currents leaving it.
  - Based on conservation of charge.
- **Kirchhoff's Voltage Law (KVL):**
  - The sum of voltage drops around any closed loop in a circuit is zero.
  - Based on conservation of energy.



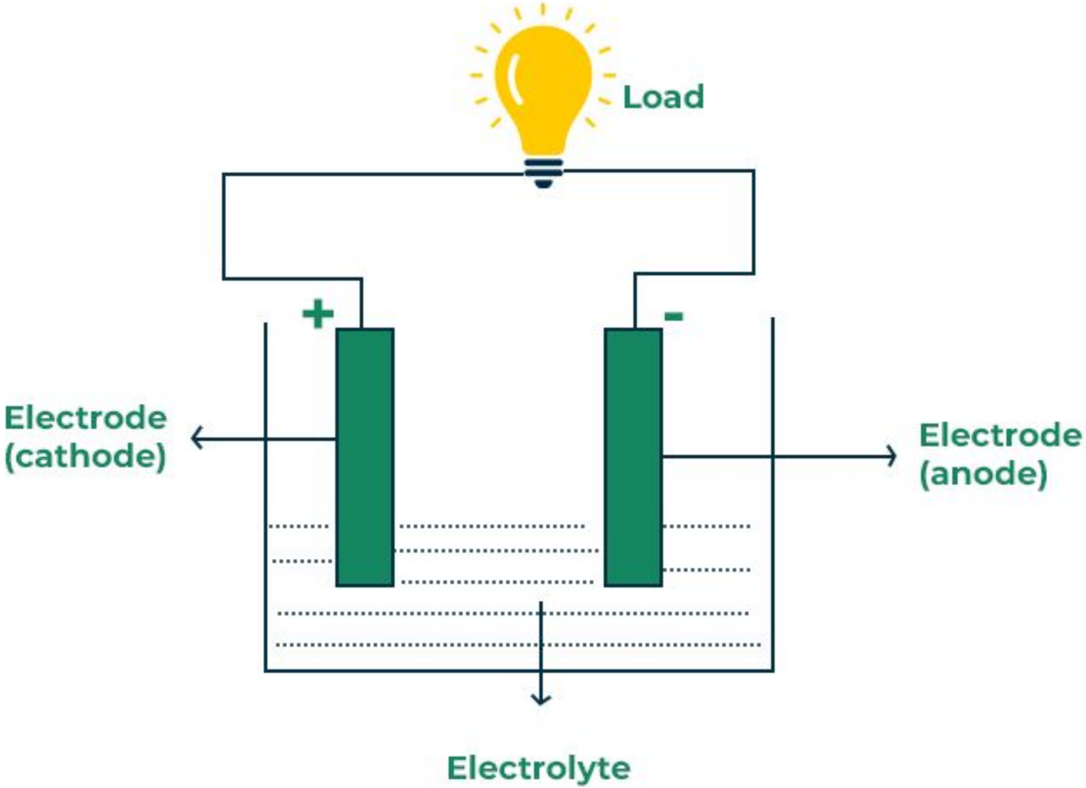
Electric Cell:

- **Function:** Converts chemical energy into electrical energy.
- **Types:**
  - Primary Cell: Non-rechargeable (e.g., Voltaic, Daniell, Leclanche).
  - Secondary Cell: Rechargeable (e.g., Lead-acid battery, Lithium-ion battery).

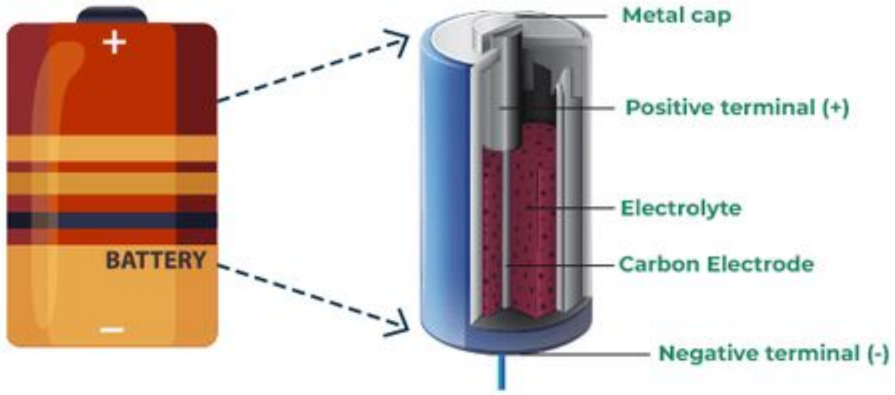
Joule's Law of Heating:

- **Explanation:** Heat is produced when electric current flows through a conductor due to resistance.
- **Formula:** $H = VIt = I^2Rt = V^2t/R$
  - H: Heat produced (Joules)
  - V: Voltage (Volts)
  - I: Current (Amperes)
  - R: Resistance (Ohms)
  - t: Time (seconds)
- **Applications:** Electric bulbs, heaters.

Working of Electric Cell



Electric Cell



Chemical Effect of Electric Current (Electrolysis):

- **Process:** Decomposition of an electrolyte (acidic or basic solution) into ions when current passes through it.
- **Ions:**
  - Positive ions move towards the cathode (negative electrode).
  - Negative ions move towards the anode (positive electrode).

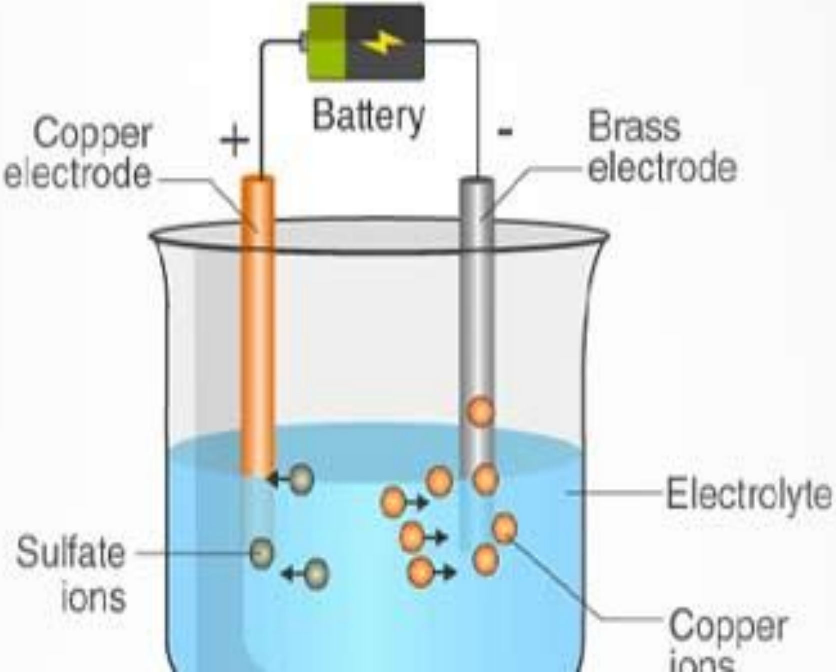
Faraday's Laws of Electrolysis:

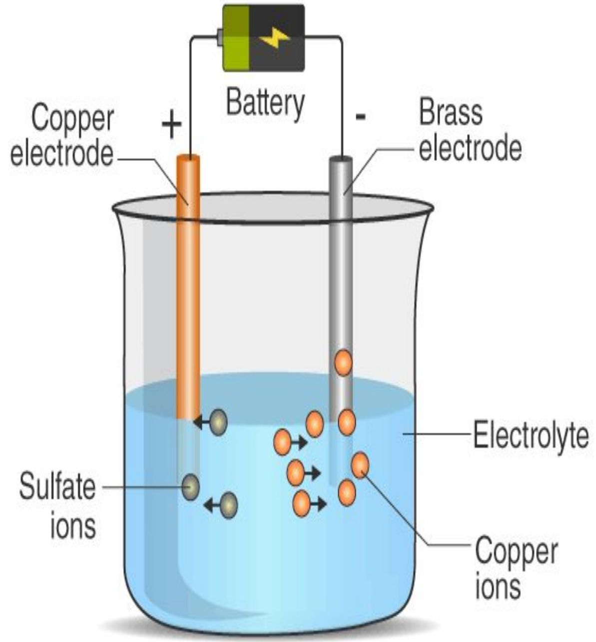
- **First Law:** Mass (M) deposited at an electrode is directly proportional to the charge (q) passed.
  - Formula: $M = Zq$ (Z = electrochemical equivalent)
- **Second Law:** If the same current passes through different electrolytes for the same time, mass deposited is proportional to their chemical equivalent.
  - Formula: $M_1/M_2 = E_1/E_2$

Electric Power (P):

- **Definition:** Rate at which electrical energy is converted into other forms of energy.
- **Formula:** $P = V^2/R = I^2R$ (V = voltage, I = current, R = resistance)
- **Unit:** Watt (W)

What is Chemical Effect of Electric Current





Electric Fuse:

- **Function:** Protects electrical appliances from excessive current.
- **Material:** Alloy of copper, tin, and lead (low melting point, high resistance).

Shunt:

- **Definition:** A low-resistance wire connected in parallel to a galvanometer.
- **Function:** Converts a galvanometer into an ammeter (measures current).

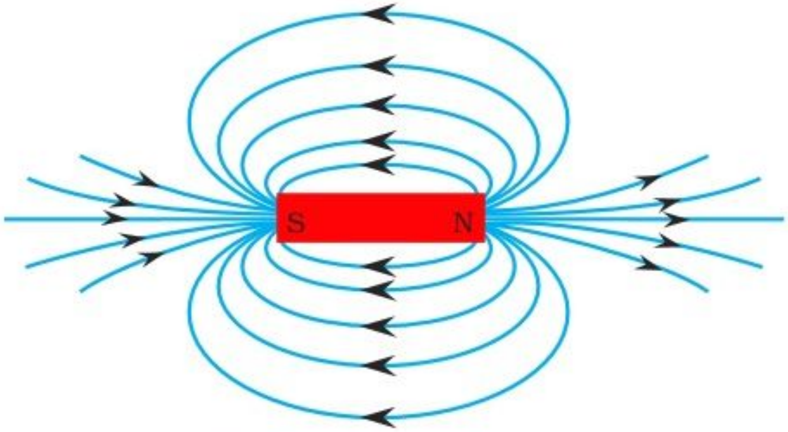
Voltmeter: Created by connecting a high resistance in series with a galvanometer.

Key Concepts

- **Magnetic Field:** The region around a magnet where its force can be detected.
- **Magnetic Field Lines:** Imaginary lines that represent the direction and strength of a magnetic field.
- **Compass Needle:** A small bar magnet used to detect and visualize magnetic field lines.
- **North Pole:** The end of a magnet that points towards the Earth's magnetic north.
- **South Pole:** The end of a magnet that points towards the Earth's magnetic south.
- **Attraction and Repulsion:** Like poles of magnets repel, unlike poles attract.

Activity to Visualize Magnetic Field Lines

1. Place a bar magnet in the center of a sheet of paper.
2. Sprinkle iron filings around the magnet.
3. Gently tap the paper.
4. Observe the iron filings aligning themselves along the magnetic field lines.

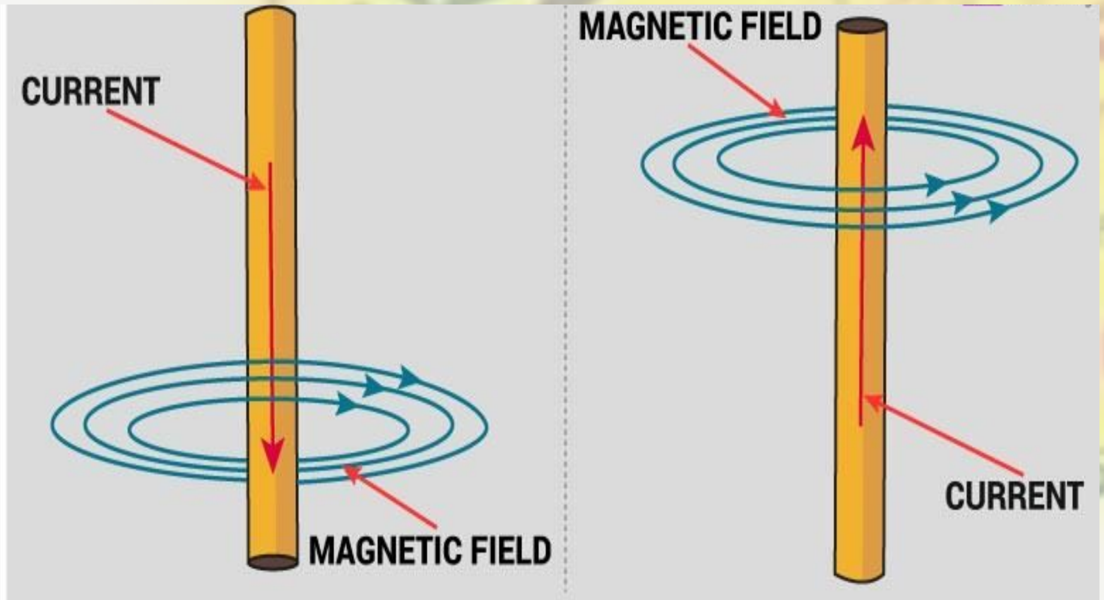


Field lines of magnet bar

Key Observations

- **Direction:** Magnetic field lines emerge from the north pole and merge at the south pole, forming closed curves.
- **Strength:** The closer the field lines, the stronger the magnetic field.
- **Non-Intersection:** Magnetic field lines never cross each other.

Important Note: The direction of the magnetic field is taken to be the direction in which a north pole of the compass needle moves inside it. Magnetic Field Due to a Current-Carrying Conductor

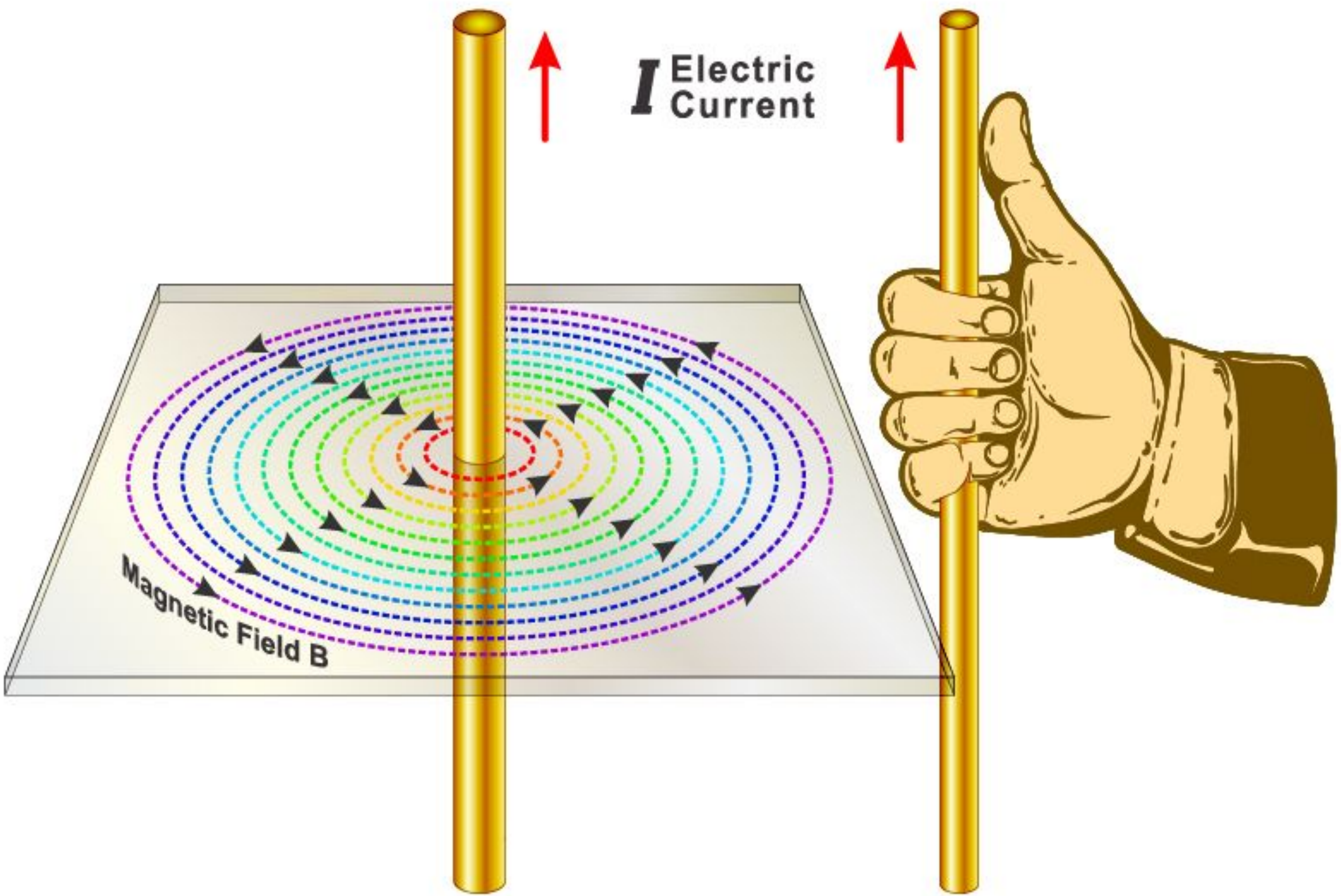


Right-Hand Thumb Rule:

- Determines the direction of the magnetic field around a current-carrying wire.
- **How to Use:**
  - Point your right thumb in the direction of the current.
  - Your curled fingers indicate the direction of the magnetic field lines.

Magnetic Field Around a Straight Conductor:

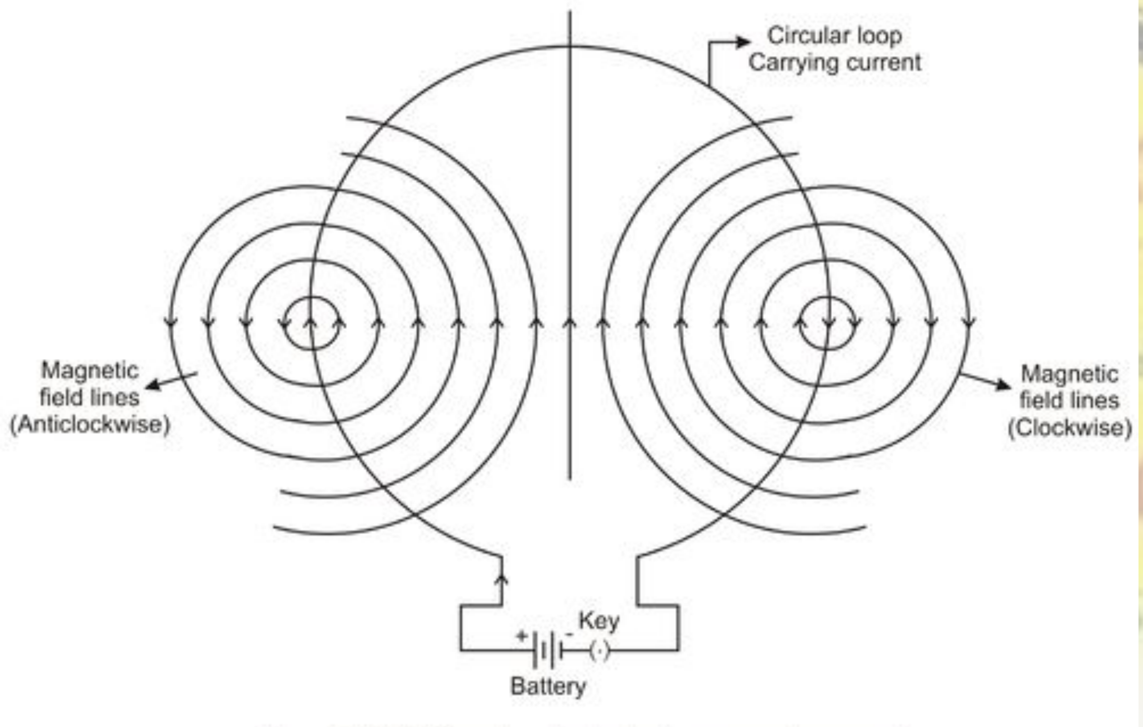
- Current flowing through a straight wire creates a circular magnetic field around it.
- Strength of the field decreases as distance from the wire increases.
- Direction of the field reverses when the current direction is reversed.



I Electric Current
Magnetic Field B

Magnetic Field Through a Circular Loop:

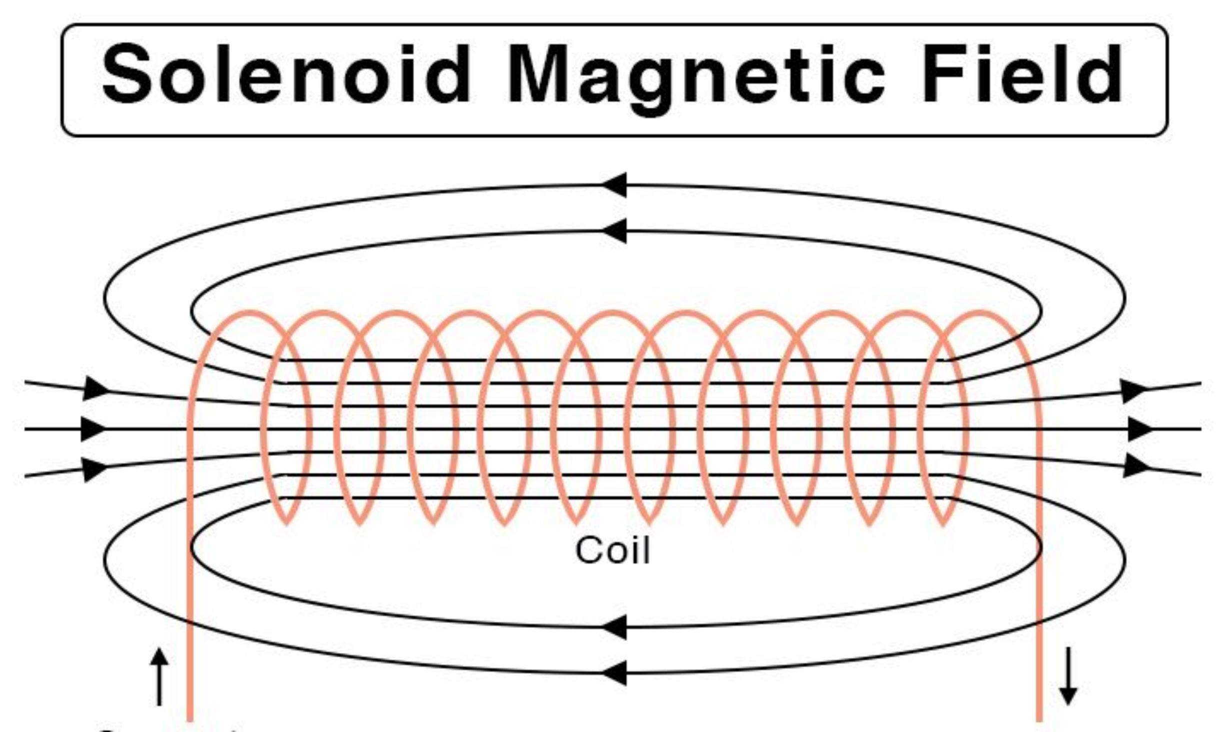
- Current flowing through a circular loop creates a magnetic field that resembles a bar magnet.
- Inside the loop, field lines are straight and in the same direction.
- Outside the loop, field lines form concentric circles.



Magnetic field lines due to circular loop carrying current

Magnetic Field in a Solenoid:

- Solenoid: A coil of many circular turns of wire.
- Creates a strong, uniform magnetic field inside the coil.
- Behaves like a bar magnet with north and south poles.
- Used to create electromagnets by placing a magnetic material (e.g., soft iron) inside the coil.

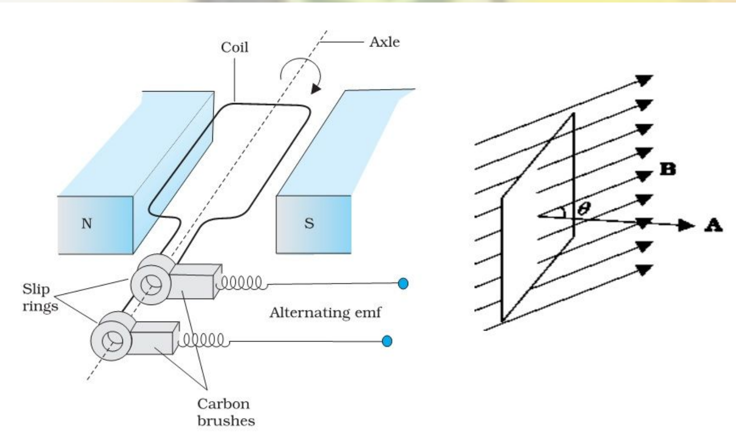


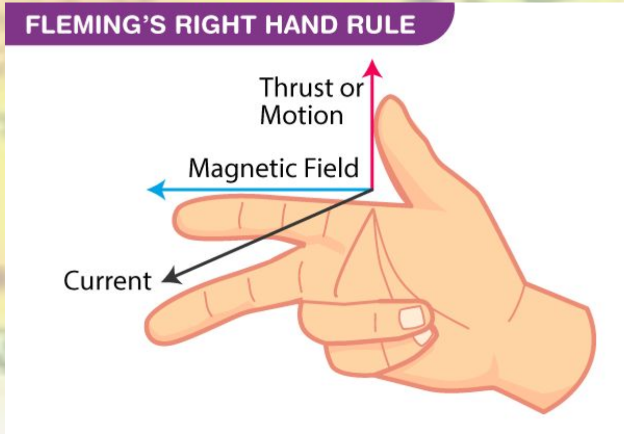
Electromagnet:

- Temporary magnet created by passing current through a solenoid with a magnetic core.
- Strength can be controlled by adjusting the current.
- Used in various applications, including motors, generators, and lifting heavy objects.

Electromagnetic Induction:

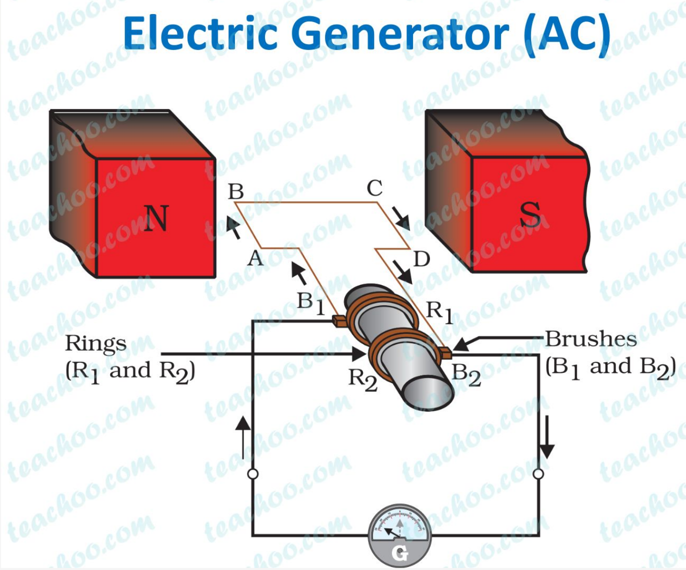
- **Discovery:** Michael Faraday, 1831.
- **Principle:** A changing magnetic field induces an electric current in a conductor.
- **Methods:**
  - Moving a conductor in a magnetic field.
  - Changing the magnetic field around a conductor.
- **Fleming's Right-Hand Rule:**
  - Thumb: Direction of motion of the conductor.
  - Forefinger: Direction of the magnetic field.
  - Middle finger: Direction of the induced current.

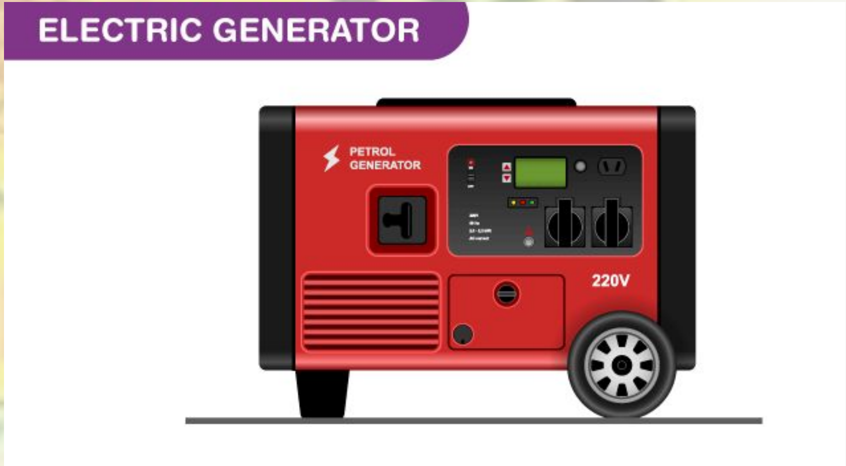




Electric Generator:

- **Function:** Converts mechanical energy into electrical energy.
- **Principle:** Electromagnetic induction.
- **Components:**
    - Rectangular coil (armature)
    - Permanent magnet
    - Slip rings (AC generator) or split ring commutator (DC generator)
    - Brushes





- **Working (AC Generator):**
  - Coil rotates in a magnetic field.
  - Induced current flows in the coil, changing direction every half rotation.
  - Produces alternating current (AC).
- **Working (DC Generator):**
  - Similar to AC generator, but uses a split ring commutator.
  - Ensures current flows in one direction only.
  - Produces direct current (DC).

AC vs. DC:

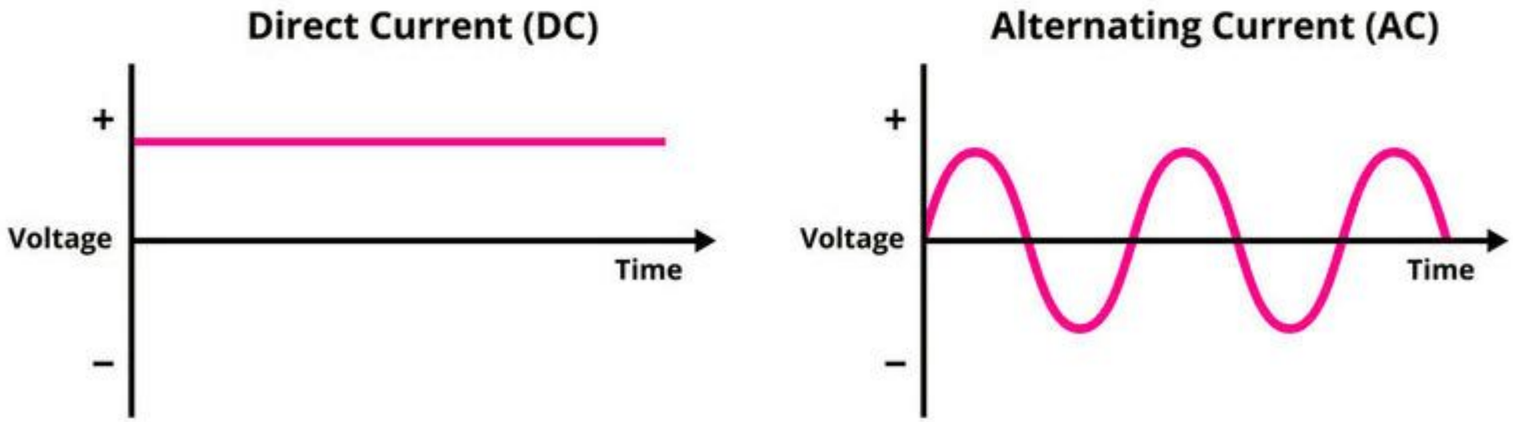
- **AC (Alternating Current):** Changes direction periodically.
- **DC (Direct Current):** Flows in one direction only.

Advantages of AC:

- Can be easily stepped up or down using transformers.
- Efficient for long-distance transmission with minimal energy loss.

Alternating Current and Direct Current

AC V/S DC



Main Supply (Mains):

- Electricity enters homes through overhead poles or underground cables.
- Two wires:
  - Live wire (red): Carries high voltage (220V in India).
  - Neutral wire (black): Completes the circuit.

Meter Board:

- Main fuse protects against excessive current.
- Main switch controls power to the entire house.
- Separate circuits for high-power (15A) and low-power (5A) appliances.

Earth Wire (Green):

- Safety measure.
- Connected to a metal plate buried in the ground.
- Provides a low-resistance path for current in case of appliance leakage, preventing electric shock.

Circuit Arrangement:

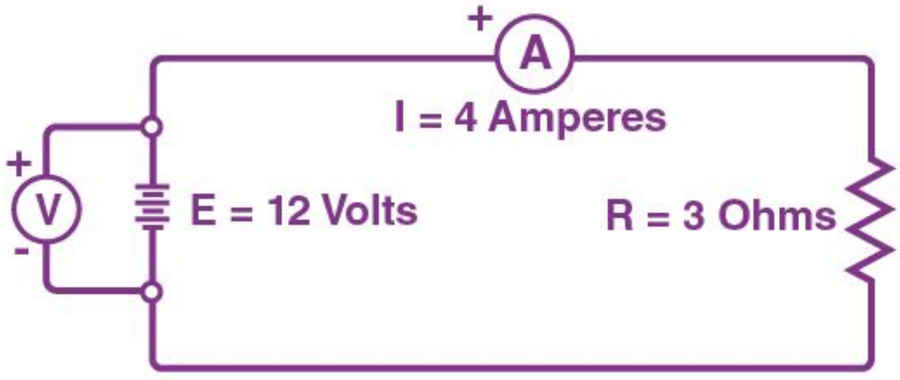
- Appliances are connected in parallel to ensure each receives the full voltage.
- Each appliance has a separate switch.

Electric Fuse:

- Safety device that melts and breaks the circuit when excessive current flows.
- Protects against overloading due to:
  - Short circuit (live and neutral wires coming in contact).
  - High supply voltage.
  - Connecting too many appliances to a single socket.

Key Points:

- Parallel connection ensures equal voltage for all appliances.
- Earth wire is crucial for safety.
- Fuses protect against overloading and short circuits.



A simple circuit diagram

NDA CDS COACHING CENTRE

Key Points:

- **Compass and Magnetic Field:**
  - A compass needle, being a small magnet, aligns with the magnetic field.
  - The Earth's magnetic field causes the compass to point north-south.
  - Magnetic field lines represent the direction and strength of a magnetic field.
- **Magnetic Field due to Electric Current:**
  - An electric current creates a magnetic field around the conductor.
  - The direction of the field is determined by the right-hand thumb rule.
  - The pattern of the magnetic field depends on the shape of the conductor.
  - A solenoid's magnetic field resembles that of a bar magnet.
- **Electromagnet:**
  - An electromagnet is created by wrapping a coil of insulated wire around a soft iron core.
  - The magnetic field is present only when current flows through the coil.
- **Force on a Current-Carrying Conductor:**
  - A current-carrying conductor in a magnetic field experiences a force.
  - The force direction is determined by Fleming's left-hand rule.
  - This principle is used in electric motors to convert electrical energy into mechanical energy.

- **Electromagnetic Induction:**
    - A changing magnetic field induces a current in a coil.
    - This can be caused by relative motion between the coil and a magnet or by changing the current in a nearby conductor.
    - Fleming's right-hand rule determines the direction of the induced current.
- **Electric Generator:**
    - Converts mechanical energy into electrical energy using electromagnetic induction.
    - AC generators produce alternating current, while DC generators produce direct current.
- **Domestic Electric Circuits:**
    - Homes receive 220 V AC power at 50 Hz.
    - Live wire (red), neutral wire (black), and earth wire (green) are used.
    - The earth wire provides safety by grounding metallic bodies of appliances.
- **Safety Devices:** Fuses protect circuits from short circuits and overloading by breaking the circuit when excessive current flows.