

Chapter 12: Electricity (Class 10 Science)

Introduction

Electricity is a form of energy resulting from the flow of electric charge. It is widely used in everyday life, from powering devices to lighting homes. Understanding the concepts of electric current, circuits, and resistance is fundamental to harnessing this energy.

1. Electric Current and Circuit

Electric Current: The rate of flow of electric charge through a conductor.

- Denoted by I, measured in amperes (A).
- Formula: I = Q / t, where Q is the charge (in coulombs) and t is the time (in seconds).

Electric Circuit: A closed and continuous path through which electric current flows. It includes various components like resistors, capacitors, switches, and power sources (cells or batteries).

Direction of Current:

- Conventional Current: Flows from positive to negative terminal of the battery.
- Electron Flow: Actual flow of electrons from negative to positive terminal.

2. Potential Difference

Potential Difference (Voltage): The difference in electric potential between two points in a circuit.

- Denoted by V, measured in volts (V).
- Formula: V = W / Q, where W is the work done (in joules) to move charge Q (in coulombs).

Measuring Potential Difference: A voltmeter is used to measure potential difference and is connected in parallel in a circuit.

3. Ohm's Law

Ohm's Law: States that the current passing through a conductor between two points is directly proportional to the voltage across the two points, provided the temperature remains constant. - Formula: V = IR, where V is the potential difference, I is the current, and R is the resistance.

Graphical Representation: The graph between V and I is a straight line for an Ohmic conductor, indicating a constant resistance.

4. Resistance and Factors Affecting Resistance

Resistance (R): The opposition offered by a material to the flow of electric current.

- Measured in ohms (Ω).

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Factors Affecting Resistance:

1. Length of the Conductor (L): Resistance is directly proportional to length (R \propto L).

2. Area of Cross-Section (A): Resistance is inversely proportional to the area of cross-section (R \propto 1/A).

3. Nature of Material: Different materials offer different levels of resistance.

4. Temperature: Resistance generally increases with temperature in most materials.

Resistivity: A property of the material that affects resistance.

- Formula: $R = \rho(L / A)$, where ρ is the resistivity (in ohm-meter).

5. Series and Parallel Circuits

Series Circuit: The components are connected end-to-end, forming a single path for current.

- Current: Same through all components.
- Total Resistance: R(total) = R1 + R2 + R3 + ...
- Voltage: Divided among components.

Parallel Circuit: The components are connected across common points, forming multiple paths for current.

- Voltage: Same across all branches.
- Total Resistance: 1/R(total) = 1/R1 + 1/R2 + 1/R3 + ...
- Current: Divided among branches.

6. Heating Effect of Electric Current

When current flows through a conductor, electrical energy is converted into heat energy. This phenomenon is known as the heating effect of current.

Joule's Law of Heating: $H = I^2Rt$, where H is the heat produced, I is the current, R is the resistance, and t is the time.

Applications of Heating Effect:

- Electric Bulbs: The filament glows due to the heat produced by electric current.
- Electric Heaters and Irons: Use resistance coils to generate heat.

7. Electric Power

Electric Power: The rate at which electrical energy is consumed or produced by a device.

- Denoted by P, measured in watts (W).

- Formula: P = VI

Using Ohm's Law (V = IR): $P = I^2R$ or $P = V^2 / R$

Commercial Unit of Electric Energy: The unit of energy used by electric companies is the kilowatt-

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hour (kWh).

 $- 1 \text{ kWh} = 3.6 \times 10^6 \text{ J}.$

Important Diagrams

- 1. Circuit diagram showing the connection of a resistor, ammeter, and voltmeter.
- 2. Graph between voltage and current to illustrate Ohm's law.
- 3. Series and parallel circuits.
- 4. Heating effect in a resistor.

Practice Questions

- 1. Define the term electric current. What is its SI unit?
- 2. State Ohm's law. How is it represented graphically?
- 3. A 100-watt electric bulb is used for 10 hours. Calculate the energy consumed in kWh.
- 4. Explain the difference between series and parallel circuits with suitable diagrams.
- 5. What factors affect the resistance of a conductor?

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