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CLASS 9 SCIENCE · MAHARASHTRA STATE BOARD

CHAPTER 3

Current Electricity

Chapter Notes

1. Conceptual Framework and Theoretical Foundation

Current electricity studies the organized flow of electric charge through conducting pathways. All metallic conductors contain a sea of delocalized "free electrons" within their crystalline lattices. When an external electromotive force or potential difference is applied across the conductor terminals, these free electrons experience an electrostatic force, resulting in a net directional drift that constitutes an electric current.

2. Fundamental Electrical Quantities and Ohm’s Law

- **Electric Current (I):** The net rate of flow of electric charge through any cross-sectional area of a conductor:

$$I = \frac{Q}{t}$$

Measured in Amperes (A).

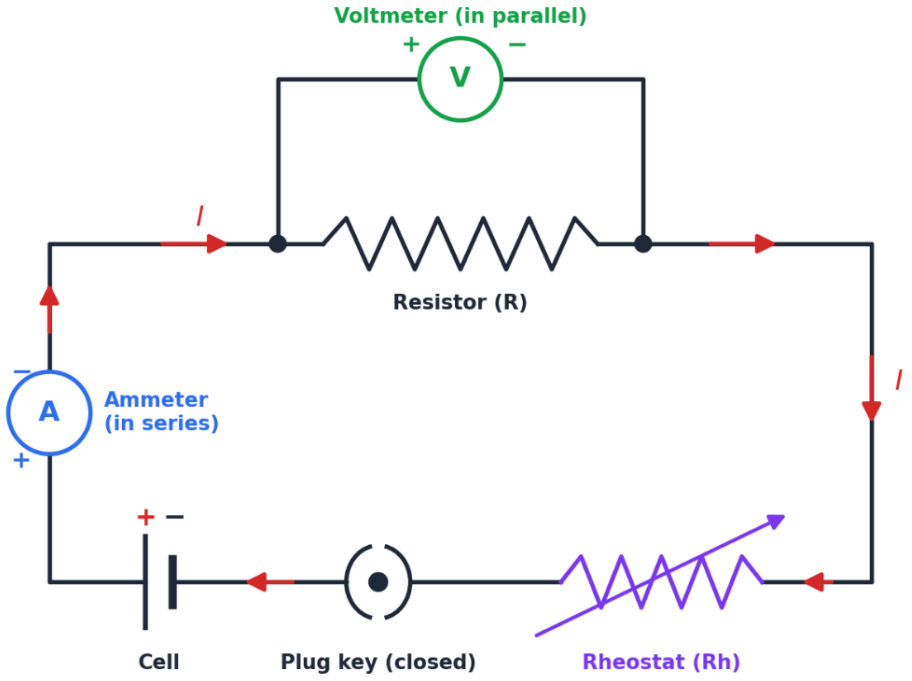
- **Potential Difference (V):** The amount of work required to move a unit positive test charge between two points in an electrostatic field. Measured in Volts (V).
- **Resistance (R):** The property of a substance that hinders or impedes the flow of electric current, caused by collisions between drifting electrons and stationary lattice ions. Measured in Ohms (Ω).

Ohm's Law

Formulated by Georg Simon Ohm, this principle states that at a constant physical temperature, the electric current (I) flowing through a metallic conductor is directly proportional to the potential difference (V) applied across its terminal ends:

$$V \propto I \Rightarrow V = IR$$

Figure 3.1 Circuit to Verify Ohm's Law



Red arrows: conventional current (+ terminal → external circuit → − terminal)

3. Resistor Combinations and Heating Effects

- **Series Combination:** When resistors are connected end-to-end, the equivalent total resistance (R_s) is the direct algebraic sum of individual resistances:

$$R_s = R_1 + R_2 + R_3 + ...$$

The current flowing through each resistor remains identical.

- **Parallel Combination:** When resistors are connected across common junction nodes, the reciprocal of the equivalent resistance (R_p) equals the sum of the reciprocals of individual branch resistances:

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

The potential difference across each parallel branch remains identical.

- **Joule Heating Effect:** When current passes through a resistive conductor, electrical energy is converted into thermal heat energy at a rate given by:

$$H = I^2 Rt$$