CHAPTER 11: ELECTRICITY

Introduction

Electricity is one of the most important forms of energy used in daily life. It is used in homes, industries, hospitals, and schools.

This chapter explains:

- Electric current and circuit
- Potential difference
- Ohm's Law
- Resistance and resistivity
- Combination of resistors
- Heating effect of current
- Electric power

Electric Current and Circuit

Electric Current

Definition:

The flow of electric charge through a conductor is called **electric current**.

- In metals → current is due to flow of **electrons**
- Conventional direction → **positive to negative terminal**

Formula of Current

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

Where:

- I = current
- Q = charge
- t = time

Unit of Current

- SI Unit: **Ampere (A)**
- 1 A = 1 coulomb / second

Electric Circuit

Definition:
A **closed conducting path** through which current flows is called an electric circuit.

- Closed circuit → current flows
- Open circuit → no current

Measuring Instruments

- **Ammeter** → measures current
    - Always connected in **series**

Electric Potential and Potential Difference

Electric Potential Difference

Definition:
Work done to move unit charge from one point to another.

Formula

$$V = \frac{W}{Q}$$

Where:

- V = potential difference
- W = work done
- Q = charge

Unit

- SI Unit: **Volt (V)**
- 1 V = 1 J/C

Measuring Instrument

- **Voltmeter**
    - Connected in **parallel**

Source of Potential Difference

- Cell / Battery
- Converts **chemical energy → electrical energy**

Ohm's Law

Statement

At constant temperature:

Potential difference is directly proportional to current.

Formula

$$V = IR$$

$$V = IR = 12$$

Where:

- V = voltage
- I = current
- R = resistance

V–I Graph

- Straight line passing through origin
- Shows direct proportionality

Resistance

Definition:
Opposition offered by a conductor to flow of current.

- Unit: **Ohm (Ω)**

Factors Affecting Resistance

Dependence

Resistance depends on:

1. **Length (l)** → directly proportional
2. **Area (A)** → inversely proportional
3. **Material (ρ)** → nature of conductor

Formula

$$R = \rho \frac{l}{A}$$

Where:

- ρ = resistivity

Resistivity (ρ)

- Property of material
- Unit: **Ω m**

Examples:

- Good conductors → Copper, Aluminium
- Alloys → Nichrome (used in heaters)
- Insulators → Rubber, Glass

Effect of Temperature

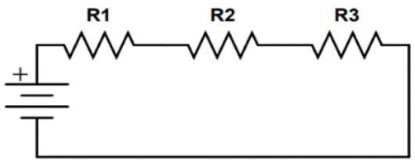
- Resistance increases with temperature (metals)

Combination of Resistors

Resistors in Series

Key Points:

- Same current flows
- Total voltage = sum of voltages



Formula

$$R_s = R_1 + R_2 + R_3$$

R_1

R_2

R_3

V

$$R_{\text{total}} = R_1 + R_2 + \cdots = 24\,\Omega,\ I = 0.5$$

V1 = 4V2 = 4V3 = 4I = 0.5

Characteristics:

- Total resistance increases
- If one device fails → entire circuit stops

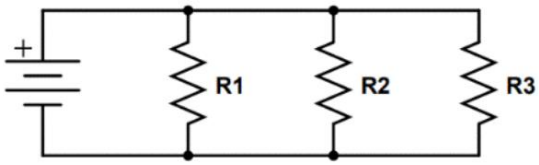
Applications:

- Decorative lights (old type)

Resistors in Parallel

Key Points:

- Same voltage across each resistor
- Current divides



Formula

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

R_1

R_2

R_3

V

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots,\ R_{\text{total}} = 2.67,\ I_T = 4.5$$

I1=1.5I2=1.5I3=1.5

Characteristics:

- Total resistance decreases
- Devices work independently

Applications:

- Domestic wiring

Comparison

Series	Parallel
Same current	Same voltage
Resistance increases	Resistance decreases
One failure stops all	Independent working

Heating Effect of Electric Current

Definition

When current flows through a conductor, heat is produced.

Formula (Joule's Law)

$$H = I^2Rt$$

Factors Affecting Heat

- Current (I^2)
- Resistance (R)
- Time (t)

Applications

Heating Devices:

- Electric iron
- Heater
- Toaster
- Kettle

Electric Bulb

- Filament made of **tungsten**
- High melting point

Electric Fuse

- Safety device
- Melts when current is high
- Protects appliances

Electric Power

Rate at which electrical energy is consumed.

Formula

$$P = VI$$

Other forms:

- $P = I^2R$
- $P = V^2/R$

Unit

- SI Unit: **Watt (W)**

Commercial Unit

- **1 kWh = 1 unit**

- 1 kWh = 3.6×10^6 J

Energy Formula

Energy = Power × Time

Important Numerical Concepts

- $I = Q/t$
- $V = IR$
- $R = \rho l/A$
- $H = I^2Rt$
- $P = VI$