

Chapter 8: Current Electricity

1. Charge

- **Charge** is a property of matter that feels a force in an electromagnetic field.
 - Two types: **Positive (+)** and **Negative (-)**.
 - SI Unit: **Coulomb (C)**
 - Formula: $Q = \pm ne$ where $e = 1.6 \times 10^{-19} \text{ C}$
 - **Non-conductors**: Charges stay fixed (no flow).
 - **Conductors**: Free electrons allow charge flow.
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2. Current (I)

- **Definition**: Rate of flow of charge.
 - **Formula**: $I = Q/t$
 - SI Unit: **Ampere (A)**
→ $1 \text{ A} = 1 \text{ C/s}$
 - Measured by **ammeter (series connection)**.
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3. Potential & Potential Difference

- **Potential (V)**: Work done per unit charge to move it from infinity.
 - $V = W/Q$, Unit = **Volt (V)**
 - **Potential Difference**: Work done to move charge between 2 points.
 - Measured by **voltmeter (parallel connection)**.
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4. Resistance (R)

- Opposition to current flow in a conductor.
- $R = V/I$, Unit = **Ohm (Ω)**
- **Depends on**:
 - Material
 - Length ($R \propto l$)
 - Area ($R \propto 1/A$)
 - Temperature ($R \propto T$)

5. Ohm's Law

- $V = IR$ (if T is constant)
 - Graphs:
 - **Straight line:** Ohmic conductors (e.g., metals)
 - **Curve:** Non-ohmic (e.g., diode, LED)
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6. Conductance & Resistivity

- **Conductance (G):** $G = 1/R$, Unit: **Siemen (S)**
 - **Resistivity (ρ):** $R = \rho(l/A)$, Unit: **$\Omega \cdot m$**
 - **Conductivity (σ):** $\sigma = 1/\rho$, Unit: **S/m**
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7. Choice of Wire Materials

- **Copper:** low resistance $\rightarrow$ wiring
 - **Nichrome:** high resistance $\rightarrow$ heaters
 - **Tungsten:** high melting pt $\rightarrow$ bulb filament
 - **Fuse:** lead-tin alloy $\rightarrow$ melts easily
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8. Superconductors

- Zero resistance at very low temp.
 - Ex: **Mercury** ($<4.2K$), **Lead** ($<7.25K$)
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9. Electric Cell & EMF

- Converts **chemical** $\rightarrow$ **electrical energy**.
- **EMF ($\mathcal{E}$):** Potential difference without current.
 - $\mathcal{E} = W/q = I(R + r)$
- **Terminal Voltage (V):** $V = IR$
- **Voltage drop (v):** $v = Ir$
- **Internal Resistance (r):** Resistance inside the cell.

10. Resistor Combinations

- **Series:**
 - $R_s = R_1 + R_2 + R_3 \dots$
 - Same current, voltage divides
- **Parallel:**
 - $1/R_p = 1/R_1 + 1/R_2 + 1/R_3 \dots$
 - Same voltage, current divides

11. Electrical Energy & Power

- **Work/Energy (W):** $W = VIt = I^2Rt = V^2t/R$
- **Power (P):** $P = W/t = VI = V^2/R = I^2R$
- **Units:**
 - Power: **Watt (W)**, kW, MW, GW
 - Energy: **Joule (J)**, kWh
 - $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$

12. Appliance Power Ratings

- Example: 100W–220V
 - $R = V^2/P$
 - $I = P/V$

13. Household Consumption

- **Energy (kWh)** = Power (kW) × Time (h)
- Cost = Energy × Rate per unit

14. Heating Effect of Current

- **Joule's Law:** $H = I^2Rt$ (in joules)
- Converts electric energy to heat, light, or mechanical energy.

