

Understanding Basic Electrical Concepts

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(A concise, organized guide for quick reference and deeper study)

1. Fundamental Quantities

Symbol	Quantity	Unit	Typical Symbolic Relationship
V	Voltage (Electric potential difference)	Volt (V)	$V = IR$
I	Current (Flow of charge)	Ampere (A)	$I = \frac{V}{R}$
R	Resistance (Opposes current)	Ohm (Ω)	$R = \frac{V}{I}$
P	Power (Rate of energy transfer)	Watt (W)	$P = VI = I^2R = \frac{V^2}{R}$
Q	Electric charge	Coulomb (C)	$Q = It$
E	Energy	Joule (J)	$E = Pt$

2. Core Concepts

2.1 Voltage (Potential Difference)

- Definition:** Work needed per unit charge to move a charge between two points.
- Analogy:** Height difference in a water tower; the larger the height, the more potential energy per liter of water.

2.2 Current

- Definition:** Rate of charge flow through a conductor.
- Direction:** Conventional current flows from positive to negative (opposite electron flow).

2.3 Resistance & Conductance

- Resistance (R):** Material property that impedes current; depends on length, cross-sectional area, and resistivity (ρ).
 $R = \rho \frac{L}{A}$
- Conductance (G):** Reciprocal of resistance, measured in Siemens (S).

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2.4 Ohm's Law

- **Linear relationship** for many conductors: $(V = IR)$.
- **Limits:** Not valid for non-linear devices (diodes, transistors) or when temperature changes significantly.

2.5 Power and Energy

- **Instantaneous Power:** $(P = VI)$.
- **Energy Consumed:** $(E = \int P, dt)$.
- **Practical formulae:**
 - Resistive load: $(P = I^2R = \frac{V^2}{R})$.

3. Circuit Elements

Element	Symbol	Typical Behavior	Key Equation
Resistor	R	Linear, obeys Ohm's law	$(V = IR)$
Capacitor	C	Stores electric field energy	$(I = C \frac{dV}{dt})$
Inductor	L	Stores magnetic field energy	$(V = L \frac{dI}{dt})$
Battery / Source	—	Provides/maintains voltage	(V_{source}) (ideal)
Switch	—	Opens or closes a path	No equation; binary state

4. Simple Circuit Analysis Techniques

4.1 Series Connections

- **Current:** Same through all components.
- **Voltage:** Divides proportionally to resistance.
- **Total Resistance:** $(R_{\text{total}} = R_1 + R_2 + \dots)$

4.2 Parallel Connections

- **Voltage:** Same across each branch.
- **Current:** Splits inversely with resistance.

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• **Total