

# Circuit Laws

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- Voltmeter — Measures voltage without drawing current
- Ammeter — Measures current without dropping voltage
- Resistance is a function of size, shape, and media properties:

$$R = \frac{V}{I} = \frac{l}{\sigma A} = \rho \frac{l}{A}$$

–  $\sigma$  is the conductivity,  $\rho$  is the resistivity,  $l$  is the length of the wire, and  $A$  is the cross-sectional area

- Siemens (S), the unit for conductance, is the inverse of resistance, where:  $S = \frac{1}{\Omega}$

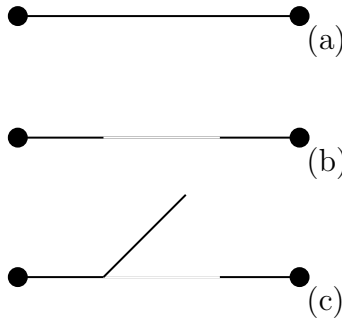


Figure 1: Different Circuit Types

- (a) shows a short circuit
- (b) shows an open circuit
- (c) shows an open switch

- Kirchhoff's Laws

- A circuit is said to be solved when voltage and current across each circuit element has been determined
- Consist of Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL)
- Node — A point where two or more circuit elements meet
- Sum of currents entering a node is zero (also holds for closed boundary)

$$\sum_{n=1}^N i_n = 0 \quad (\text{KCL})$$

- For any node, a unique voltage can be assigned
- Sum of voltages around a closed path is zero, or the sum of voltage drops is equal to the sum of voltage rises

$$\sum_{n=1}^N v_n = 0 \quad (\text{KVL})$$

- Add up the voltages in a systematic, clockwise movement around the loop
- Assign a positive sign to the voltage across an element if the (+) side of that voltage is encountered first, and assign a negative sign if the (-) side is encountered first

- Equivalent Circuits

- If the current and voltage characteristics at nodes are identical, the circuits are considered “equivalent”
- Identifying equivalent circuits simplifies analysis
- The following two equations may be used when working with resistors

$$R_{eq} = \sum_{i=1}^N R_i \quad (\text{in series})$$

$$v_i = \left( \frac{R_i}{R_{eq}} \right) v_s$$

- Variable resistors are useful in making an adjustable voltage divider circuit