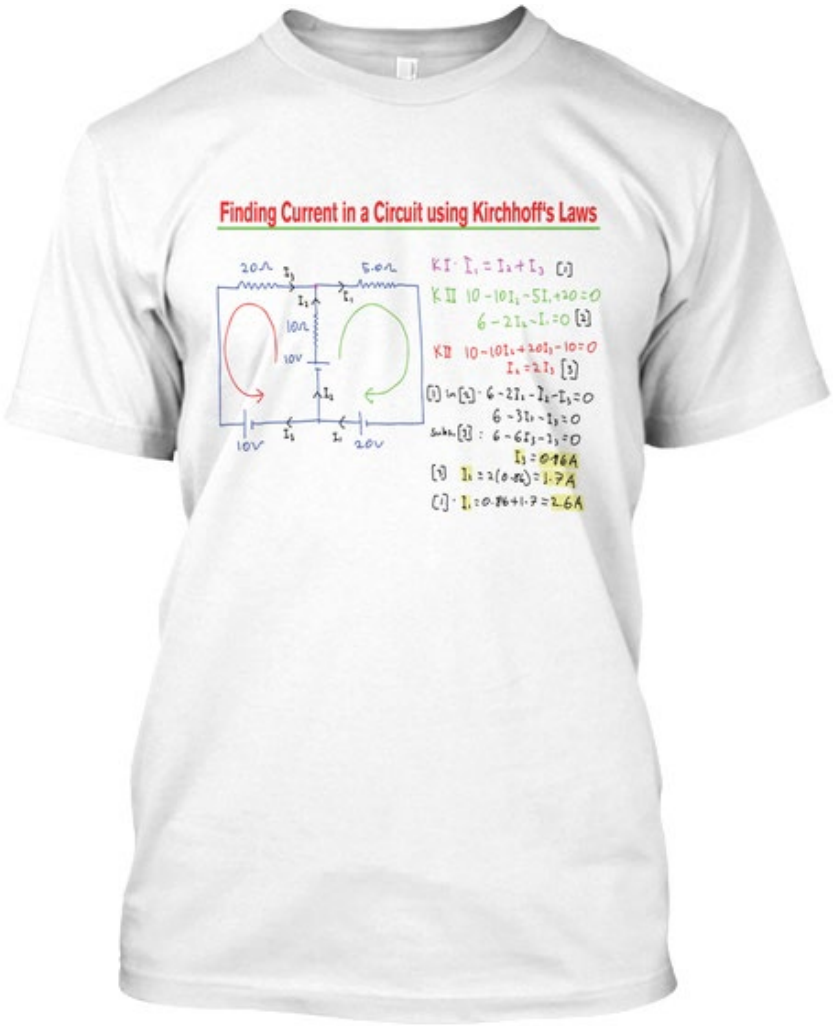
Kirchoff's Laws

Kirchoff's Laws form the foundation of all circuit analysis tools and techniques.

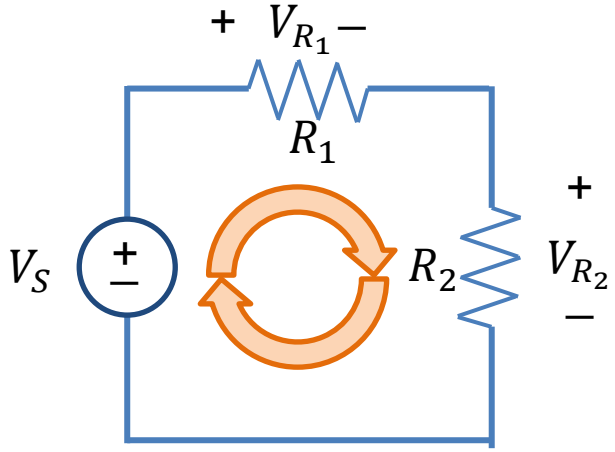
- ✓ Kirchoff's Voltage Law (KVL) – The sum of all voltage drops around a closed loop in a circuit must be equal to zero.

- ✓ Kirchoff's Current Law (KCL) – The sum of all currents entering any node in a circuit must be equal to the sum of all currents leaving that same node.



Kirchoff's Laws

Kirchoff's Voltage Law (KVL): The sum of all voltage drops around any closed loop in a circuit must be zero.



$$-V_S + V_{R_1} + V_{R_2} = 0$$

or equivalently

$$V_S = V_{R_1} + V_{R_2}$$

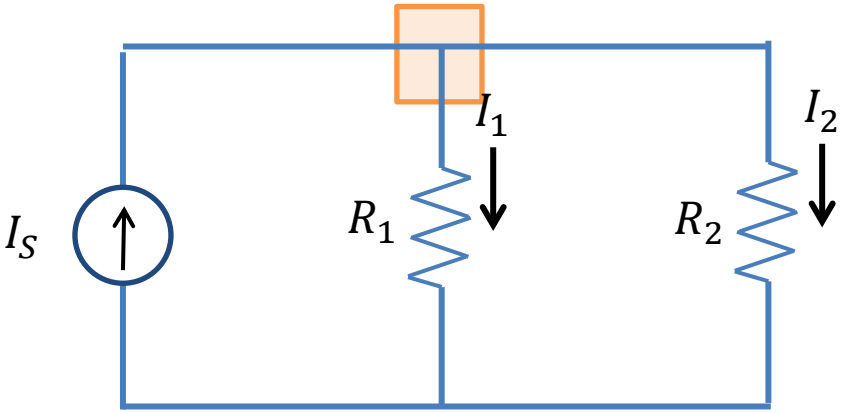
A Hiker's Analogy: Suppose we were hiking over hilly terrain. As we move along the hiking trail, we keep track of the changes in elevation (analogous to voltage rises/drops in our circuit). If we hike along a trail that eventually loops back to the starting point, the sum of all the elevation changes we encounter along the way must be zero.

Note:

- ✓ it doesn't matter where we start and end on the loop
- ✓ nor does it matter in which direction we traverse the loop.

Kirchoff's Laws

Kirchoff's Current Law (KCL): The sum of all currents entering (or leaving) any node of a circuit must be zero.



$$I_S - I_1 - I_2 = 0 \quad \text{(net flow in = 0)}$$

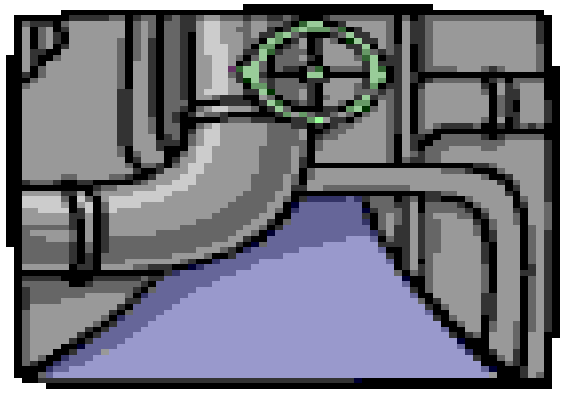
or equivalently

$$-I_S + I_1 + I_2 = 0 \quad \text{(net flow out = 0)}$$

or equivalently

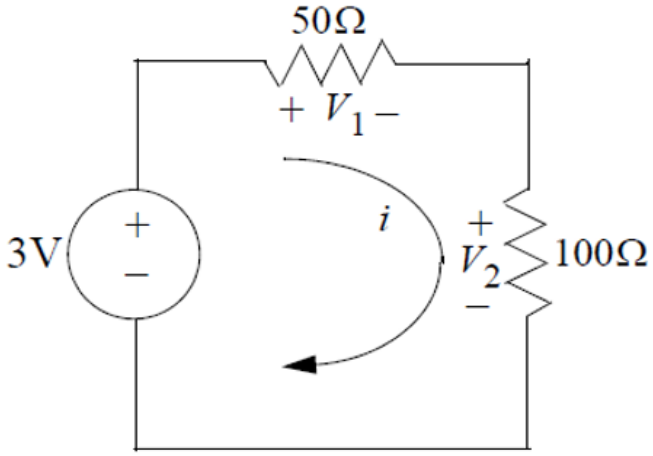
$$I_S = I_1 + I_2 \quad \text{(flow in = flow out)}$$

A Water Analogy: Consider water flowing through a series of pipes. At any junction where multiple pipes intersect, the net flow into the junction must be zero.



Example

For the circuit shown:
(a) Find the current flowing through the circuit.
(b) Find the voltage across each resistor.



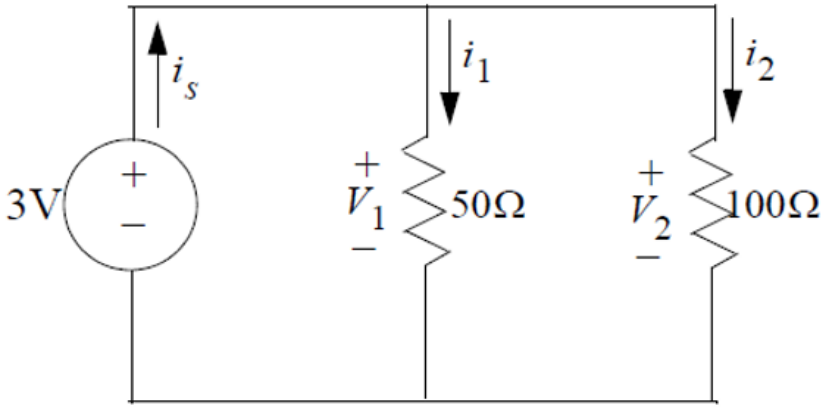
Example

For the circuit shown:

(a) Find the voltage drops across each resistor.

(b) Find the currents flowing through each resistor.

(c) Find the current flowing through the voltage source.



Example

For the circuit shown, find all voltages and currents for the three resistors.