Kirchoff's Laws

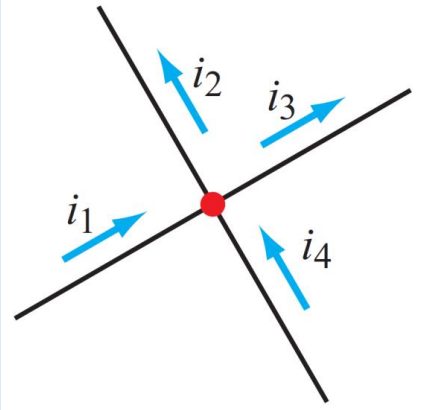
Kirchoff's Current Law (KCL)

The sum of currents entering a node must always be zero.

Common convention is to assign a positive "+" sign to a current if it is entering the node and a negative "–" sign if it is leaving it.

Given the node to the right, we can write:

$$i_1 - i_2 - i_3 + i_4 = 0$$



Note that this is equivalent to the perhaps more intuitive observation that the sum of currents entering a node must equal the sum of current exiting a node:

$$i_1 + i_4 = i_2 + i_3$$

Lastly, KCL applies to any closed surface, not just a node. This fact is used in some circuit analysis techniques (like the super-node method).

Kirchoff's Voltage Law (KVL)

The voltage across an element represents the amount of energy expended in moving positive charge from the negative terminal to the positive terminal, thereby establishing a potential energy difference between those terminals. The law of conservation of energy mandates that if we move electric charge around a closed loop, starting and ending at exactly the same location, the net gain or loss of energy must be zero.

The algebraic sum of the voltages around a closed loop must always be zero.

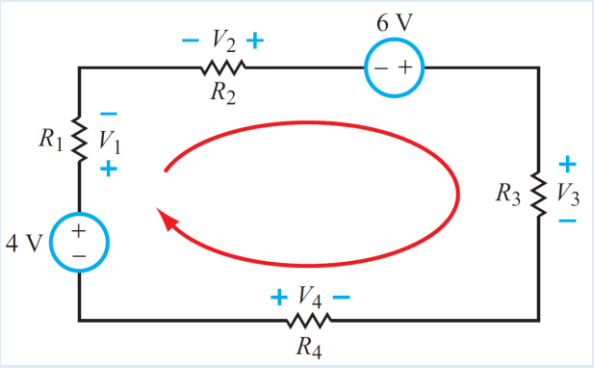
We make use of the following convention:

- 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.

Given the loop to the right and starting at the bottom left corner:

$$-4 + V_1 - V_2 - 6 + V_3 - V_4 = 0$$

This procedure will always hold for any loop in a circuit.



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