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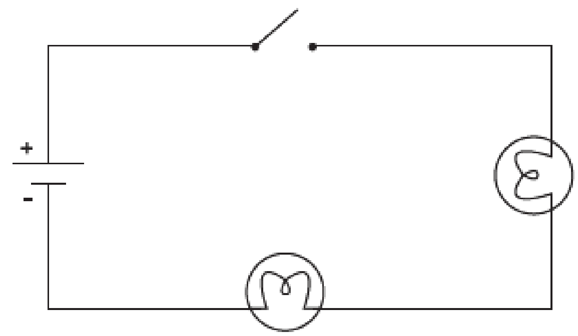
Parallel and Series Circuits

There are two main types of circuit set-ups for building electronic devices: Series and Parallel circuits.

Series Circuits

Series circuits are circuits with only one path from the negative terminal to the positive terminal of the voltage source. This means that the charges/current will flow through all loads and components in the circuit before returning to the voltage source.

Any breakage in the circuit, be it a damaged load or a break in the wiring will cause the circuit's current to stop entirely.

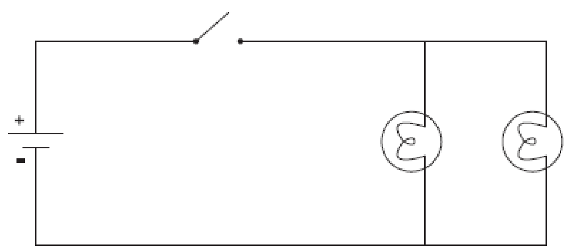


series circuit

Parallel Circuits

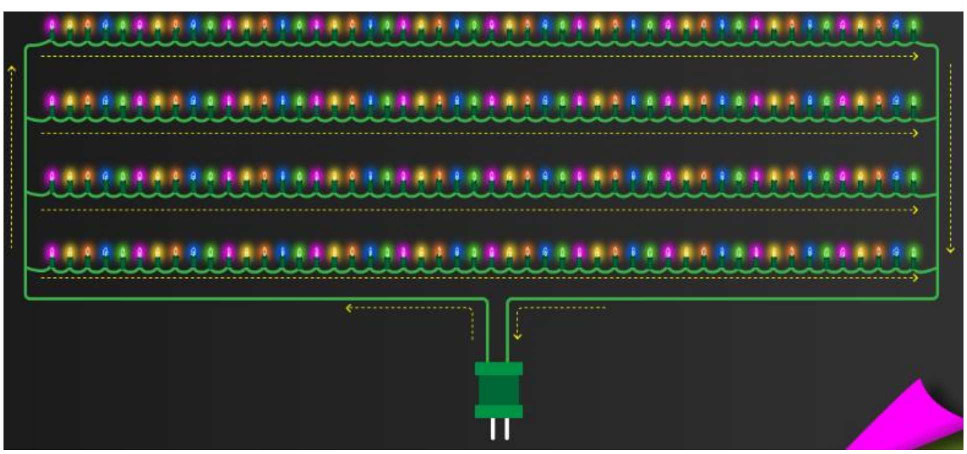
Parallel circuits are circuits that have two or more pathways in which the charges can leave the negative terminal of the voltage source and arrive at the positive terminal. Some charges will take one path, while others will take an alternative path. However, all charges will return to the voltage source.

The place where the pathways separate or join back together is called a **junction point.**



parallel circuit

A breakage in one circuit's path will not stop the circuit from flowing, allowing the circuit to become more robust than a series circuit.



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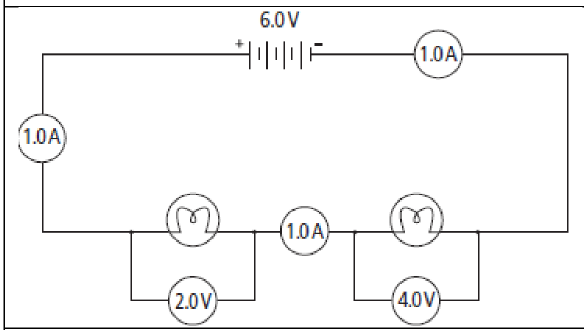
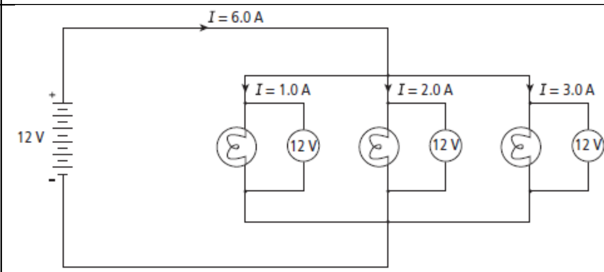
What happens to the current, voltage, and resistance in a series and parallel circuit?

The table below summarizes the effects that series and parallel circuits have on current voltage and resistance, along with mathematical formulas to determine specific values.

Series circuit	**Parallel circuit**
 	
Current The current through the whole circuit is the same throughout and is equal to the total current supplied by the source. $I_{total} = I_1 = I_2 = I_3 = ...$	**Current** The current through each pathway of the circuit adds up to the total current supplied by the source. $I_{total} = I_1 + I_2 + I_3 + ...$
Voltage The voltages across each of the loads in the circuit add up to the voltage supplied by the source. $V_{total} = V_1 + V_2 + V_3 + ...$	**Voltage** The voltages across each of the loads in a circuit are equal to each other and to the voltage supplied by the source. $V_{total} = V_1 = V_2 = V_3 = ...$
Resistance Resistors or loads placed in series increase the total resistance of the circuit. As a result, the total current throughout the circuit decreases. $R_{total} = R_1 + R_2 + R_3 + ...$ In the above example, the resistance across the first bulb is 2 Ω and the resistance across the second bulb is 4 Ω. This gives a total resistance around the circuit of 6 Ω. 2V / 1A = 2 Ω 4V / 1A = 4 Ω 2 Ω + 4 Ω = 6 Ω	**Resistance** Resistors placed in parallel decrease the total resistance of the circuit. As a result, the total current throughout the circuit increases. $\frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$ In the above example, the resistance across the first bulb is 12 Ω, the second bulb is 6 Ω, and the third bulb is 4 Ω. This gives a total resistance around the circuit of 2 Ω. 12V / 1A = 12 Ω 12V / 2A = 6 Ω 12V / 3A = 4 Ω $1/R_{total} = 1/12 + 1/6 + 1/4$ $1/R_{total} = 1/12 + 2/12 + 3/12 = 6/12 = 1/$**2** Therefore, $R_{total} = 2$ Ω