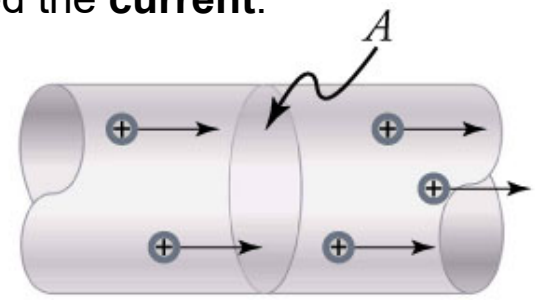


Electric Circuits

- An electric charge leaves a power source with potential energy (**voltage**) and travels through a circuit.
  - Voltage is measure in volts (V).
- As the charge moves through the circuit some of its potential energy is transformed to other types of energy by the components in the circuit.
  - light bulb (light energy), motor (mechanical energy), heater (heat energy)

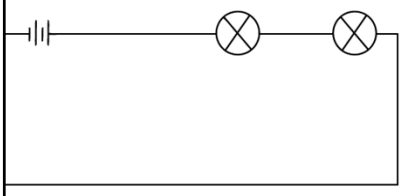
- When the charge returns to the power source, all its potential energy has been transformed into other forms of energy.
  - mechanical, light, sound, heat
- More than one charge moves through the circuit at a time. The amount of charge passing through the circuit every second is called the **current**.



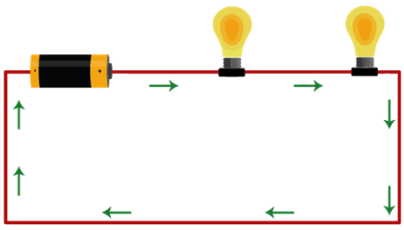
- It is the electrons in the wire that carry the energy through the circuit.
  - The electrons move from the negative side of the power source to the positive side.
- Current, however, is defined as flowing from positive to negative.
  - This is a result of naming conventions in place before the discovery of the electron.
  - Current is measured in amperes or amps (A).

- When charges flow through a circuit, they encounter obstacles.
  - other atoms, flaws in the wire, other charges
- When a charge collides with one of these obstacles, some of its energy (voltage) is transformed into heat energy.
- This opposition to the movement of charge is known as resistance.
  - Resistance is measured in ohms (Ω).

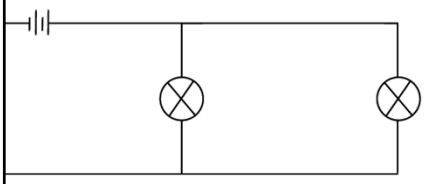
- Circuits can be divided into two types: series and parallel.



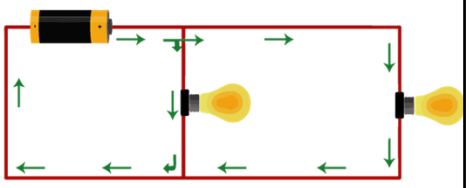
Series Circuit



Series Circuit

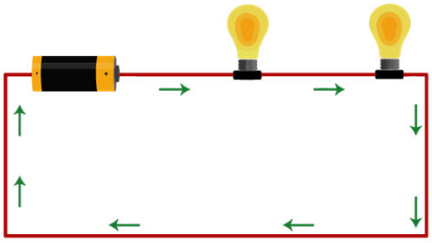


Parallel Circuit



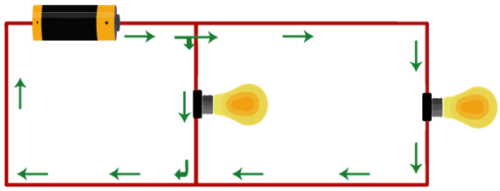
Parallel Circuit

- In a **series circuit**, the charges (current) have only one path to follow.



Series Circuit

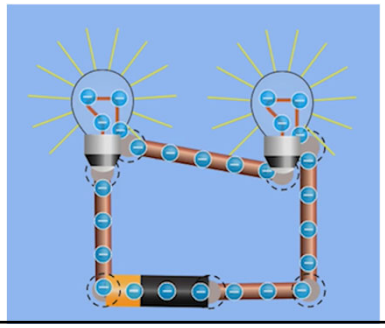
- In a **parallel** circuit, the charges (current) are split between multiple paths.

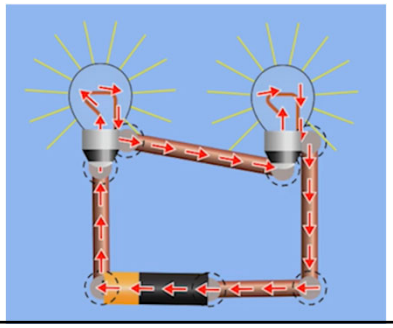


Parallel Circuit

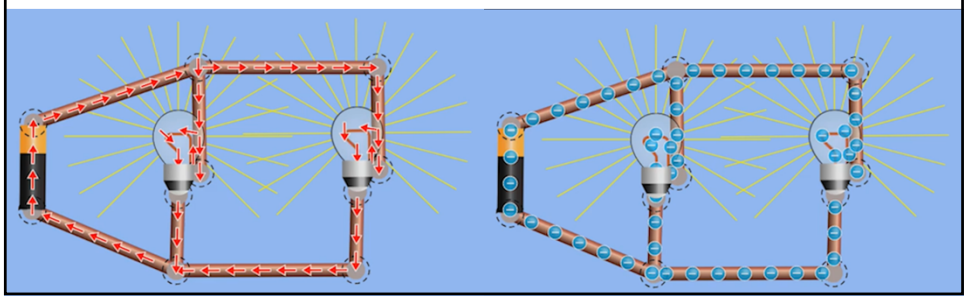
- In a series circuit, the **same** number of charges (**current**) flow through each device.
- In a parallel circuit, the **same** amount of potential energy (**voltage**) is transformed by each component.
  - Each charge must have 0 potential energy left when it returns to the power source regardless of how it traveled through the circuit.

- If more components are added to a series circuit, each one will get **less** energy (**voltage**).
- The **same** number of charges (**current**) flow through each component and the energy must be distributed to all the components.



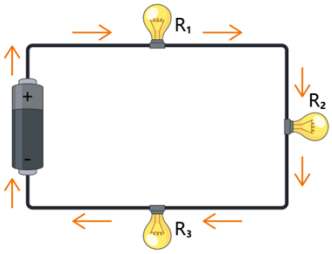


- If more components are added to a parallel circuit, the number of charges moving through circuit (current) must **increase**.
- Each component must receive the **same** amount of potential energy (**voltage**).



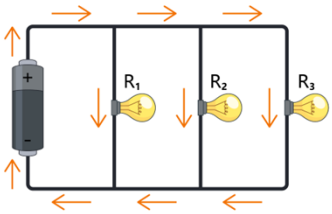
- If more components are added in series to a circuit, the total resistance in the circuit **increases**.
- If more components are added in parallel to a circuit, the total resistance in the circuit **decreases**.

Series Circuit



$R=R_1+R_2+R_3+...R_n$

Parallel Circuit



$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+...\frac{1}{R_n}$

Series

- Same current through all components.
- Voltage available to each component decreases when components are added.
- Resistance increases when components are added.

Parallel

- Same voltage across all components.
- Total current in the circuit increases when components are added.
- Resistance decreases when components are added.

- All buildings are wired in parallel.
  - The voltage is the same at every outlet, appliance and light.
  - When one component on a circuit fails (like a light bulb burning out), nothing else in the circuit is affected.



- Power is the amount of energy used (or transformed) by a circuit every second.
  - Power is measured in watts (W).
  - Energy is measured in joules (J).



- Power companies charge for energy used.
- You can calculate the amount of energy used by multiplying the power by time.
  - Power companies use kilowatt hours (kWh) as the units for energy, so you need to convert the power to kW and use hours for time.



Example

A light bulb has a power rating of 10.5 W.

a) How much energy is used if the light bulb is left on for 24 hours?

b) If the cost of electricity is 9.587 ¢/kWh, what is the cost of running the bulb continuously for 365 days?

a) $\frac{10.5}{1000} \times 24 \text{ hours} = 0.252 \text{ kWh}$

b) $0.252 \times \$\, 0.09587 \times 365 = \$\, 8.82$

Electrical Safety

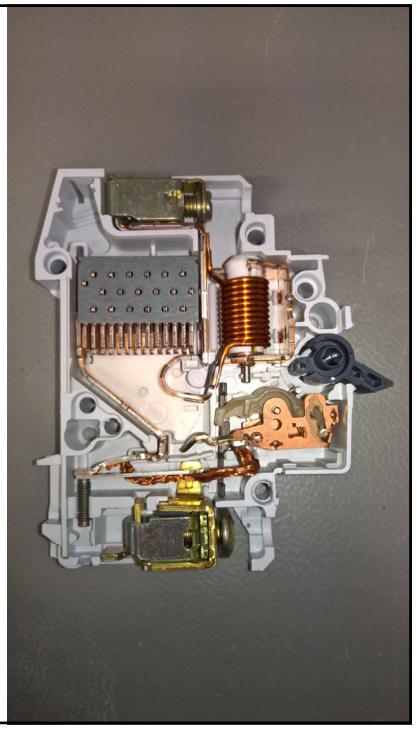


Circuit Breaker

- Each item in a circuit increases the amount of current flowing in the circuit.
- Too much current flowing through the wires could cause them to overheat and start a fire.
- A circuit breaker prevents the current from exceeding a specific amount.
  - A 15A breaker limits the current to 15A.

- If a circuit breaker stops working, it should be replaced with the same rated breaker.
  - Otherwise, you are violating building codes and increasing your chances of an electrical fire.





Power bar

- Power bars have a built-in circuit breaker to limit the amount of current flowing through them.
- Overloading a power bar can cause it to overheat and start a fire.



Extension Cord

- The thickness of the wires and the length of an extension cord determine the maximum current that can flow through it.
  - Putting too much current through an extension cord will cause it to heat up and become a fire hazard.
  - Connecting two extension cords together increases the total resistance which can cause the cords to heat up and start a fire.

Current	25 feet	50 feet	100 feet
up to 7 A	#18	#16	#14
8-10 A	#16	#14	#12
11-15 A	#14	#12	#10

