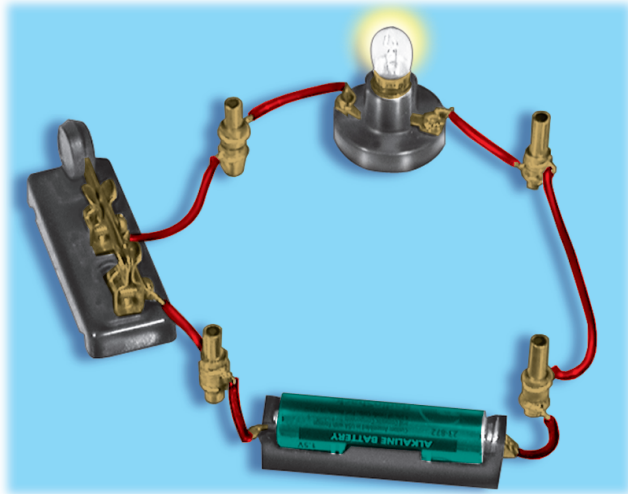
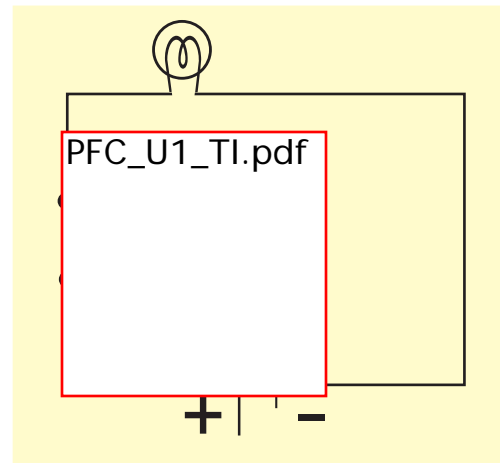


Circuit Diagrams

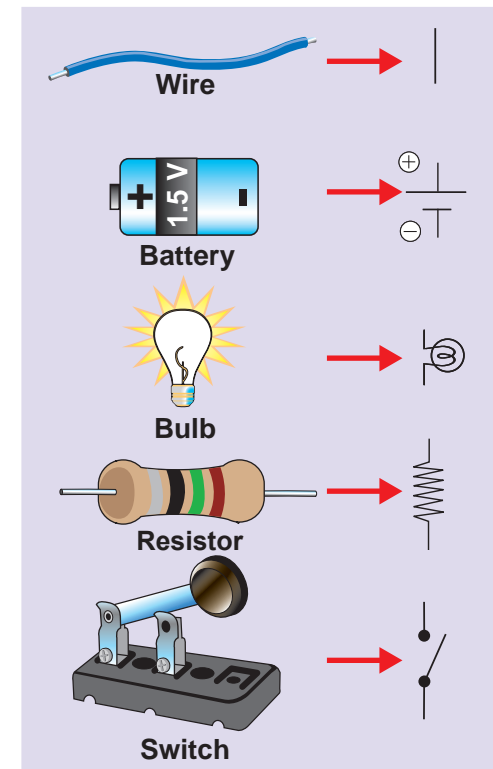
"Real life" example



Circuit diagrams are used to represent "real life"

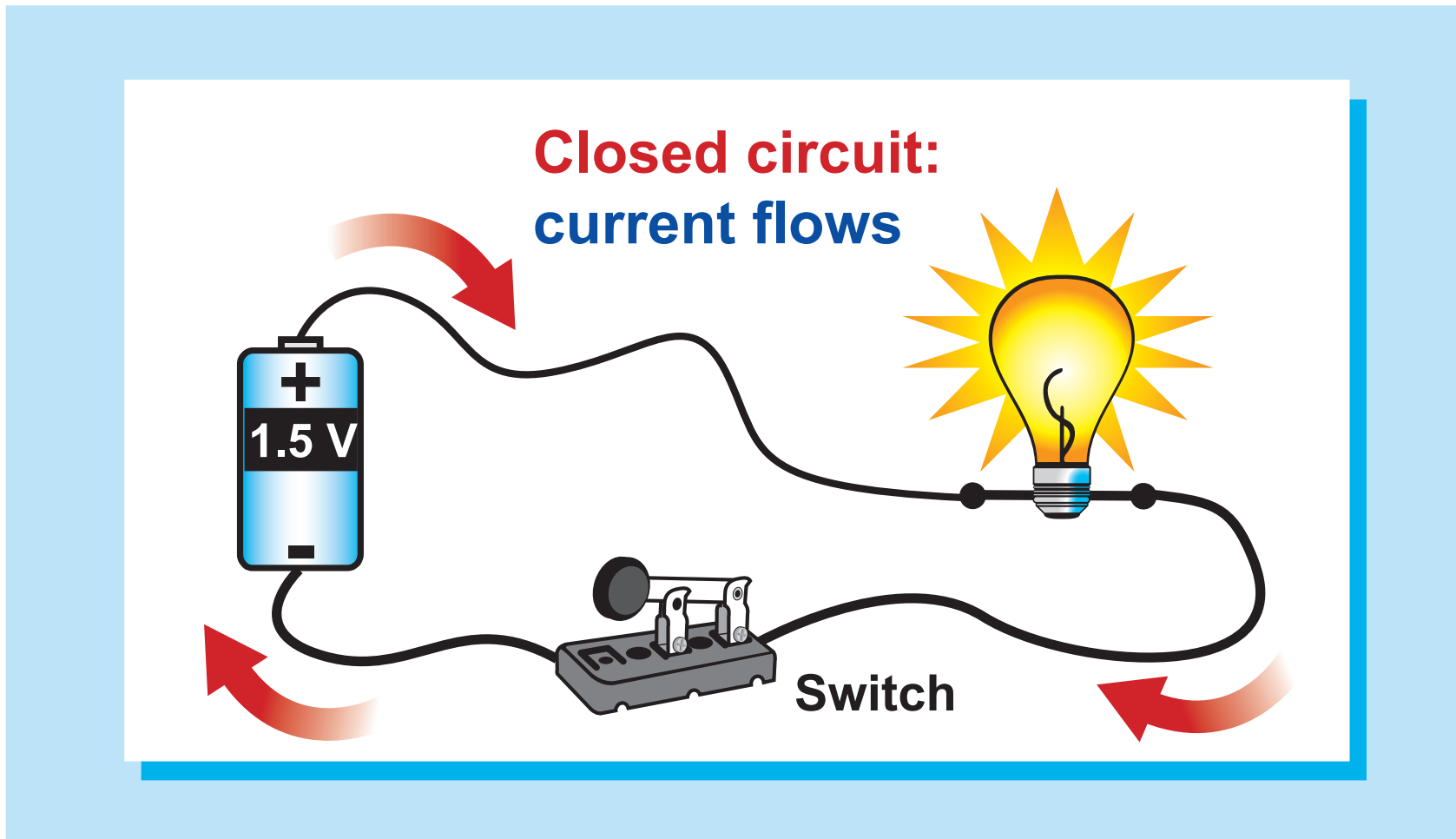


Circuit diagrams



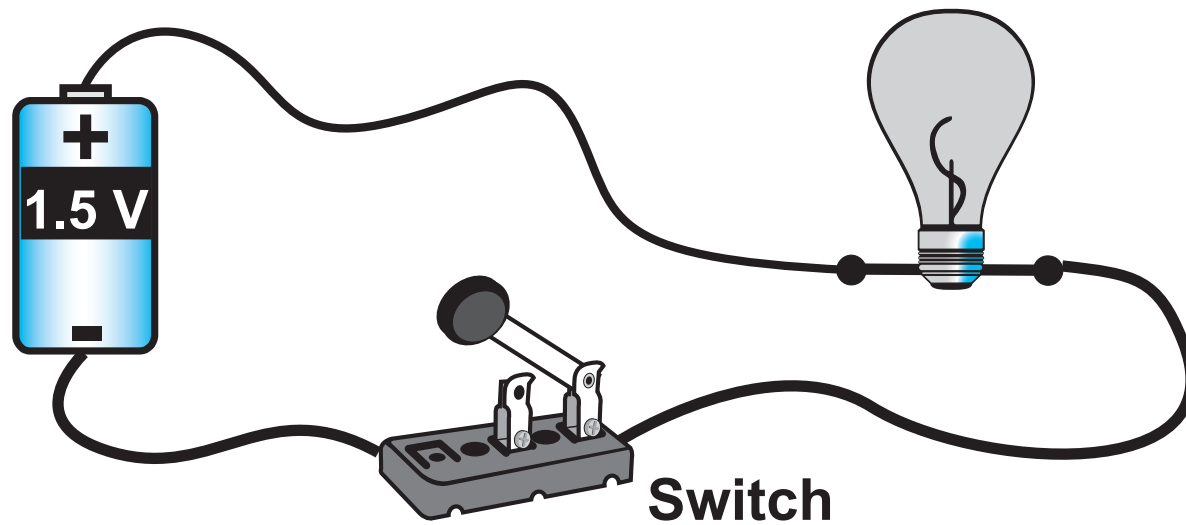
Symbols to use

Closed Circuit and Current

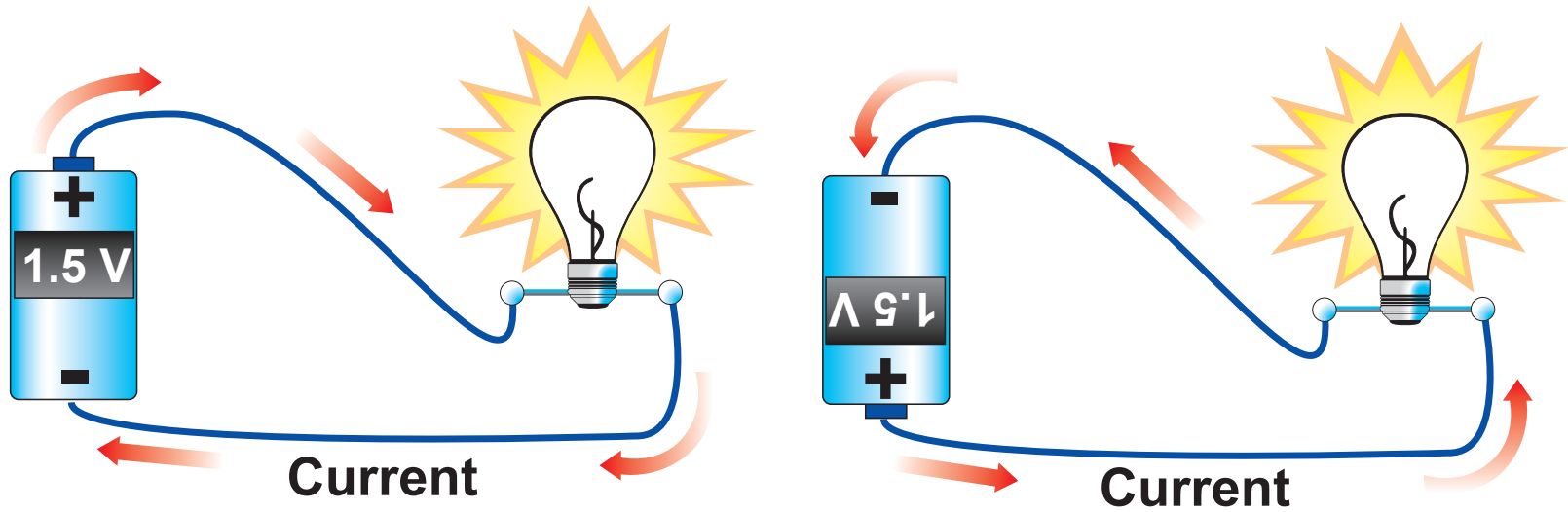


Open Circuit and Current

Open circuit:
no current flows

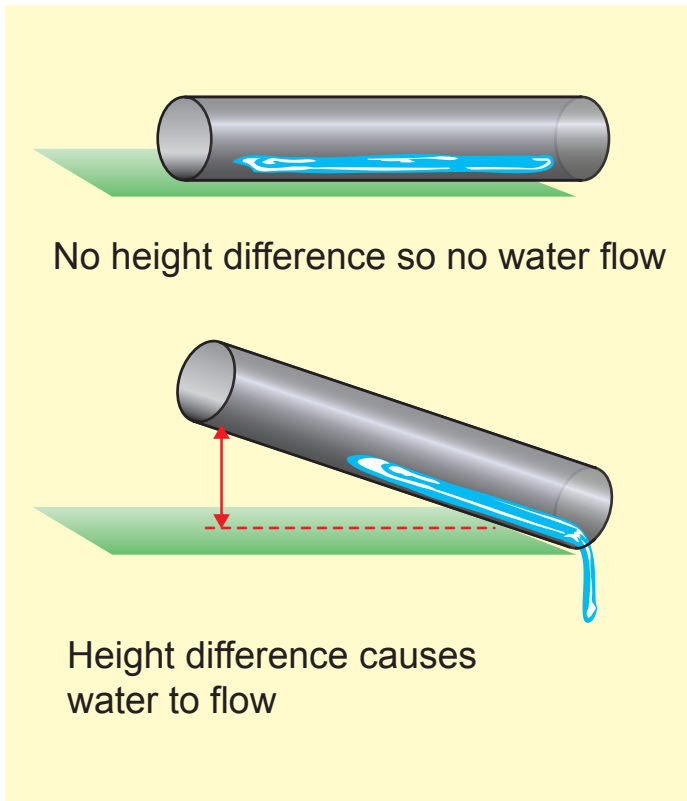


Current

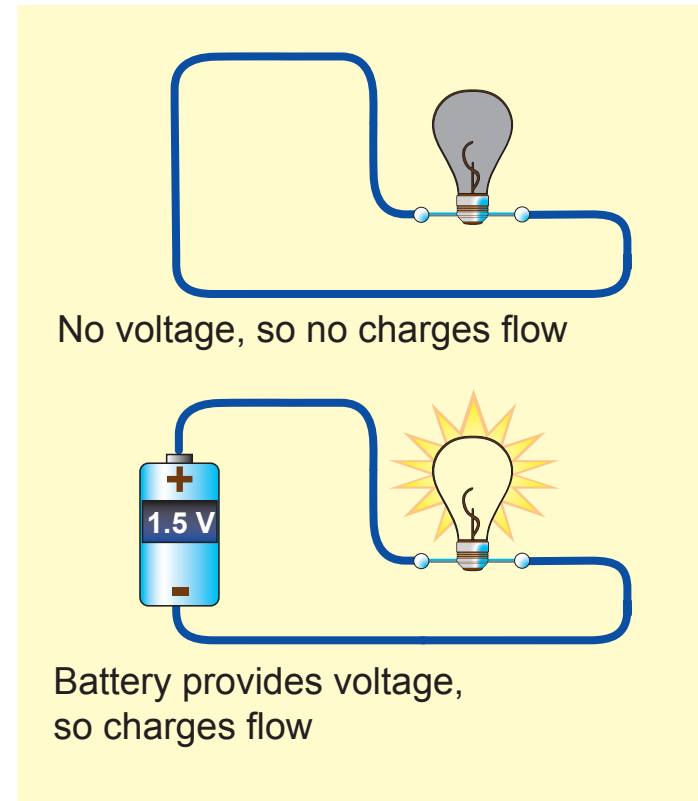


Electric current flows in a circuit from the positive end of a battery and returns toward the negative end.

Voltage



A change in height causes water to flow in a pipe.



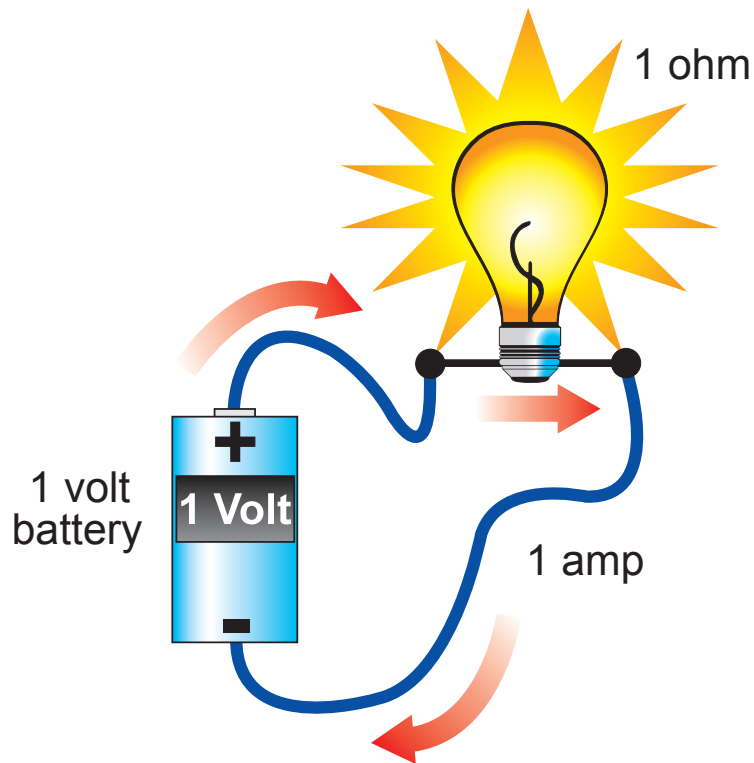
Current flows in a circuit because a battery creates a voltage difference.

Ohm's Law

$$\text{Current (amps, A)} \rightarrow I = \frac{V}{R}$$

Voltage (volts, V)

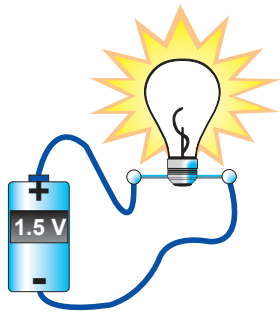
Resistance (ohms, Ω)



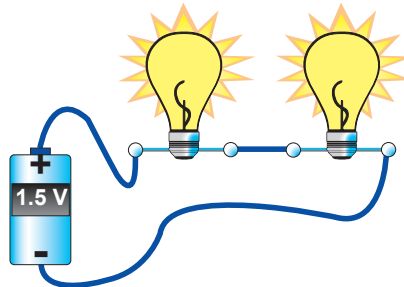
$$1 \text{ amp} = \frac{1 \text{ volt}}{1 \text{ ohm}}$$

1 volt creates a current of 1 amp through a resistance of 1 ohm.

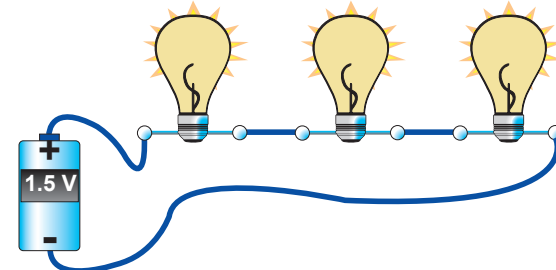
Resistance



One bulb
Single resistance
Full current



Two bulbs
Twice the resistance
Half the current

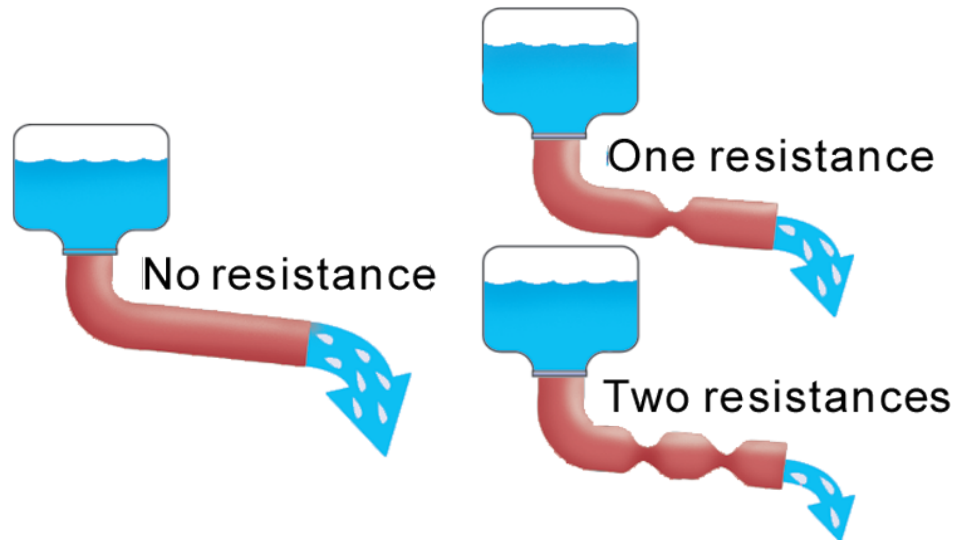


Three bulbs
Three times the resistance
One-third the current

Adding Resistances in Series

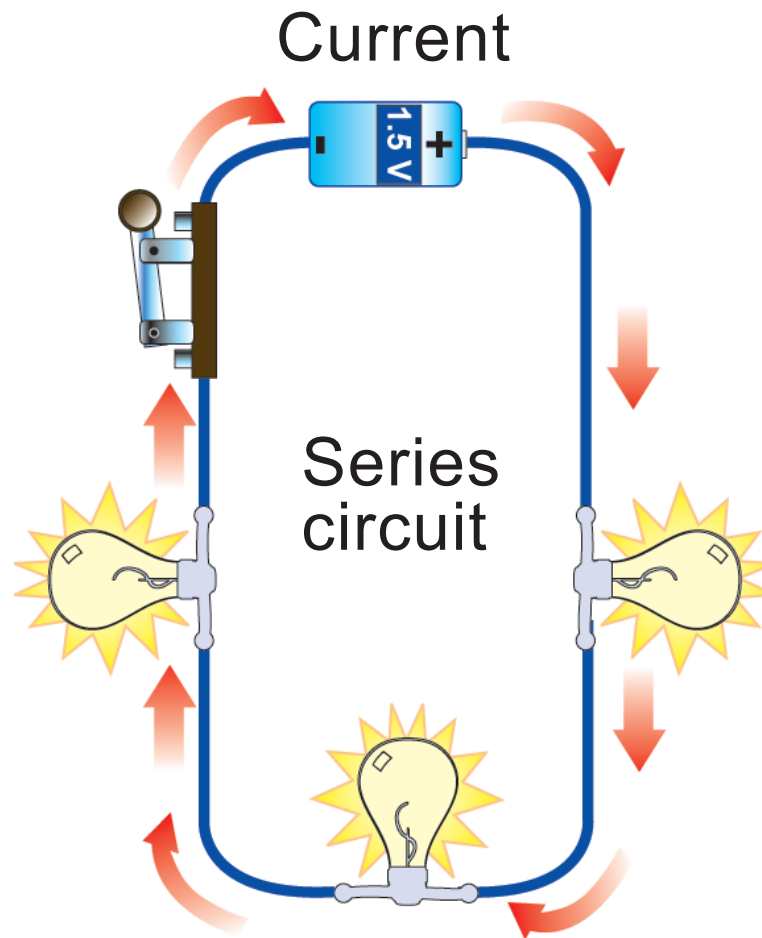
$$\underbrace{R_{total}} = \underbrace{R_1 + R_2 + R_3 + \dots}$$

Total resistance (Ω) *Individual resistances (Ω)*



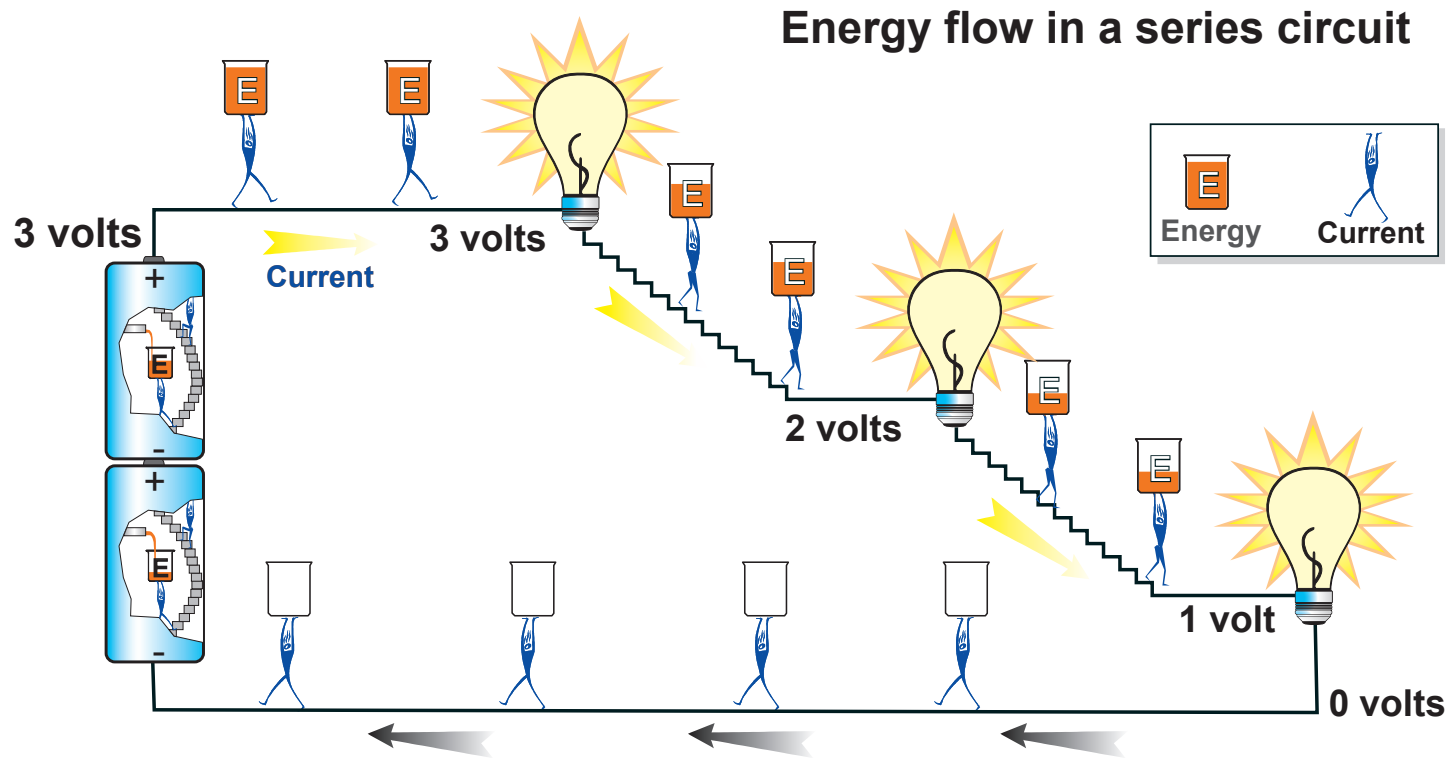
Adding resistors in a circuit is like adding pinches to a hose. The greater the number of pinches or resistors, the greater the resistance to current.

Series Circuits



A series circuit has only one path for the current so the current is the same at any point in the circuit.

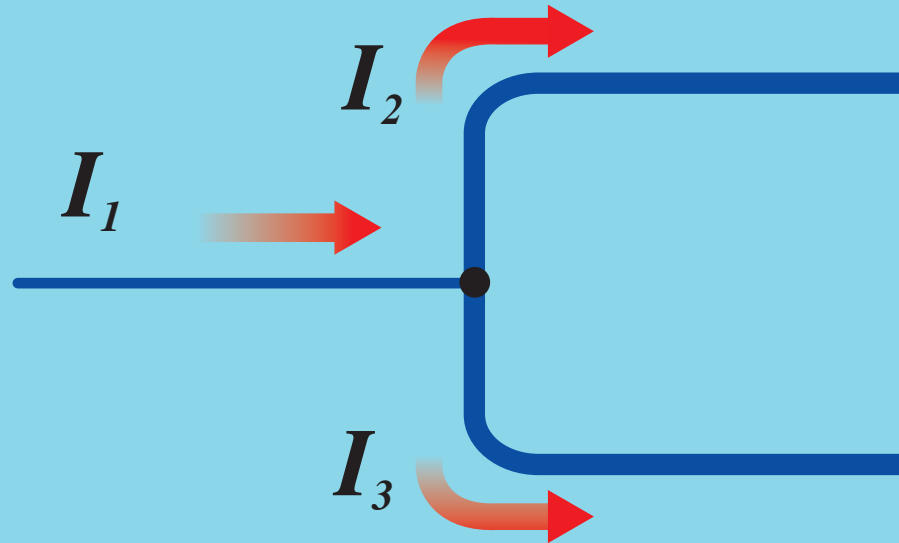
Voltage Drop



A voltage drop is the difference in voltage across an electrical device that has current flowing through it.

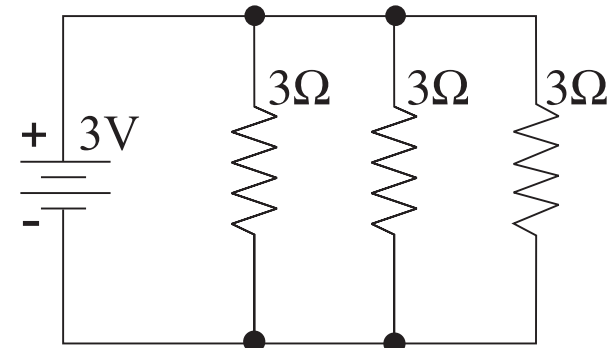
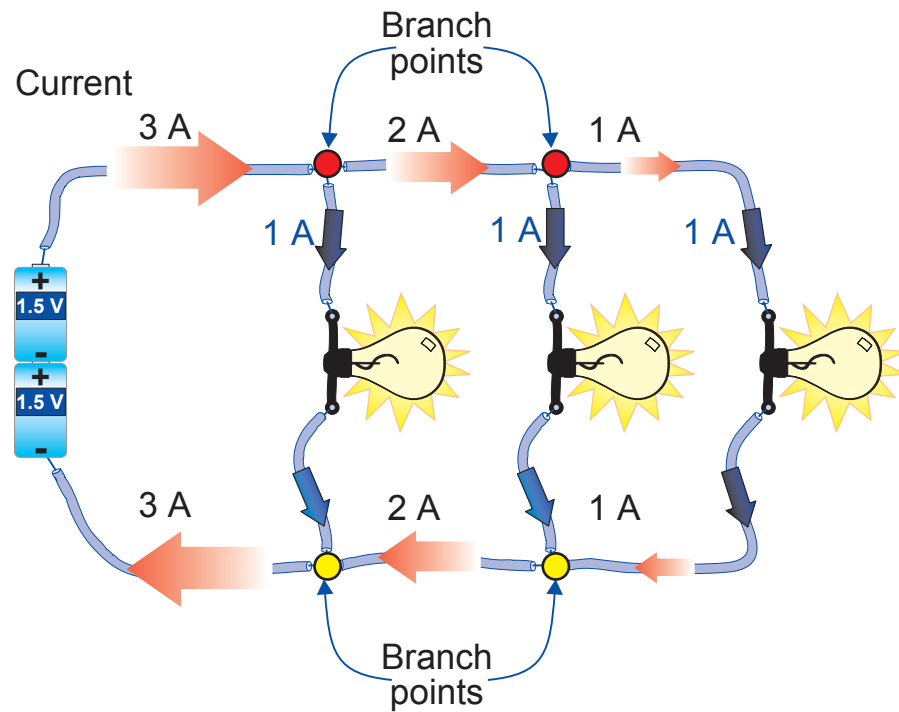
Kirchhoff's Current Law

All current flowing into a branch point must flow out again

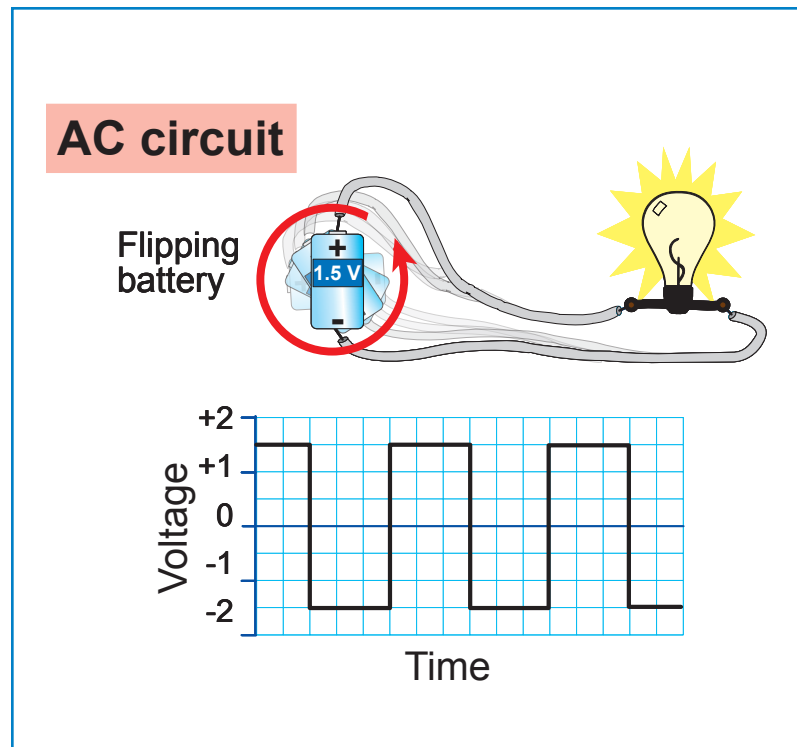


$$I_1 = I_2 + I_3$$

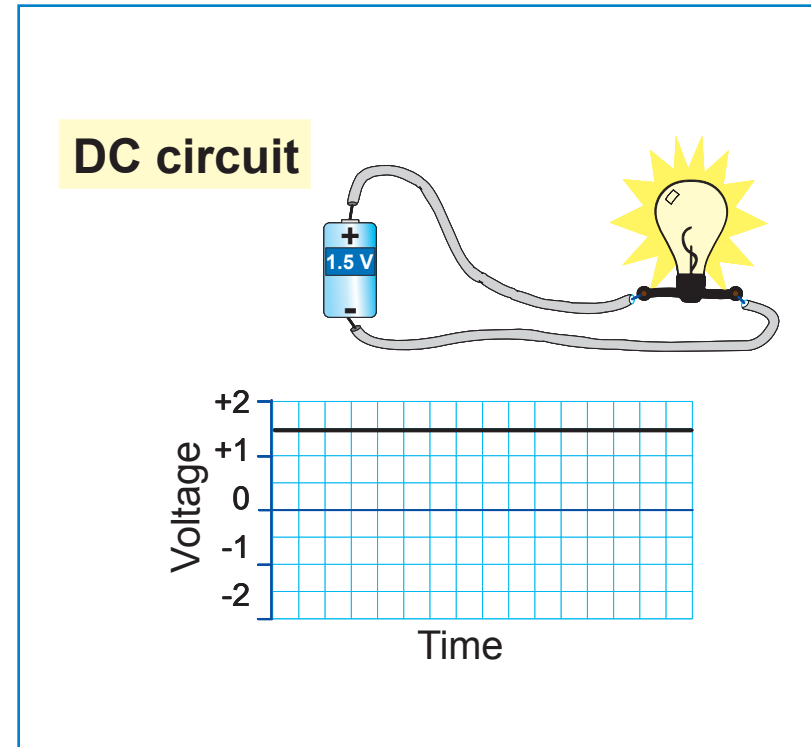
Parallel Circuits



Alternating and Direct Current



An AC current or voltage reverses sign usually 60 times per second in the United States.



A DC current or voltage keeps the same sign over time.

Electrical Power

Current (amps)

$$P = IV$$

Power (watts)

Voltage (volts)

Charges

There are only 2 kinds of electric charge:

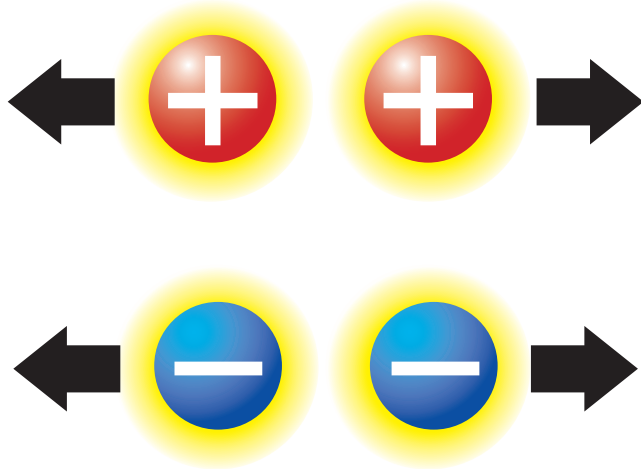
Positive



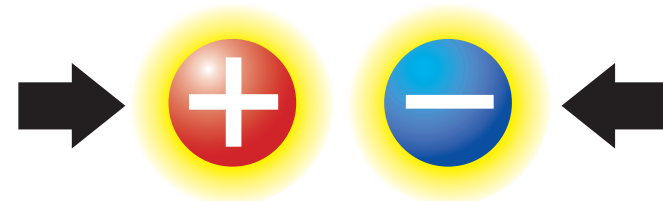
and Negative



Like charges repel.



Unlike charges attract.



Coulomb's Law

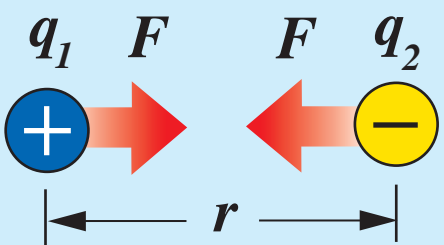
Constant
($9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)

Charges (C)


Electric force (N)

$$F_E = k \frac{q_1 q_2}{r^2}$$

Distance (m)




Force



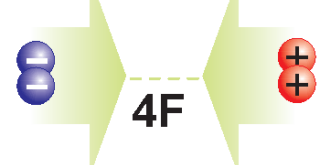
Force F

Doubling one charge doubles the force




Force $2F$

Doubling both charges multiplies the force by 4



Force $4F$

Doubling the distance reduces the force to 1/4 its original strength

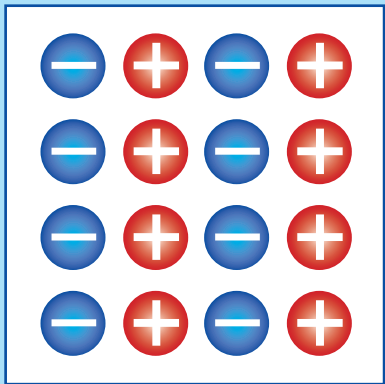


Force $F/4$

Static Electricity

A charged object has a small excess of one kind of electric charge.

This object is neutral.

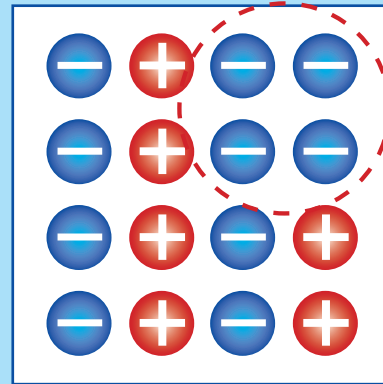


positive charge +8
negative charge -8

total 0

When an object has an equal number of positive and negative charges it is **NEUTRAL**.

This object is negatively charged.

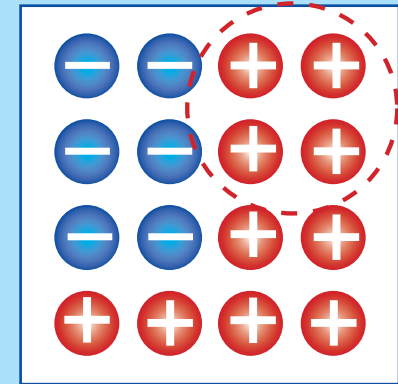


positive charge +6
negative charge -10

total -4

When an object has an unequal number of positive and negative charges it is **CHARGED**.

This object is positively charged.

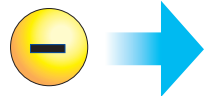


positive charge +10
negative charge -6

total +4

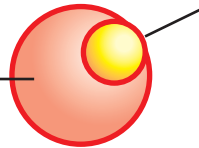
Conductor vs. Insulator

Moving electron



Electrical current is made of moving electrons; atoms stay fixed in place.

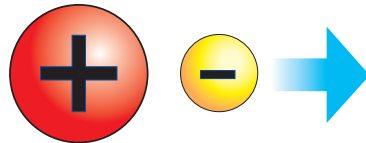
Atom in an insulator



Bound electron

In an insulator, the electrons are tightly bound to atoms and cannot move.

Atom in a conductor



Moving electron

In a conductor, some electrons come free and can move to create electrical current. Since electrons are negative, they move in a direction opposite the (positive) current.

Capacitors

Three factors determine a capacitor's capacitance.

