Science of Electricity

Unit 1

Electricity

Movement of electrons

Invisible force that provides

light, heat, sound, motion . . .

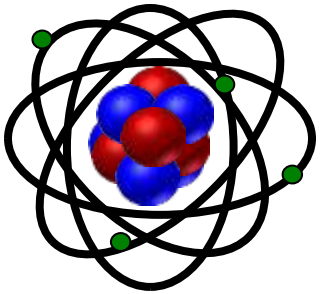
Electricity at the Atomic Level

Elements—The simplest form of matter

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 *La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 +Ac	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113					

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Atoms—Smallest piece of an element containing all of the properties of that element



Electricity at the Atomic Level

Components of an Atom

Nucleus

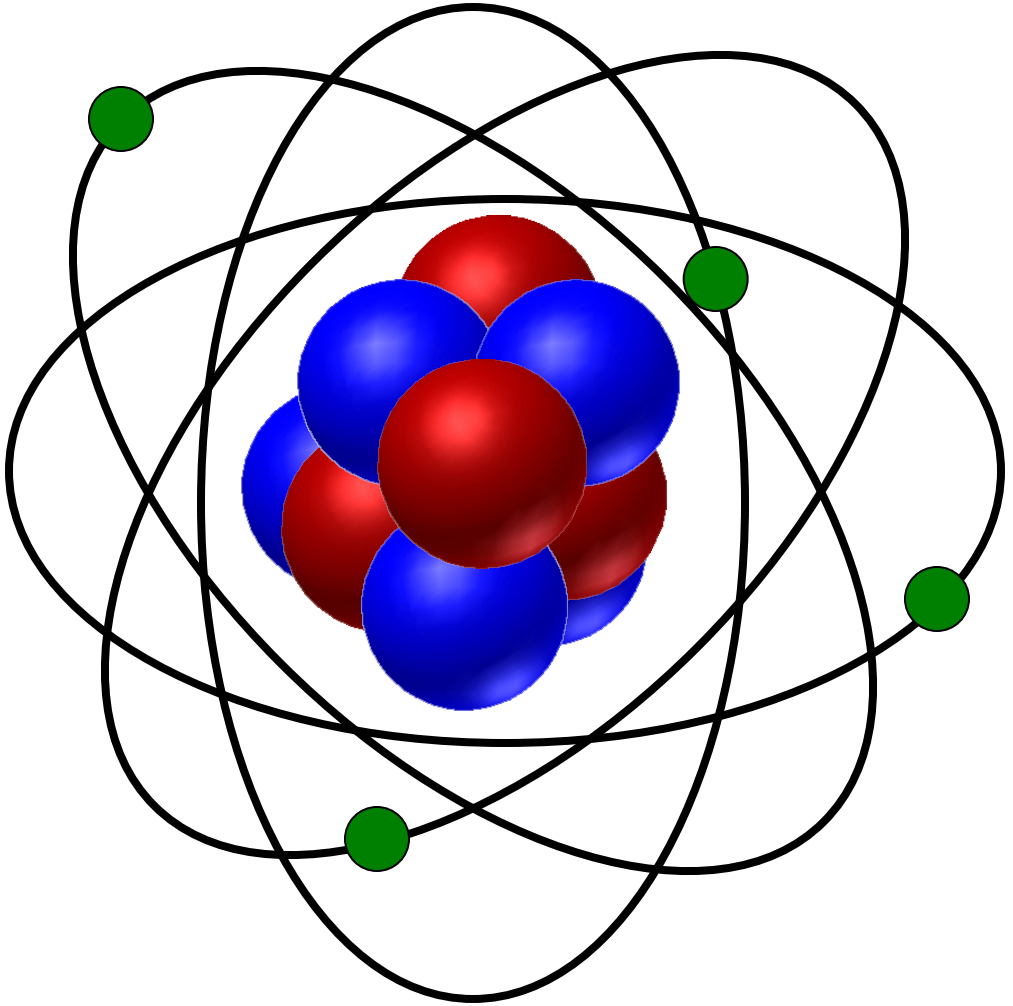
The center portion of an atom containing the protons and neutrons

Protons

Positively charged atomic particles

Neutrons

Uncharged atomic particles



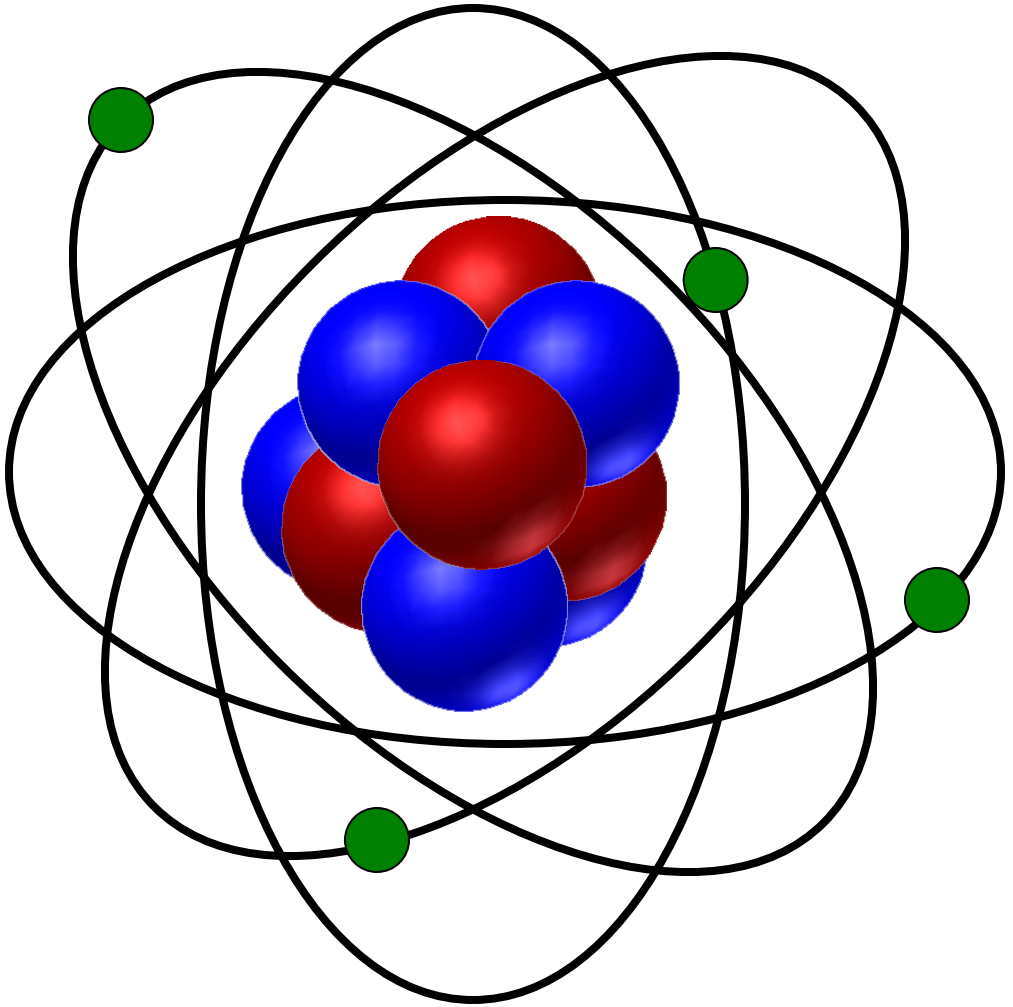
Electricity at the Atomic Level

Atomic Number

The atomic number is equal to the number of protons in the nucleus of an atom.

The atomic number identifies the element.

How many protons are in this nucleus?



Electricity at the Atomic Level

Electrons

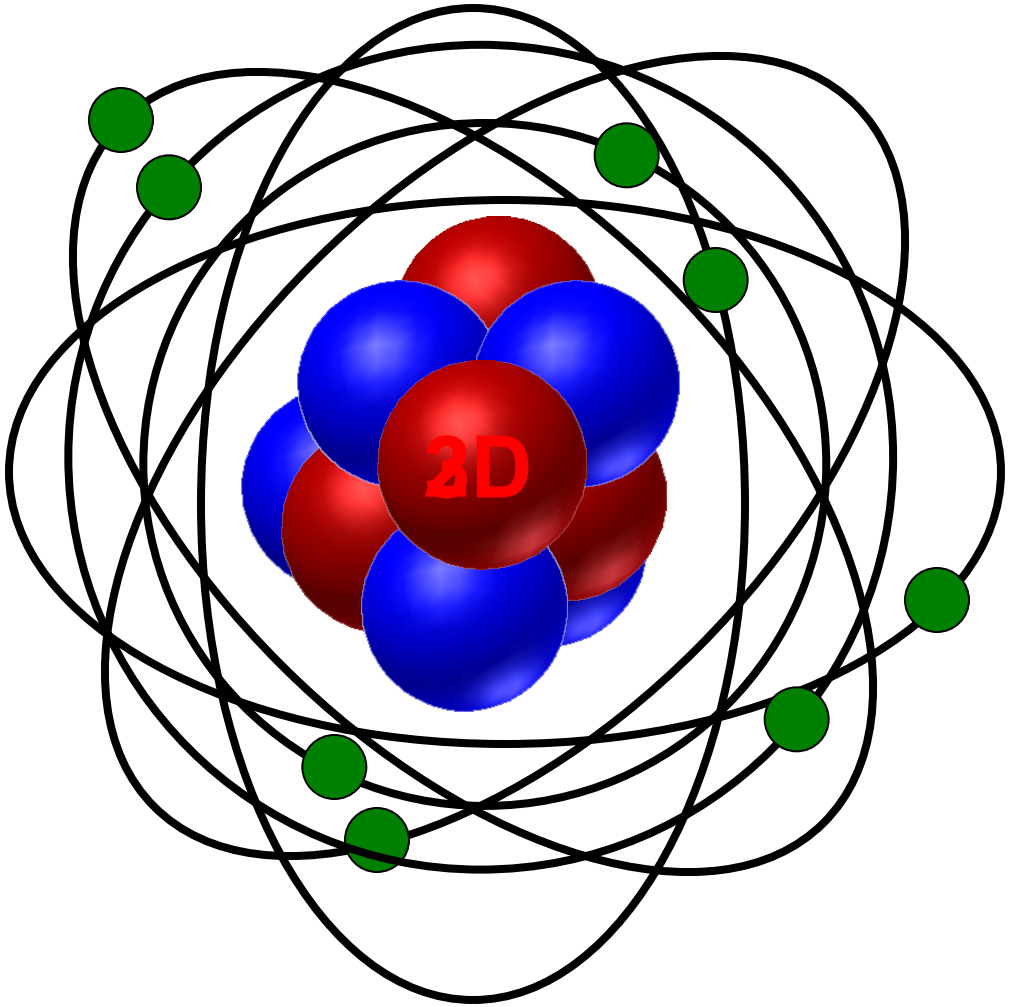
Negatively charged particles

Electron Orbitals

Orbits in which electrons move around the nucleus of an atom

Valence Electrons

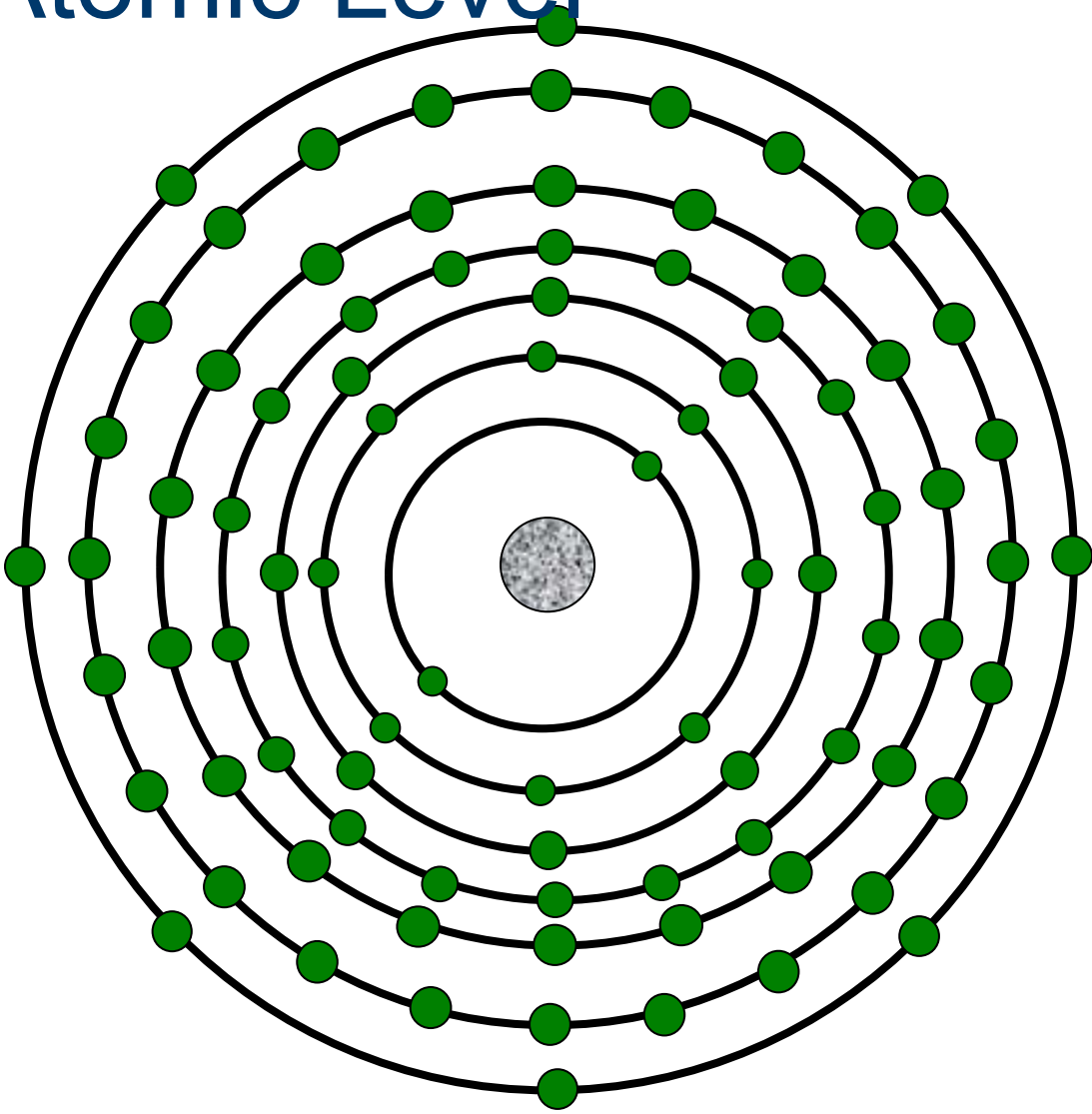
The outermost ring of electrons in an atom



Electricity at the Atomic Level

Electron Orbits

Orbit Number	Maximum Electrons
1	2
2	8
3	18
4	32
5	50
6	72
Valence Orbit	8
Max # of Electrons = $2n^2$ n = Orbit Number	



Orbits closest to the nucleus fill first

Electricity at the Atomic Level

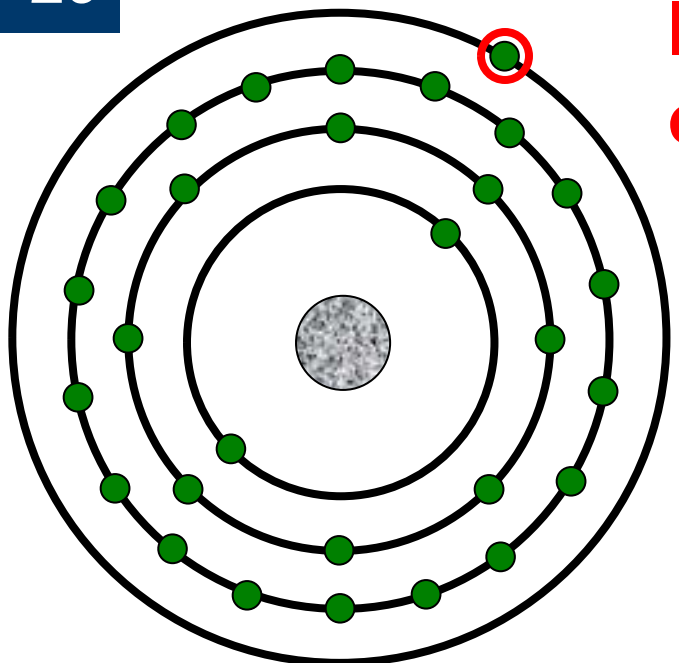
Electron Orbits

Atoms like to have their valence ring either filled (8) or empty(0) of electrons.

Copper

Cu

29



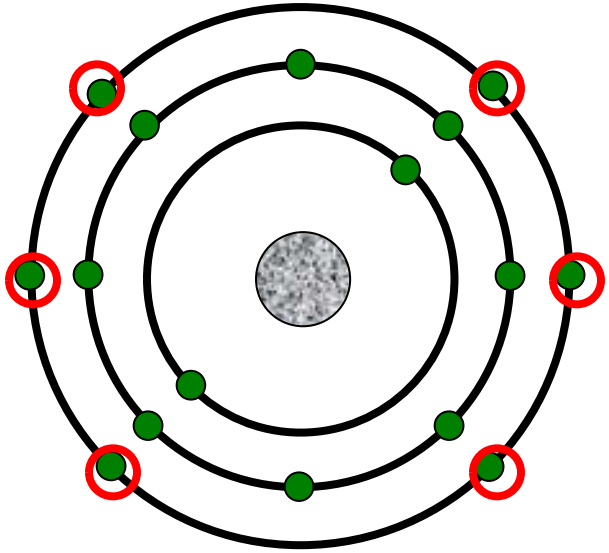
How many electrons are in the valence orbit? 1

Is copper a conductor or insulator? Conductor

Why?

Electricity at the Atomic Level

Electron Orbits



How many electrons are in the valence orbit?

6

Is sulfur a conductor or insulator?

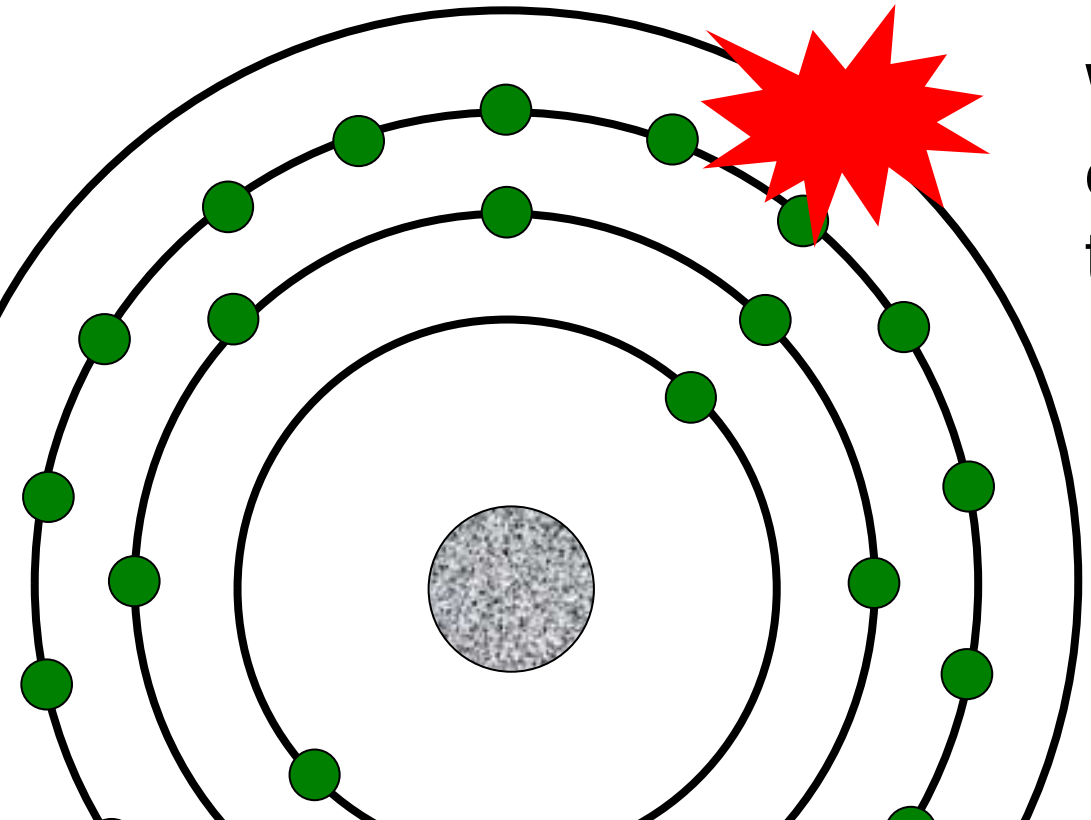
Insulator

Why?

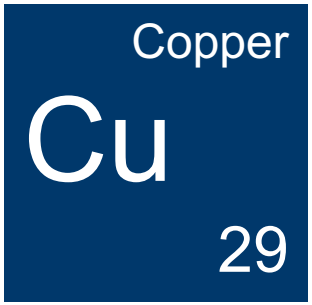
Electricity at the Atomic Level

Electron Flow

An electron from one orbit can knock out an electron from another orbit.



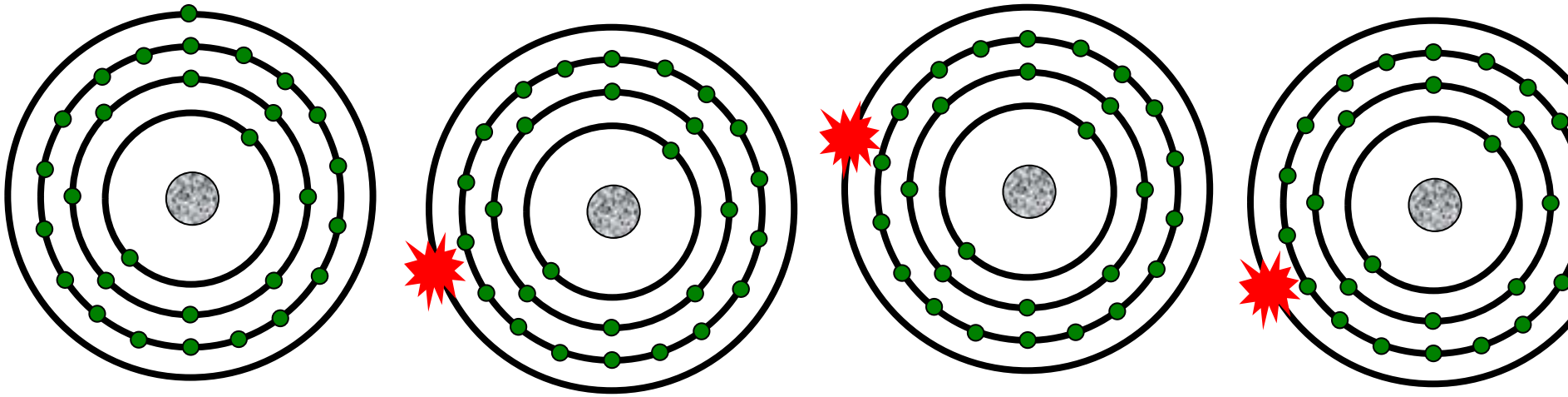
When an atom loses an electron, it seeks another to fill the vacancy.



Electricity at the Atomic Level

Electron Flow

Electricity is created as electrons collide and transfer from atom to atom.



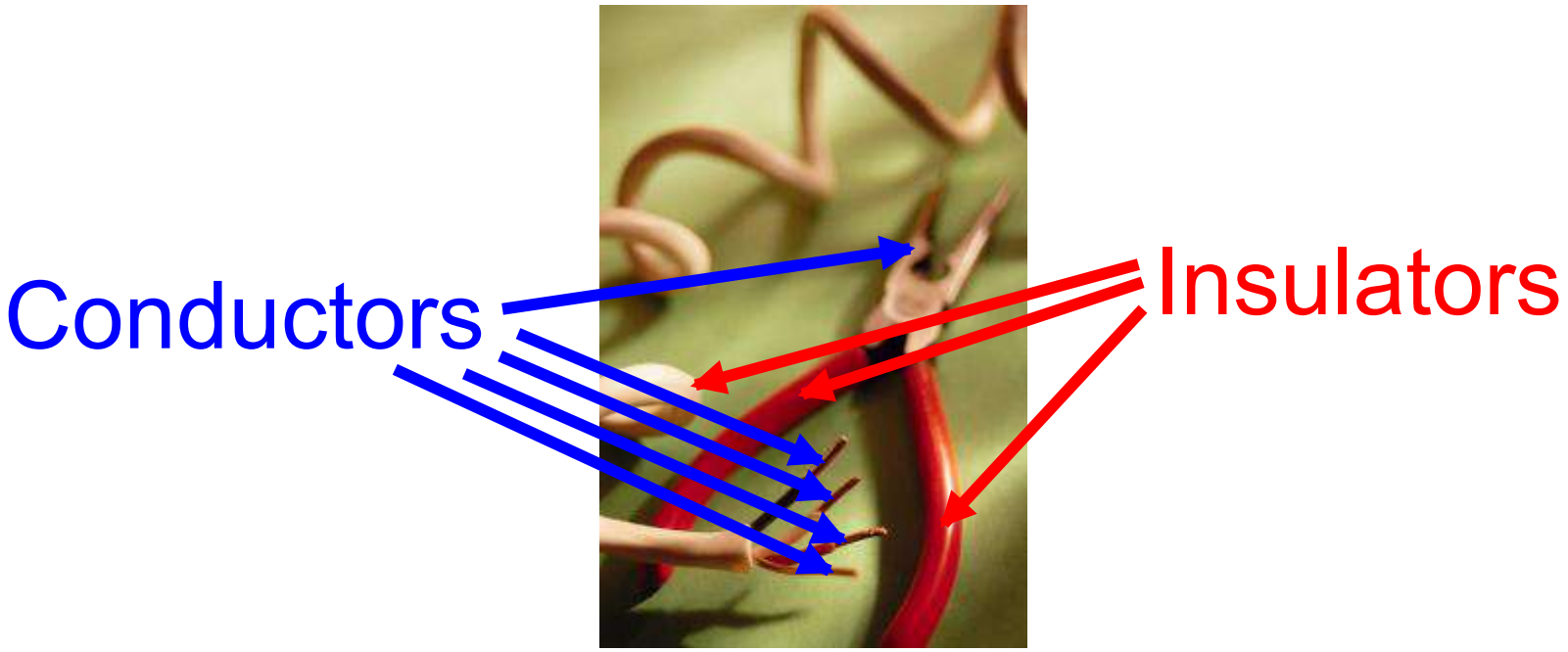
Play Animation

Conductors and Insulators

Conductors	Insulators
Electrons flow easily between atoms	Electron flow is difficult between atoms
1–3 valence electrons in outer orbit	5–8 valence electrons in outer orbit
Examples: Silver, Copper, Gold, Aluminum	Examples: Mica, Glass, Quartz

Conductors and Insulators

Identify conductors and insulators



Electrical Circuit

A system of conductors and components forming a complete path for current to travel

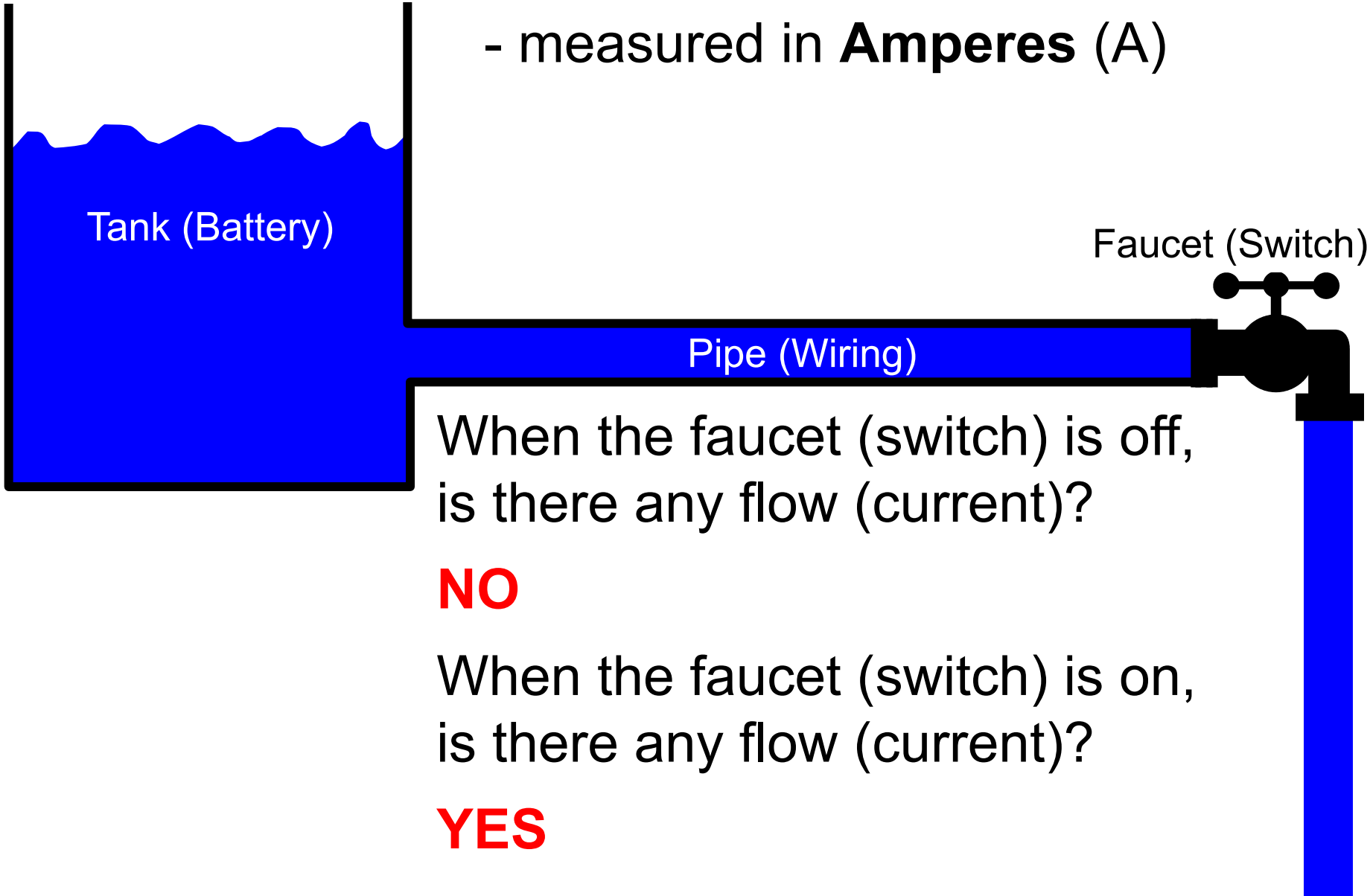
Properties of an electrical circuit include

Voltage	**Volts**	**V**
Current	**Amps**	**A**
Resistance	**Ohms**	**Ω**

Current

The *flow* of electric charge

- measured in **Amperes** (A)



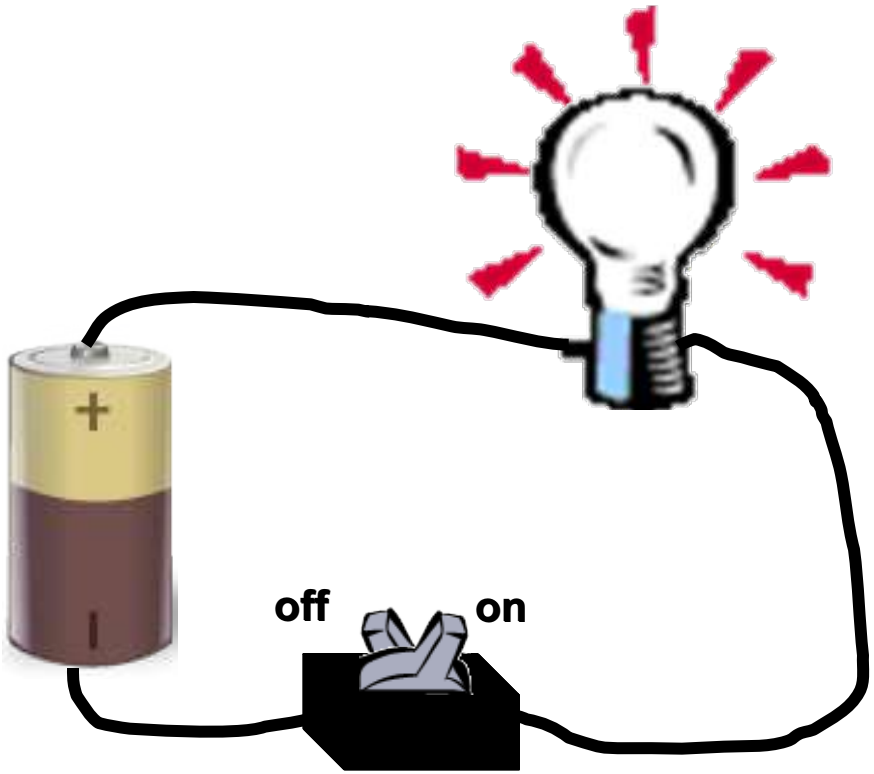
When the faucet (switch) is off, is there any flow (current)?

NO

When the faucet (switch) is on, is there any flow (current)?

YES

Current in a Circuit

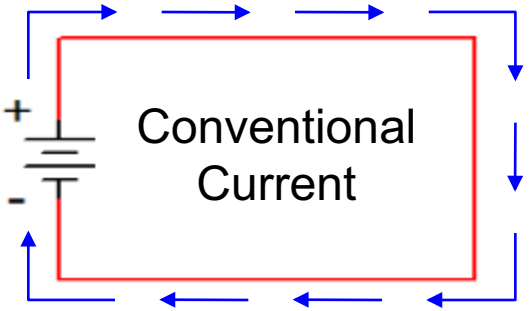


When the switch is off, there is no current.

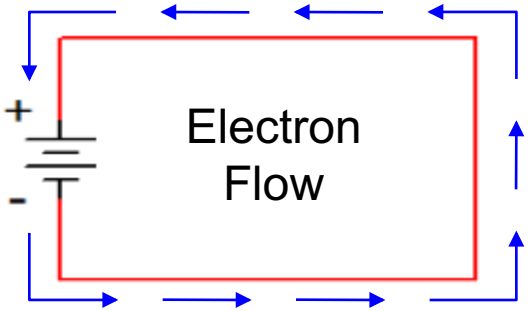
When the switch is on, there is current.

Current Flow

Conventional current assumes that current flows out of the positive side of the battery, through the circuit, and back to the negative side of the battery. This was the convention established when electricity was first discovered, but it is incorrect!



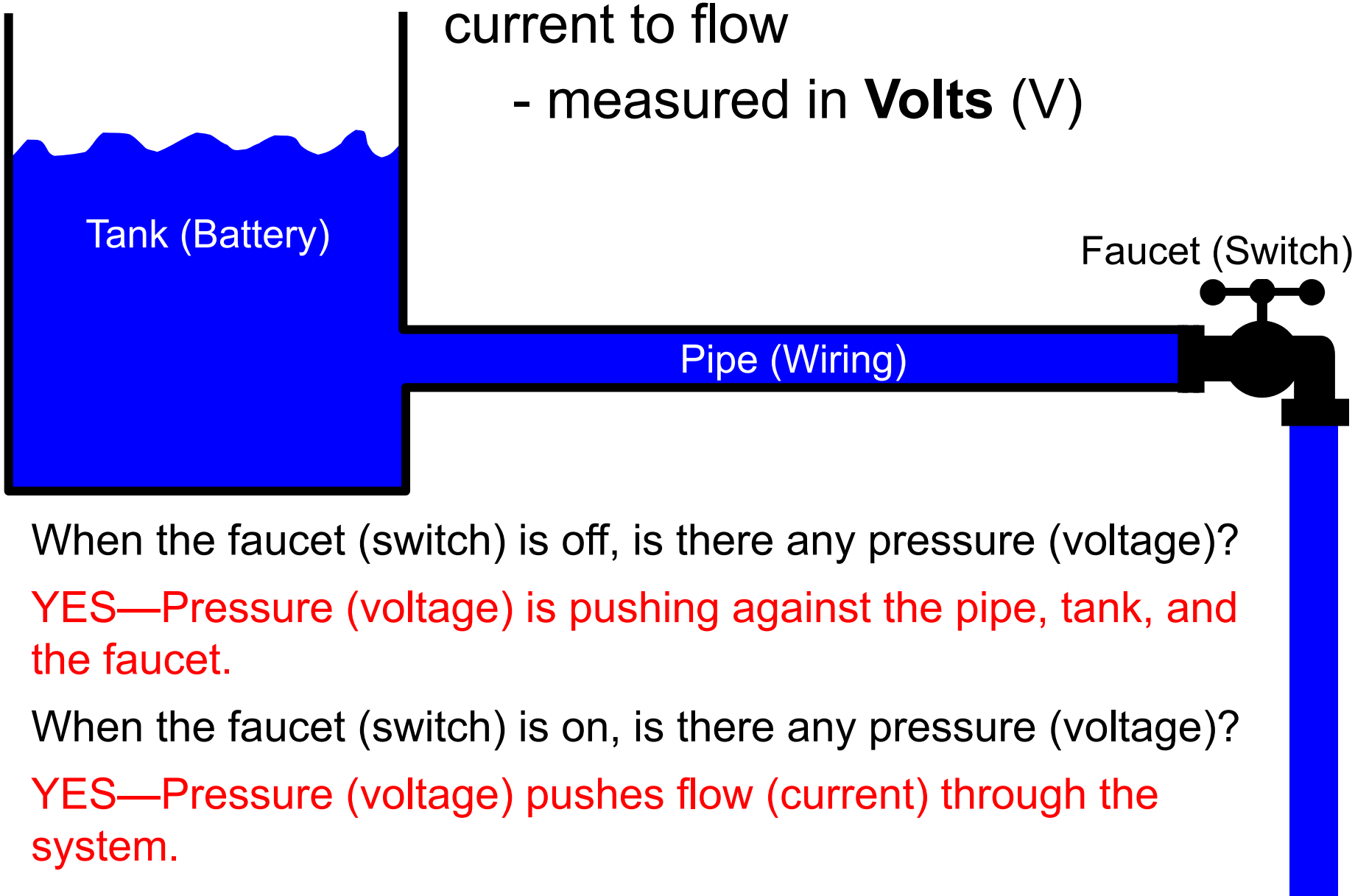
Electron flow is what actually happens. The electrons flow out of the negative side of the battery, through the circuit, and back to the positive side of the battery.



Voltage

The force *(pressure)* that causes current to flow

- measured in **Volts** (V)



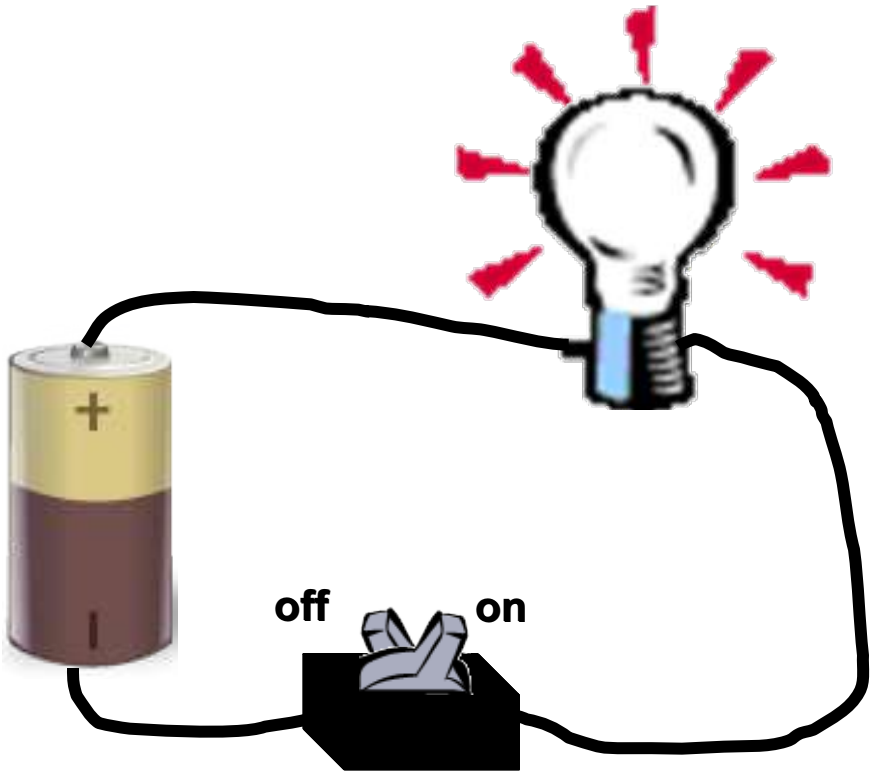
When the faucet (switch) is off, is there any pressure (voltage)?

YES—Pressure (voltage) is pushing against the pipe, tank, and the faucet.

When the faucet (switch) is on, is there any pressure (voltage)?

YES—Pressure (voltage) pushes flow (current) through the system.

Voltage in a Circuit

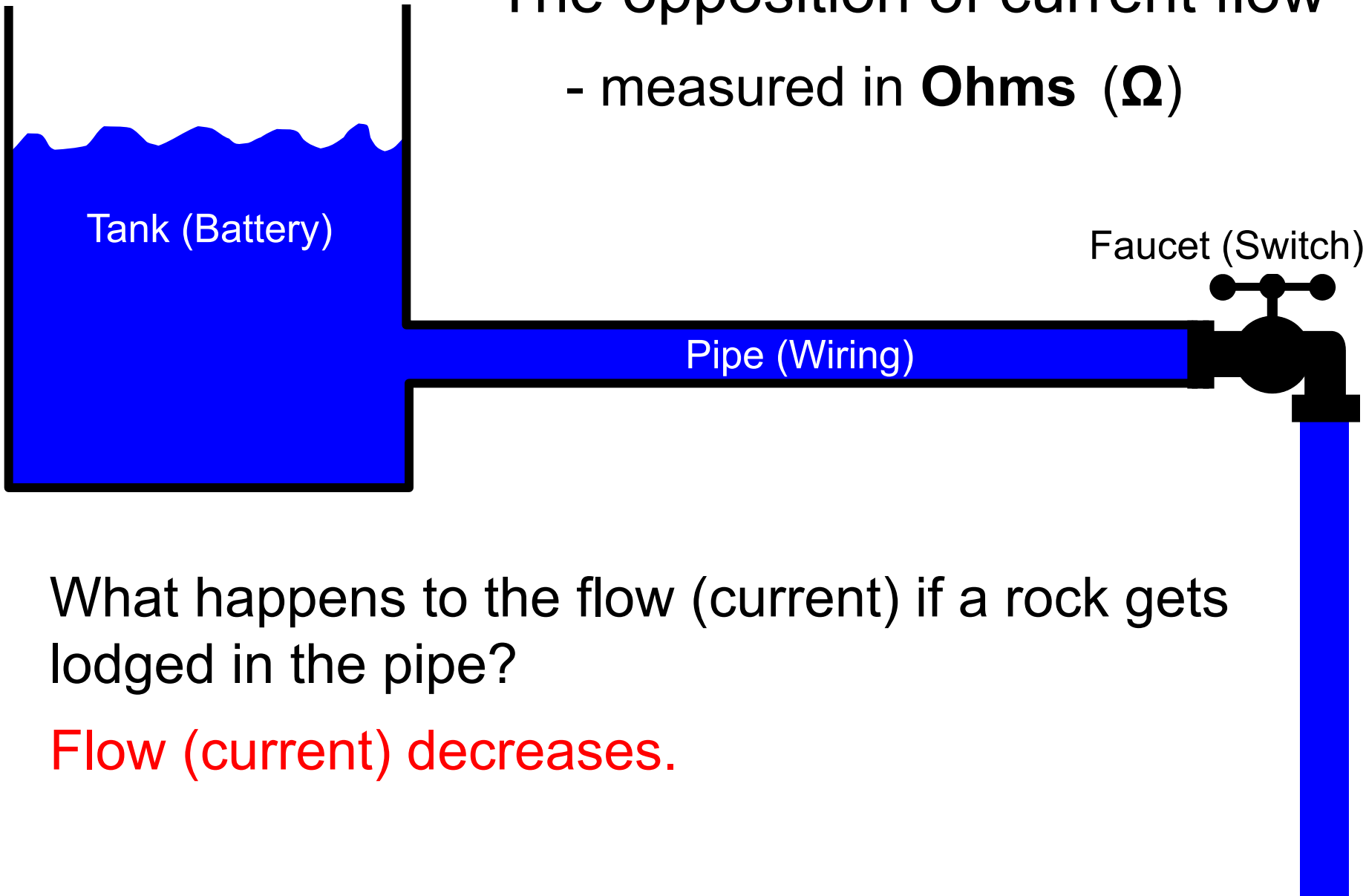


The battery provides voltage that will push current through the bulb when the switch is on.

Resistance

The opposition of current flow

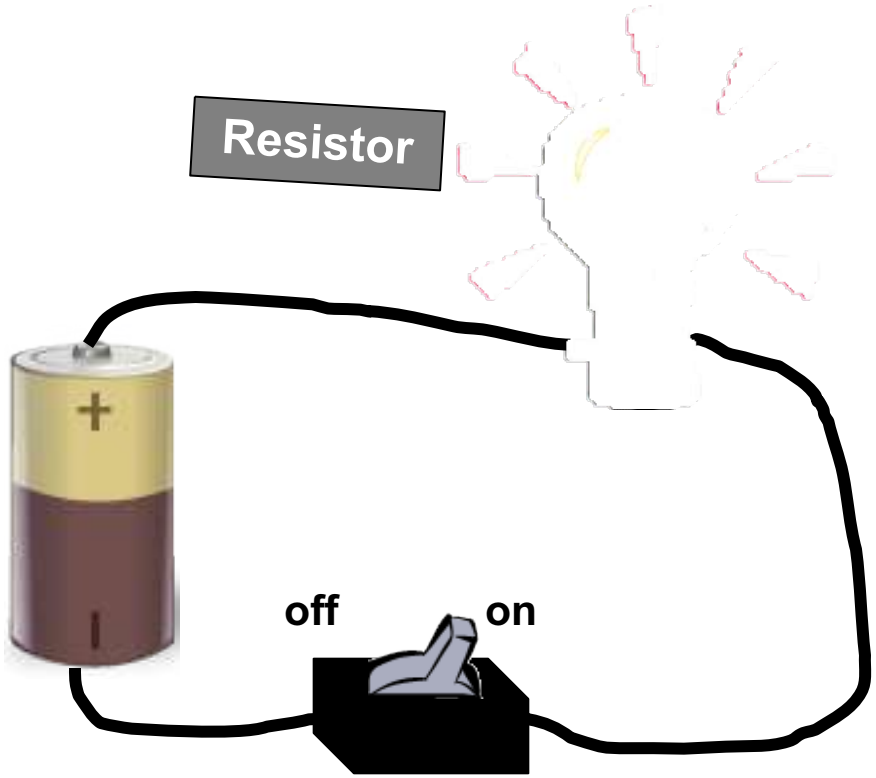
- measured in **Ohms** (**Ω**)



What happens to the flow (current) if a rock gets lodged in the pipe?

Flow (current) decreases.

Resistance in a Circuit



Resistors are components that create resistance.

Reducing current causes the bulb to become more dim.

Ohm's Law

Current in a resistor varies in direct proportion to the voltage applied to it and is inversely proportional to the resistor's value

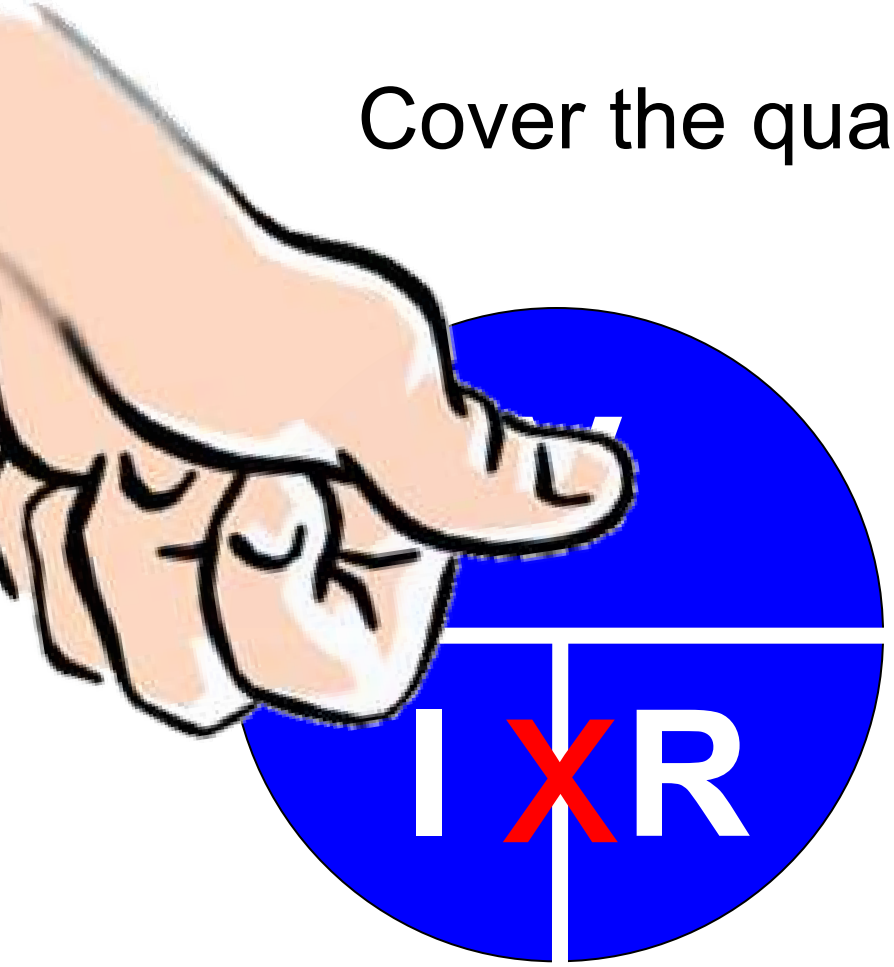
The mathematical relationship between current, voltage, and resistance

If you know two of the three quantities, you can solve for the third.

Quantities	Abbreviations	Units	Symbols
Voltage	**V**	**Volts**	**V**
Current	**I**	**Amperes**	**A**
Resistance	**R**	**Ohms**	**Ω**

V=IR **I=V/R** **R=V/I**

Ohm's Law Chart

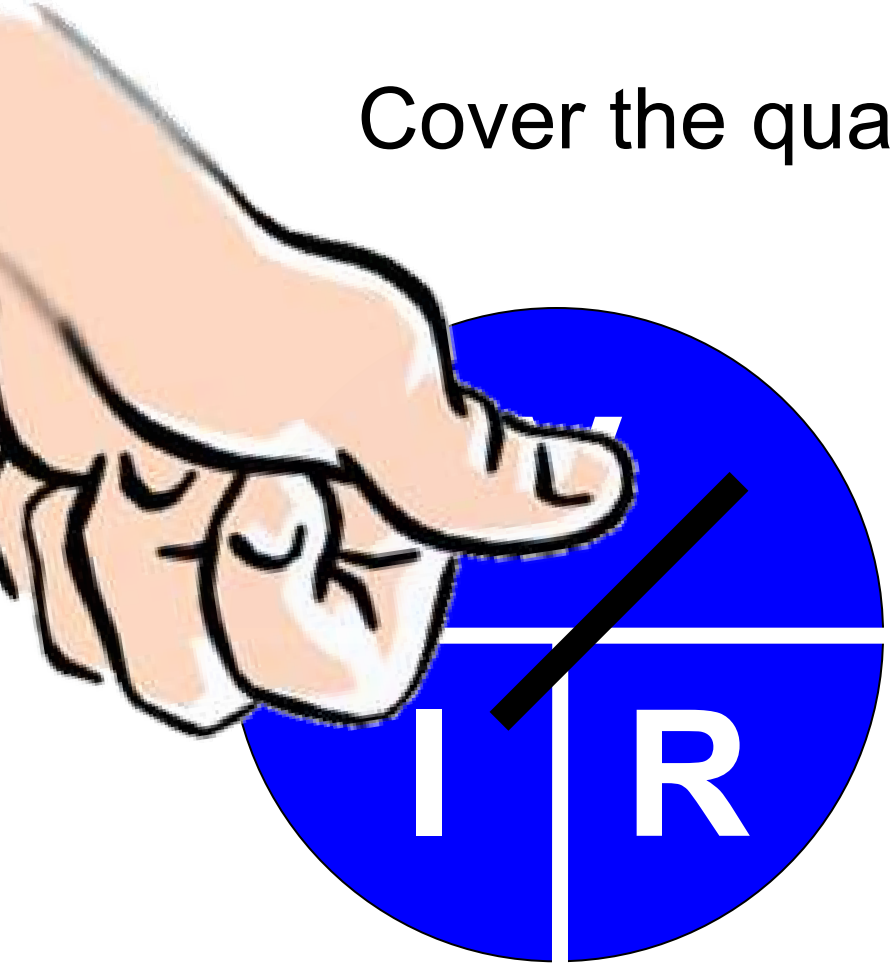


Cover the quantity that is unknown.

Solve for V

V=IR

Ohm's Law Chart



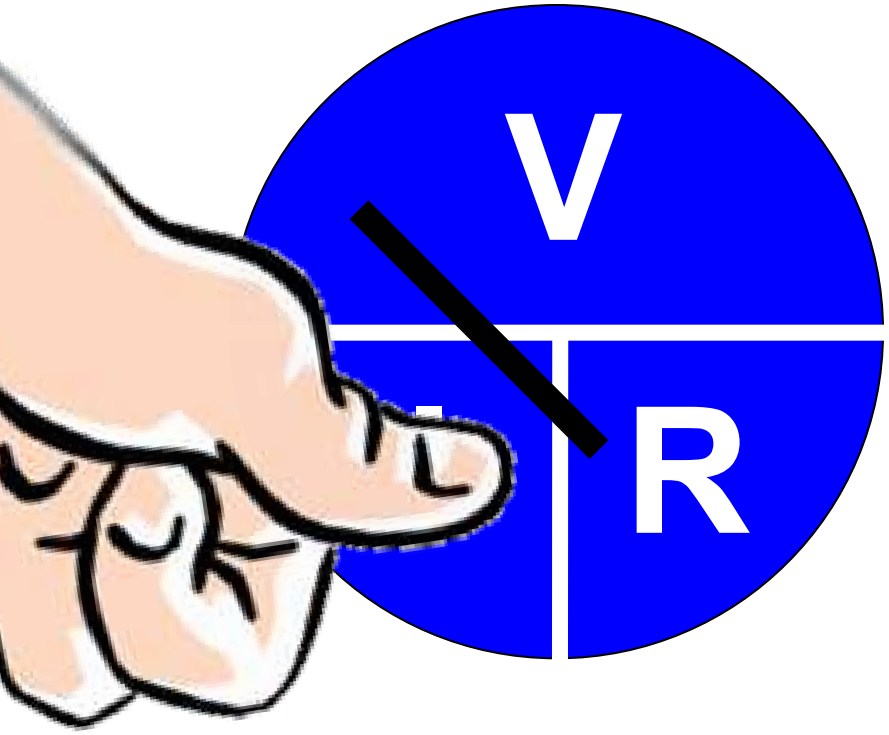
Cover the quantity that is unknown.

Solve for I

I=V/R

Ohm's Law Chart

Cover the quantity that is unknown.



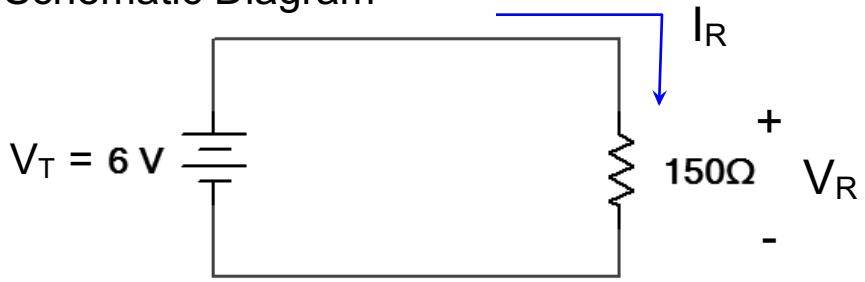
Solve for R

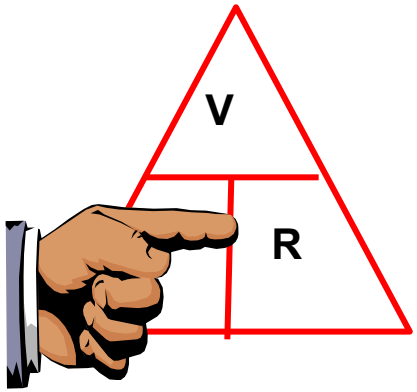
R=V/I

Example: Ohm's Law

The flashlight shown uses a 6-volt battery and has a bulb with a resistance of 150 Ω. When the flashlight is on, how much current will be drawn from the battery?

Schematic Diagram





$$I_R = \frac{V_R}{R} = \frac{6\ \text{V}}{150\ \Omega} = 0.04\ \text{A} = 40\ \text{mA}$$

Circuit Configuration

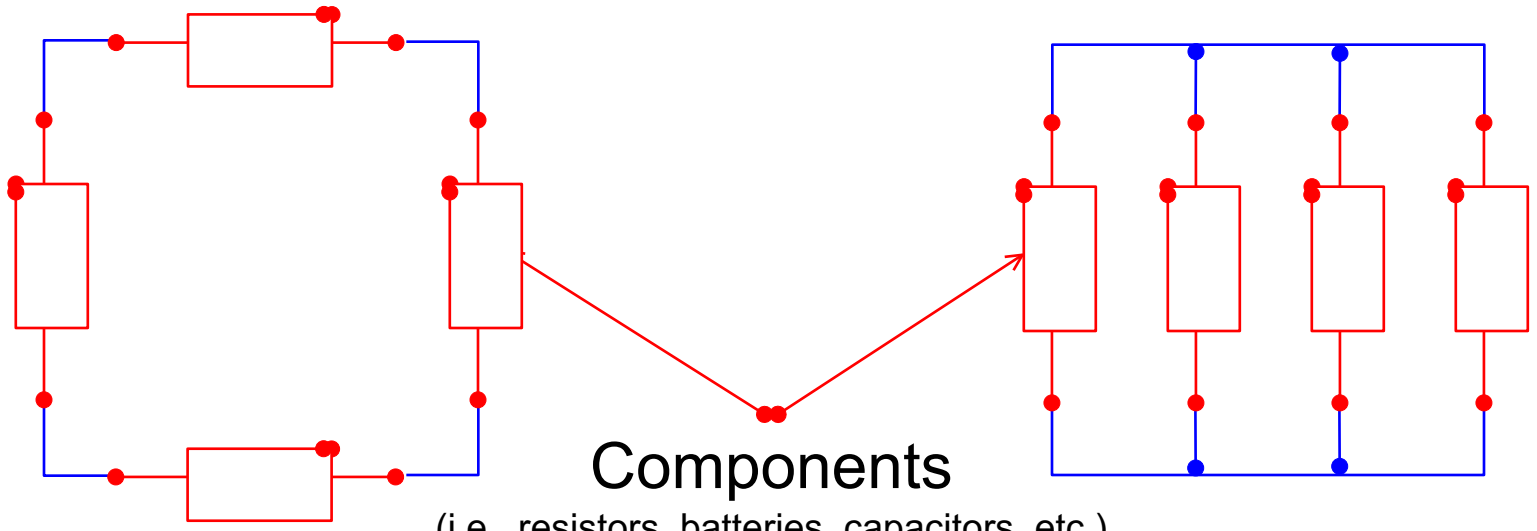
Components in a circuit can be connected in one of two ways.

Series Circuits

- Components are connected end-to-end.
- There is only a single path for current to flow.

Parallel Circuits

- Both ends of the components are connected together.
- There are multiple paths for current to flow.



Electrical Power

Electrical power is directly related to the amount of current and voltage within a system.

$$P = I V$$

Power is measured in watts