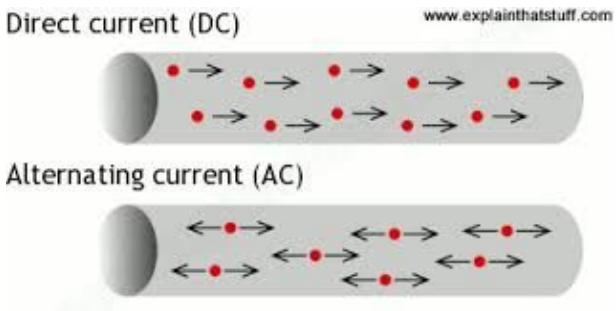
Electric Current

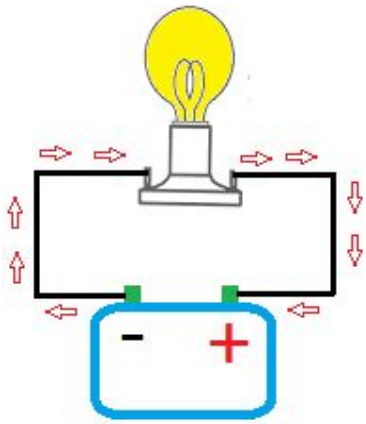
"For the LORD your God is bringing you into a good land, a land of brooks of water, of fountains and springs, that flow out of valleys and hills" Deuteronomy 8:7

- Current electricity: flow of electrons or other charged particles from one place to another
  Electricity is either static or current electricity
- Current electricity divided into two types depending on how it flows:

1. Direct current (DC): electricity only flows in one direction without reversing; used in battery-powered devices and is the type in static electricity; safer than AC
2. Alternating current (AC): electricity that flows first in one direction and then the other, reversing at regular intervals; can be produced and transmitted over long distances bc DC loses energy faster

- Electrons move from one place to another because of the attraction and repulsion of electric charges; if (+) and (-) charges applied to either end of a rod, e- will be repelled from the (-) end and go toward the (+), forming an electric current which only exists for a fraction of a second
  → if the electric charges at each end of the rod are constantly replenished, an electron current flows through the rod; <u>batteries</u> can constantly replenish electric charge and be a source of current





- A wire carrying a current does not have an overall charge itself

<u>Voltage, Current and Power</u>

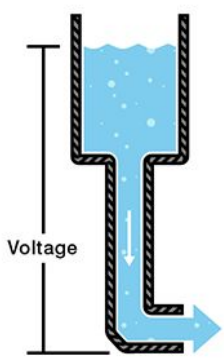
When beginning to explore the world of electricity and electronics, it is vital to start by understanding the basics of voltage, current, and resistance. These are the three basic building blocks required to manipulate and utilize electricity.

	Definition	Unit	F\\ormula abbreviation
voltage	force of current	volt	V
current	amount of charge	amperes (amps)	I

	per second		
resistance	amount that e- flow is hindered	ohm (Ω)	R
power	energy used per unit time	watts (W)	P

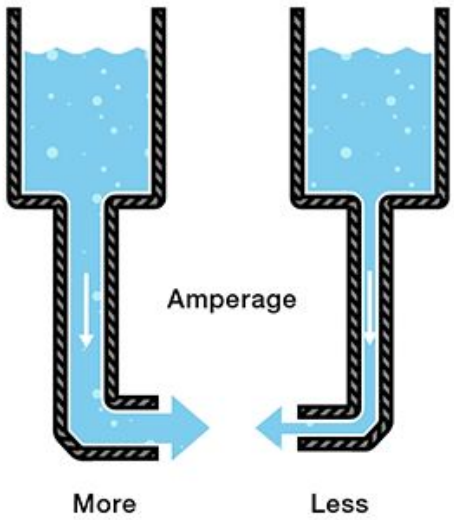
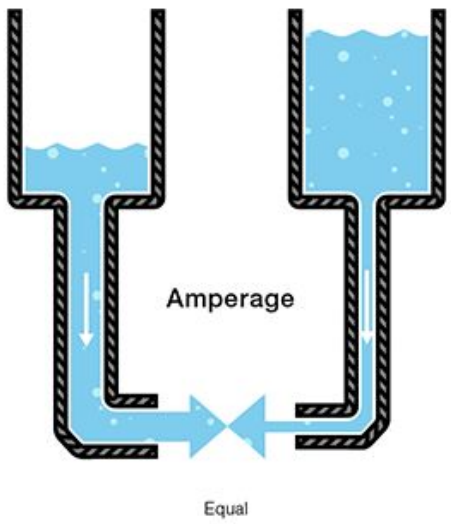
<u>Voltage</u>

- voltage: difference in charge between two points
- force with which an electric current flows
- determined by the difference between the charges
  (remember the unit of charge = Coulomb)
  → the greater difference between two electric charges [the more (-) and the more (+) they are] drives e- from the negative end to the positive end
  -greater difference between the charges → e- move more forcefully from the (-) end to the (+) end → higher voltage
- SI unit of voltage = volt (V)
  -the unit "volt" is named after the Italian physicist <u>Alessandro Volta</u> who invented what is considered the first chemical battery.
  -batteries: cylindrical (1.5V), rectangular (9V), household (120V)

	Consider a water tank at a certain height above the ground. At the bottom of this tank there is a hose. • water in the tank represents charge → more water in tank means higher charge→ more pressure at end of hose • draining the tank means pressure at the end of the hose goes down and less water flowing

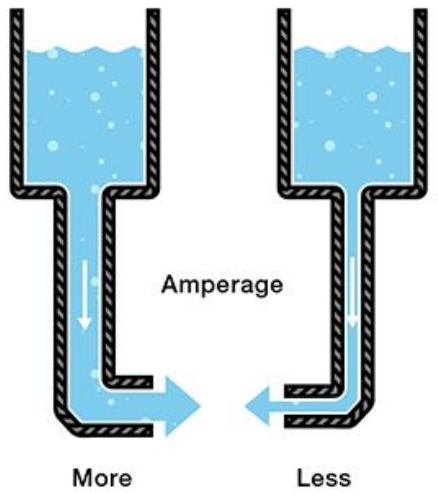
<u>Current</u>

- current: how much charge flows past a given point in a certain amount of time
  -measured as the number of coulombs of electric charge that pass a given point in a second
  -SI unit of current = ampere (A); represented as (I) in electricity

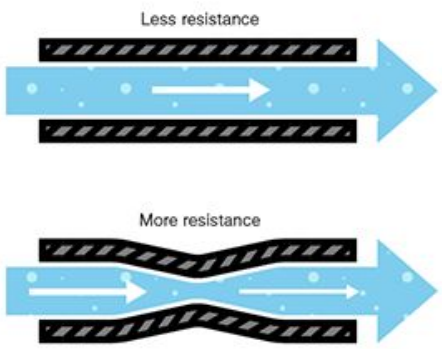
 	We can think of the amount of water flowing through the hose from the tank as current. The higher the pressure, the higher the flow, and vice-versa. ● We measure the same amount of pressure at the end of either hose, but when the water begins to flow, the flow rate of the water in the tank with the narrower hose will be less than the flow rate of the water in the tank with the wider hose. ● The current through the narrower hose is less than the current through the wider hose. ● If we want the flow to be the same through both hoses, we have to increase the amount of water (charge) in the tank with the narrower hose. ● This increases the pressure (voltage) at the end of the narrower hose, pushing more water through the tank. This is analogous to an increase in voltage that causes an increase in current.

<u>Resistance</u>

- Resistance: amount a certain object hinders e- flow
- Unit = ohm (**Ω**)
  <u>Georg Ohm</u> was a Bavarian scientist who studied electricity
- Resistor: electrical device designed to add resistance to circuit
  -used to protect delicate electrical components that cannot handle larger currents
  -variable resistors commonly used as volume controls, light dimmers



- It stands to reason that we can't fit as much volume through a narrow pipe than a wider one at the same pressure. This is resistance.
- The narrow pipe "resists" the flow of water through it even though the water is at the same pressure as the tank with the wider pipe.



- In electrical terms, this is represented by two circuits with equal voltages and different resistances.
- The circuit with the higher resistance will allow less charge to flow, meaning the circuit with higher resistance has less current flowing through it.

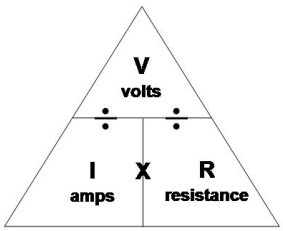
- Factors affecting resistance:

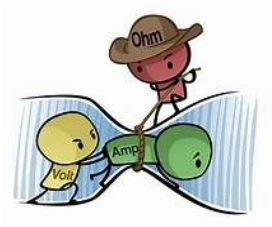
1. Type of material
2. Diameter of the conductor
3. Length of the conductor; longer conductor → more resistance bc current hindered more along a longer path
4. Temperature; resistance increases as temp rises bc energy and speed of free e- increases, hindering progress of high-speed e-

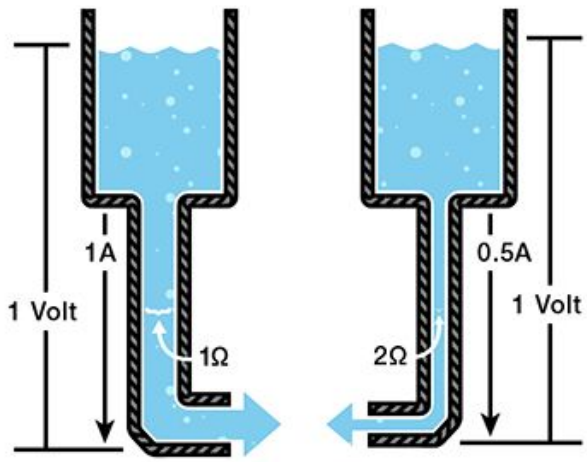
<u>Ohm's Law</u>

- Ohm's Law: the current flowing through a conductor is directly proportional to the voltage and inversely proportional to the resistance:

Voltage = current x resistance OR V = I x R





	• The current is lower in the tank with the higher resistance. • If we know two of the three values, we can solve for the third using Ohm's Law.

- Conductors: easily conduct electricity (Ag, Cu, Au, Al)
- Insulators: materials through which a current does not easily flow (rubber, glass, dry wood, plastic)
- Semiconductors: allow current flow in one direction but not in the opposite direction
- Superconductor: material that allows current to flow through it with no resistance

<u>Power</u>

- Rate at which electrical energy is supplied to a circuit or to a load
- Power: energy used per unit time
  -SI unit of power = watt (W), but power referred to (P) in electricity
  -power = voltage x current
  -light bulb (15-150W), hair dryer (1200 W)

- Amount of electrical energy used by a device depends on
  1)amount of power used and
  2)length of time that the device operates; measured in kilowatt-hour (kW x hr)