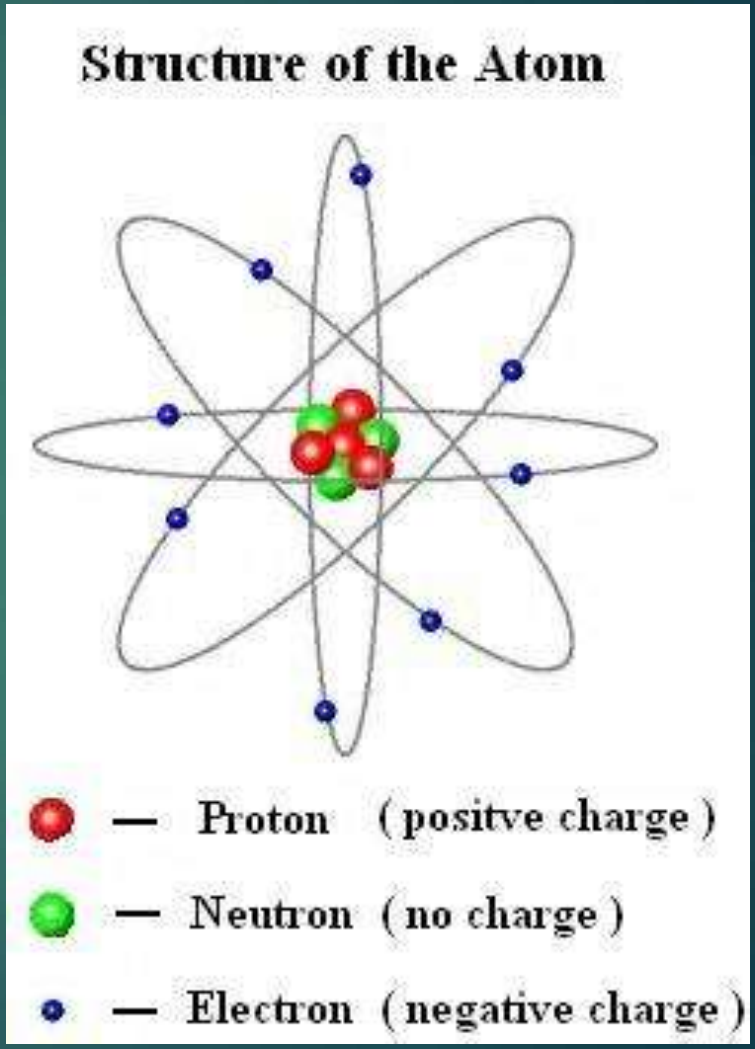
Electricity

MR. BANKS

8TH GRADE SCIENCE

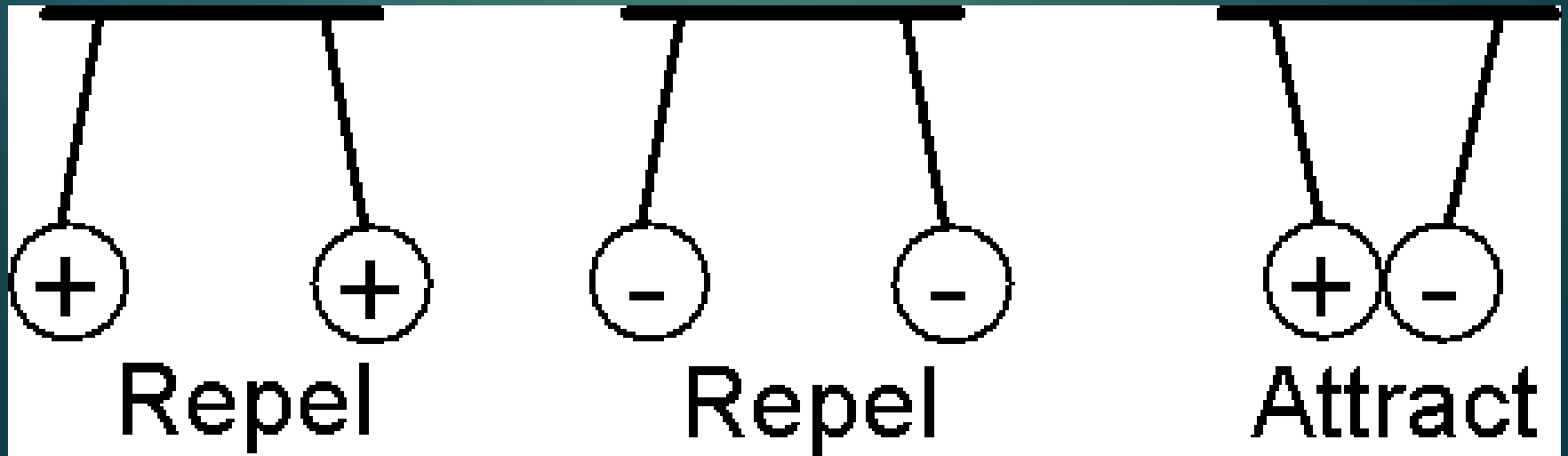
Electric charges

- Atoms and molecules can have electrical charges.
  - These are caused by electrons and protons.
    - Electrons are negatively charged.
    - Protons are positively charged.



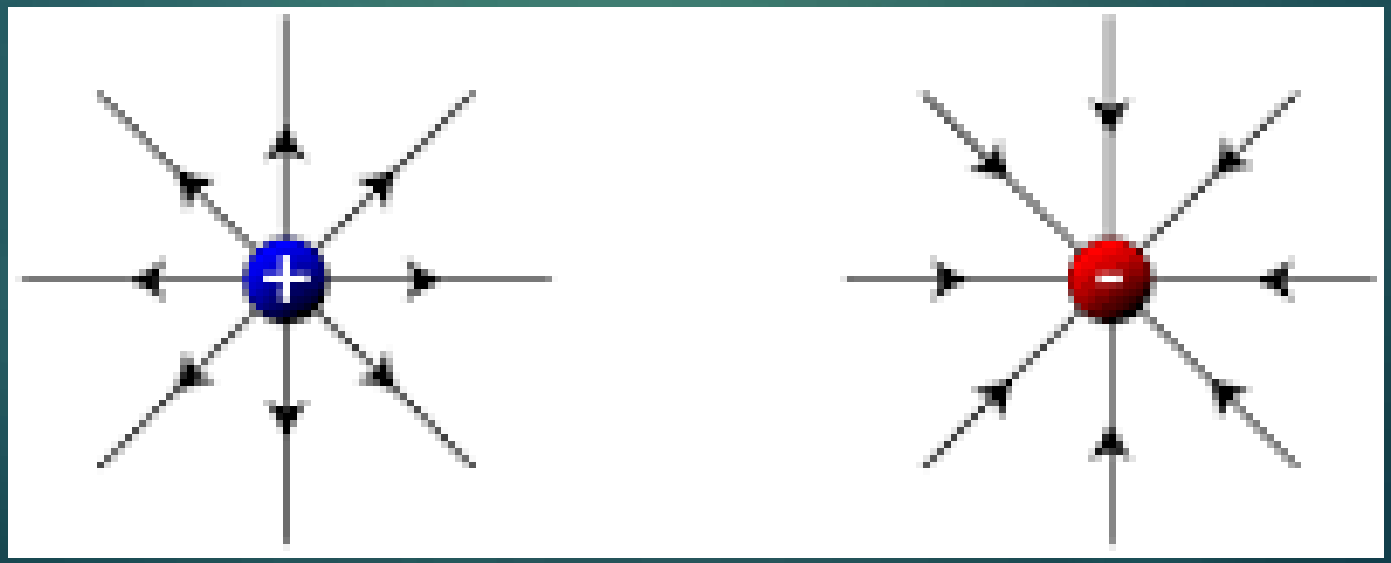
Electric charges

- Like magnets, electric charges interact with one another.
- Also like magnets, like charges repel each other and opposite charges attract one another.
- The attraction and repulsion between electric charges is known as <u>electric force.</u>



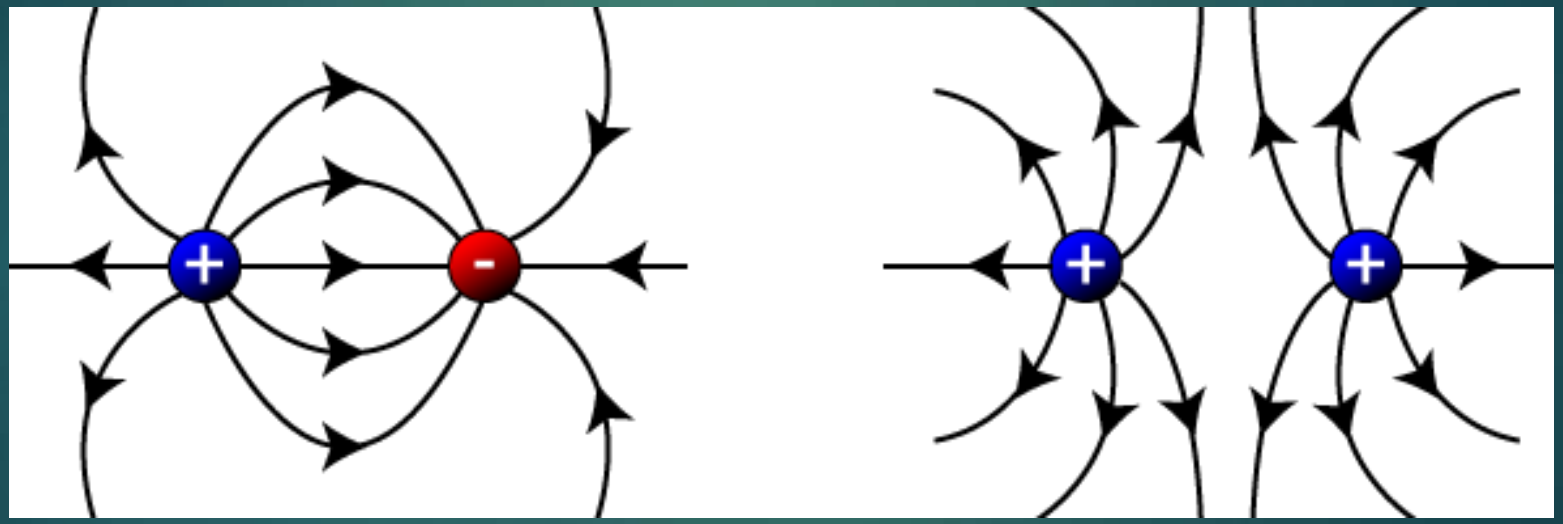
Electric charges

- Electric field – the region around a charged object where the objects electric force interacts with other electric charges.
- Unlike magnets, electric charges can exist on their own.
  - A material does not have to have a corresponding positive charge when it has a negative charge and vice versa.



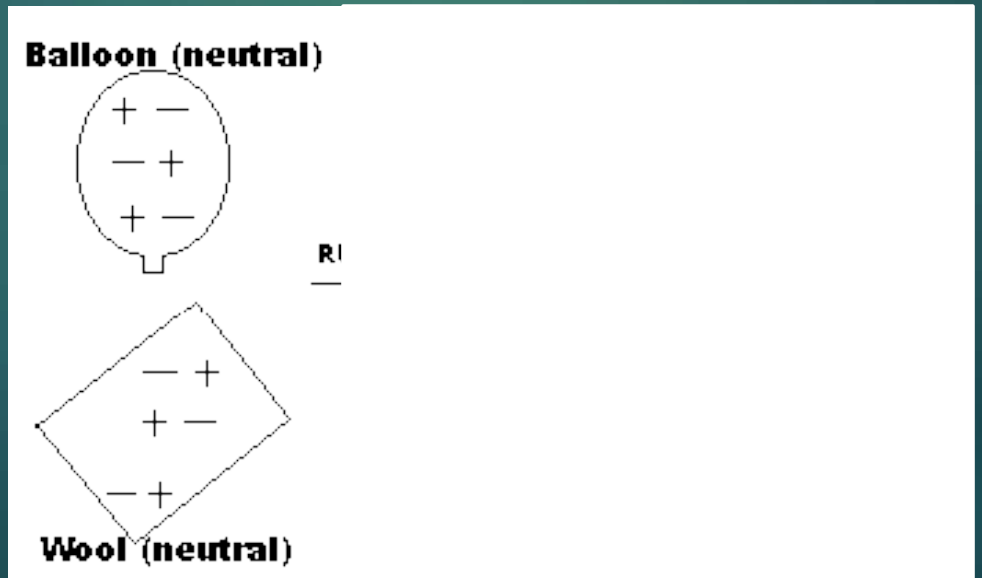
Electric charges

- Electric fields interact with one another in much the same way as the poles of two magnets interact.



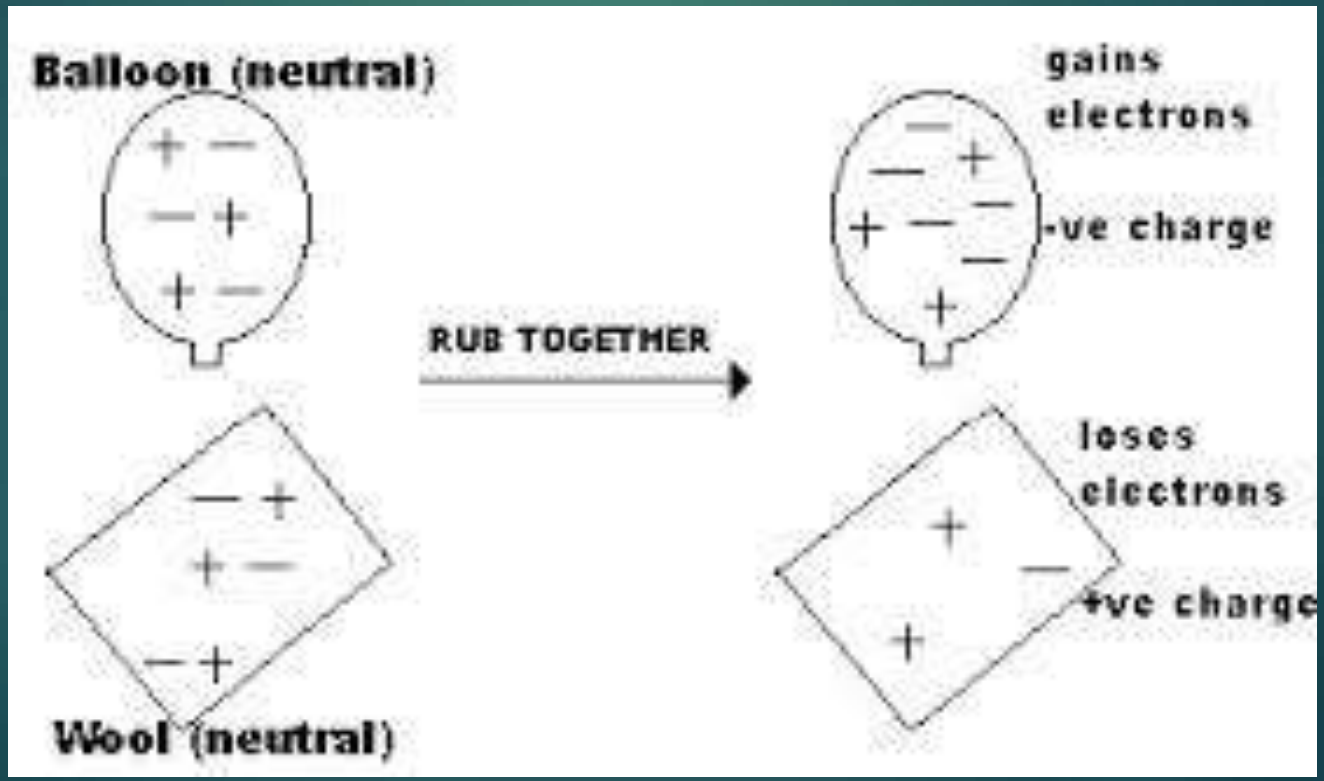
Static electricity

- Most objects have no overall charge.
- Things can become charged through the transfer of electrons from one object to another.
  - Protons are stuck in the atoms that they make up, but electrons can move around.
  - Things that lose electrons become positively charged.
  - Things that gain electrons become negatively charged.



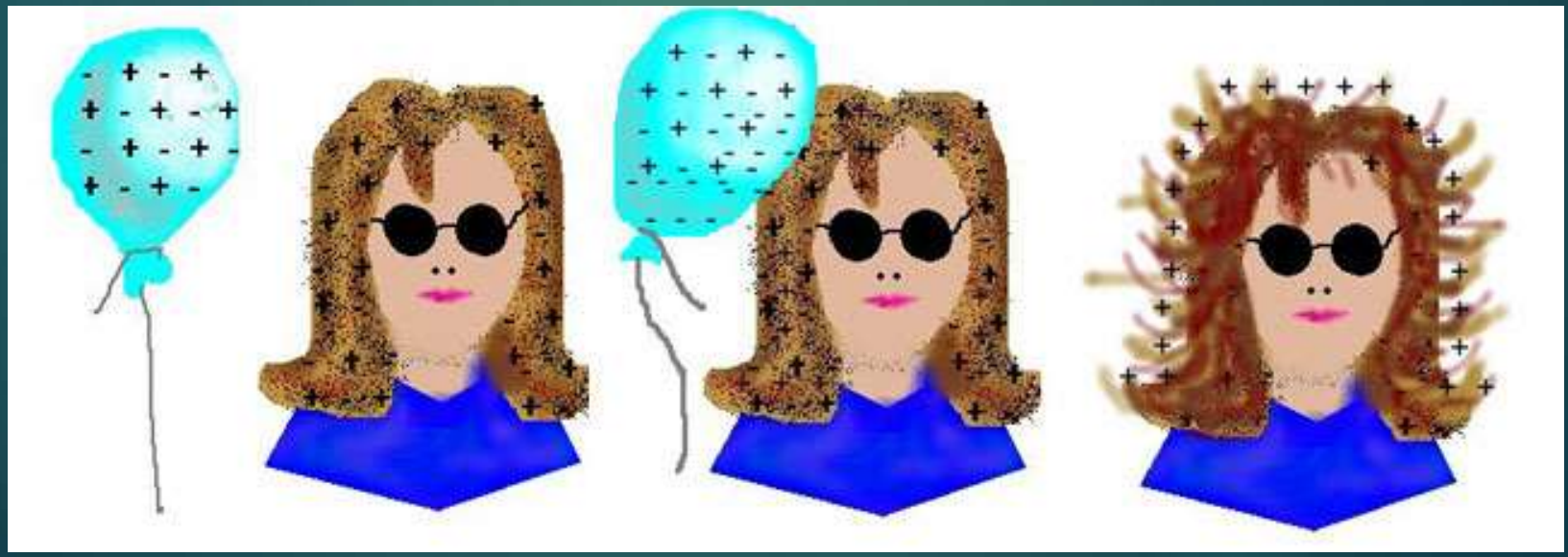
Static electricity

- This simple charge on an object is known as Static electricity.
  - In static electricity, charges build up on an object, but they do not "flow" (move) continuously.



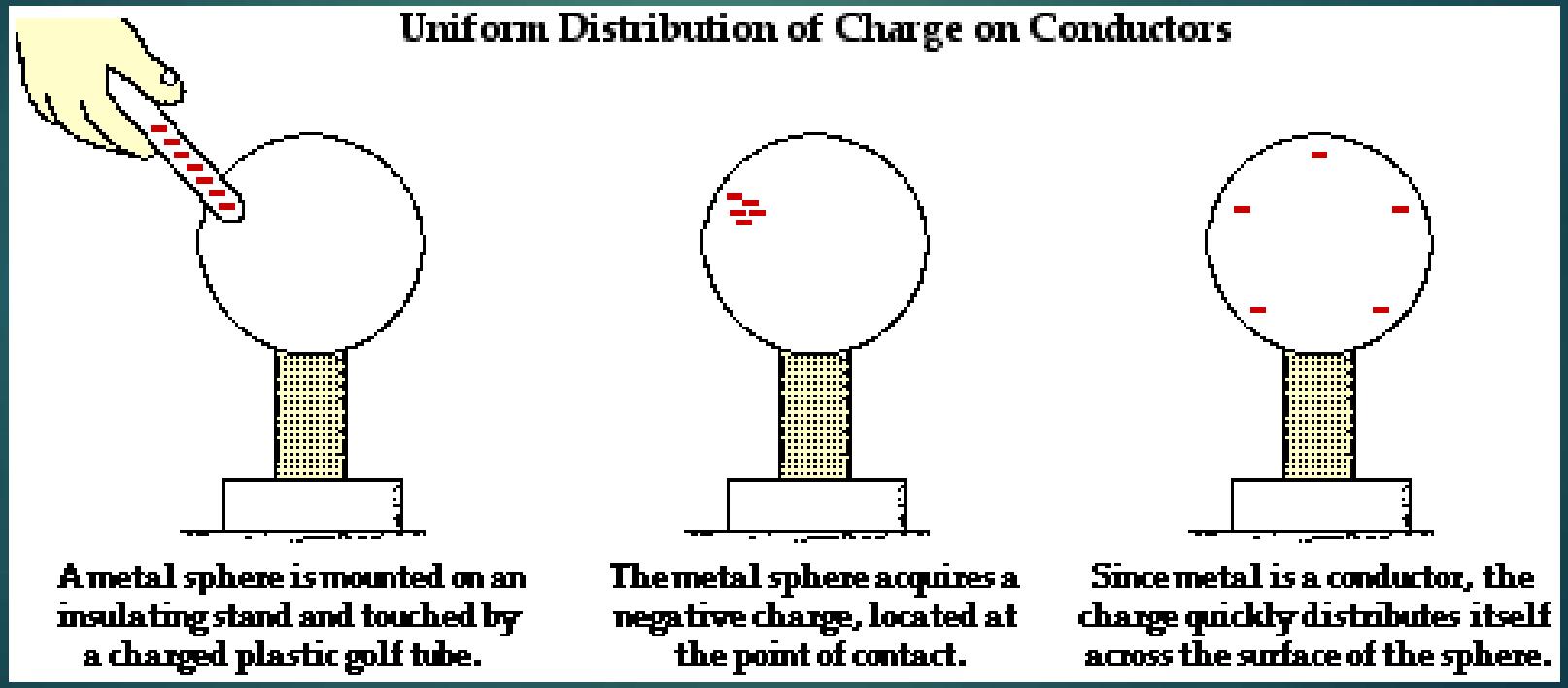
Transferring static charge

- Static charges can be transferred between objects in three ways.
  - Friction, conduction, and induction.
- Friction – When two uncharged objects are rubbed together some electrons may move between objects.



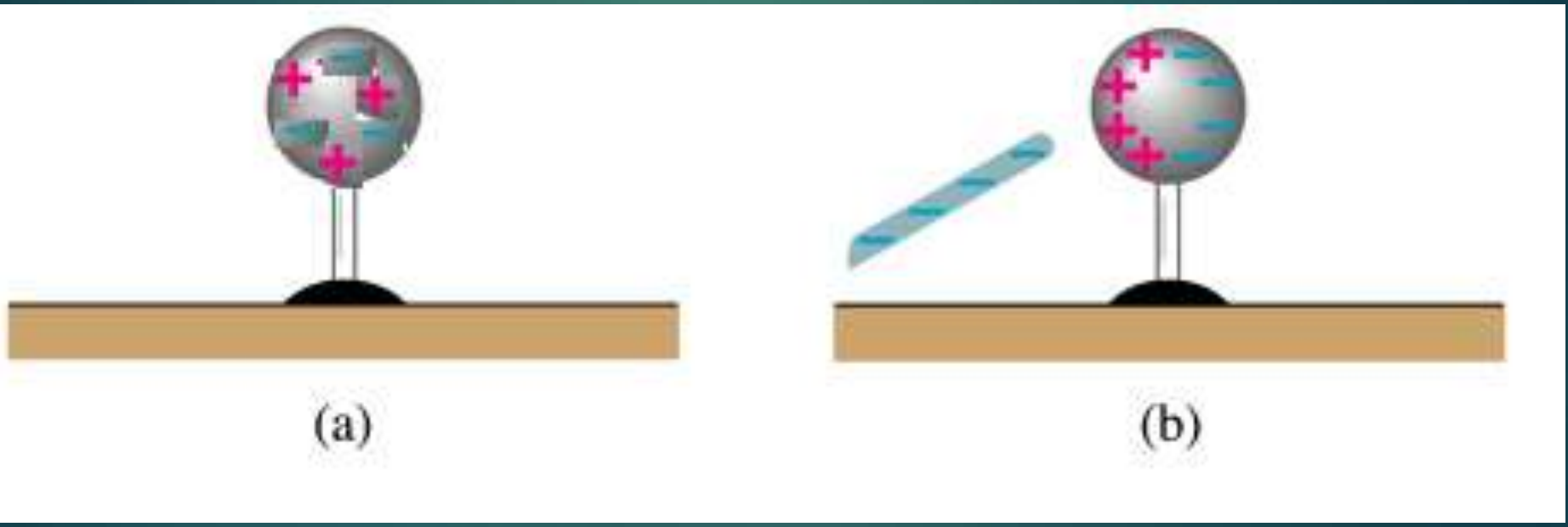
Transferring static charge

- Conduction – when a charged object touches an uncharged object electrons may be transferred from one to another.



Transferring static charge

- Induction – The movement of charges within something by bringing a charged object close to it.



Static discharge

- Static discharge – When a negatively charged object and a positively charged object are brought together electrons transfer until the two objects have the same charge.
  - Often static discharge produces a spark

Static discharge

- Lightning is a great example of static discharge on a large scale.

Chapter 2.1 “book work”

- Vocab
  - Electric field
  - Static electricity
  - Friction
  - Conduction
  - Induction
  - Static discharge
- Page 41
  - 1a, 1b, 1c
  - 2b
  - 3a, 3b, 3c

Electricity pt. 2

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8TH GRADE SCIENCE

Static electricity

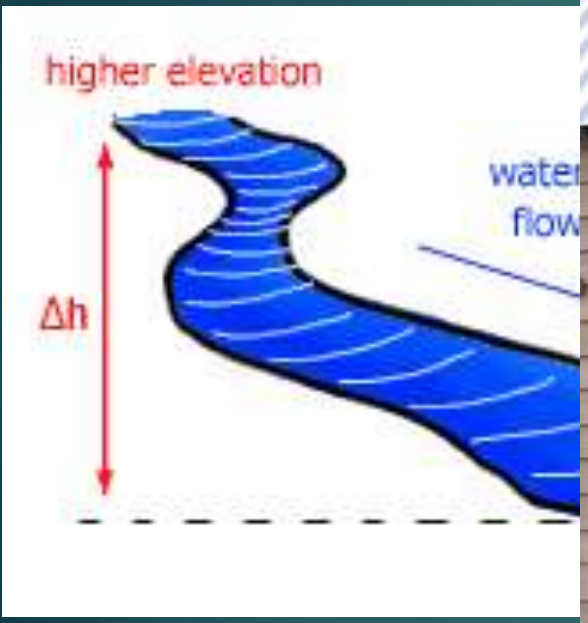
- Why is static electricity "static"?
- Can we use static electricity to power electric devices?
  - Lightning contains millions of volts of electricity, can we use it?
    - No
- Why not?

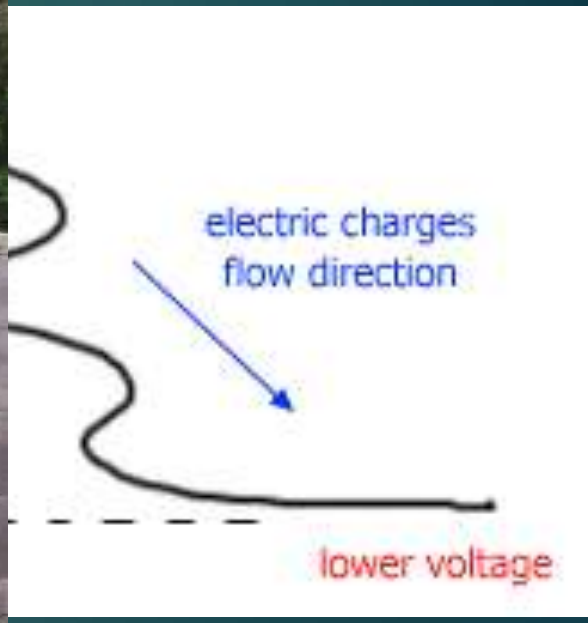
Electric current

- To power electric devices we need a different type of electricity.
- We need electricity that replaces itself as it is used.
  - We need electricity that flows.
- **Electric current** is the continuous flow of electric charges through a material.

Electric current

- Think of electricity like water, if it's sitting still it can't do much, but if it is flowing it will be able to do work.





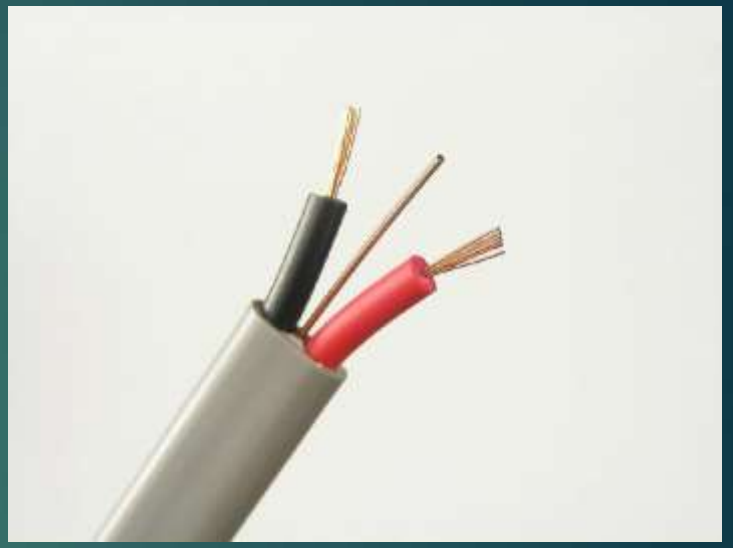
Measuring current

- The amount of electric charge that passes through a wire in a given time is the rate of electric current.
- The unit is the ampere or amp for short.
- An amp is the amount of charge that passes a point each second.
  - Kind of like Hertz are for waves.

Andre Ampere

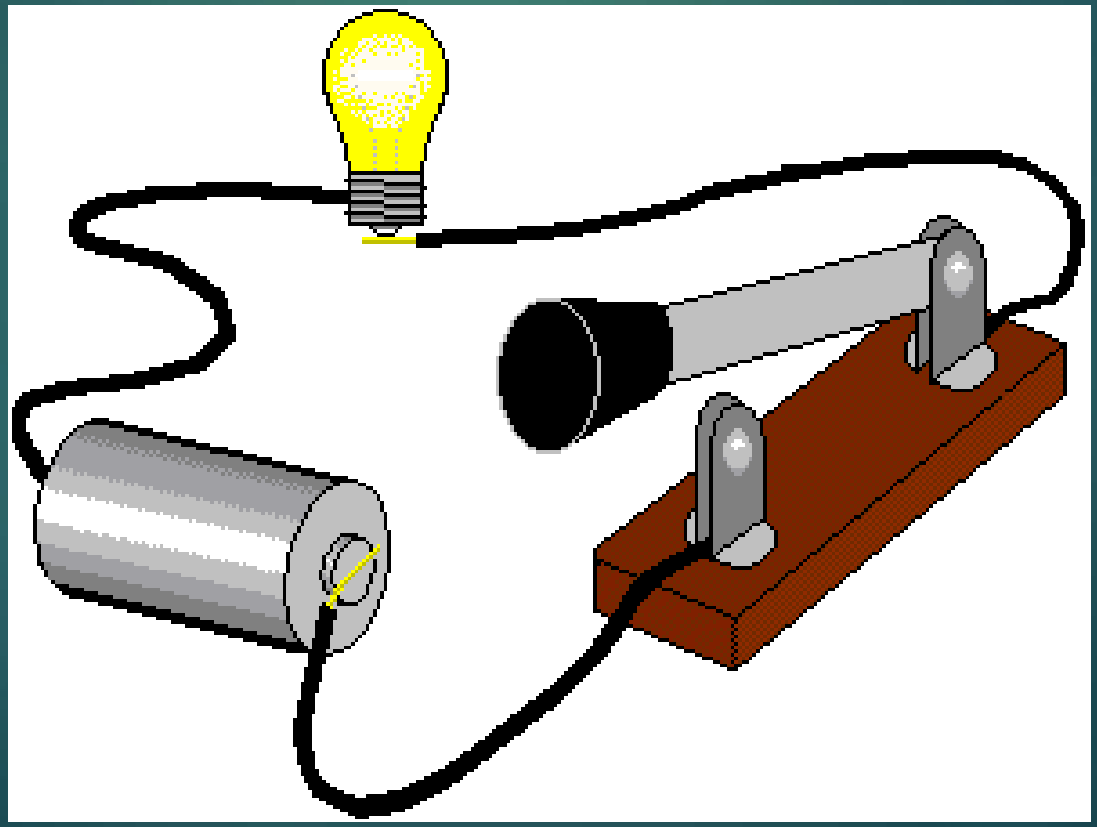
Electric Circuits

- Electric current cannot just exist in a material.
  - It must have a path to follow.
    - Like a wire.
- Electric current requires the ability to flow from one place to another in an unbroken path.
  - If there is a break in the path at any point there can be no flow of electricity.
- An **electric circuit** is a complete unbroken path through which electric charges can flow.



Electric circuits

- Electric circuits must also exist as a loop where there is a connection that goes out from the energy source and returns without being broken.
  - They cant just go to a destination and stop.



Conductors and insulators

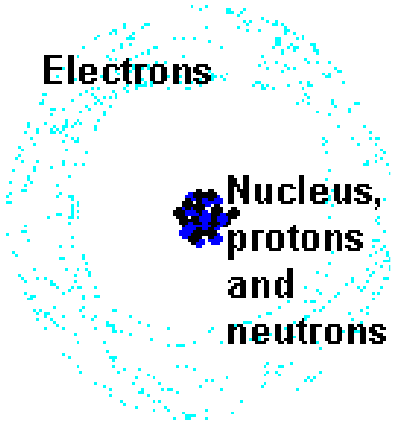
- Does electricity flow equally in all materials?
  - NO
- A **conductor** is a material that transfers electric charge well.
  - Electricity flows easily through a conductor.
- An **insulator** is a material that does <u>not</u> transfer electric charge well.
  - Electricity has trouble flowing through an insulator.

Conductors

- Metals are generally good conductors of electricity.
  - Silver, copper, aluminum, and iron are all good conductors.
- Materials that are good conductors hold on to their electrons loosely therefore the electrons are able to move easily.

Conductors

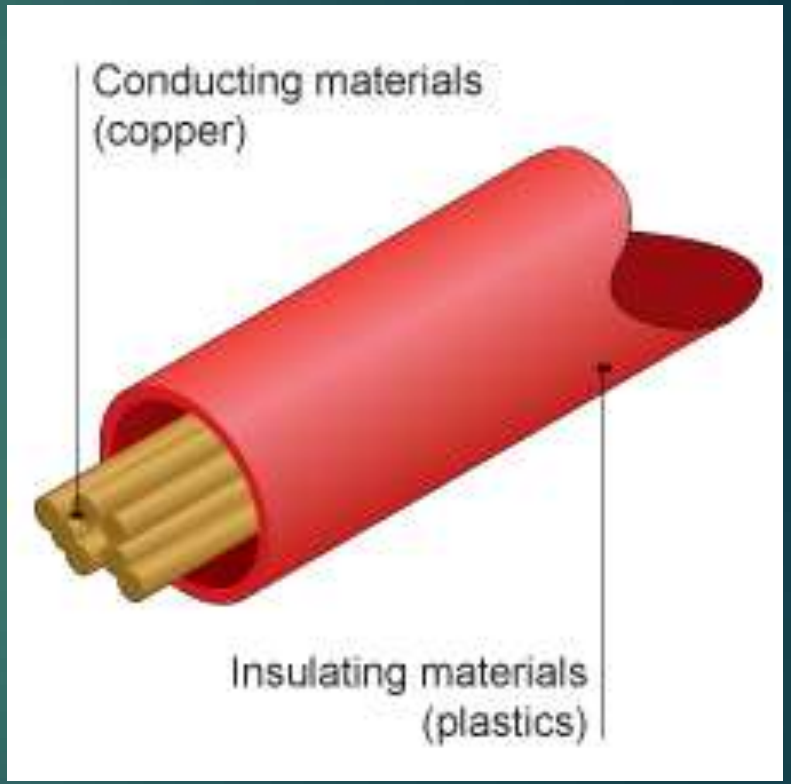
- Electrons are already present in conductors, but in order to move they need to be forced to.
  - When an electric current is hooked up, one end of the wire pushes the electrons and the other end of the wire pulls electrons.
    - This forces electrons to jump from one atom to the next.



An Atom

Insulators

- Rubber, glass, sand, plastic, and wood are all good insulators.
- In insulators, the electrons are bond tightly to their atoms and are unable to easily break free.
  - Therefore electricity cannot easily "flow" through them.
- Insulators can still conduct electricity, but they just don't do it as well.
  - You can still get shocked through an insulator.

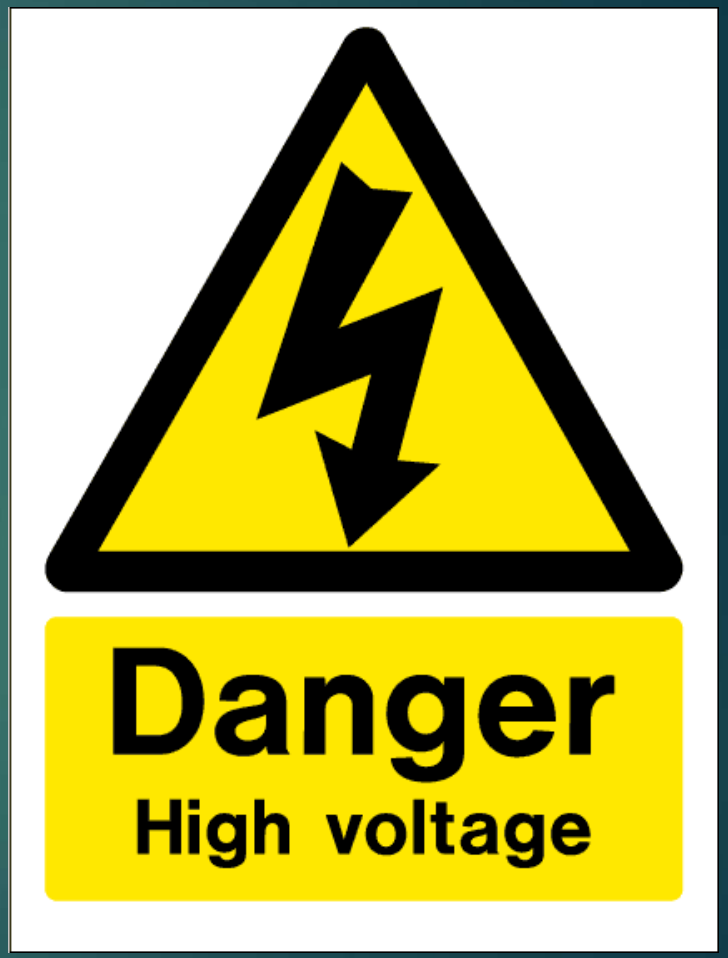


Voltage

- If I make a loop of wire, will electricity flow all by itself?
  - No
- Much like a physical thing, electricity must have a push or pull in order to move.
- This push and pull is accomplished by having a difference in electrical potential energy from one end of the circuit to the other.

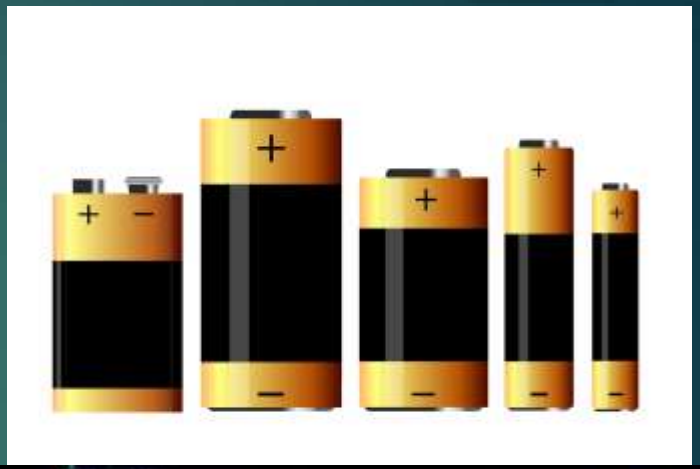
Voltage

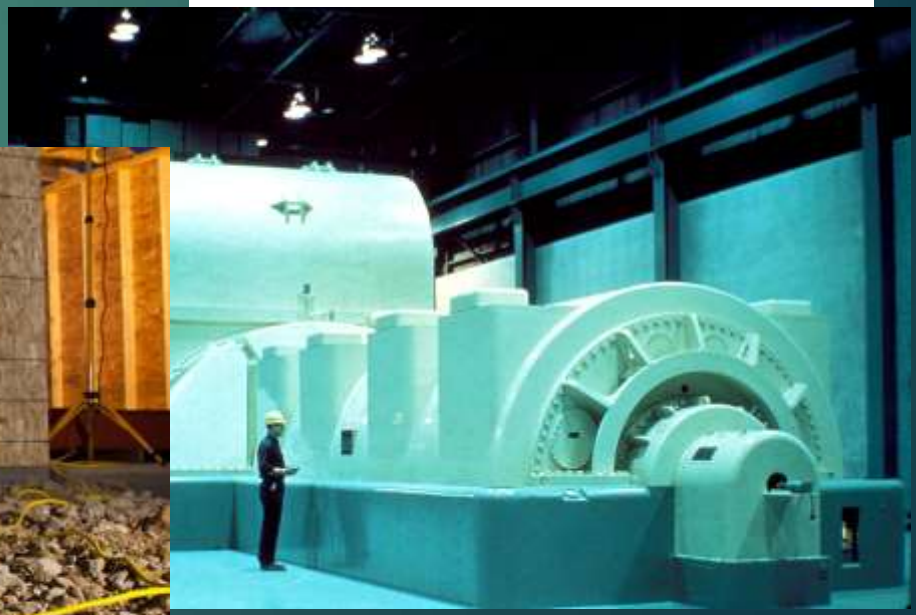
- **Voltage** is the difference in potential energy between two places in a circuit. Voltage is what creates the current in a circuit.
  - Think of it as how hard the charge is being pushed through the wire.
  - The unit for voltage is the volt (V).



Voltage sources

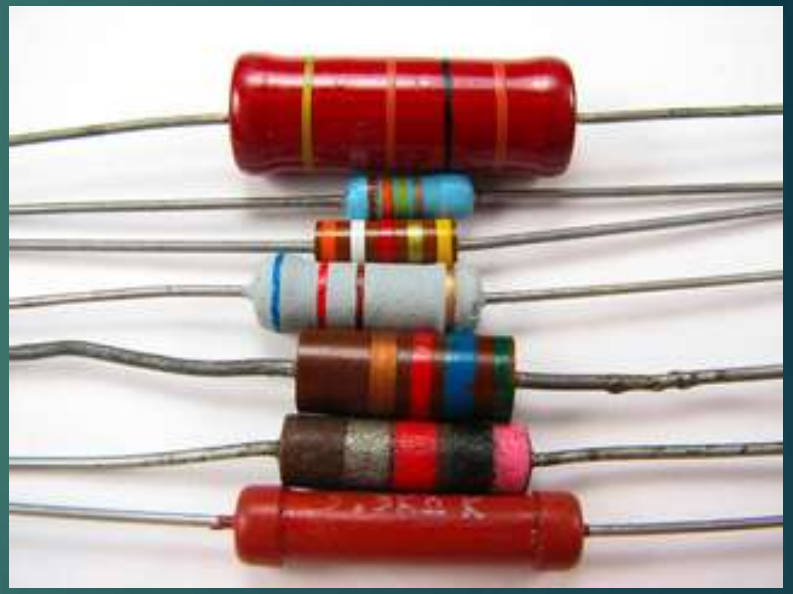
- A device that creates an electrical potential difference in an electric circuit.
  - Batteries
  - Electric generators





Resistance

- Current depends on more than voltage.
- **Resistance** is the measure of how difficult it is for charges to flow through a material.
  - The higher the resistance, the less current (flow) there is for a given voltage.
  - The unit of resistance is the ohm (Ω).



Resistance

- Multiple factors contribute to resistance
  - The material of the wire
    - Conductors do not have much resistance
    - Insulators have a higher resistance since electrical charge has a more difficult time moving through them.

TABLE 27.1 Resistivities and Temperature Coefficients of Resistivity for Various Materials

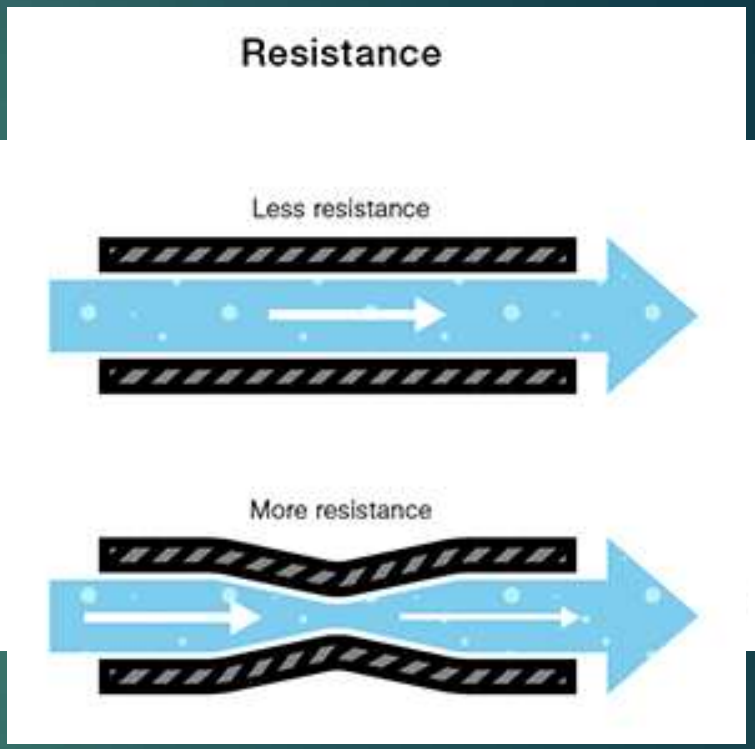
Material	Resistivity[a] ($\Omega \cdot m$)
Silver	1.59×10^{-8}
Copper	1.7×10^{-8}
Gold	2.44×10^{-8}
Aluminum	2.82×10^{-8}
Tungsten	5.6×10^{-8}
Iron	10×10^{-8}
Platinum	11×10^{-8}
Lead	22×10^{-8}
Nichrome[b]	1.50×10^{-6}
Carbon	3.5×10^{-5}
Germanium	0.46
Silicon	640
Glass	10^{10} to 10^{14}
Hard rubber	$\approx 10^{13}$
Sulfur	10^{15}
Quartz (fused)	75×10^{16}

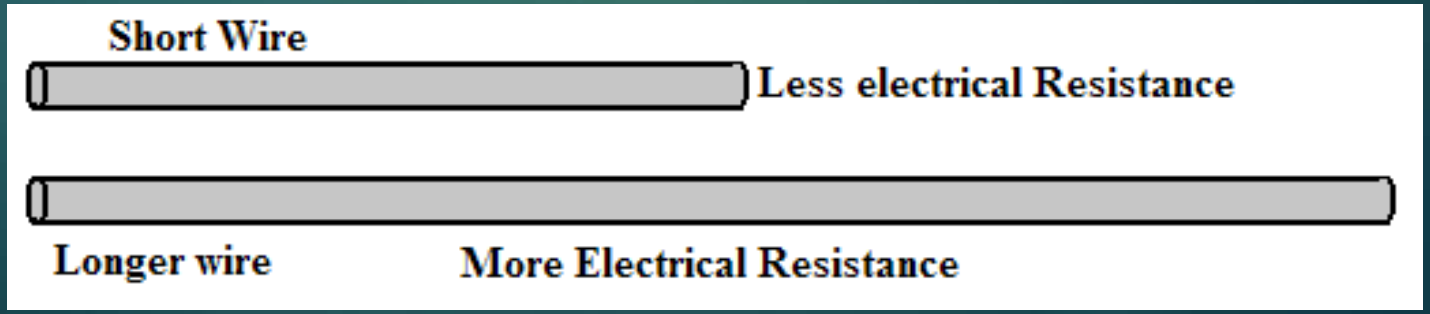
[a] All values at 20°C.

[b] A nickel–chromium alloy commonly used in heating elements.

Resistance

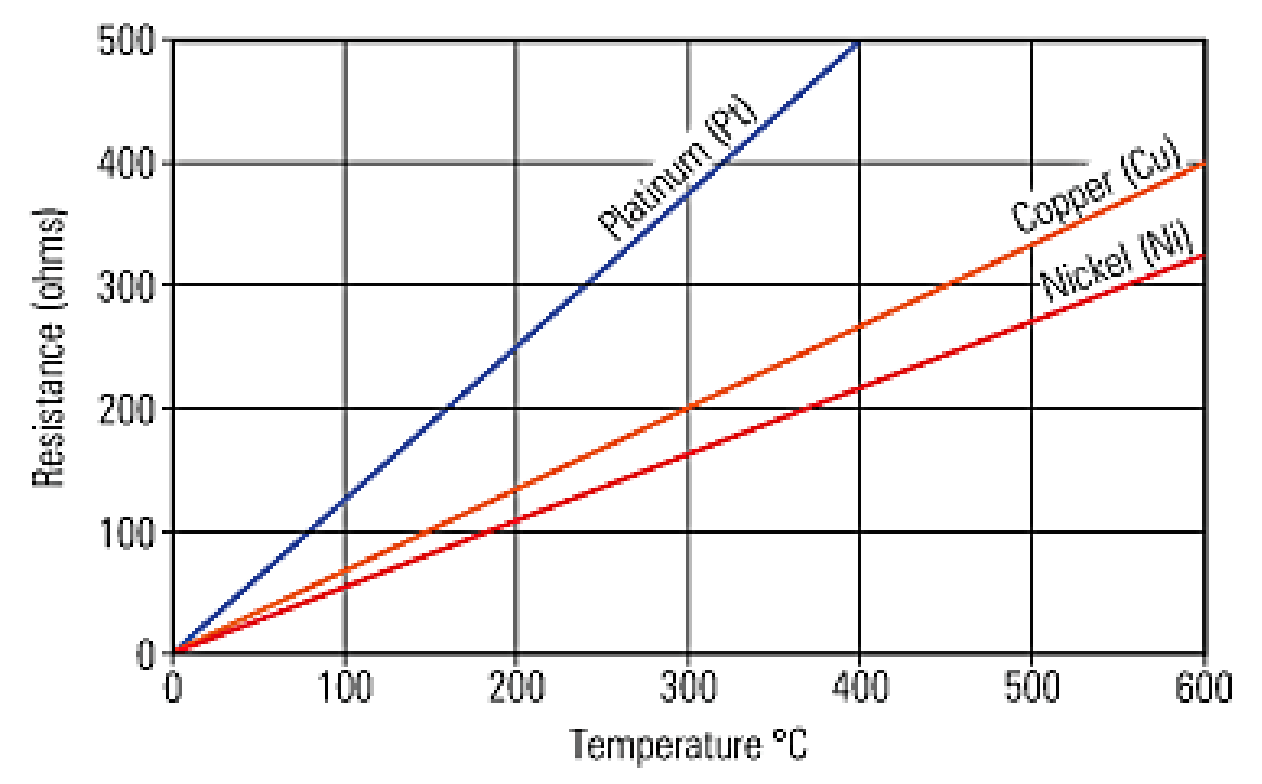
- Length
  - Longer wires of the same material have more resistance than short ones.
- Diameter
  - Smaller diameter wires have more resistance than large diameter ones.
- Think about water moving through a pipe.





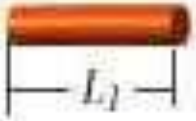
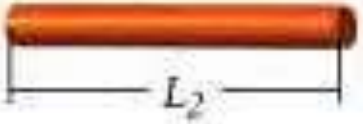
Resistance

- Temperature
  - Resistance increases as the temperature increases in most materials.



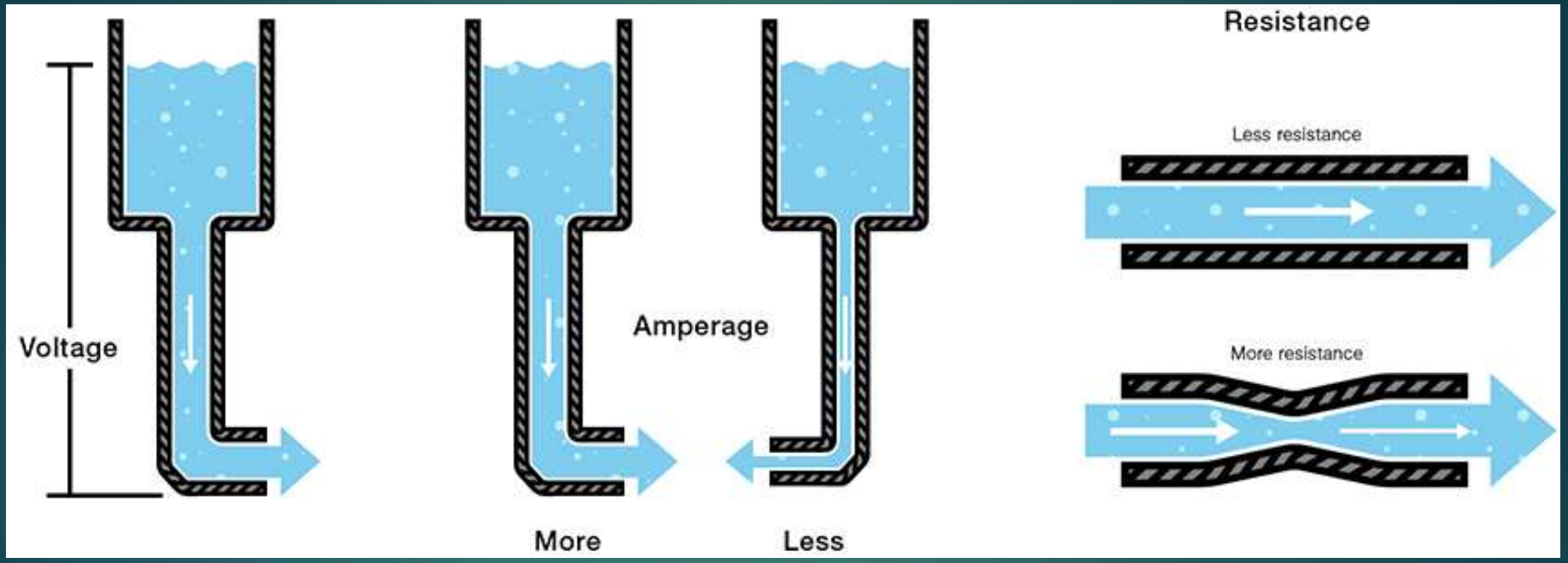
Resistance

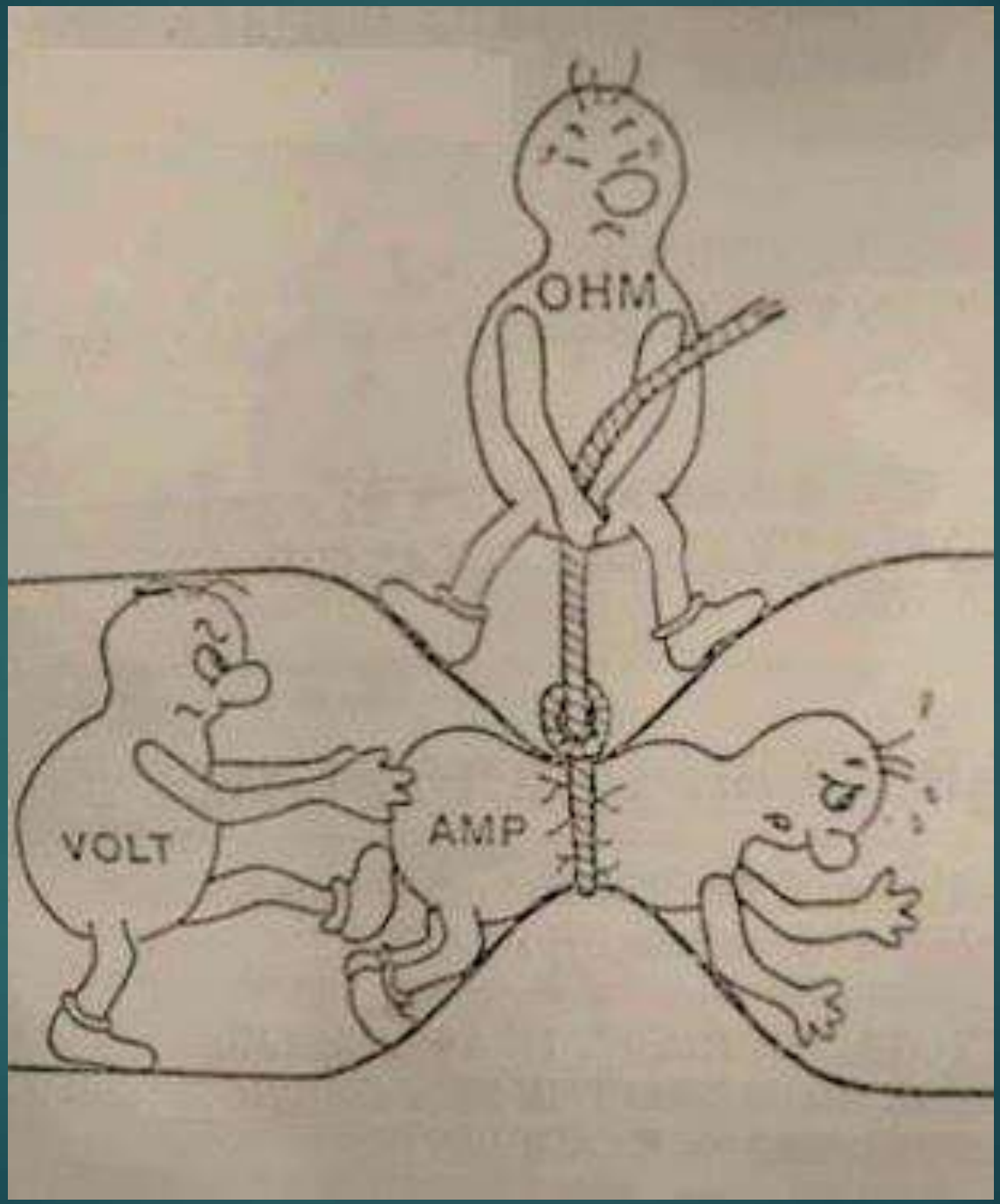
Table 19-2 Factors that affect resistance

Factor	Less resistance	Greater resistance
length		
cross-sectional area	 A_1	 A_2
material	 Copper	 Aluminum
temperature	 T_1	 T_2

The path of least resistance

- When given the opportunity to pass down two paths, electric current will always choose the one with the lower level of resistance.
- This can lead to a short circuit.


Voltage
Amperage
More
Less
Resistance
Less resistance
More resistance


OHM
VOLT
AMP

Chapter 2.2 “book work” page 44

- Vocab
  - Electric current
  - Electric circuit
  - Conductor
  - Insulator
  - Voltage
  - Resistance
- Page 51
  - 1b, 1c
  - 2a, 2b, 2c
  - 3a, 3c
  - 4a, 4b

Batteries

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8TH GRADE SCIENCE

Energy

- Energy can be transformed from one form into another.
- For example, chemical energy can be stored in the bonds of chemical compounds.
  - When those bonds are broken or formed, energy can be stored or released.

Energy

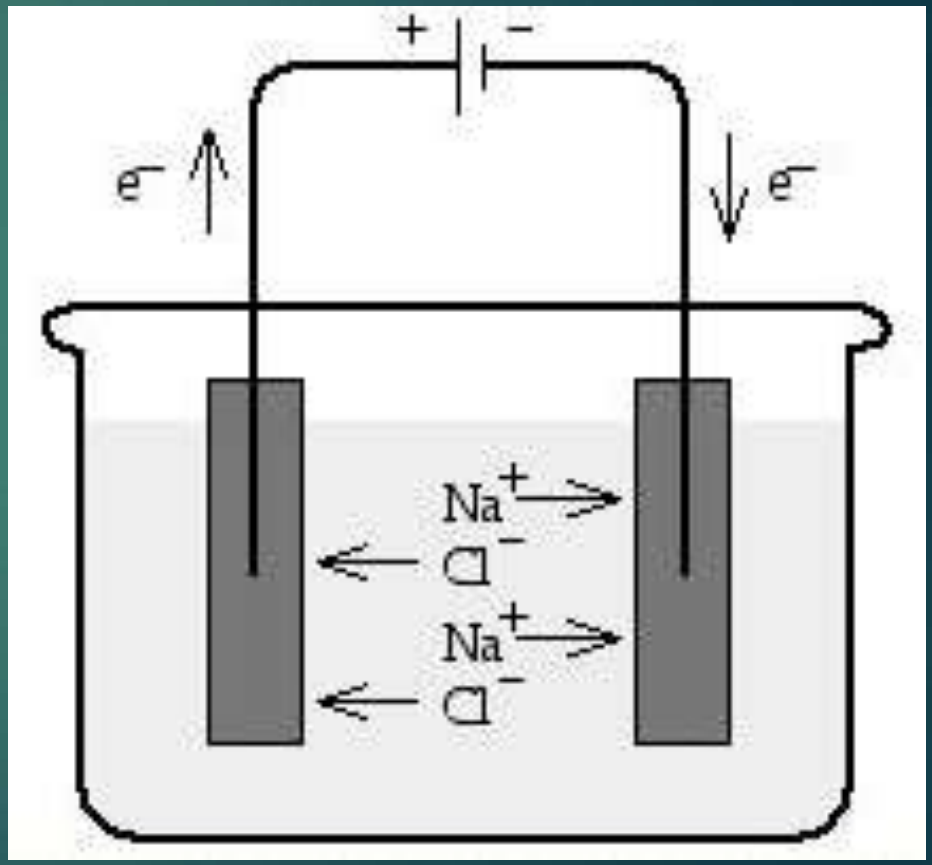
$$C_{12}H_{22}O_{11} + 12\,O_2 \rightarrow 12\,CO_2 + 11\,H_2O$$

Batteries

- Batteries store chemical energy which can then be transformed into electrical energy.
  - Two chemical reactions happening in tandem create the flow of electric current.
    - One pushing electrons, one pulling.

Electrochemical cells

- Basic batteries are based off of a simple electrochemical cell.
  - Two metal plates
    - They must be different
  - An electrolyte solution
    - A liquid that conducts electricity
  - A wire connecting the metal plates

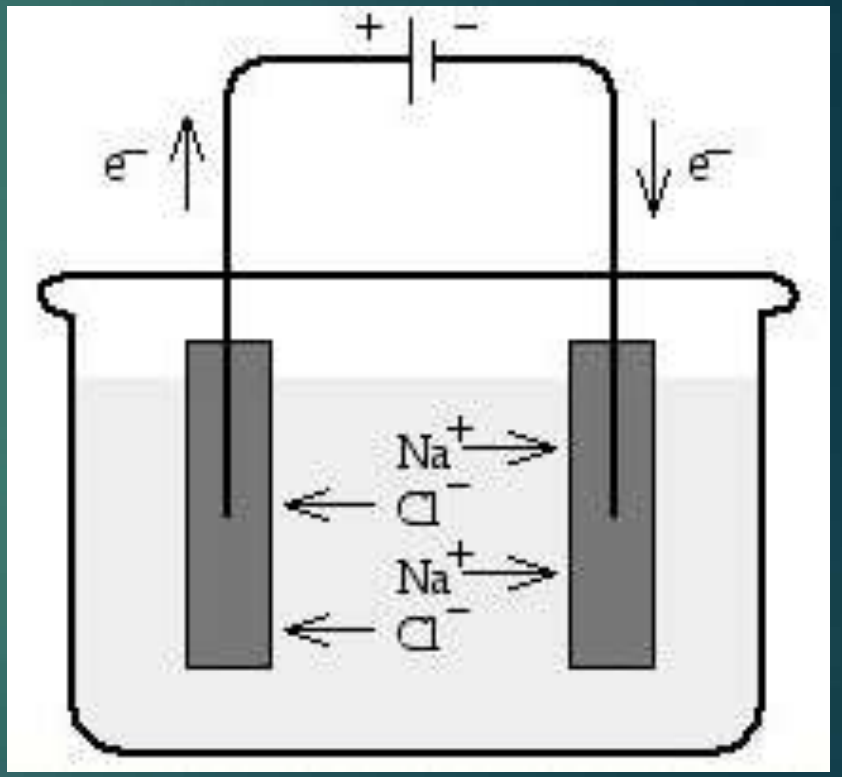


Terminals

- The point where the wire attaches to the metal is called the terminal
  - There is a positive and a negative terminal
  - These are the "ends" of the battery
  - These are attached to the wire to create a circuit.

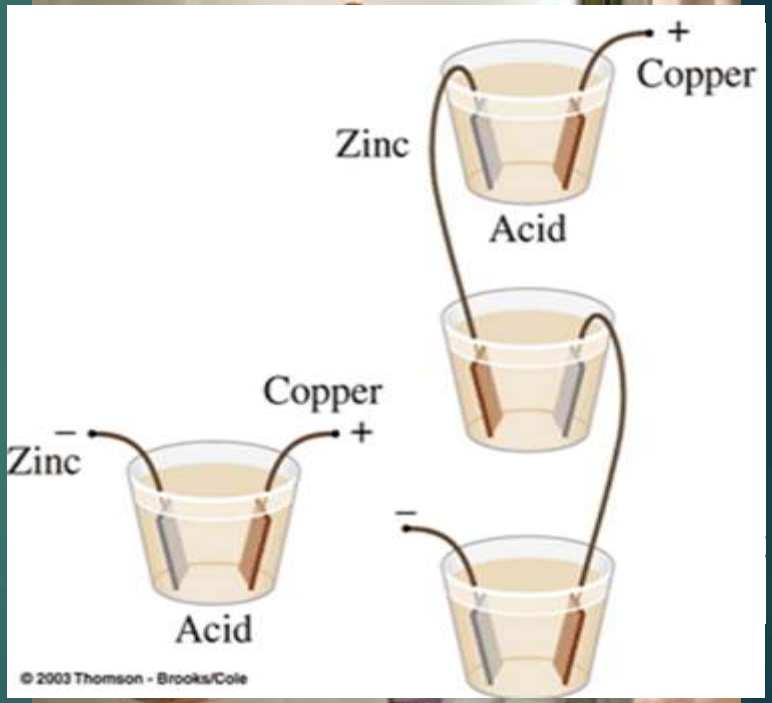
Chemical reactions

- Two chemical reactions occur on the surface of each metal plate
- These reactions cause one electrode to become negatively charged and the other to become positively charged.
- This difference in charge pushes and pulls the electrons from one terminal to the other.



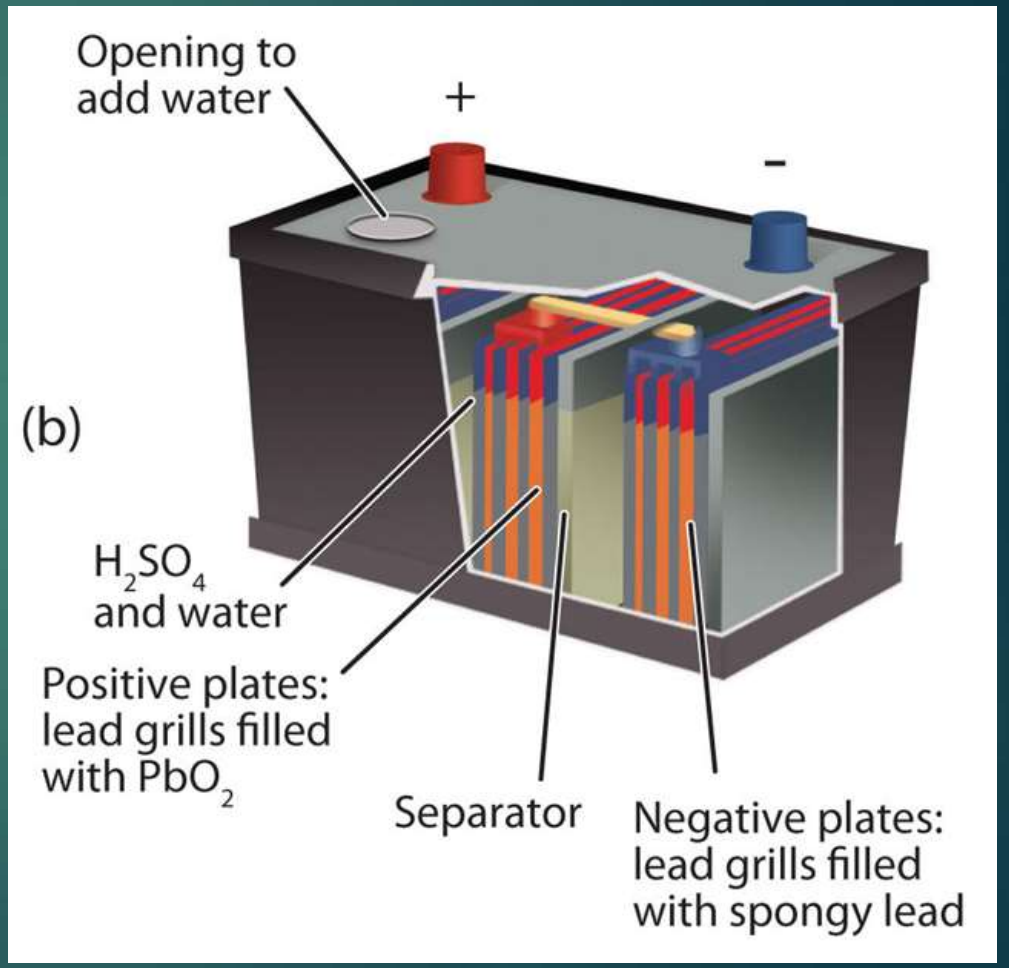
Batteries

- Several electrochemical cells stacked together form a battery.
  - Though today even single cells are called batteries
- In a battery, the positive end of one cell is connected to the negative end of the next cell.
- Many electronic devices connect multiple batteries in this way.
- The total voltage of the battery is found by adding the cells (or batteries) together.



Wet cell batteries

- Called an electrochemical cell because the electrolyte is a liquid.
- In a car battery the electrolyte solution is sulfuric acid in water.
- The metal plates are two forms of lead.



Dry cell batteries

- Dry cells are much more common.
- The electrolyte in a dry cell is actually a paste, not completely dry.