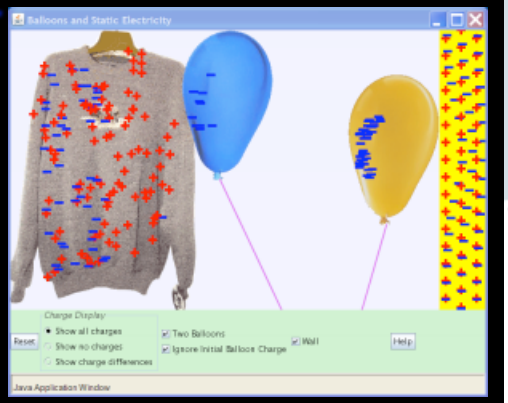
ELECTRICITY

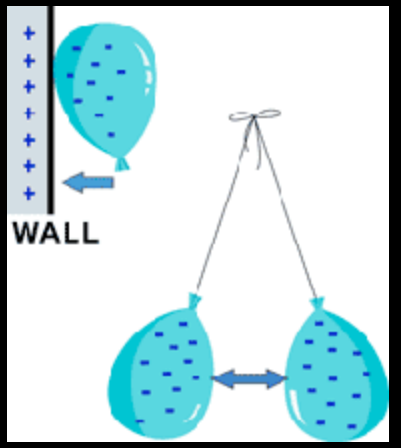
Brown Science Prep

What makes the balloon stick to the wall???

Static Electricity

- Static electricity occurs when **charge** builds up on the surface of an object
- The force created by these charges can cause objects to stick together or repel each other

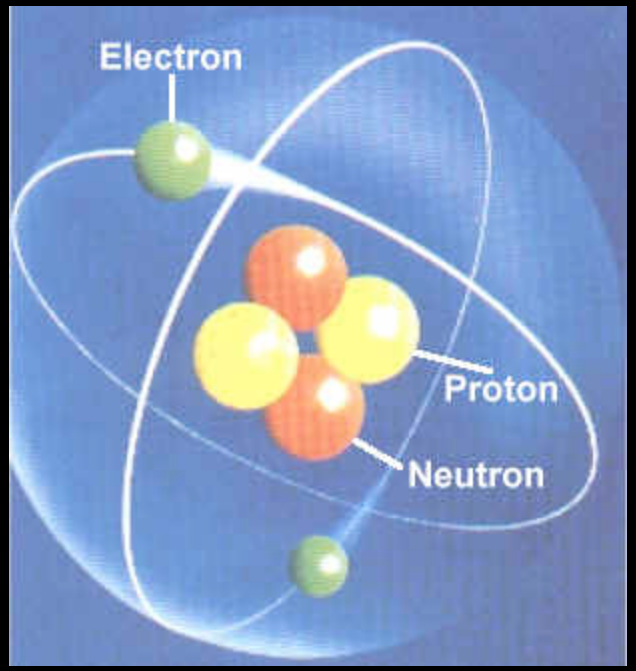




When you charge a balloon by rubbing it, it picks up extra negative charge. Placing it on a neutrally charged object will make the charges in the object move. Positive charges are drawn toward the balloon, while the negative charges are repelled. Now there are more positive charges closer to the negative balloon and the balloon sticks, because opposites attract!

Atoms!

So what exactly is charge?!?!

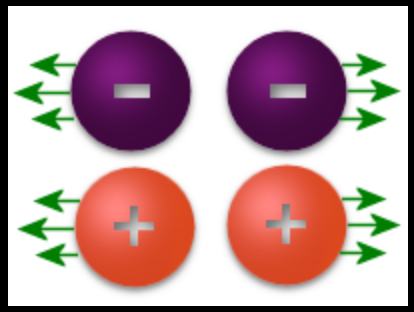


Charge is a property of the electrons and protons within atoms.

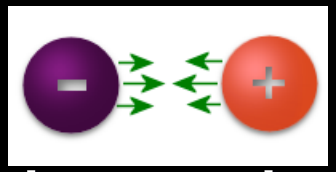
The charges of these particles are the same in magnitude so they balance perfectly, but electrons are (-) and protons are (+).

Normally, objects have a NEUTRAL charge, because there is an even amount of protons and electrons

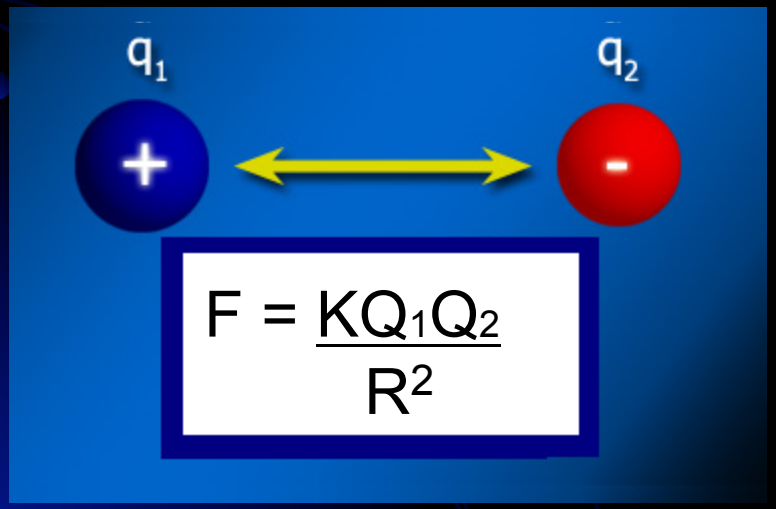
Electrostatic Force



- Like charges repel (i.e. two electrons)
- Opposite charges attract



- The strength of this force depends on the distance between the charges

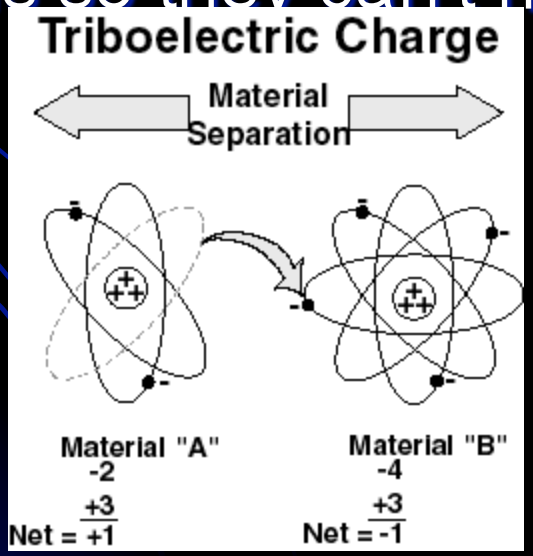


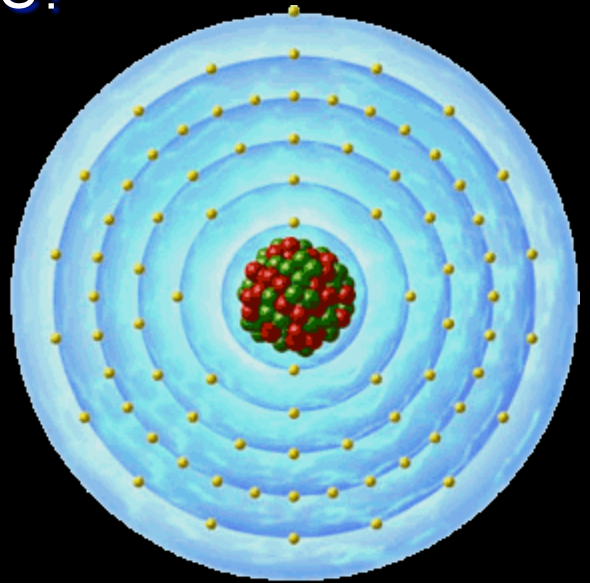
Like gravity acting on two planets, the closer the two charges get to each other, the stronger the force between them becomes

The magnitude of the force also depends on the magnitude of the charges!

Charge Transfer

- Objects become charged when the number of electrons and protons becomes unbalanced.
- This happens when electrons that are loosely attached to one material rub off onto another one.
- Remember, protons are very snug inside the nucleus so they can't move!





Triboelectric Series

- Materials can be listed in order for their charge affinity!
- The (-) ones will take electrons from (+)!

+ **0** **-**

Skin, glass, hair, wool, silk, cotton, paper, amber, rubber, styrofoam, teflon







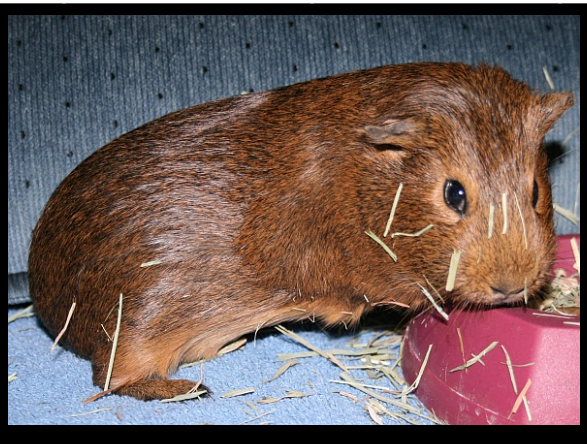




+	0	-
• Human skin • Leather • Rabbit's fur • Glass • Quartz • Mica • Human hair • Nylon • Wool • Lead • Cat's fur • Silk • Aluminum	•Paper •Cotton •Steel •Wood	•Amber •Polystyrene •Rubber balloon •Hard rubber •Nickel •Copper •Sulfur •Brass •Silver •Gold •Platinum •Rayon •Styrofoam •Plastic wrap •Scotch tape •PVC •Silicon •Teflon •Silicone rubber

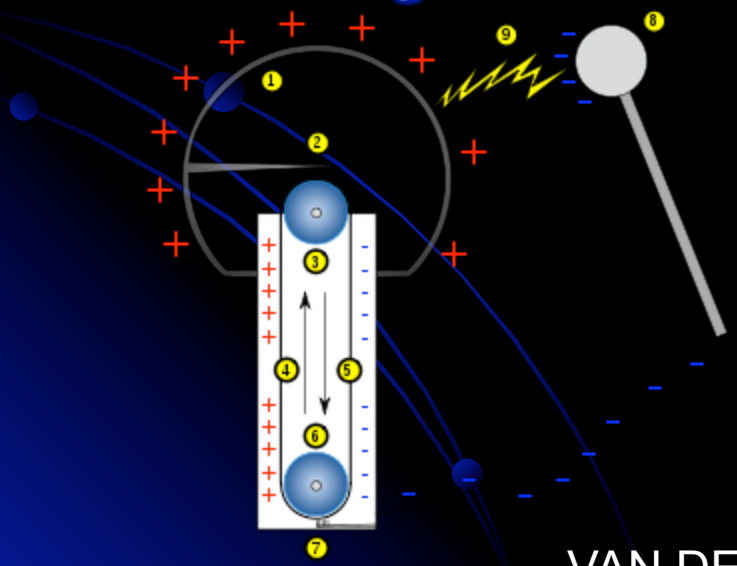
Mat.1 + rub on + Mat. 2 + touch to + Mat. 3 = ?

Material 1	Material 2	Material 3	Result?
Rubber balloon	Human hair	Wall	Sticks!
Paper	Wood	Steel	???????
Styrofoam	Wool	Cotton	???????
Nylon	Steel	Gold	???????



Hamster	Carpet	Straw	?????

- Charges naturally oppose each other, so when charge builds up on an object its tendency is to want to neutralize.
- Excess electrons will leave an object whenever they can to try to balance + and – charge.
- When charge neutralizes, its called "discharge"



VAN DE GRAAFF GENERATOR!!!

- At the Museum of Science in Boston, one of the largest Van De Graaff generators in the world exists! It was built by Mr. Van de Graaff himself…

http://www.youtube.com/watch?v=4WxD4PEBinQ&feature=related

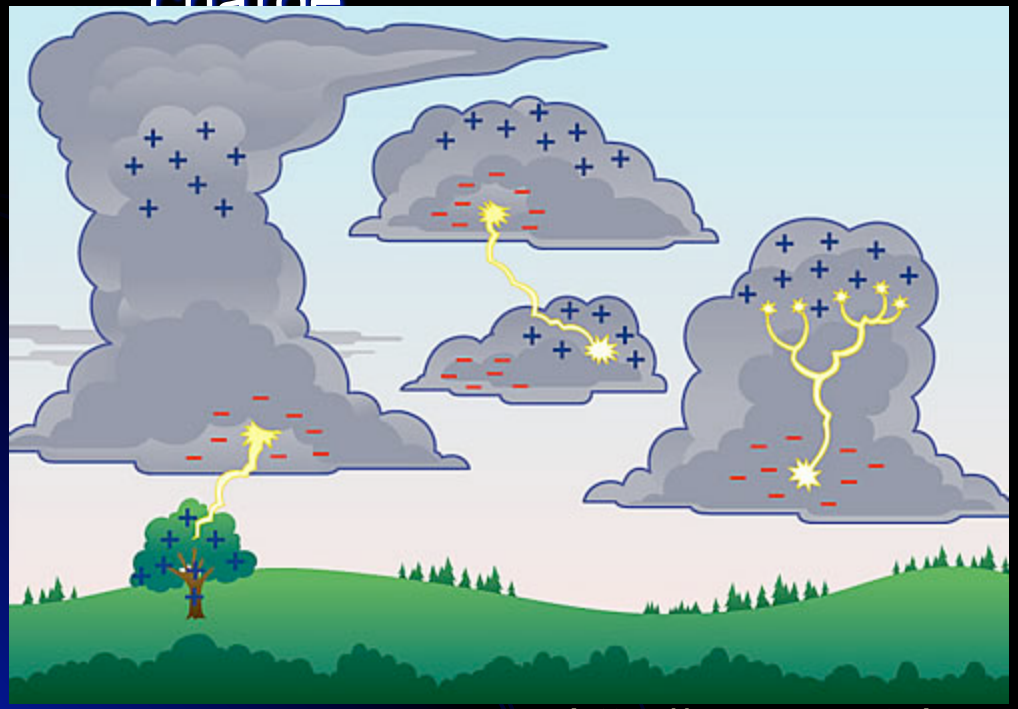
Shocking!

- Have you recently been shocked by one of your friends?
- How do you think this happens?

Lightning!!!

It's not known exactly how the charges that lead to lightning storms are separated.

But, when the unbalance of charge between the atmosphere and ground becomes strong enough, an electrical discharge (lightning!) occurs to neutralize charge.



http://www.youtube.com/watch?v=zpUHC21FOE4

In a storm…

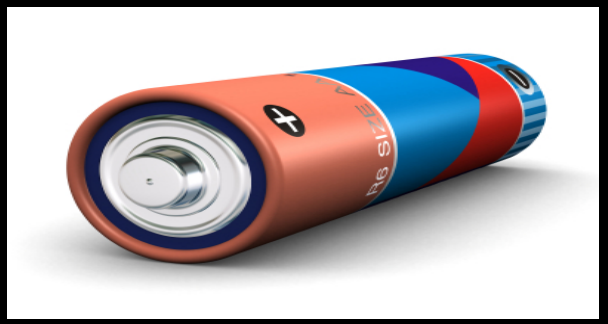
- For an American, the chance of being struck by lightning is approximately 1 in 576,000.
- The chance of actually being killed by lightning is approximately 1 in 2,320,000.

1. Stay AWAY from the water and metal objects.
2. If there is a nearby car, get inside it!
3. If you can't find shelter, stay away tall objects.

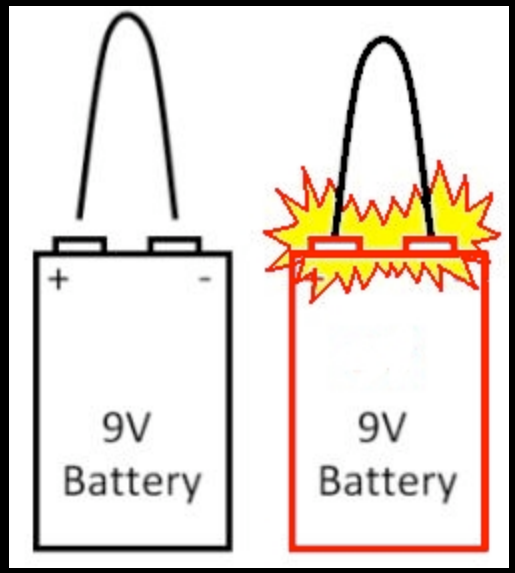
"If only isolated trees are nearby, your best protection is to crouch in the open, keeping twice as far away from isolated trees as the trees are high."

1. "If your skin tingles or your hair stands on the end, a lightning strike may be about to happen. Crouch down on the balls of your feet with your feet close together. Keep your hands on your knees and lower your head. Get as low as possible without touching your hands or knees to the ground. DO NOT LIE DOWN!"

Batteries



- A battery is a device that creates electric potential (it has a + end and a – end)
- When a wire, or conductor, is connected to the ends of the battery, charge will flow from one end to the other



Voltage

- You may have noticed that all batteries have some “voltage” (i.e. 9V, 1.5V, 12V)
- Voltage is a measurement of how much “pressure” there is for charge to move

•Therefore, compared to a 1.5 Volt battery, the electrons of a 9 Volt battery have a much greater “desire” to flow from one end to the other

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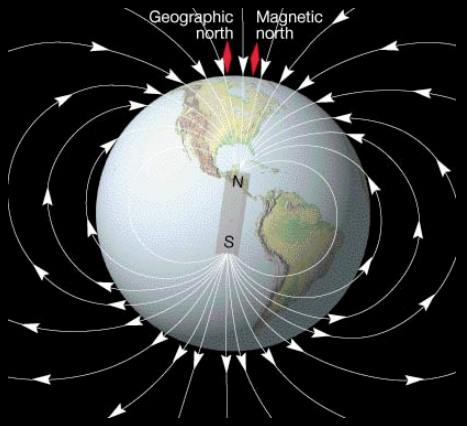
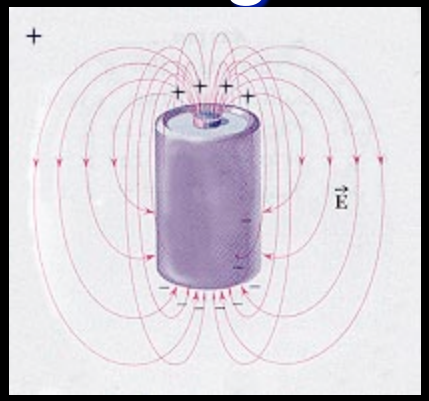
Electric Field

How do electrons "feel" this pressure?

- Have you ever heard of a magnetic field before?

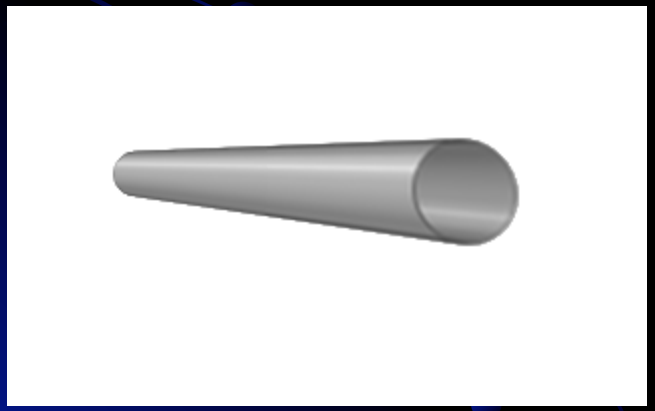


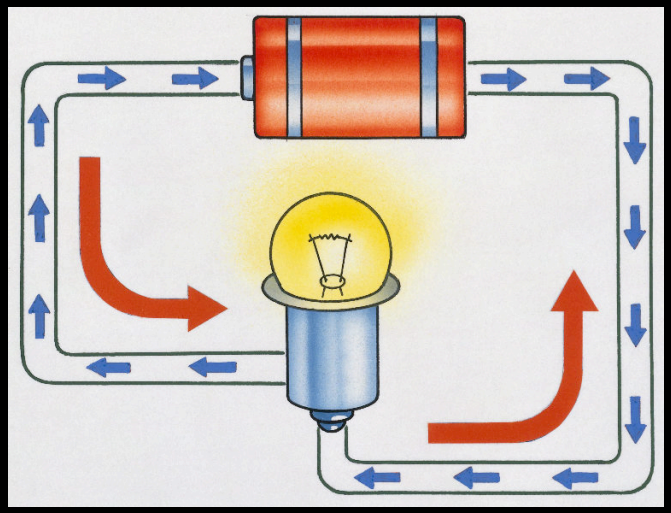


- The electric field works in almost the exact same way!
- When you hold a magnet near one end of the field, it tries to push away so that it can go to the other end of the field… The force of this attraction and repulsion depends on the strength of the field.
- Electrons work the same way!
- A battery with a high voltage means it will have a strong electric field and want to move the electrons more forcefully.

Current

- Electric current occurs when electrons flow from the negative (-) end of a battery to the positive (+) end.
- Current: think of charge flowing in wires like water flowing in pipes.

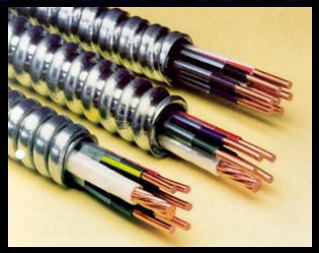




Conductors vs. Insulators

- Current will only flow through conductors:

  Copper, aluminum, gold, silver

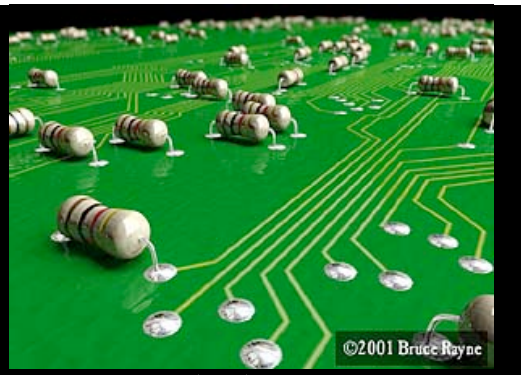


- Current does not flow through insulators

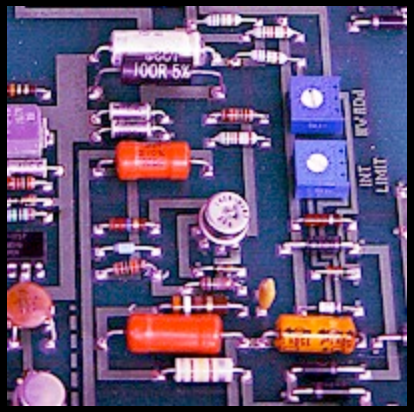
  Plastic, glass, air, rubber, wood

- What are some other conducting and insulating materials? What about yourself? Water? The ground?

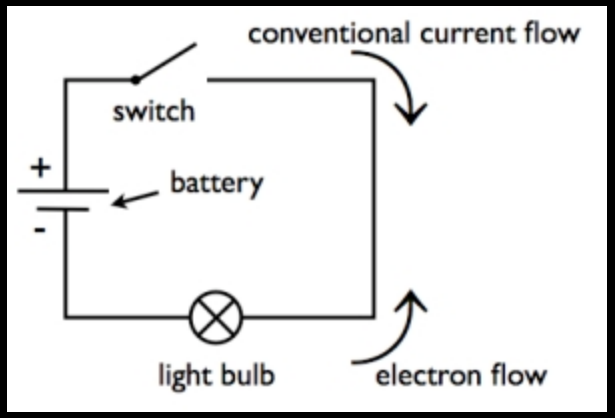
Circuits



A circuit is a complete path for current to flow through with a built-in device to provide force to move charge



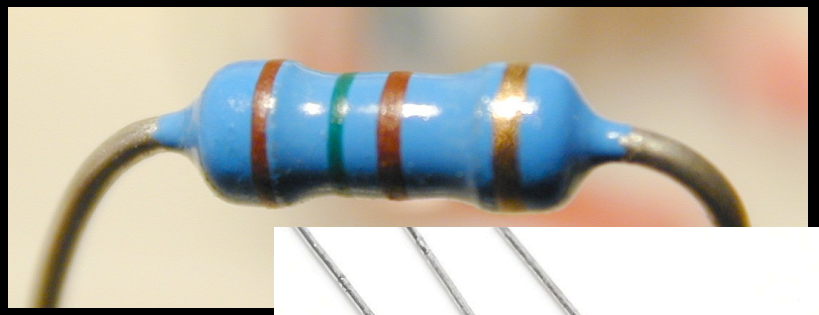
We usually draw circuits like this:

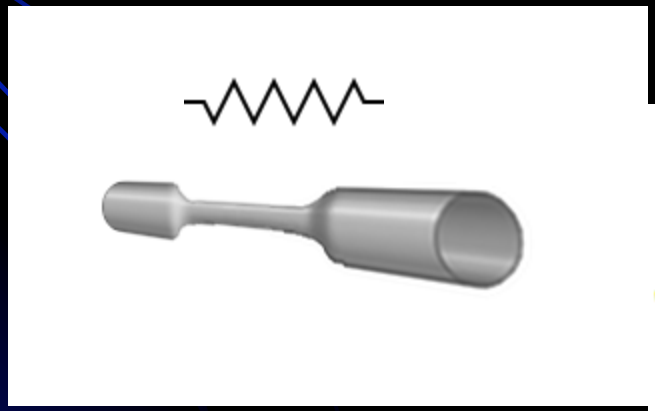


Resistors

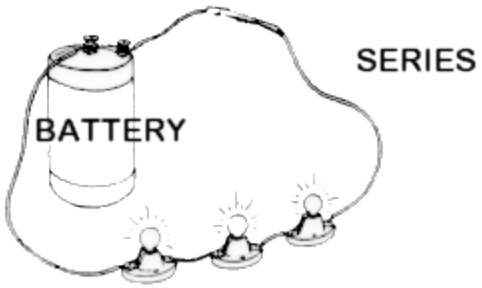
A resistor lowers the current in a circuit by making it harder for charge to flow through

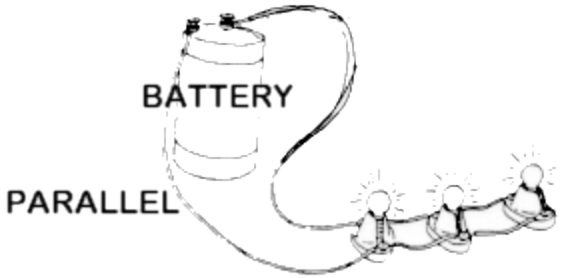
You can imagine a resistor in a circuit as a narrow pipe in a plumbing system! As the water reaches this spot, less will be able to flow through and the current will be reduced.

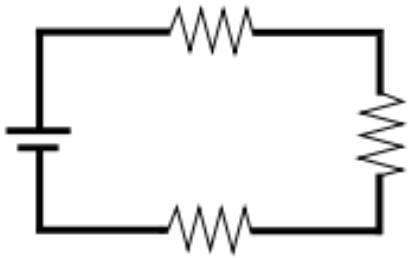


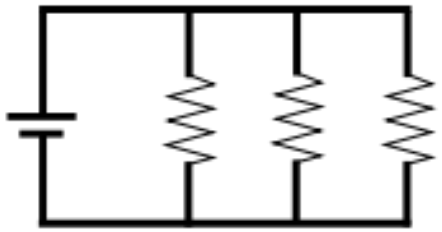


Series vs. Parallel





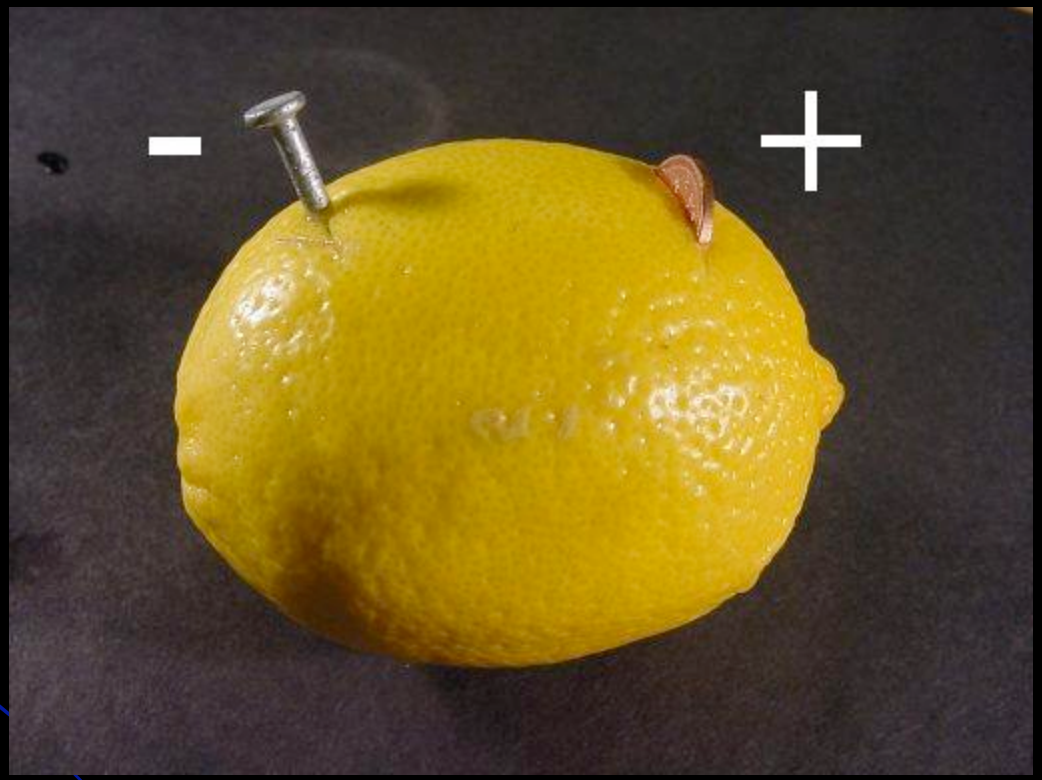




What happens if a light goes out in each type of circuit?

BONUS: Can you predict which will have brighter light bulbs?

LEMON BATTERIES!



$Zn \rightarrow Zn^{2+} + 2e^-$
OXIDATION

$2H^+ + 2e^- \rightarrow H2$
REDUCTION

http://www.youtube.com/watch?v=zvoeeq-BH4w