DC Circuits for Indiana 4-H Electric

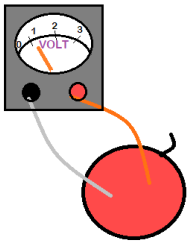
The long-neck dinosaurs had a problem with lightning when they stuck their head up in the air during a thunderstorm!

KA-BOOM! Lots and lots of voltage! About 1,000 Volts per 1/8 inch of spark! You do the math for a foot. Dinosaurs can't.

Lightning is caused by the force of friction making static electricity. You make static electricity when you walk on a carpet (friction) and touch a doorknob and get shocked. When you come up with a way to capture a lightning bolt and put it to work, you will be a very honored person!

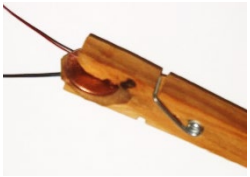
In the meantime, we will use other sources of electricity. We often use chemical **cells**. A cell will have two different metals and an acid.

Use an apple to make a cell. *Any fruit is acidic.* You need a shiny iron wire or nail, and a shiny copper wire to make this cell. Stick the wires deep in the apple.



There will be a small voltage between the copper and the iron wires. If you do not have a voltmeter, touch the wires to the terminals of an earphone and listen.

Another way to make a cell is to use a shiny copper penny and a shiny steel washer. Place a piece of brown paper, which has been soaked with soda pop or lemon juice, between the penny and the washer. Hold the cell together with a clothespin. You can stack two or more of these cells together for more voltage. Test the cell with earphones.



There are many different kinds of cells that produce different voltages. Most car storage batteries use 2-Volt lead-acid cells. TV remotes often use 1-1/2-Volt carbon-zinc cells. Some cells are rechargeable, and some are not. Many cordless tools and mobile phones use rechargeable lithium cells.

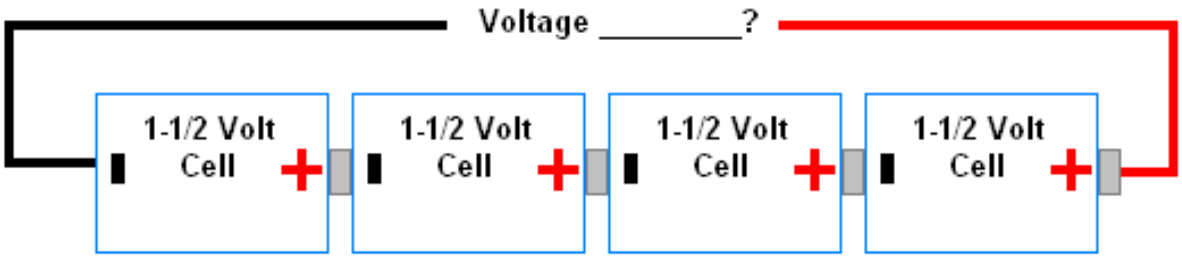
A **battery** is simply two or more cells connected together to provide more voltage. A car storage battery has six 2-Volt cells for a 12-Volt battery. There are six 1-1/2-Volt cells in a 9-Volt battery.

The first practical battery was made by the Italian, Alessandro Volta, in 1799. *Guess where we got the word volt.* He stacked copper washers and cloth washers, soaked in a mild acid, and zinc washers on top of each other to produce a battery of about 30-Volts. Larger diameter washers provide more surface area for more amps of current for more power.

By 1850 there were several improvements in batteries, such as the Crow's Foot battery, for powering the nation's telegraph system. You could now "talk," using Morse code, with someone hundreds of miles away! Thanks to batteries!

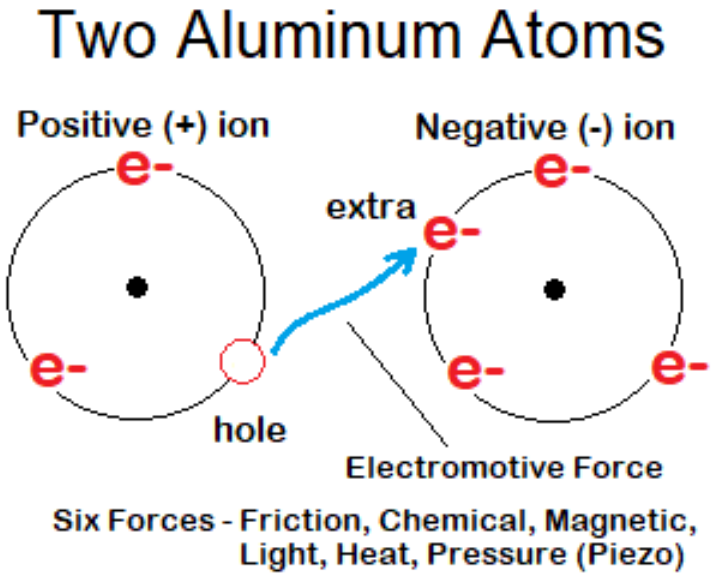
Do you think you could make a 6-Volt voltaic battery?

The more cells connected together, positive to negative, the higher the voltage and the more dangerous it becomes for an electric shock. A rule of thumb saying is: Anything over 50-Volts is risky! People can be killed (**electrocuted**) by batteries. Some old-time radios used 90-Volt batteries, and these could be connected together to get 180-Volts for some big radios!



So, what is electricity?

Electricity is simply the movement of an electron, by one of six forces, from the outer orbit of one atom into the outer orbit of another atom.



The outer orbit of aluminum has three electrons, and they move rather easy. Therefore, aluminum is a **conductor** of electricity. It is hard to move electrons through an **insulator** like glass, plastic, or dry wood.

The atom with the "hole" in its orbit is a positive (+) charged atom and the atom with the extra electron is a negative (-) charged atom. The "extra" electron wants to get back to the "hole." These charged atoms are often called **ions**.

Batteries produce **DC** (direct current) electricity which means that the electric current moves only in one direction. For batteries, we often think of current flow going from positive to negative.

Note: Which direction does the current flow? An early use of electricity was silver plating. You could see the positively charged silver going through the solution to the negatively charged iron spoon or fork. So positive ion current flow is positive to negative in the solution. However, after the electron was discovered, it was realized that electron current flow was negative to positive through solid wires and solutions.

For simple battery circuits, we often think positive to negative. For more complex electronic circuits, we often think negative to positive. While the negative electrons (–ion) go in one direction, the positive holes (+ion) are going the other direction. Just don't let your brain get confused.

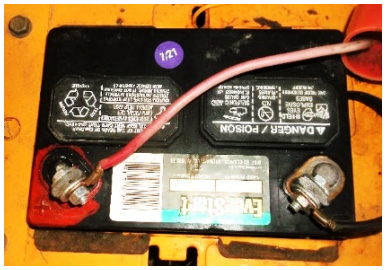
For electricity to do work there needs to be a **circuit**. The word circuit comes from the word circle, something that goes round and round. An electric current has to go round and round in a circuit to get work done. A typical circuit will have:

Source (battery) **Conductors** (wires) **Load** (Light bulbs) **Control** (switch)

The **electromotive force,** or pressure, which pumps the electrons round and round in a circuit is measured in **Volts**. The amount, or number of electrons that are pumped per second, is measured in **Amperes** or **Amps**.

One amp is 6.24 X 10^{18} *electrons (called a Coulomb) past a point in a conductor in one second.*
(We measure kernels of corn by the bushel and electrons by the Coulomb.)

In the early days of electricity, all rubber-insulated wires were black in color. To avoid confusion, some electricians would grab a can of paint and paint the ends of the "hot" wires red. Over time, red became the standard color for the positive (+) wire of a DC circuit. Black became the color of the negative (-) wire.



Pop open the hood of a car or a lawn tractor and find the battery. What color wire is connected to the positive (+) terminal of the battery? Note the black wire. It may be connected to the steel frame. The frame may be used as a conductor. This is often called frame or chassis "grounding". What do you find in electronic equipment?

Some work tips:

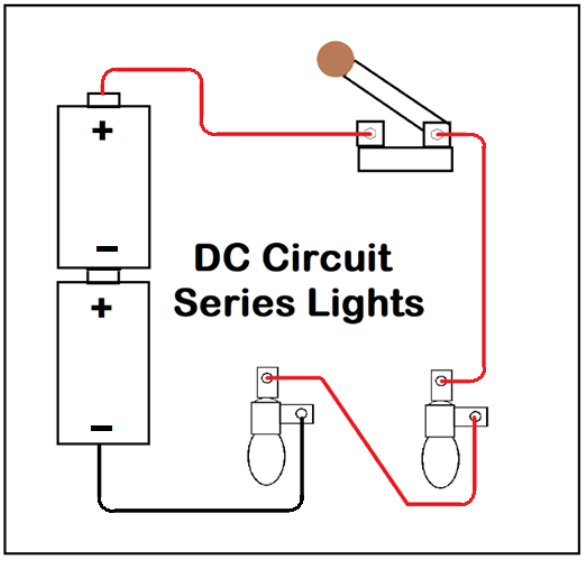
To make a white wire red, use a red permanent marker.

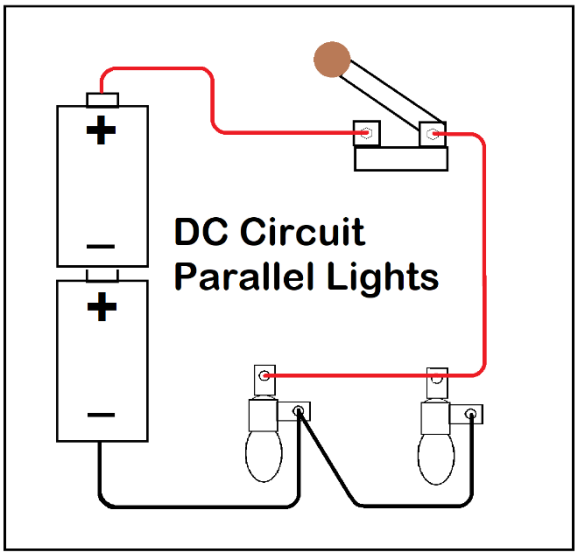
No sharp bends in a wire. They break. Use smooth, gentle bends.

For a "third hand", pliers and a rubber band make a good holding vice.

SERIES AND PARALLEL CIRCUITS

Decision time! Do you wish to wire a series or a parallel circuit?





For the series circuit, each light bulb (same size) gets 1-1/2-Volts. (The lights will be dim because they are 3-Volt bulbs.) If one bulb is removed the other bulb will go out. The same current (amps) passes through each bulb.

For the parallel circuit, each bulb gets 3-Volts. If one bulb is removed the other bulb stays on. The current splits. Half of the amps go through one light and the other half of the amps go through the other light.

Big power line generators produce **AC** (alternating current) electricity which means the current moves back and forth several times a second. A long time ago, when all wires were black, some house wiring electricians would paint the grounded wires white and left the hot wires black.

Today, the AC wires in a house will have a hot black wire and a grounded white wire. So, black wires are hot for AC and “grounded” for DC. Sorry about that.

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January 18, 2023