Simple Electric Circuits

THE BASICS	THE TOOLBOX
 Grade Level: K-12  Estimated Time: 25 min.	• Large bulb and battery drawing • 2 D-cell batteries per person • 2 flashlight bulbs (about 3-volt) per person • 2 strips of aluminum foil ½" wide by 5-6" long per person.

EDUCATION STANDARDS	**Physical Science Content Standard:** Understanding the properties of electricity and how electricity travels within a simple circuit.
SAFETY CONCERNS	The voltage of 1, 2, or 3 D-cell batteries will not hurt you. Do not store batteries and aluminum foil together in plastic bags or the bag may melt.
FOR KIDS WITH DISABILITIES	For students with vision impairments, instead of a lightbulb, use a device that makes a sound. For students with limited dexterity, use battery and bulb holders.

What To Do

Educational Objective:

To demonstrate that a battery is a source of energy (electricity) that can make a lightbulb turn on. To demonstrate that the electricity has to follow a particular type of path (complete circuit) in order for the bulb to light. To demonstrate that there is more than one way to make a complete circuit.

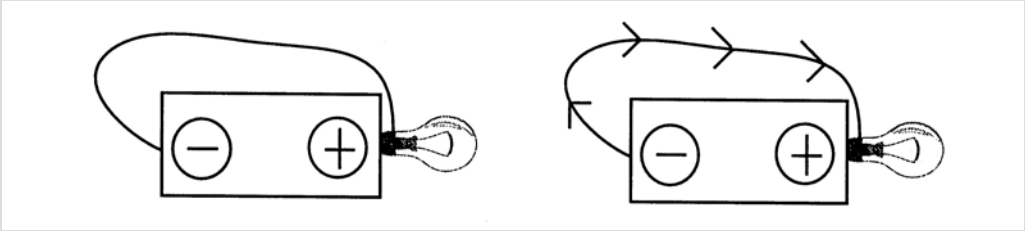
What to Do:

- Make a simple circuit yourself with a fresh battery and a fresh bulb in order to see how brightly the bulb will light up. Later, you can use this as a comparison to see if the batteries have gotten low and need to be replaced, or use the tester included in the packaging of some batteries.
- Cut pieces of aluminum foil to the appropriate sizes.
- Arrange for a place to work where participants can sit at tables with their materials.

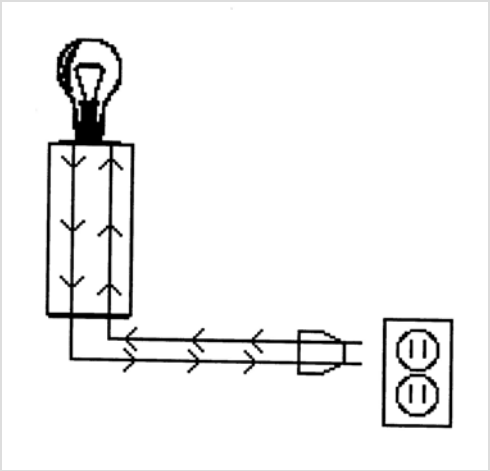
Questions to Ask Students As They Do This Activity: (Also see the questions throughout the activity sheet.)

- Does it matter whether the bulb touches the positive end or negative end of the battery?

- What happens to the aluminum foil when you create a **short circuit** (by connecting the positive terminal of the battery directly to the negative terminal without the bulb in the path)?
- If the electricity is running through the foil, why don't you get a shock when holding the foil?
- What happens to the brightness of the bulb if you use two batteries? Three batteries? What would happen if you kept stacking up more and more batteries? Try it on one bulb.
- Why do you think there are two wires in an extension cord or electrical appliance cord? Why are there two prongs on the electrical plug at the end of the cord?
- Can you draw arrows on the diagram to show how the electricity flows in a simple circuit? (The diagram is shown below on the left, and the answer on the right.)



- Can you draw a diagram to show how electricity flows through a lamp in your house?



- How do you think the switch works on your lamp? Open one up and see! **Be sure to get an adult's permission first, and be sure the lamp is unplugged.**

Why It Happens:

Inside the battery, there are chemical reactions going on that cause negatively charged particles to accumulate on the bottom (-) end of the battery and positively charged particles to be more abundant on the top (+) end. This sets up a difference in electrical potential (**pressure**) between the two ends, since the negative charges are attracted toward the

positive terminal of the battery. But because of the construction of the battery, the negative charges cannot just flow toward the positive charges on the inside of the battery. There needs to be some kind of connection made on the outside of the battery that links the two ends so that the negative charges can flow and produce a current. When the positive and negative ends are connected by a complete, uninterrupted path, the difference in electrical potential (pressure) between the two ends causes the current to flow through the path. This path is called a **circuit**. When the circuit is complete and is allowing current to flow through it, it is described as a **closed circuit**. If the path is interrupted in any way, such as a disconnected wire, then the current will not flow. That is called an **open circuit**.

When the light bulb is connected as part of the circuit, it has to be connected so that the current still has a complete, uninterrupted pathway between the two terminals of the battery. When this happens, the light bulb will light (if it's not burned out). In order for the light bulb to be connected to form a closed circuit, the metal parts of the bulb have to be part of the circuit. The electrons will not flow through the light bulb's glass or plastic parts.

By the way, the light bulb works because it contains a tiny filament of wire that has a very high **resistance** to electricity flowing through it. This resistance in the filament is similar to friction that occurs when you rub your hands together briskly. When you do this, the friction produces heat. Since the atoms in the filament resist, or oppose, the flow of electrons through them, some of the electrical energy gets converted to heat, and the filament gets so hot that it begins to glow. Other devices that purposefully waste electrical energy like this to produce heat and/or light include toasters, irons, and space heaters or the heating elements (burners) on an electric stove. If the ends of the battery are connected by a conducting path without any device in the circuit to use the circuit (such as the bulb in this activity), then a larger amount of current will flow. This situation is called a short circuit. In the case of this activity, that means that the battery will die out more quickly, and the foil may get warm.

Most larger circuits are designed so that a certain amount of resistance is supposed to be part of the circuit. When this resistance is present, the right amount of current will flow in the circuit and not too much heat will be produced. If the resistance in the current is low, then too much heat can be produced. This is why a short circuit in a home electrical system can be very dangerous. If the wires get too hot, they can cause a fire. Again, this is not a danger with this activity because the source of electricity we are using (batteries) does not have enough voltage to produce a dangerously high current.

A note about materials: While both alkaline and regular batteries work in this activity, most of them contain mercury. Recently developed mercury-free batteries are now available; these are safer for the environment.

Many kinds of flashlight bulbs will work with a D-cell battery in this activity. We recommend #47 and #48. They are not very bright when used with one battery, but they will burn brightly when used with two or more. The advantage is that it will take a stack of 8 or 9 batteries to make these bulbs burn out. While bulbs are available at local electronic stores, it is more cost-effective to make a bulk purchase from a supplier listed in Appendix B.

Web Sites

- **A Spark...of Brilliance**
  http://sln.fi.edu/qa98/attic12/index.html (Grades 4-12)
- **Thomas A. Edison Papers**
  http://edison.rutgers.edu/ (Grades 9-12)
- **Battery Life – A Science Experiment**
  http://www.energy.ca.gov/education/projects/projects-html/battery.html (Grades 2-12)

Software

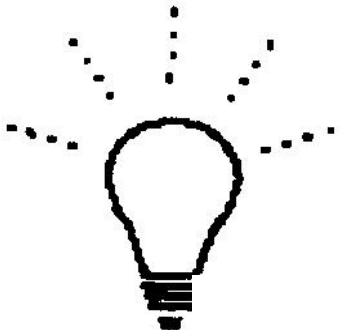
- **Physics Explorer: AC/DC Circuits**
  LOGAL Software, Inc., 1999.
  (Grades 9-12)
- **School House Rock: Science Rock**
  Creative Wonders, 1995.
  (Grades 2-6)

Reading Room

- Houghton, Janaye & Robert. **Circuit Sense for Elementary Teachers and Students**. Teacher Ideas Press, 1994. (Grades 2-6)
- Robson, Pam. **Electricity**. Gloucester Press, 1993. (Grades 2-6)
- Schafer, Larry. **Taking Charge: An Introduction to Electricity**. NSTA, 1992. (Grades 7 and up.)

Career Connections

Scientists who study space depend on instruments containing many circuits. For more information on careers in space, contact your local planetarium or science museum.



SIMPLE ELECTRIC CIRCUITS ACTIVITY SHEET

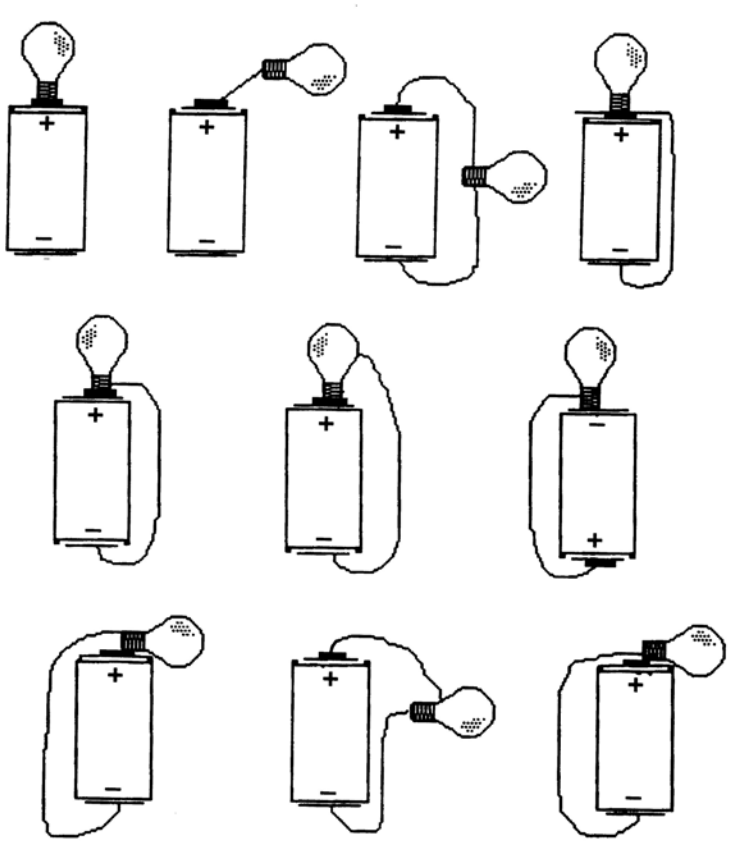
What To Do:

1. Look at your battery. What differences are there between the two ends? If you've used batteries before, in flashlights for example, then you may be familiar with this difference. Look at the labeling on the battery to determine which end is positive (+) and which end is negative (-).

2. Look at your light bulb. What kinds of materials are put together to make the light bulb? How do you suppose the materials and the way they are put together are related to making the bulb work?

3. Take your battery, light bulb, and 1 strip of aluminum foil and try to connect them so that the bulb will light. Try as many different ways of connecting them as you can. When the bulb lights, the path that you have made with your connections is called a circuit. Some possible circuits to try are shown below. Before you try them, predict whether each one will cause the bulb to light. Then, see whether or not you are right.

4. After you have made one or more successful circuits with just one piece of foil, try to make some circuits with two pieces of foil and/or two batteries and/or two bulbs. Again, make predictions first and then try it out. Use scrap paper to draw the circuits that you try.



5. Now, try to make:

- A circuit in which the bulb does not directly touch the battery;
- A circuit that lights two bulbs; and
- A flashlight that uses two batteries.

Electric Light Bulb