



Lights, Sound, Action!

| THE BASICS | THE TOOLBOX | EDUCATION STANDARDS | Physical Science Content Standard: |
|--|--|-----------------------------------|--|
|  Grade Level: K-12  Estimated Time: 45 min. | <ul style="list-style-type: none"> • 3 D-cell batteries • 5 pieces of 6" long insulated copper wire • 2 flashlight bulbs (3-volt) • 3 battery holders & 2 bulb holders • Buzzer, motor and fan blade • Alligator clips | SAFETY CONCERNS | Understanding electrical circuits and that circuits can be formed in series or parallel. The voltage of 1, 2, or 3 D-cell batteries will not hurt you. Remember to emphasize that electrical wall outlets can be dangerous! |
| | | FOR KIDS WITH DISABILITIES | For students with vision impairments, instead of a lightbulb, use a device that makes a sound. |

What To Do

Educational Objective:

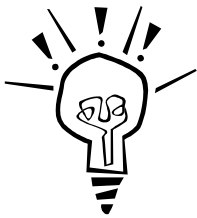
To demonstrate that a battery is a source of electrical energy that can be used to produce light, sound, or motion. Also, that electricity has to follow an unbroken path (a complete circuit) in order for the bulb to light, and that circuits can be wired in series or parallel.

Materials Preparation:

- Make a simple circuit yourself with a fresh battery and a fresh bulb in order to see how brightly the bulb will light. Later, you can use this as a comparison to see if the batteries are low or need to be replaced.
- Cut pieces of copper wire to the appropriate sizes.

Questions to Ask Students As They Do This Activity:

- What happens to the wire when you create a short circuit?
- If the electricity is moving through the wire, why don't you get a shock when holding the wire?
- What happens to the brightness of the lit bulb if you use two batteries? Three batteries?
- What would happen if you kept stacking up more and more batteries? Try it!



- Where do the electrons flow through the circuit?
- Why does one bulb remain lit in the parallel circuit?
- What is one disadvantage of wiring a string of lights in parallel?
- To light the bulb, does it matter which direction the battery is facing? Does it matter for the buzzer? Motor?

Why It Happens:

The current produced from the battery in these experiments is called direct current because the electrons only move in one direction. The current from the electrical outlets in your house is called alternating current because the electrons move first in one direction, then stop and reverse direction. This back-and-forth motion is repeated constantly and very quickly—60 times per second!

In series wiring, there is only one path for the electrons to follow. They must travel through both bulbs to reach the positive end of the battery. If one bulb is disconnected, the circuit is not complete and both bulbs go out. Also, the resistance in the circuit is greater because there are two bulb filaments resisting the flow of electrons. Therefore, the bulbs do not glow as brightly.

In parallel circuits, the electrons have more than one path on which they can travel. They flow through both bulbs and, therefore, both bulbs light. When one bulb is disconnected, the other path is not broken. The circuit remains complete, and the other bulb remains lit. Also, since each path in the parallel circuit passes through only one bulb, the resistance in each arm of the circuit is the same as that of a simple circuit, but twice as much current flows (and runs the battery down twice as fast).

Parallel wiring obviously has many advantages. In our homes, it allows each appliance to receive a full allocation of electrical power. If our homes were wired in series, as we turned on more and more lights, each would become dimmer and dimmer. Parallel wiring also allows other appliances to work even when one is turned off or burned out. One disadvantage of parallel wiring is that it requires more wire than series wiring does.

Series wiring is advantageous when you want all appliances to be turned on and off from one switch. When appliances, such as lights, are wired in series, it is more difficult to determine which one has burned out or is out of order. You may have experienced this in a string of Christmas or patio lights—a very frustrating experience.

You have used electricity to produce light (with a lightbulb), heat (with the filament on the lightbulb and with the short circuit), and sound (buzzers). We've already discussed how the lightbulb works, but how do buzzers work? Tiny pulses of electricity cause vibrations, thus creating sound (much like wiggling a sheet of metal back and forth). For the buzzer, the sound is constant.

The direction of the flow of electricity does not matter in lighting the bulb. Most buzzers and motors have more complex internal wiring that requires the flow to go in a certain direction. If these appliances do not work at first, encourage students to experiment with reversing the

direction of the battery on the appliance. Many buzzers and motors come with two wires attached. The wires are two different colors to indicate that one should be attached to the positive end and another (usually a black wire) should be attached to the negative end of the battery.

WEB SITES

- **Lemon Power**
<http://www.energy.ca.gov/education/projects/projects-html/lemon.html> (Grades 2-12)
- **Safety With Electricity**
<http://www.energy.ca.gov/education/safety/safety-html/safety.html> (Grades K-2)

SOFTWARE

- **Virtual Physics: Escape from Braindeath**
Cubic Science, Inc.
(Grades 6-9)
- **School House Rock: Science Rock**
Creative Wonders, 1995.
(Grades 2-6)

READING ROOM

- Carrow, Robert. **Turn on the Lights from Bed! Electronic Inventions, Contraptions, and Gadgets Kids Can Build.** Learning Triangle Press, 1997. (Grades 9 and up.)
- Bonnet, Bob, and Dan Keen. **Science Fair Projects with Electricity and Electronics.** Sterling, 1996. (Grades 7 and up.)

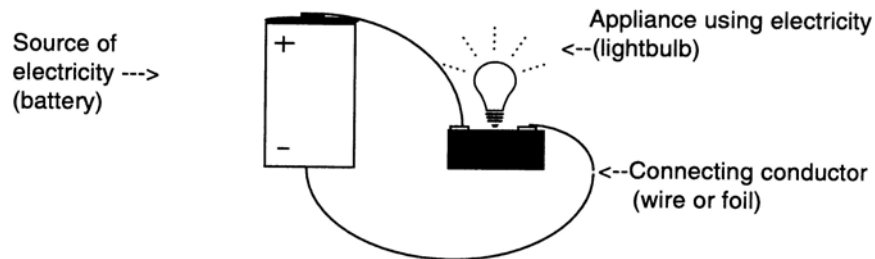
Career Connections

Industrial engineers use their knowledge of circuits to build all kinds of appliances from hair dryers to rides at a theme park.

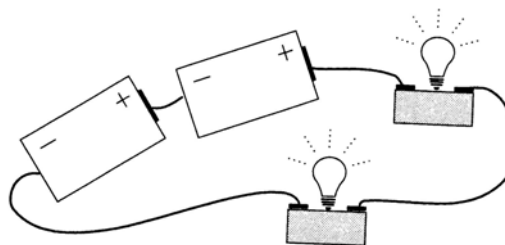
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ACTIVITY SHEET #1

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 lightbulb. What kinds of materials are put together to make the lightbulb? How do you suppose the materials and the way they are put together are related to how the bulb works?
3. Take your battery, lightbulb, a bulb holder, and 2 pieces of copper wire. Make sure that $\frac{1}{2}$ inch of insulation has been stripped from each end of the wires. Carefully screw the bulb into the holder. Connect the two wires to the two clips on the bulb holder. Now connect them so that the bulb will light. When the bulb lights up, the path you have made with your connections is called a complete circuit (or closed circuit).

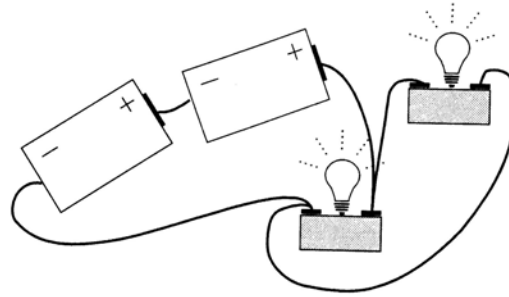


4. Now, try to make two bulbs light at the same time. Try building a circuit this way:



When you used two bulbs, what did you notice about the bulbs? Did they burn as brightly as the one did before? Did they both glow with the same brightness? What happens when you unscrew one bulb? How could we make the bulbs glow more brightly? Try your idea to see if it works. When we wire a circuit so that the electricity flows first through one bulb and then through the second, we say the circuit is wired in series.

5. How else could we wire a circuit with two bulbs? Try this one:



Did both bulbs light up? If not, check your circuit to make sure all your wire connections are tight. Do both bulbs burn with the same brightness? Are they brighter or dimmer than they were in the series circuit? Why do you think this is so?

6. Think about the electrons that are moving through this circuit. Pretend you're an electron at the negative end of the battery. Trace a pathway through the wires and bulbs through which you could get to the positive end of the battery. Remember that electrons can only travel through metal. They can't jump through the air, or travel through glass or plastic, or even move inside the battery at all!
7. Now let your partner try to find a different pathway for the electron to get from the negative end to the positive end. Did he or she find another path? How about through the other bulb?
8. Now, unscrew one bulb. What happens to the other? Screw that bulb back in and unscrew the second bulb. What happens?

Note: The second circuit you built is wired in parallel since the electrons can move through both bulbs side by side rather than one after the other. In a parallel circuit, if you disconnect one side of the circuit (by unscrewing one bulb) the other side can still provide a complete path (or circuit) for electrons to flow, so the bulb remains lit.

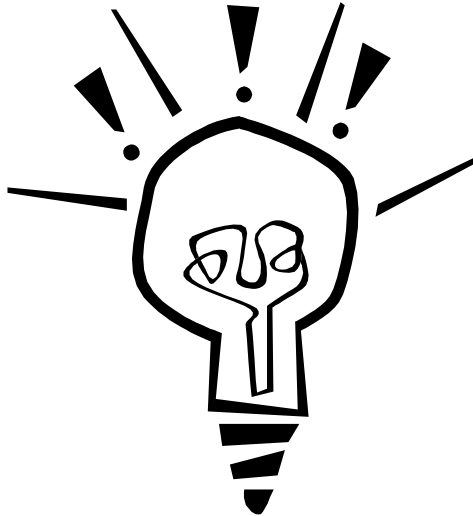
Suppose you had a string of Christmas or patio lights plugged in and one bulb burned out. Tell what would happen to the other bulbs if your lights were wired in series:

What would happen to the other bulbs if your lights were wired in parallel?

How do you think the lights in your house are wired? Explain why you think this.

Name at least one advantage and one disadvantage of electrical wiring done in parallel and electrical wiring done in series:

| | Advantage | Disadvantage |
|--------------------------------|------------------|---------------------|
| Wiring Done in Parallel | | |
| Wiring Done in Series | | |



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ACTIVITY SHEET #2

What to Do:

In this activity, we'll use electricity to produce motion and sound. Work with a partner!

1. First, let's build a circuit with one battery and a buzzer. Use a battery, battery holder, and alligator clips (or tape) to hold your connections together. Does the buzzer make any sound?
2. Add a second battery and holder to your circuit. Be sure that your batteries all "point" the same direction (that is, the positive end of one battery should always be connected to the negative end of the next battery). Now, does the buzzer buzz? What do you think would happen if you used three batteries with the buzzer? Try it! What happened?
3. Now, let's use electricity to make motion. Push a fan blade onto the shaft of a 1.5-volt electric motor. Connect one battery to the wires on the motor. What happens? Which way is the air blowing? Now, reverse the direction of the electric current by turning the battery over so the wires from the motor are connected to opposite ends of the battery. Which direction does the wind blow now? What happens if you use two batteries with the motor? Be sure you don't use more than two batteries. The motor can get hot and the blade can fly off.
4. Can you create a circuit that produces light, sound, and motion all at once? Will you need extra batteries? Try it!
5. Can you wire a buzzer and a motor in series? In parallel? How many batteries do you think you'll need?

