



# Conductors and Insulators

THE BASICS	THE TOOLBOX	EDUCATION STANDARDS	Physical Science Content Standard:
 <p>Grade Level: K-12</p>  <p>Estimated Time: 20 min.</p>	<ul style="list-style-type: none"> <li>• D-cell (1.5 volt) battery</li> <li>• Strip of aluminum foil about 1/2 inch wide by 5-6 inches long</li> <li>• Flashlight bulb (3-volt)</li> <li>• Clothespin</li> <li>• Masking tape 6" long</li> <li>• Items to test (see list below)</li> </ul>	<p><b>SAFETY CONCERNS</b></p>	<p>The voltage of 1, 2, or 3 D-cell batteries will not hurt you. Remember to emphasize that electrical wall outlets can be dangerous!</p>
		<p><b>FOR KIDS WITH DISABILITIES</b></p>	<p>For students with vision impairments, instead of a lightbulb, use a device that makes a sound.</p>

## What To Do

### Educational Objective:

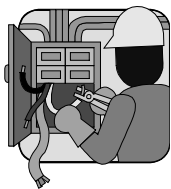
To demonstrate that electricity will travel only through certain materials, known as **conductors**, and that most conductors are metals while most **insulators** (nonconductors) are nonmetals.

### Materials Preparation:

Before beginning this activity, you need to gather materials to test for conductivity. The following are some suggestions:

- |             |                      |
|-------------|----------------------|
| Copper wire | Coin                 |
| Steel wool  | Paper clip           |
| Rubber band | Brass paper fastener |
| Sponge      | Nail, bolt, or screw |
| Pencil      | Plastic              |
| Toothpick   | Tape                 |
| String      | Marble               |
| Candle      |                      |

- If you wish, prepackage the materials in small Ziploc bags.
- Cut pieces of aluminum foil to appropriate sizes.
- Test batteries and bulbs to be sure they are still in working order.
- Arrange for a place where the participants can sit with their materials at tables.



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

- How did you make your predictions about which materials would conduct and which would insulate? Did all of your predictions prove to be correct? Which ones weren't? Do you know why?
- Did some items have parts that would conduct and parts that wouldn't? (Hint: Try a wooden clothespin that has a metal spring.)
- Why do you think people who work with electrical wiring often wear rubber gloves or rubber shoes?
- Is water a conductor or an insulator? Why is it dangerous to be wet or standing in water when you're working with something electrical? Why is it ok to be wet while standing with a D-cell battery? (Hint: Try adding several teaspoons of table salt to half a cup of water. If you set up your tester with 3 to 4 batteries, it will probably be able to conduct electricity through this **very** salty water.)

**Why It Happens:**

The ability of a material to carry, or conduct, electricity is related to the structure of atoms, particularly electrons. All materials contain electrons, and so the labels **conductor** and **insulator** are not absolute. In other words, a material that is a good conductor can also be called a poor insulator, and a material that is a poor conductor can also be called a good insulator. The materials that are best conductors are usually metals. This is because the metals have a particular chemical structure that makes them pass along their electrons easily. A metal wire can be thought of as an efficient bucket brigade. The wire and its atom are like the people standing in line in the brigade, and the electrons are like the buckets that get passed easily down the line. Insulators don't pass the buckets (electrons) as efficiently. Their atoms tend to hold on to their own buckets (electrons). The lists below show some conductors and insulators arranged in order. The closer a material is to the top of the conductor list, the better a conductor (or poorer an insulator) it is. And, the closer a material is to the top of the insulator list, the better an insulator (or poorer a conductor) it is.

**Good Conductors**

Silver  
Copper  
Gold  
Aluminum  
Brass  
Iron  
Lead  
Mercury  
Graphite  
Water containing dissolved materials

**Good Insulators**

Amber  
Hard rubber  
Nylon  
Porcelain  
Beeswax  
Glass and wood  
Shellac  
Very pure water  
Air

## WEB SITES

- **Conductivity**  
[http://www.physics4kids.com/files/elec\\_conduct.html](http://www.physics4kids.com/files/elec_conduct.html) (Grades 3-8)
- **The Transistor**  
<http://www.lucent.com/minds/transistor/> (Grades 6-12)

## SOFTWARE

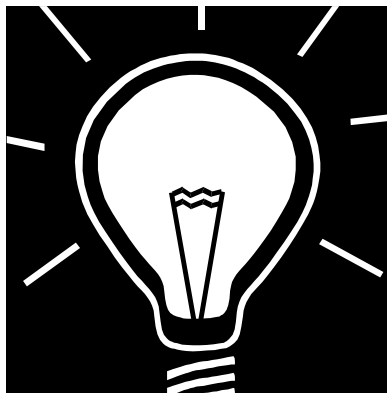
- **School House Rock: Science Rock**  
Creative Wonders, 1995.  
(Grades 2-6)
- **PowerLab Electricity**  
PowerLab Studios, Inc., 1997.  
(Grades 3-6)

## READING ROOM

- Parker, Steve. **Benjamin Franklin and Electricity**. Chelsea House, 1995.  
(Grades 2-6)
- VanCleave, Janice. **Janice VanCleave's Electricity: Mind-Boggling Experiments You Can Turn Into Science Fair Projects**. Wiley, 1994. (Grades 2-6)

## Career Connections

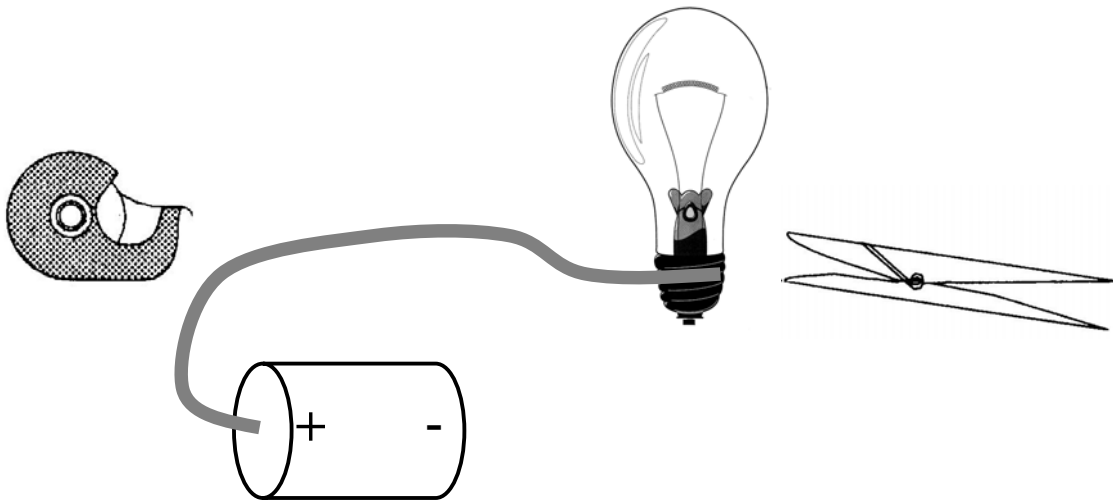
A materials engineer designs new and better ways to make materials such as conductors and insulators.



# CONDUCTORS & INSULATORS ACTIVITY SHEET

## Build a Tester:

1. Fold a 6-inch strip of aluminum foil lengthwise until it is no more than a ½ inch wide.
2. Wrap one end of the foil strip around the base of the bulb. Clip a wooden clothespin around the foil to hold it in place against the bulb.
3. Use some tape to fasten the other end of the aluminum foil securely to one end of the battery.
4. Test the circuit by touching the bottom tip of the bulb against the other end of the battery. The bulb should light. Make any necessary adjustments if it does not light.



## Use the Tester:

1. You should have a bag or pile of materials on your table to test to find out whether they conduct electricity (electricity passes through them easily) or insulate (tend to prevent the flow of electricity). Before using your tester, predict which materials will be conductors and which will be insulators. Separate the materials into two piles based on your predictions. Now, get ready to test your hypotheses!
2. How do you think your tester can be used to find out which things conduct electricity? Try to test a small extra piece of aluminum foil with your tester to get the bulb to light. Figure out how to put this extra piece of foil into your circuit so that the circuit will work.
3. Once you have figured out how to hold the extra piece of foil to make a complete circuit, try your other materials in place of the extra foil. Try the materials one at a time to see which materials will conduct electricity (make the bulb light) and which materials will not conduct electricity (won't make the bulb light even when connected properly). Were all of your predictions correct?

4. Based on your tests, divide your materials into two new groups—those that conduct electricity and those that do not. Look at the materials that do conduct electricity. Do those materials have anything in common? What? Now, look at the group of materials that do not conduct electricity (the insulators). Do those materials have anything in common? What?
5. Now, look at your lightbulb again. Can you locate parts of the lightbulb that are conductors and parts that are insulators?

**Other Things to Try:**

- When you find a conductor, reverse the direction of the battery in your circuit to see if it makes a difference which end of the battery you connect to the wires in the circuit.
- Or, if you have more than one battery, see what difference, if any, it makes when you connect more than one battery in the circuit.

**Conductor/Insulator Data Chart**

Item	Prediction (Conductor/Insulator)	Results (Conductor/Insulator)