

Introduction

We have seen in earlier activities that electricity flows through a complete path called a circuit. Within a circuit, electricity flows through conductors. Conductors are materials through which electricity can flow. Insulators, on the other hand, block the flow of electricity. Insulators are materials through which electricity *cannot* flow.

The properties of both types of materials—conductors and insulators—are useful.

In this chapter we'll investigate which kinds of materials and objects are good conductors and which are insulators.

Goals of this Activity

When you have completed this Activity, you will be able to:

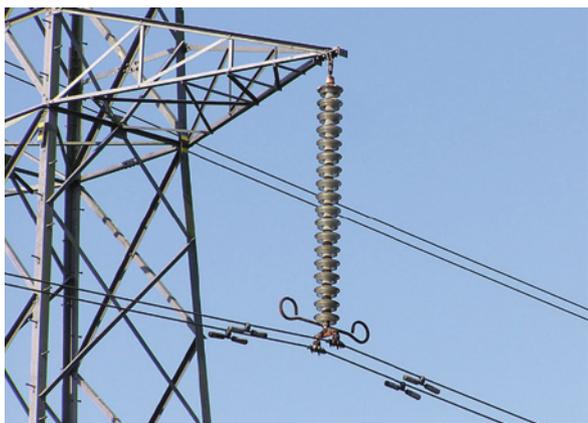
1. Describe the difference between electrical conductors and insulators.
2. Identify electrical conductors and insulators through experimentation.
3. Describe why it is important to have both conductors and insulators.

To Flow or Not To Flow

We know that electricity flows in a path called a circuit. Without a complete circuit, electricity cannot flow. If it does not flow, electricity cannot do work such as lighting a lamp, powering a computer, or turning a motor.

However, experience tells us that electricity doesn't flow through everything. If it did, we'd get an electric shock every time we turned on a lamp, touched a computer keyboard, or picked up a battery.

Electricity flows through objects that are conductors and doesn't flow through objects that are insulators. Good conductors are generally made of metal such as copper, aluminum, silver, gold, brass, tin, and lead. Good **insulators** are often made of glass, plastic, rubber, ceramic, or cloth.



Insulators are useful for separating electricity from objects and living things that it could damage. In the picture at the left, power lines are separated from the metal tower by a stack of ceramic insulators.

Insulators also protect electric circuits from objects that could interfere with the proper functioning of the circuit. Most importantly, insulators are necessary for health and safety because they separate people from electricity. For example, the conductor in most appliance power cords is copper wire, but it is surrounded by insulating plastic so that we can safely touch a plugged-in cord.

In this Activity we experiment with different kinds of materials and objects to identify good conductors of electricity, poor conductors of electricity, and insulators.

We will build a working circuit using a lamp as our load. Then we will test different objects to see if they are conductors or insulators. Some of the objects have been supplied in this KitBook. You will also be asked to find other objects to test and record your results. If the lamp lights up with the object in the circuit, then the object is a conductor. If the lamp doesn't light up, the object is an insulator.

Definitions and Symbols

Conductor

Electricity flows through conductors. Conductors are usually made of metal. Copper, aluminum, silver, and gold are good conductors. The PowerPage in this KitBook uses copper wire and steel snaps for conductors. A conductor is the opposite of an insulator.

Insulator

An insulator is a material, usually non-metallic, that partially or completely blocks the flow of electricity (and heat, too). Plastic, rubber, leather, glass, and ceramic are good insulating materials. An insulator is the opposite of a conductor.

You will need these parts in order to complete this Activity:

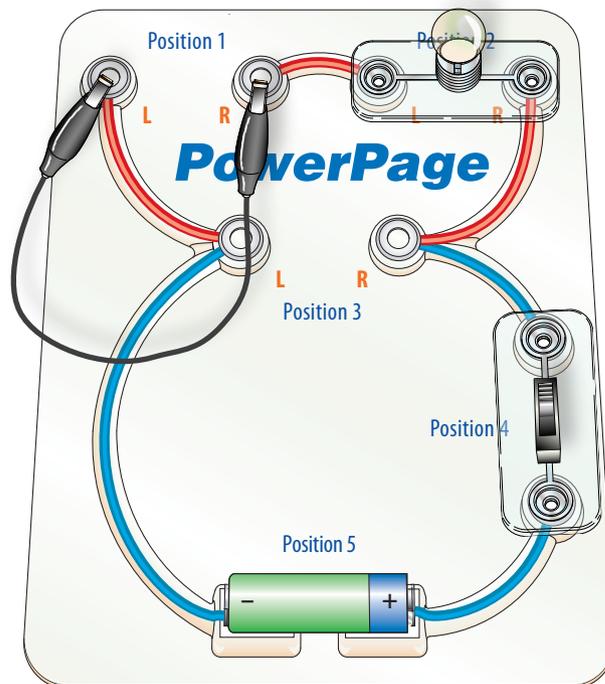
- | | |
|----------------|-------------------------------------|
| 1 Battery | 2 Jumper wires with alligator clips |
| 1 Lamp | 1 Rubber band |
| 1 Penny | Conductors |
| 1 Slide switch | Insulators |

- 1 Place the battery in Position 5 with the positive terminal on the right.
- 2 Place the slide switch in Position 4.
- 3 Make sure the switch is in the ON position.
- 4 Place a lamp in Position 2.
- 5 Use a jumper wire to connect the right side of Position 1 to its left side.

Does the lamp light up? Is the jumper wire a good conductor?

- 6 Remove the alligator clip from Position 1L and clip the other jumper wire lead into 1L.

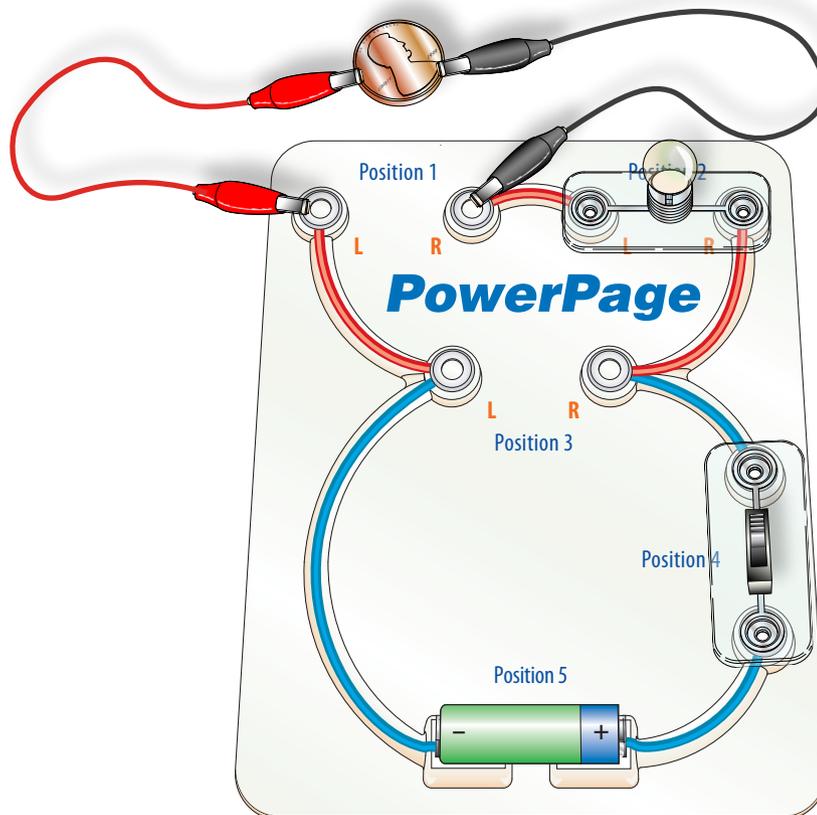
This is where we will connect objects to determine whether they are conductors or insulators, as shown in the figure on the next page.



Activity 5

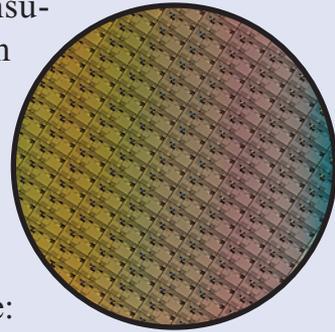
Conductors and Insulators (continued)

- 7 Attach the alligator clips to a penny. Does the lamp light up? Is the penny a conductor or insulator?
- 8 Remove the penny and replace it with a rubber band. Does the lamp light up? Is the rubber band a conductor or an insulator?
- 9 Remove the rubber band and replace it with the straw, then a paper clip, and then the craft stick. Does the lamp light up? Which of these objects are conductors? Which are insulators?
- 10 Now try at least four different objects available in the classroom. Record your observations on a separate sheet of paper. Draw a picture of each object and label whether it is a conductor or an insulator.
- 11 Turn off the switch. Remove all parts and return them to the tray. Put all the conductors and insulators you tested back where you found them.
- 12 Go on to the reading and questions at the end of the chapter when you are ready.



Did You Know?

Some materials are good conductors and some are good insulators. But there is also an important class of materials with unique electrical properties known as *semiconductors*. These materials have physical properties somewhere in between a conductor and an insulator. They carry electricity moderately well—not well enough to be called a conductor like copper wires, but not poorly enough to be called an insulator like a piece of glass. Hence, their name: semi-conductor. Examples include germanium and silicon.



Because of their unique properties, semiconductors can perform special functions that have led them to become the basic building blocks of modern electronics.

Transistors, invented in 1947, were the first practical applications of semiconductors. Since then, every major electronic invention has been made possible by the transistor. In 1958, a huge breakthrough took place with the invention of the integrated circuit—the microchip—consisting of thousands of interconnected transistors. Microchips took the transistor innovation to an exciting new level and gave rise to the Information Age.

Questions

1. Can you tell if an object will be a good conductor or insulator just by looking at it? How?
2. Why is it just as important to have insulators as it is to have conductors?
3. Name three examples of insulators used in electrical devices at home and in the classroom.

Challenges

1. Who was Georg Ohm and for what is he best known?
2. Research and write a short paper (less than one page in length) about the history of the transistor. Who invented it and why?
3. Who was Jack Kilby and what was his most important contribution to society?