Chapter 7

Electricity and Magnetism

This girl is visiting a science museum. What is happening to her? She is touching a machine that gives her body a small amount of electricity. This electricity makes her hair stand on end.

Introducing the Chapter

Electricity can be exciting and fun. It can make your hair stand on end. In the activity below, you will make a small amount of electricity. This electricity is fun, but not useful. People can control larger amounts of electricity to make it useful. These amounts of electricity can be dangerous if not used safely.

DISCOVER!

Observing Electric Charges

Make about ten tiny pieces of white paper. Each piece should be as small as you can make it. Put the tiny pieces on a sheet of colored paper. Sprinkle a small amount of salt and pepper on the same paper. Slowly move a comb near the objects on the paper. Observe what happens.

Next, rub the comb back and forth a few times on a piece of wool cloth. Slowly move the comb toward the tiny pieces of paper, salt, and pepper. Observe what happens.

Talk About It

1. What happened the first time you moved the comb near the paper, salt, and pepper?
2. What happened the second time?
3. What do you think caused the change?

1 What Is Electricity?

LESSON GOALS

You will learn
- how an electric charge builds up.
- how a closed circuit is needed for an electric current to flow.
- how to use electricity safely.

Imagine that you are sorting the clean laundry in the picture below. You might find that some pieces of clothing stick together when you take them out of the dryer. The clothes stick together because they have a small amount of electricity. Much larger amounts of electricity move through wires and make appliances like the clothes dryer work.

Electric Charge

You know that the clothes are made of atoms. Each atom is made of even smaller bits of matter. Some of these tiny bits are **electrons.** An electron has a negative electric charge. Electric charge is the amount of electricity in or on an object. Every electron in any kind of matter has the same amount of negative electric charge.

electron (i lek′tron), a tiny bit of an atom that has a negative charge.

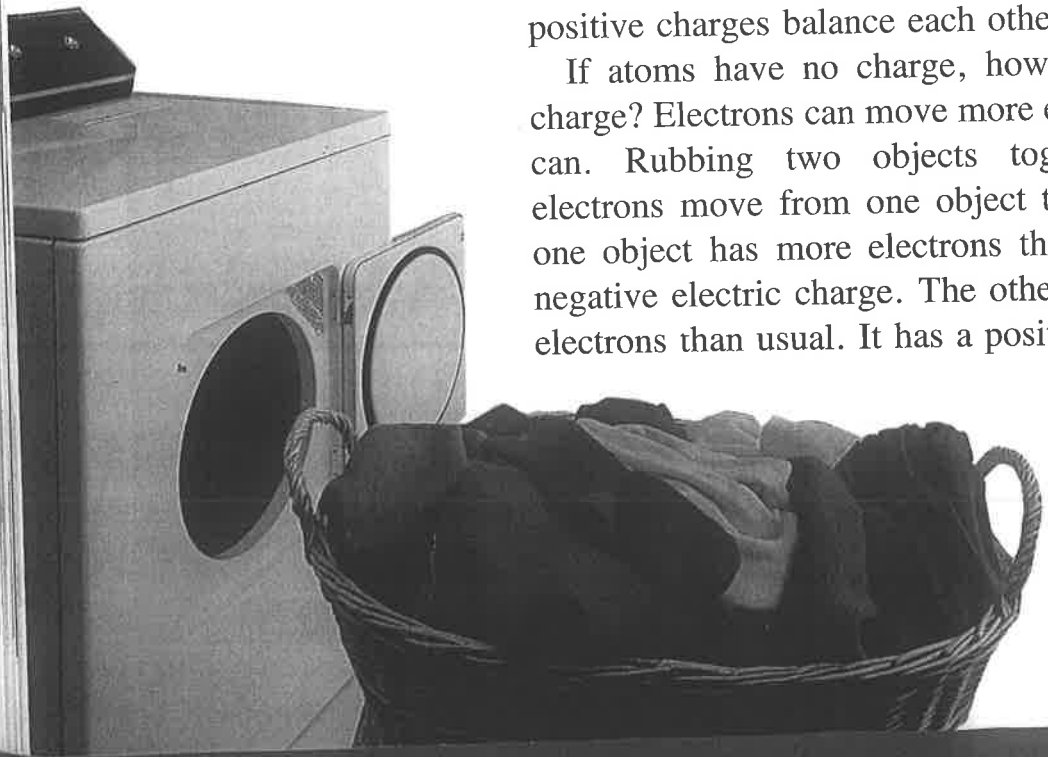
proton (prō′ton), a tiny bit of an atom that has a positive charge.

Some of the other tiny bits of matter that make up an atom are **protons.** A proton has a positive electric charge. Every proton in any kind of matter has the same amount of positive electric charge.

Atoms have no electric charge. They have one electron for every proton. Therefore, the negative and positive charges balance each other.

If atoms have no charge, how do objects get a charge? Electrons can move more easily than protons can. Rubbing two objects together can make electrons move from one object to the other. Then one object has more electrons than usual. It has a negative electric charge. The other object has fewer electrons than usual. It has a positive charge.

The clothes have a small electric charge.



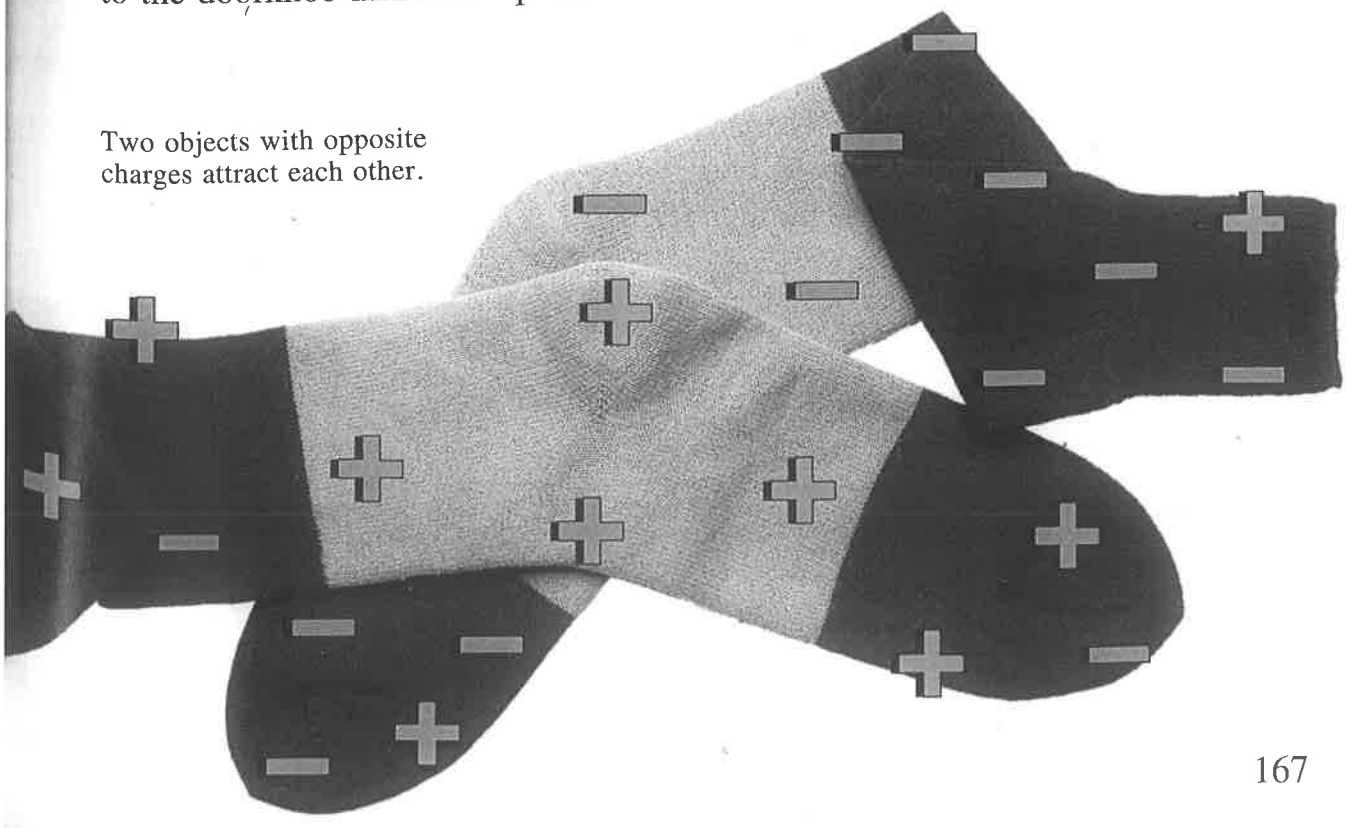
Two objects with opposite charges attract each other. The two objects pull together. Two objects with the same charge push away from each other.

What makes the clothes in the dryer stick together? The clothes rub against each other in the dryer. Some electrons move from one object to another. If one sock loses electrons, it has a positive charge. If another sock gains electrons, it has a negative charge. The two socks pull toward each other because they have opposite charges. The socks below have opposite charges. These opposite charges make them cling together.

Sometimes many extra electrons build up on an object. Have you ever walked across a rug and then felt a shock when you touched a doorknob? When you walk across a rug, your shoes rub against it. Your shoes gain electrons. The electrons spread out over your body. When you touch a metal object, the electrons jump to it. You feel a shock. Sometimes you can see a spark. The electrons jumping from you to the doorknob make the spark.

SCIENCE IN YOUR LIFE

Lightning is an example of what can happen when electrons become crowded on a cloud. The electrons jump suddenly from one place to another. The lightning you see is a big spark.



Two objects with opposite charges attract each other.

conductor (kən duk′tər), a material through which electric current passes easily.

insulator (in′sə lā′tər), a material through which electric current does not pass easily.

resistance (ri zis′təns), how well electricity flows through a material.

Electric Current

Sparks are moving electrons. Electrons can do more than jump from one place to another. Electrons can also flow smoothly through matter. Flowing electrons—or a flow of an electric charge—make electric current. People can control electric current to make electricity work for them.

Electric current passes easily through some materials. These materials are **conductors.** Many metals are good conductors.

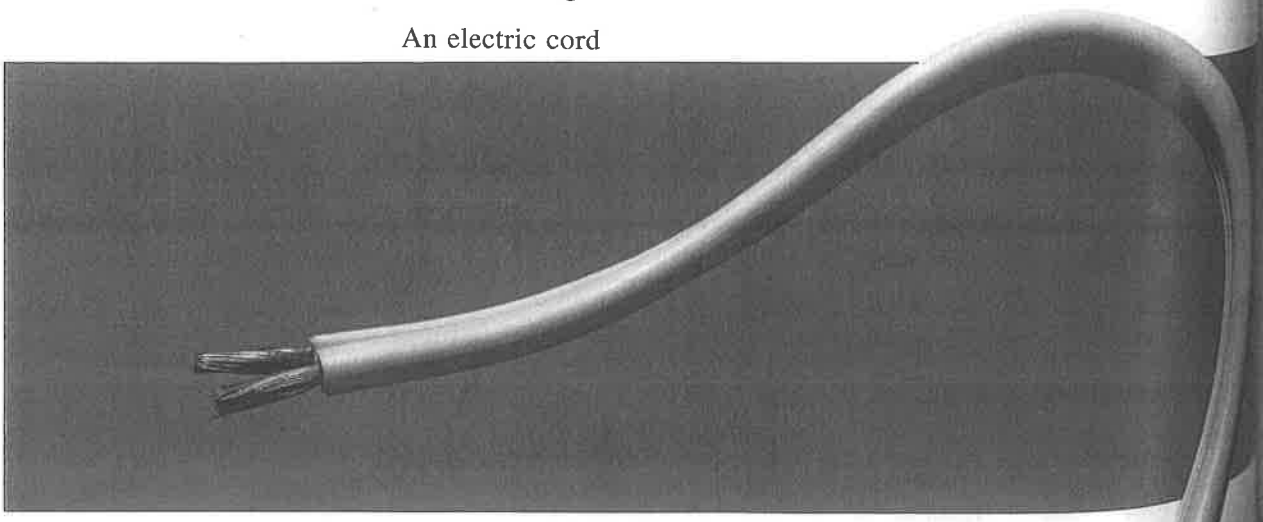
Electric current does not pass easily through other materials. These materials are **insulators.** Air, rubber, glass, and plastic are insulators.

Look at the electric cord in the picture. The metal wire inside conducts—or carries—the current into an appliance. The rubber insulator on the outside keeps the current from flowing where it should not go.

Resistance measures how well electricity flows through a material. Good insulators have high resistance. Good conductors have low resistance. Superconductors have no resistance at all.

Resistance can be useful. Notice the glowing wire in the light bulb at the bottom of the next page. This wire is made from matter that has high resistance. The wire becomes very hot and glows as the electrons flow through it.

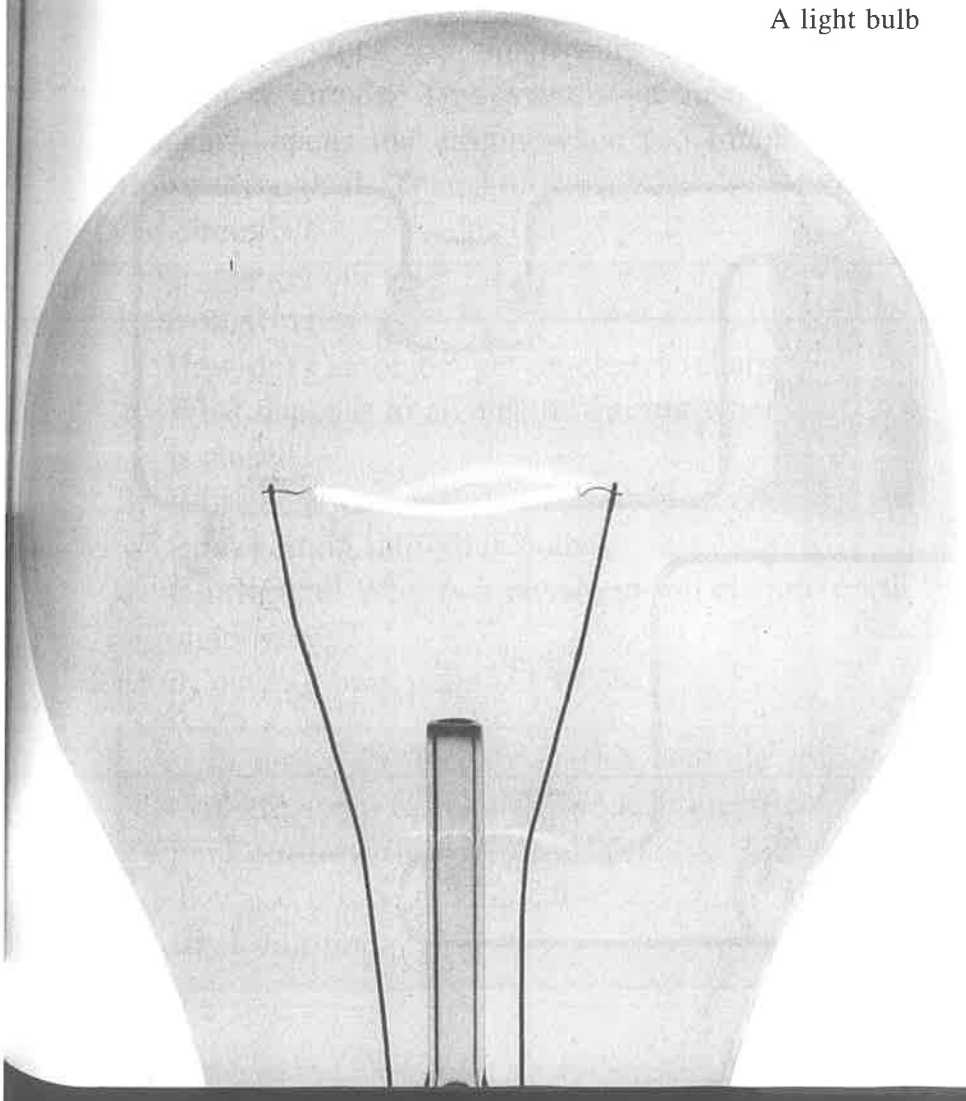
An electric cord

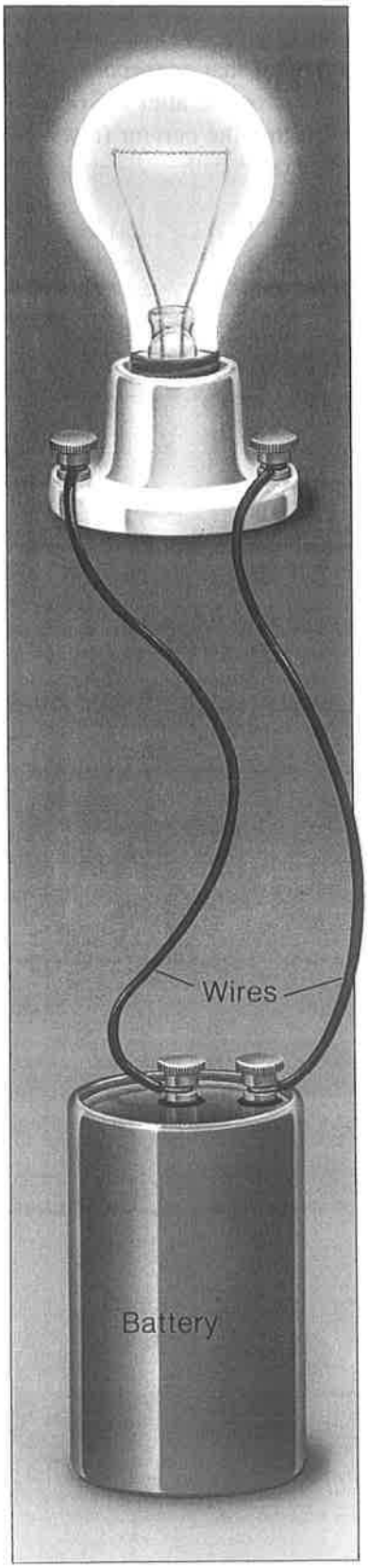


Electric current flows only when it can follow a closed path called a closed circuit. The circuit in the picture has three parts. First, something must push electrons through the path. The battery pushes the electrons. Second, an object in the circuit must allow the current to flow through it. The bulb lights up when current passes through it. Third, wires must connect the parts of the circuit. A wire connects the battery to the bulb. A wire also connects the bulb back to the battery.

What would happen if you took away one of the wires of the circuit in the picture? You would break the path that the electric current follows. You open the circuit. Because current can flow only through a closed circuit, the bulb would not light up.

A light bulb





A closed circuit

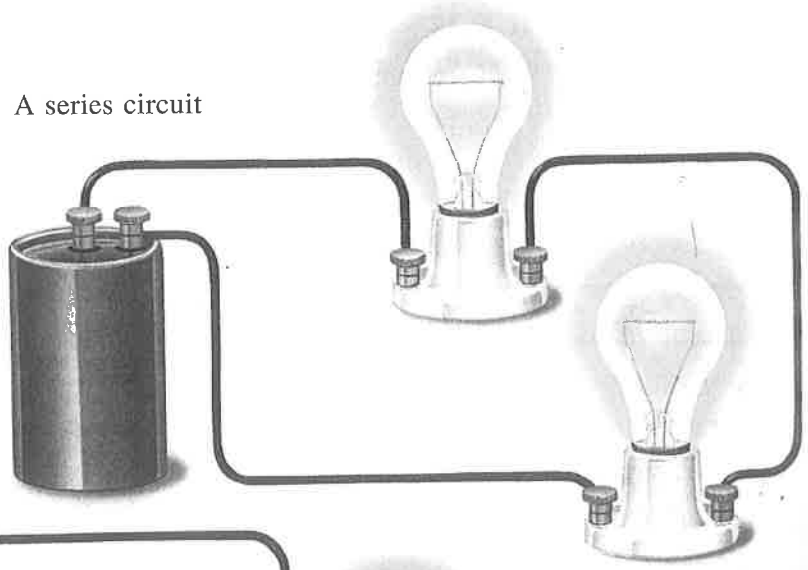
series (sir′ēz) **circuit,** a circuit that connects several objects one after the other so that the current flows in a single path.

parallel (par′ə ləl) **circuit,** a circuit that connects several objects in a way that the current for each object has its own path.

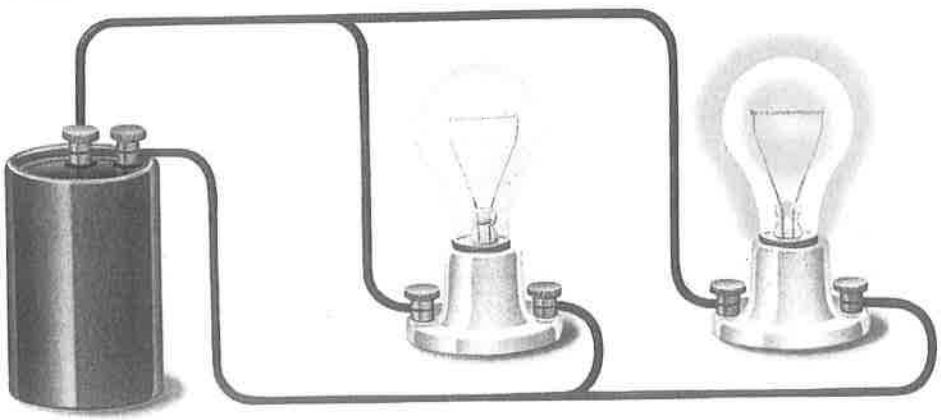
Light bulbs can be a part of two kinds of circuits—series circuits and parallel circuits. In a **series circuit,** the bulbs are in the same path. Find the two bulbs in the series circuit in the picture. If you remove or turn off either bulb, the circuit opens. Current cannot reach the other parts of the circuit. Think about what would happen if all the lights and appliances in your home were parts of a series circuit. Unless you had all the lights and appliances on, the circuit would be open. None of the lights and appliances would work.

In homes, lights and appliances are parts of **parallel circuits.** The electric current for each light and appliance has its own path. Find the two bulbs in the parallel circuit in the picture. Use your finger to trace the path of electric current for each bulb.

A series circuit



A parallel circuit

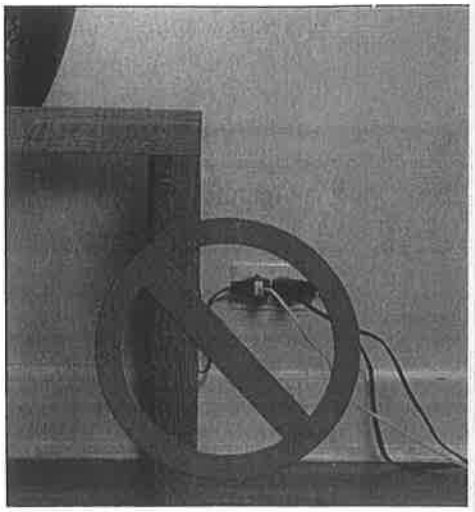


Using Electricity Safely

Electricity is dangerous if it is not used correctly. It can cause burns, shock, and death if it travels through a person's body. An important safety rule to follow is never touch anything electrical while you are wet. Water on your skin can conduct electricity. It can lead the electricity into your body.

Do not use electric lamps and appliances that have cords with worn, cut, or broken insulation around the wires. The electric current could easily travel to your body. The current also could start a fire.

People also need to be careful not to plug too many lamps and appliances into the same outlet. Too much electric current flowing through the outlet in the picture might make the wires in the wall hot enough to start a fire. However, most homes have a kind of switch that stops too much current from flowing through a circuit. This switch—a fuse or circuit breaker—opens the circuit when too much current flows through it. Then no current can flow through the circuit.



Do not plug too many cords into the same outlet.

Lesson Review

1. How does an object get an electric charge?
2. What happens to an electric current when a circuit is closed?
3. What are two ways you can keep electric current from getting into your body?
4. **Challenge!** Why is it unsafe to run electric cords under a rug?

Study on your own, pages 388–389.

LIFE SCIENCE
FIND OUT ON YOUR OWN
CONNECTION

Electric eels, electric catfish, and electric rays are some fishes that produce electricity. Find out how they make electricity. How do they use this adaptation? Write a report about what you find.