Lesson 1

# How Does Electricity Move?

**Your cousin sends you a hand-knit wool sweater that took months to make. You eagerly pull it out of the box and hold it up! It's great! But why are those foam peanuts sticking to it?**

**You will learn:**

- **how electrons cause objects to attract and repel.**
- **what causes electrons to jump from one object to another.**
- **how an electric current flows in an electric circuit.**

## Attracting and Repelling

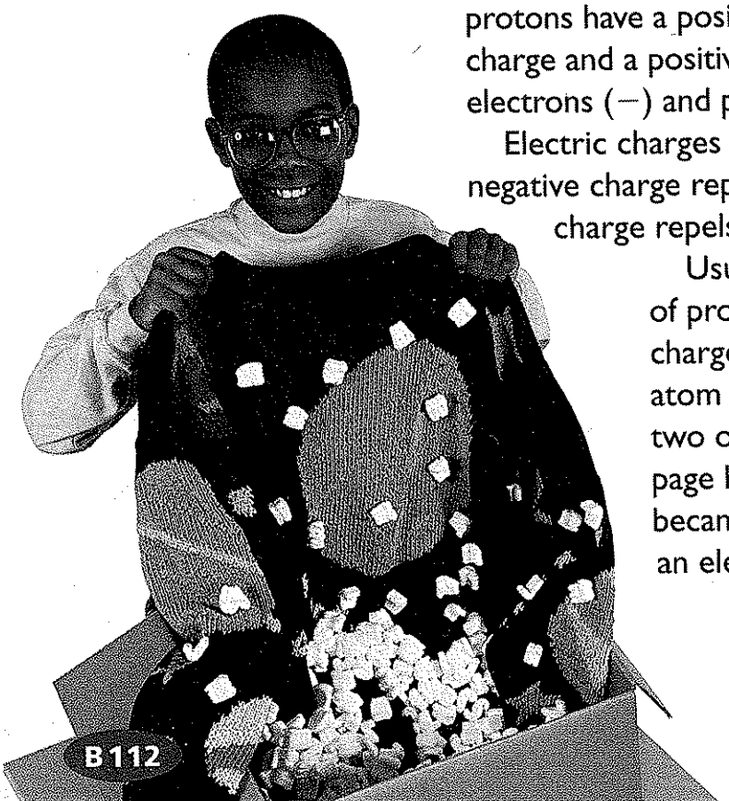
You know that both the sweater and the foam peanuts in the picture are made of atoms. Protons and neutrons are packed together in the nucleus at the center of each atom. Electrons move around the nucleus. The electrons stay in the atom because they are attracted to the protons.

Why do electrons and protons attract each other? Electrons have a negative electric charge (−) and protons have a positive electric charge (+). A negative charge and a positive charge attract each other, so electrons (−) and protons (+) attract each other.

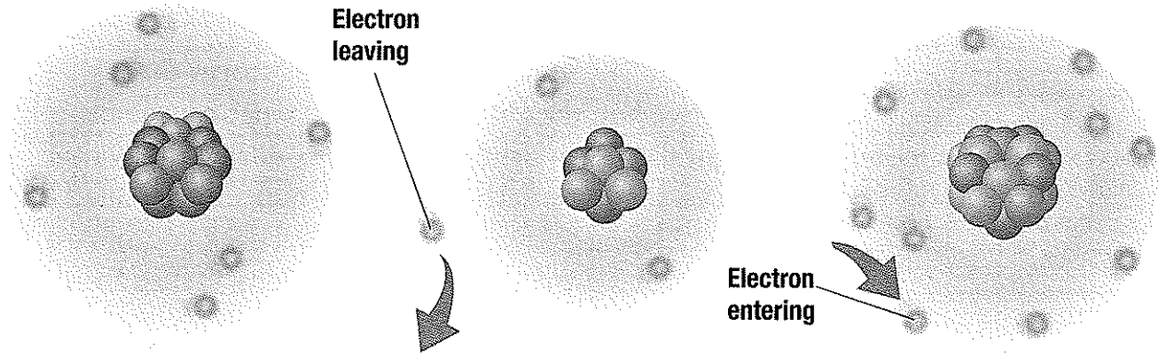
Electric charges can also repel each other. A negative charge repels a negative charge. A positive charge repels a positive charge.

Usually, an atom has the same number of protons and electrons. Positive charges balance negative charges, so the atom has no charge overall. However, two of the atoms at the top of the next page have a charge. You can see that they became charged when they gained or lost an electron.

*Foam peanuts stick to this wool sweater for the same reason that clothes sometimes have "static cling."* ▼





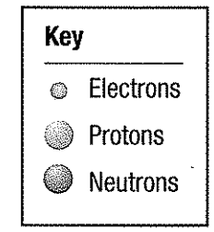



▲ *The number of negative charges equals the number of positive charges. This atom is not charged.*

▲ *This atom has lost one of its electrons. The atom has a positive charge.*

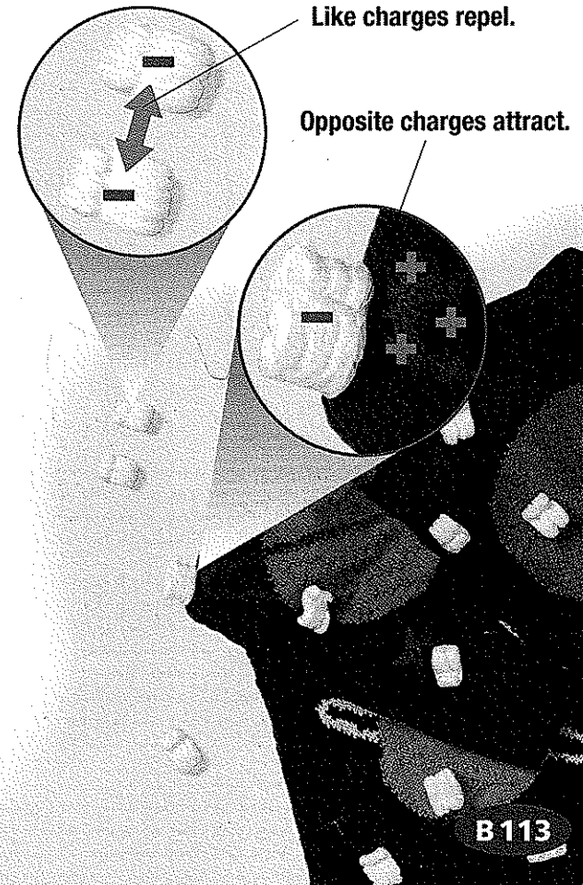
▲ *This atom gained an extra electron from another atom. With one extra electron, this atom has a negative charge.*

The atoms in some objects gain or lose an electron when the objects are rubbed against each other. Protons are in the nucleus of the atom, so rubbing doesn't affect them. However, the outer part of an atom has electrons, which can be rubbed off. If an uncharged object rubs against another uncharged object, some electrons may rub off one and move onto the other. Rubbing causes both objects to become charged.




The picture on the right shows what happens when foam peanuts rub against a wool sweater. Electrons rub off the sweater and onto the foam peanuts. With these extra electrons, the foam peanuts are negatively charged. The sweater is positively charged because it lost electrons. Because opposite charges attract, the foam peanuts cling to the sweater.

Imagine if you took two foam peanuts off the sweater and pushed them together. You would discover that the peanuts repel each other. This is because both peanuts are negatively charged, and like charges repel.



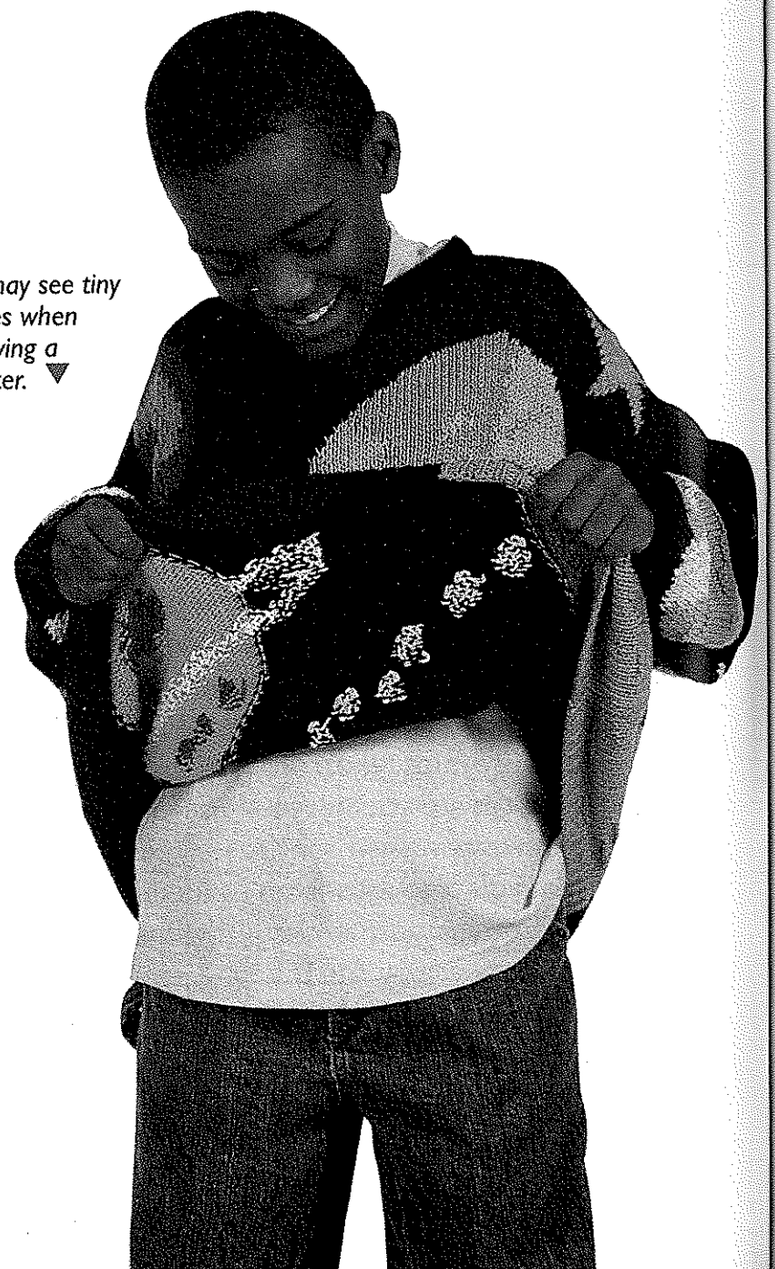
## Jumping Charges

Maybe you've watched a thunderstorm through a window. You may have wondered what causes the bright flashes of lightning. Perhaps during the winter you've seen tiny flashes of light when you've pulled off a wool sweater over your head in a dark room. Are the bright lightning flashes and the tiny flashes from your sweater in some way the same? Study the pictures below to learn how the tiny flashes occur.

▲ *As you move, your wool sweater rubs against your cotton shirt. Electrons rub off the sweater's atoms and move onto the atoms of your cotton shirt. As you pull off the sweater, you rub even more electrons off the sweater onto your shirt. The sweater becomes positively charged, and your shirt, negatively charged.*

▲ *The many extra electrons on your shirt repel each other. At the same time, the extra positive charges on your sweater attract those electrons strongly. Eventually, some electrons leap from the shirt toward the sweater, making tiny sparks. You see each tiny spark as a faint flash of light.*

*You may see tiny flashes when removing a sweater.* ▼

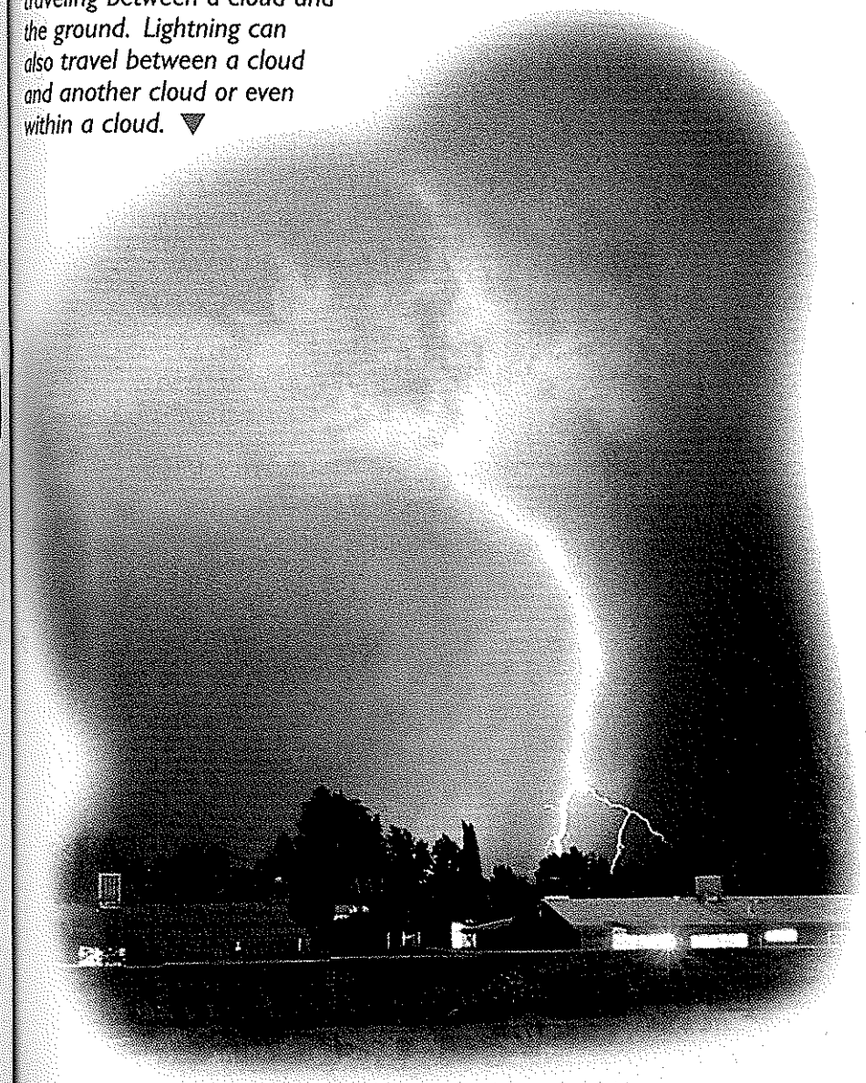


Earth Science

What causes those giant sparks of moving electric charges called **lightning?** Study the pictures below to find out how lightning travels between a cloud and the ground. The steps are simplified and show only one way lightning can occur. Compare the process to the tiny flashes you saw when you removed your sweater.

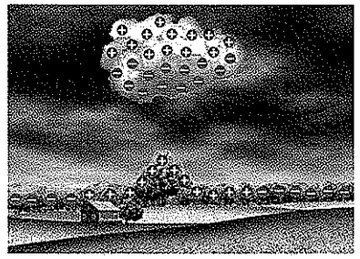
The enormous sparks you see in a thunderstorm and the little sparks from your sweater are examples of one way that electric charges can move—by jumping. On the next page, you will learn how electricity can flow steadily.

*This photo shows lightning traveling between a cloud and the ground. Lightning can also travel between a cloud and another cloud or even within a cloud.* ▼

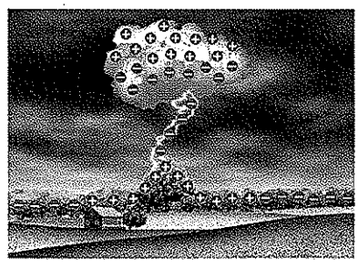


Glossary

**lightning ,** a giant spark of electric charges moving between a cloud and the ground, between a cloud and another cloud, or within a cloud



▲ *Movements within the cloud cause the upper part of the cloud to become positively charged and the lower part to become negatively charged. This negatively charged lower part repels electrons strongly. This force is so strong it pushes away electrons on the ground. This leaves the ground underneath the cloud with extra positive charges. The ground is positively charged.*



▲ *The many extra electrons in the lower part of the cloud repel each other strongly. The positively charged ground attracts these electrons strongly. Eventually, electrons leap from the lower part of the cloud toward the ground, making a bright spark called lightning.*

Glossary

**Glossary**

**electric current** (i lek′trik kėr′ənt), the steady flow of electric charges, usually in a wire

## Electric Current

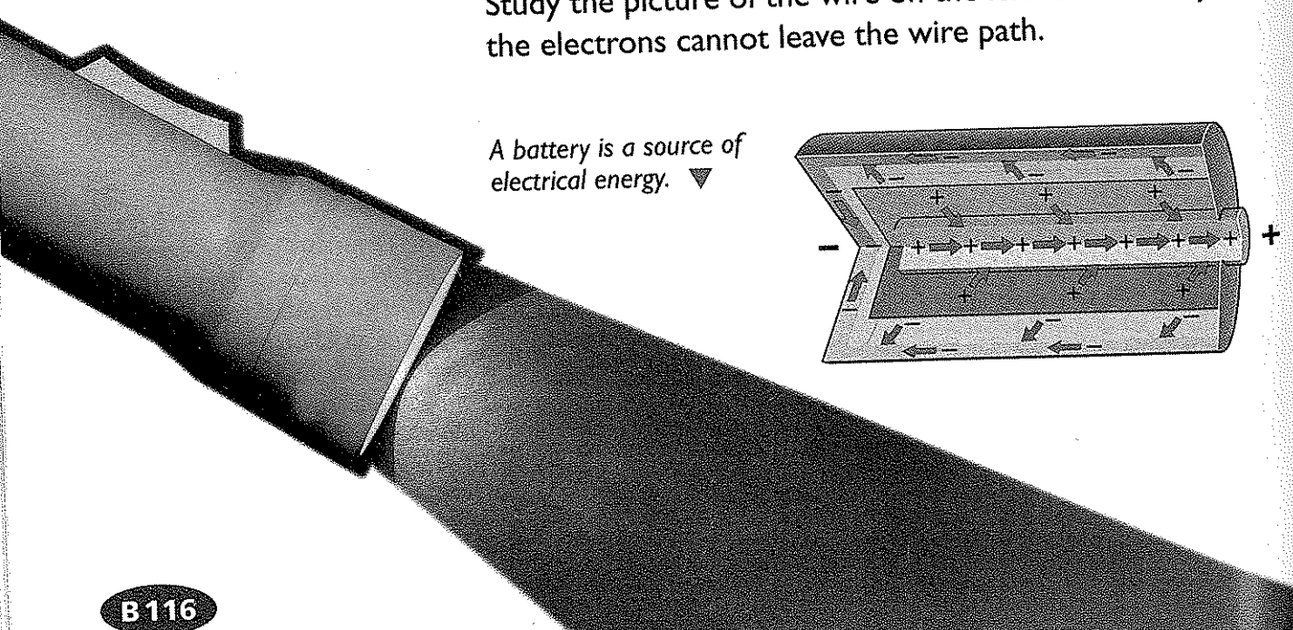
You just learned how a sweater can make sparks and how lightning flashes. Imagine if the electric devices you use every day worked the same way. Your hair dryer would work for just a second. Your flashlight would flash occasionally. Fortunately, electric devices like these use an **electric current,** not jumping charges. In these devices, electricity flows steadily.

To understand how an electric current works, think of a flashlight shining a bright beam. First, the flashlight needs an energy source. A battery changes chemical energy to electrical energy. A chemical reaction in the battery makes electrons move to the negative end of a battery—that's why it's marked negative (−). At the same time, positive charges move to the positive (+) end of the battery. You can see this in the picture at the bottom.

Next, the electrons must move through the wire path. Imagine a wire from the negative part of the battery to the positive part. Electrons gathered at the negative end of the battery would repel and push some electrons out of the battery and into one end of the wire. Positive charges gathered at the positive part of the battery would attract and pull electrons. Pushed from one end and pulled from the other, electrons would move through the metal wire path. Study the picture of the wire on the left to learn why the electrons cannot leave the wire path.

**Metal**
*The electrons move through metal wire easily. Because metals move, or conduct, electricity well, scientists classify metals as conductors.*

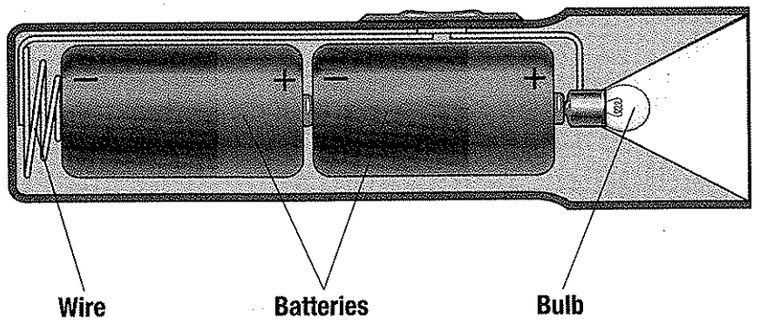
**Plastic Covering**
*Scientists call the special plastic that covers the wire an insulator because electricity cannot move through it.*



*A battery is a source of electrical energy.* ▼



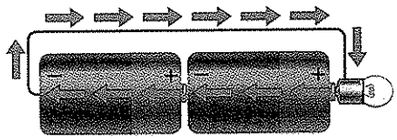



▲ *This cutaway view shows the basic parts of a flashlight.*

Scientists call the path that electricity takes an electric circuit. The path begins and ends at the source of electricity. Using the picture in the upper right, follow the path of electricity in a flashlight's electric circuit.

Electric currents are useful because you can use them to do things you want to do, such as shine a flashlight in a dark room. In the next lesson, you will learn more about using and controlling electricity.



**▲ Electric Circuit of a Flashlight**
*Follow the path of the electrons through the circuit. Begin and end at the left battery. As many electrons leave each part of the circuit as enter it.*

1 *Electrons leave the negative end of the left battery.*

2 *Electrons move through the wire.*

3 *Electrons enter the light bulb and move through a very tiny wire inside the bulb. This wire gets so hot that it glows brightly.*

4 *Electrons leave the light bulb and move into the positive end of the right battery.*

5 *Electrons travel through the right battery, out the negative end, and into the positive end of the left battery.*

### Lesson 1 Review

1. What happens when two positively charged objects are brought near each other?
2. Give two examples of when electrons build up and suddenly jump from one object to another.
3. Describe the path electrons take in a simple flashlight circuit.
4. **Cause and Effect**
   When a wire leads from the negative part of a battery to the positive part, two things occur: electricity moves through the wire and a chemical reaction takes place in the battery. Which is the cause? Which is the effect?