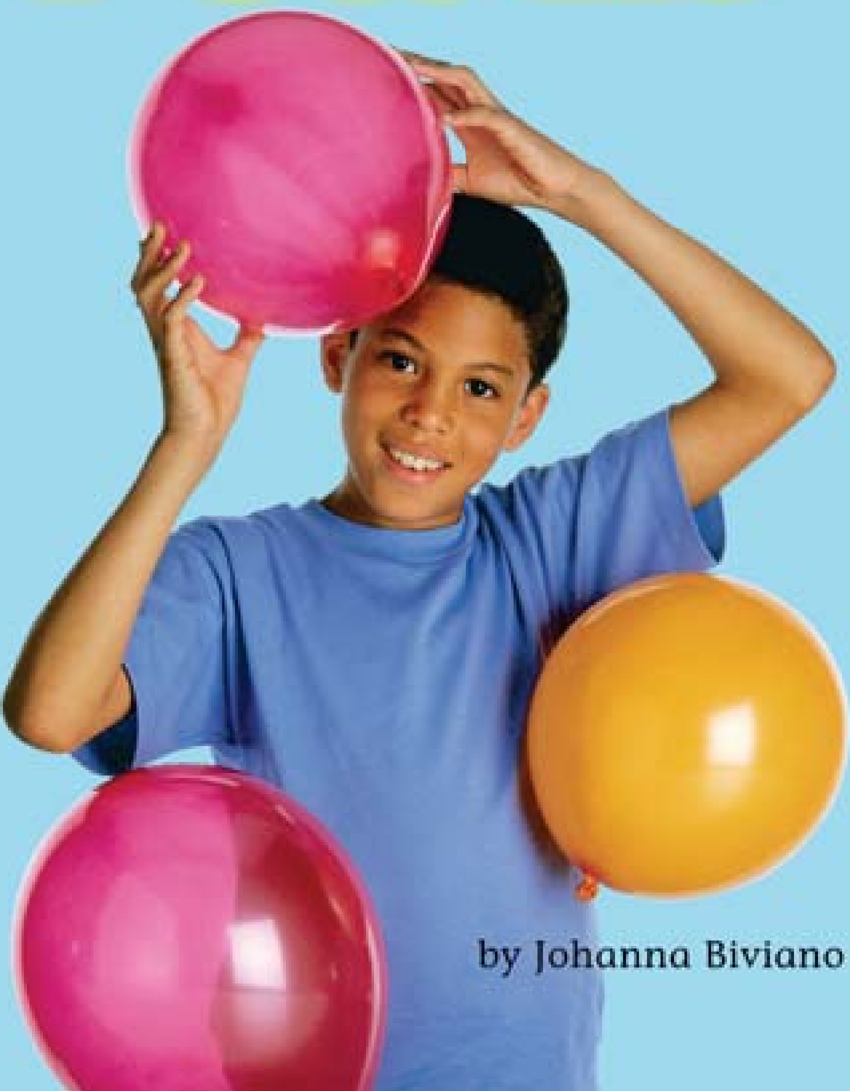
Science

Electricity's POWER



by Johanna Biviano

Before Reading

Show What You Know

Before you read this book, draw a chart like the one shown. The first column lists topics that are in the book. They are all about electricity.

Read each topic. **Write** what you know about that topic in the second column. **Write** a question about that topic in the third column.

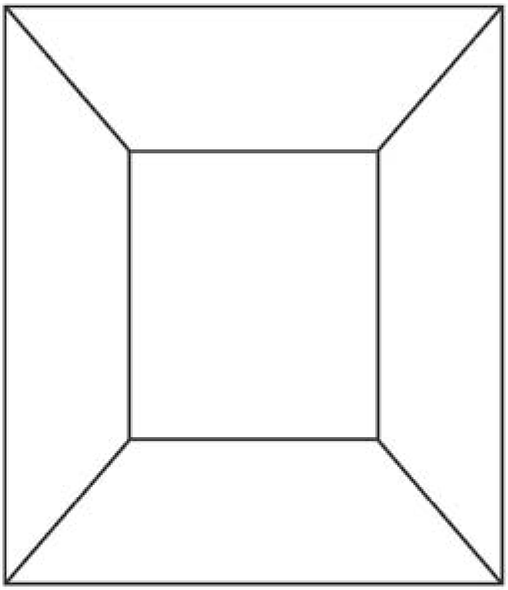
Topics	What I know	What I wonder	What I learned
How electricity works			
Kinds of electricity			
Staying safe around electricity			

After you read this book, finish the chart. **Write** what you learned about each topic in the last column. If you learned the answers to any of your questions, add them to the chart.

During Reading

Make a Word Frame

Draw a word frame like the one shown.



Write the word *resistance* in the space at the top of your word frame.

Look through this book for that word. Look for pictures that help tell about the meaning of the word.

1. **Write** a definition in one space.
2. **Draw** a picture that shows something about the word in another space.
3. **Write** an example or other detail in another space.

Do you understand?

Write and **draw** your answers.

1. What kind of electricity can give you a shock when you touch a doorknob? What else might this type of electricity cause?

2. **Draw** a picture of a closed circuit. **Draw** a picture of an open circuit. Label each drawing.

3. You want to buy a string of lights to use as decoration. Would you choose lights in a series circuit or in a parallel circuit? Explain your choice.

4. **Write** About Science
   Write about rules for staying safe around electricity. **Draw** pictures to go with your sentences.

Electricity's POWER

by Johanna Biviano

PEARSON

Glenview, Illinois
Boston, Massachusetts
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Upper Saddle River, New Jersey

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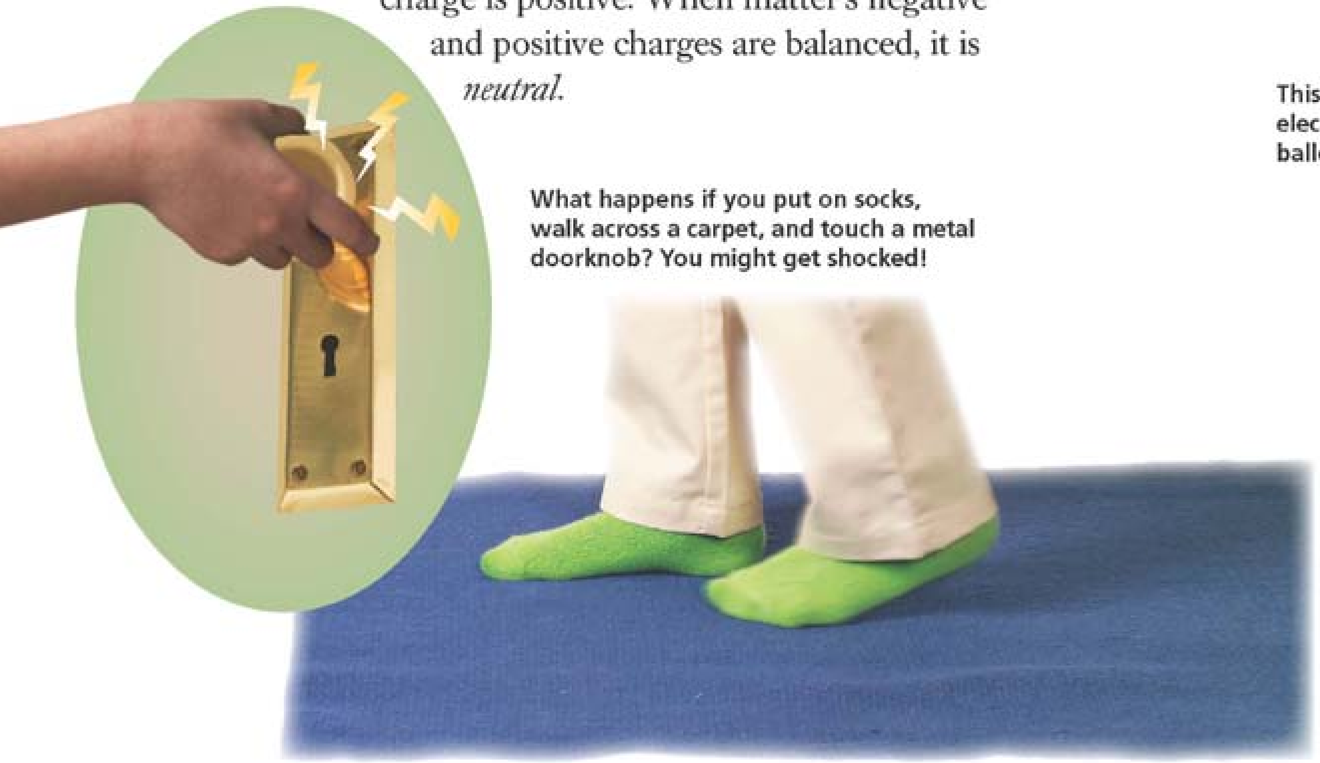
Electric Charges

Has this ever happened to you? You put on socks and walk across the carpet to where your friend is sitting. As you reach out to tap her shoulder, ZAP! A spark leaps from your finger to your friend. What just happened?

You were shocked by an **electric charge,** a property of some parts of matter that is described as positive or negative. Atoms make up matter. Atoms are made up of tiny particles. These particles can have either a positive or negative charge.

Matter's charge depends on the charges of its particles. When matter has more negative than positive particles, its charge is negative. When it has more positive particles, its charge is positive. When matter's negative and positive charges are balanced, it is *neutral.*



What happens if you put on socks, walk across a carpet, and touch a metal doorknob? You might get shocked!

What happens when charged or neutral objects meet? If they are both positively or negatively charged, they have *like* charges. Objects with like charges pull away from each other. They *repel.* Other times, a positively charged object meets a negatively charged object. These objects have *unlike* charges. They *attract* each other. Finally, objects that are both neutral neither attract nor repel each other.

When an object comes close to another object, electrons from one object can leap to the other. Think about your socks rubbing against the carpet. As they rub, they pick up electrons. Objects that pick up electrons become negatively charged. The carpet lost electrons. It became positively charged. The built-up charges are **static electricity.**

This girl caused static electricity by rubbing the balloon on her hair.

Gathering Static Electricity

So what happened when you got shocked? It started with your feet shuffling across the floor. As you shuffled, electrons jumped from the carpet to your socks. Your socks gathered up more and more electric charge. When your hand touched your friend's shoulder, the extra electrons you gathered jumped from you to her. This caused the spark and the shock.

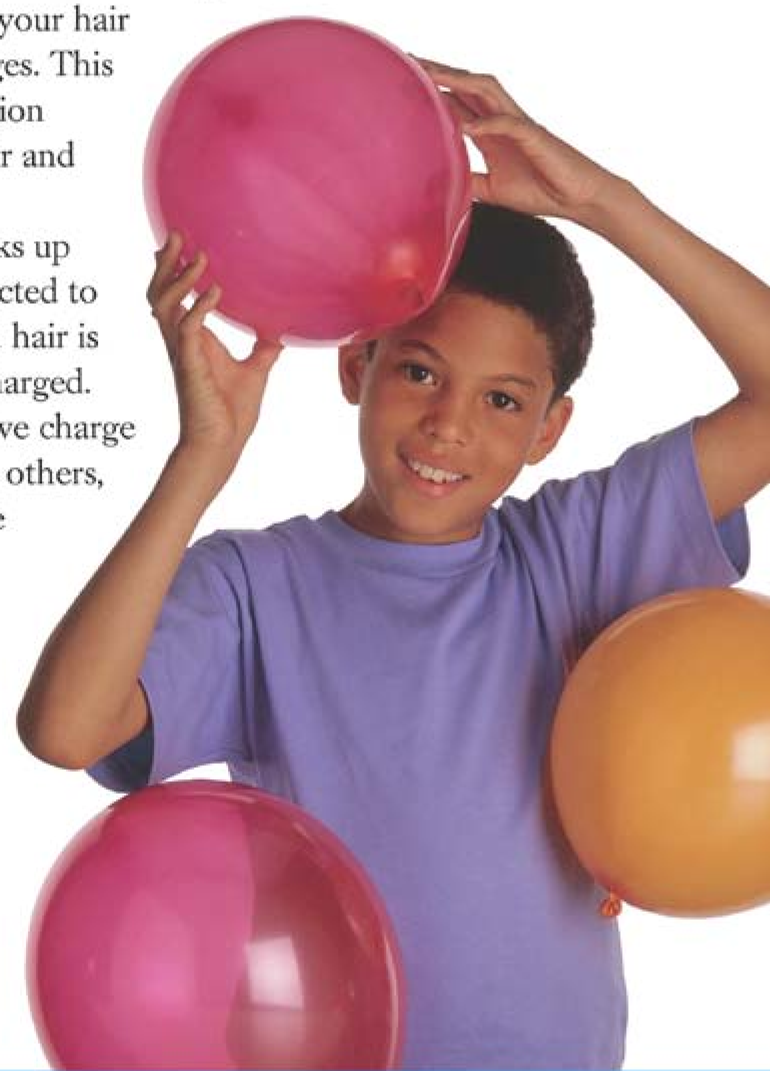
Static electricity causes many common events. It makes your hair stand on end when you go down a plastic slide. The static electricity caused by ice and water droplets rubbing together in clouds makes lightning storms.

Lightning storms are caused by ice and water droplets rubbing together inside of clouds.

Moving Electrons

Using a balloon and your own hair, you can learn about charged objects. Take a balloon filled with air and rub it against your hair. As you rub, electrons move from your hair to the balloon. Your hair becomes positively charged. The balloon becomes negatively charged. When you pull the balloon away, your hair sticks up. It tries to reach the balloon. The balloon and your hair have unlike charges. This causes the attraction between your hair and the balloon.

Your hair sticks up because it is attracted to the balloon. Each hair is now positively charged. Each hair's positive charge repels it from the others, so the hairs move apart.



You can experiment safely with charged objects by rubbing a balloon on your hair.

Charged Objects and Neutral Objects

Neutral objects' charges are balanced. But charged objects can affect the positive or negative charges in neutral objects.

Try this experiment: rip a sheet of paper into small pieces. Pull a comb through your hair 20 times to give it a negative charge. Place the comb near the paper.

The paper is neutral. But its negatively charged particles repel the comb's negative charge. The comb's negative charge attracts the paper's positively charged particles. Now the side of the paper facing away from the comb has a negative charge. The side facing it has a positive charge. The force of the attraction lifts the paper to the comb!

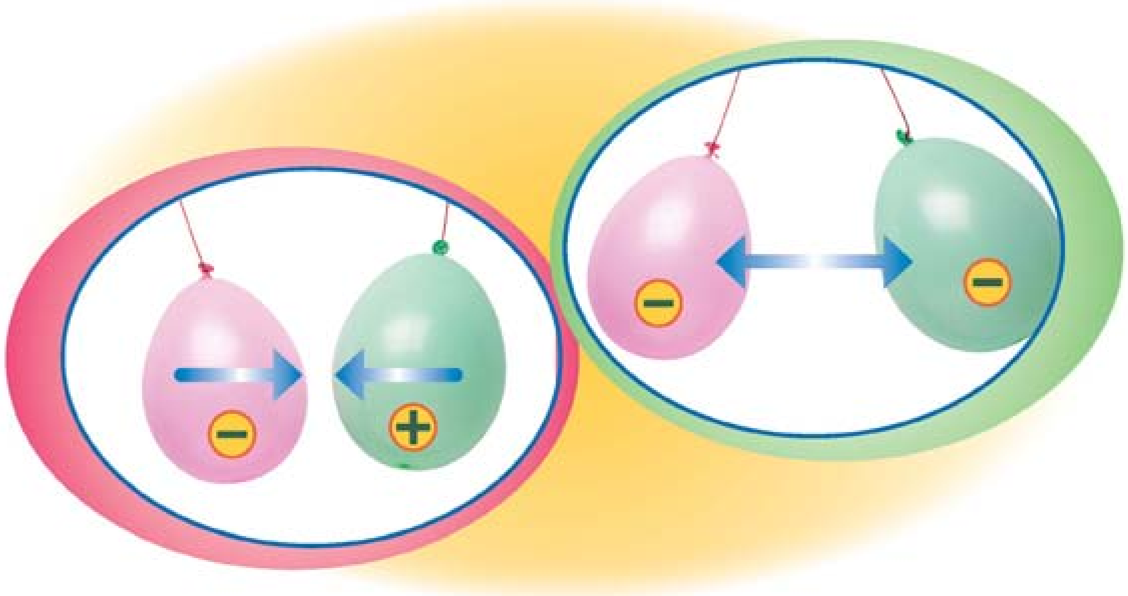
Eventually, the comb will lose its charge. The built-up negative charges will move to the neutral paper until the comb's charges are balanced. Then it, too, will be neutral.

These pieces of paper are positively charged. They are attracted to the comb's negative charge.

Charged Objects and Their Force

Why do the little pieces of paper only rise when the comb is nearly touching them? The force of static electricity becomes stronger the closer you get to a charged object. It becomes weaker the farther you are from it. You can see this with two charged balloons. Rub two balloons with felt or a wool sock. Hold the balloons far enough apart so you don't see or feel any effect of their charges. Slowly bring them closer. When do you notice the force of their static electricity?

When you bring the two balloons together, you see and feel the balloons repelling each other. What causes them to push apart? Now suppose the balloons were attracting each other. What would cause them to do that?



The balloons on the left attract each other. The balloons on the right repel each other.

Charges in Motion

Static electricity builds up charges and then releases them. Static electricity is not very useful, but you can control electricity in many ways. Each day, you use electricity with things such as light switches and appliances. Flashlight and remote control batteries use electricity.

These devices use the power of **electric current,** or electric charges in motion. An *electrical circuit* controls the direction and flow of the current.

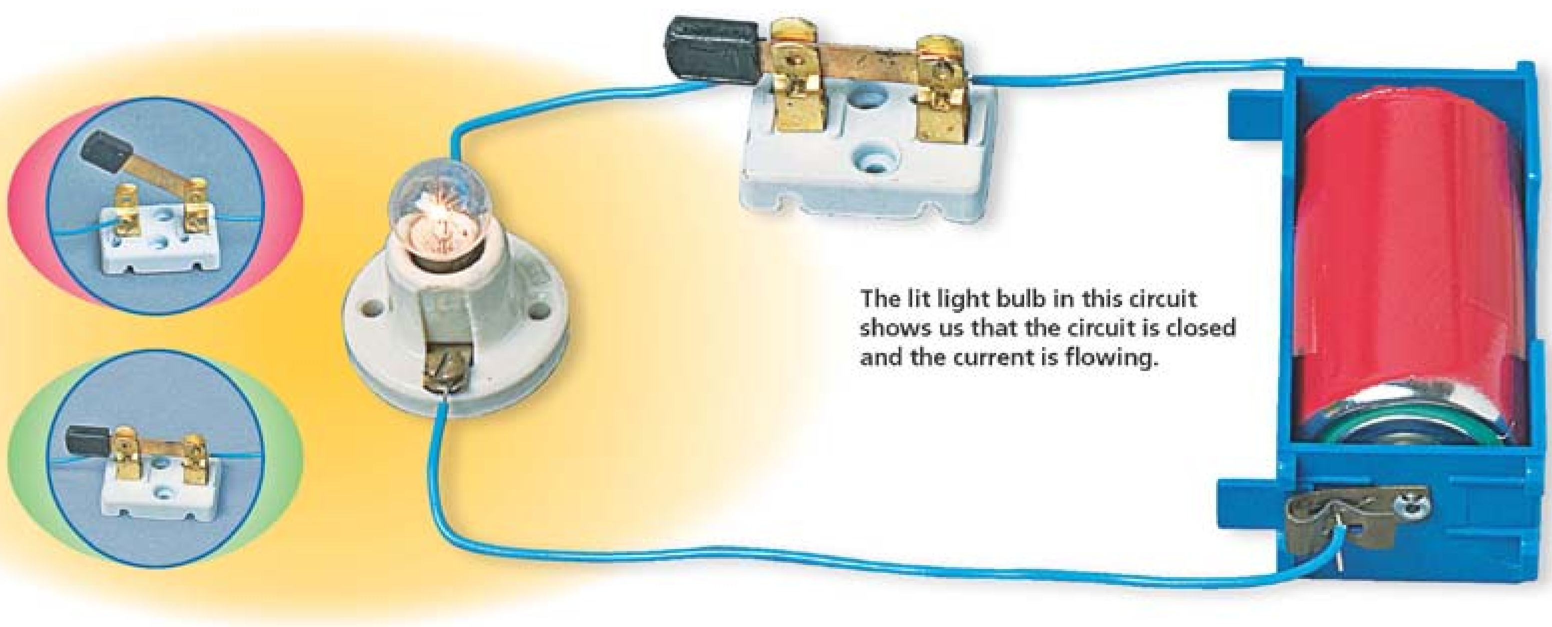
An electrical circuit allows the current to flow only if it makes a complete loop. If there are any breaks in the loop, no current can flow. A working, complete loop is called a *closed circuit.* A loop with any breaks in it is called an *open circuit.* An open circuit won't allow current to flow.

Parts of a Circuit

An electrical circuit consists of several parts. In this example, the battery is the energy source. The wires, clips, and switches connecting the parts are *conductors.* They must be made of a material that carries electricity easily. Often copper or another metal is used. Conductors provide a path for the electricity to flow.

Insulators help make conductors safe. Insulators stop the flow of electricity. Wires used for electrical circuits are covered with plastic or rubber insulators.

A *resistor* can show us that current is flowing. The wire inside a light bulb is a resistor. It is made of material that slows the flow of electricity. The **resistance** of a material can turn electrical energy into heat, light, and energy of motion.



The switch on the top is open. The switch on the bottom is closed.

The lit light bulb in this circuit shows us that the circuit is closed and the current is flowing.

Series Circuits

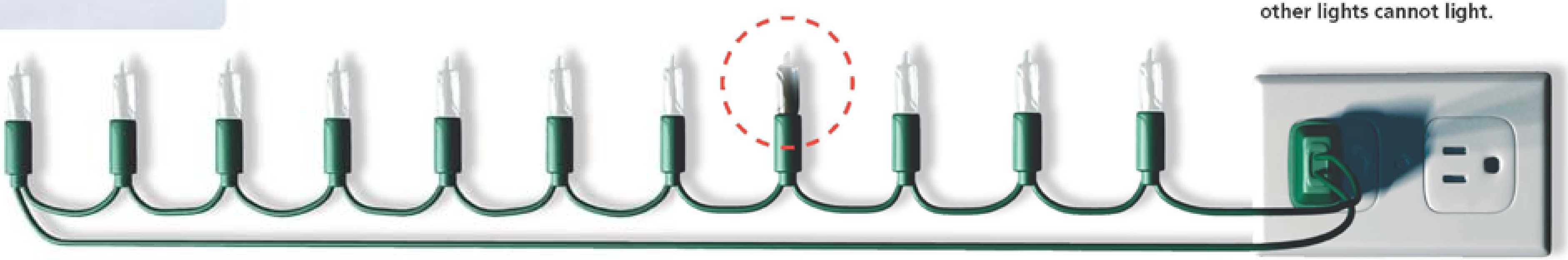
Have you ever set up a row of dominoes standing on end and tipped the first domino to make the line fall? Suppose you removed several dominoes from the middle of the line. If you tipped the first domino, the line would begin to fall. Then it would come to where you had removed the dominoes. The rest of the line would stay upright.

If a break occurs in a circuit, then the flow of current will stop, just like when the domino was removed. A **series circuit** is a circuit in which electricity can flow in only one path. Any break in the circuit will stop the electricity from completing the loop. The electricity in a series circuit runs from a battery or other power source, through conductors and resistors, and back to the battery.

A break in a series circuit resembles a break in a line of dominoes.

Each resistor in the series circuit uses the same amount of energy. Each turns the current into different forms of energy. In the circuit shown here, the resistors are light bulbs. Each bulb receives the same amount of current and burns with the same brightness and heat. If a bulb burns out, the circuit breaks. Then none of the bulbs will light.

Series circuits might be okay for a simple strand of lights. But suppose a single light bulb and an entire refrigerator were on the same series circuit. There would be too much current for the light bulb and too little for the refrigerator. If the light bulb burned out, your refrigerator would turn off too! You might not know which one caused the electricity to stop flowing. The electrical currents that you use each day rarely flow through series circuits.

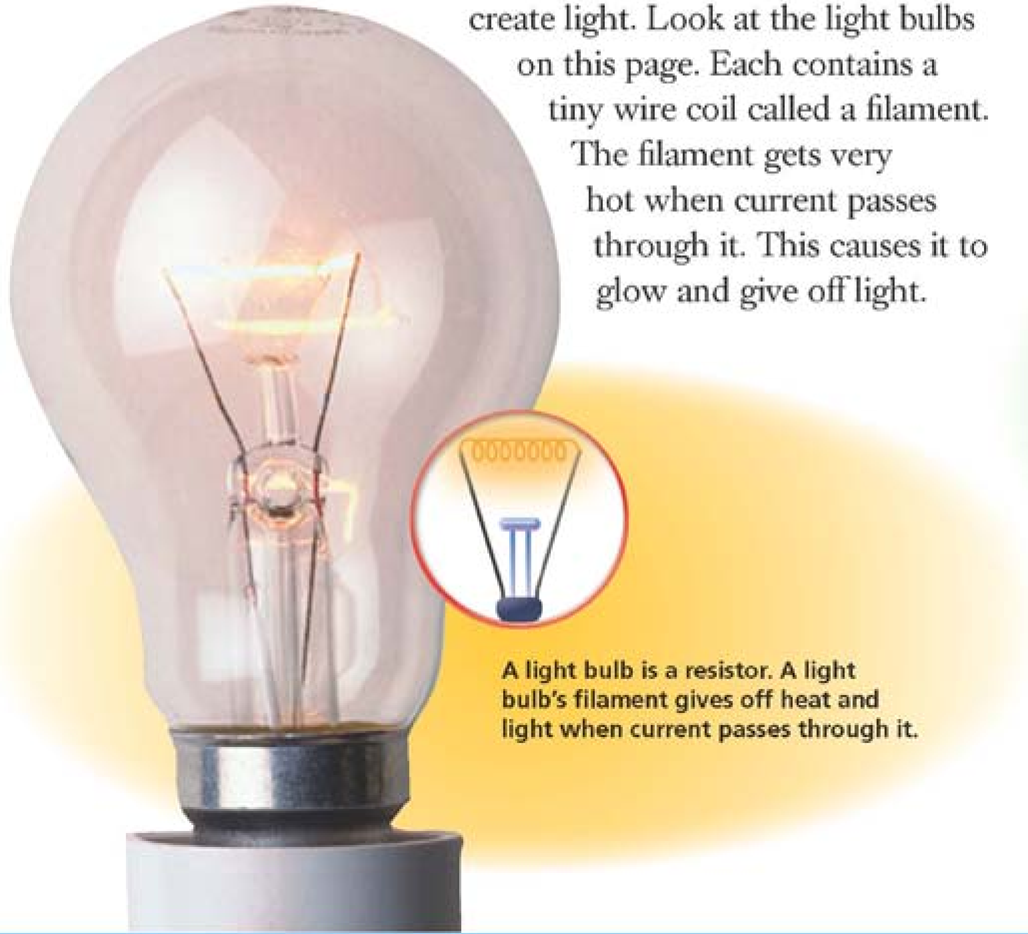


The circled bulb in this series circuit is burnt out. The other lights cannot light.

Changing Forms of Energy

You've read that resistors change electrical current into other forms of energy. For instance, the light bulbs in our series circuit create both heat and light. Resistors change current into usable forms of energy. Current is most often changed into heat energy, light energy, or energy of motion.

Energy often changes form. But it is never lost. Electric current often changes into heat. For example, if lightning strikes a field, the heat energy can cause the field to burn. With enough heat, a resistor can create light. Look at the light bulbs on this page. Each contains a tiny wire coil called a filament. The filament gets very hot when current passes through it. This causes it to glow and give off light.

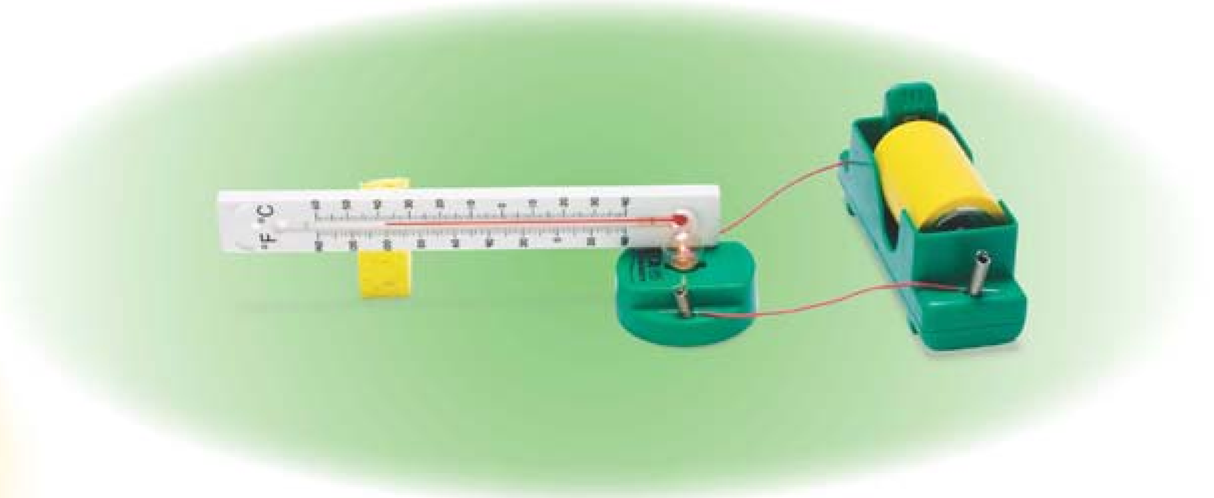


A light bulb is a resistor. A light bulb's filament gives off heat and light when current passes through it.

Heat and Light from Electricity

Think about your home's electrical appliances. Do you have a toaster or an electric oven? How about all of the light bulbs and lamps in your house? Some of these convert electricity into heat. You may see the wires inside your toaster glowing. These wires give off light as well as heat.

Appliances such as lamps are meant to give off light. Lamps give off heat as well. Devices that use electricity to produce light will often produce heat. And sometimes devices that use electricity to produce heat also produce light. Some devices are made to produce both light and heat.



A simple experiment shows how heat and light are related. Record the temperature of a light bulb before you turn it on. After turning it on, watch the temperature rise.

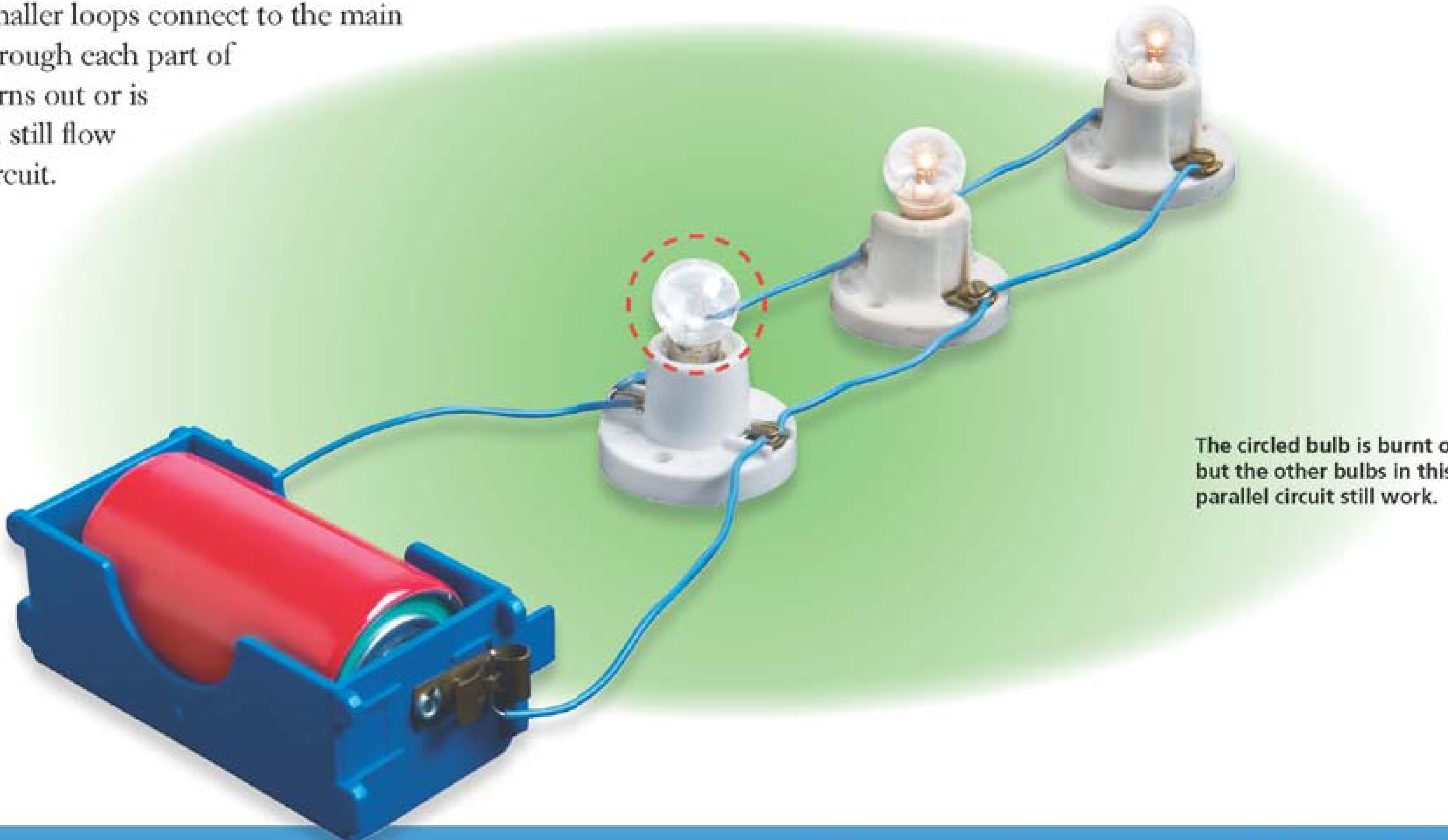
Parallel Circuits

In the past, series circuits were often used in strings of lights. If one bulb burned out, the whole string went out. This is not the case in parallel circuits. In a **parallel circuit,** current can flow through more than one path. So even if one bulb burns out, the rest of the string stays lit.

Why does a parallel circuit work this way? Think about the series circuits we talked about. A parallel circuit starts with that simple loop to and from the power source. The difference is that many smaller loops connect to the main loop. Current can flow through each part of the circuit. If one loop burns out or is disconnected, current can still flow through the rest of the circuit.

Look at the picture of the parallel circuit. You should be able to recognize several parts that are the same as in a series circuit. The power source, wires, switch, and resistors are all the same. What differences do you notice?

Another important benefit of parallel circuits is that they allow different amounts of current to flow to different resistors. If you have a light bulb and a refrigerator on the same circuit, the light bulb will use less current. More current will flow through to the refrigerator, which needs more current than the bulb.



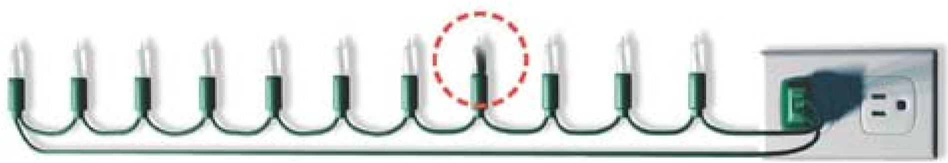
Compare the parallel circuit shown here with the series circuit shown on page 11. What is the same? What is different?

The circled bulb is burnt out, but the other bulbs in this parallel circuit still work.

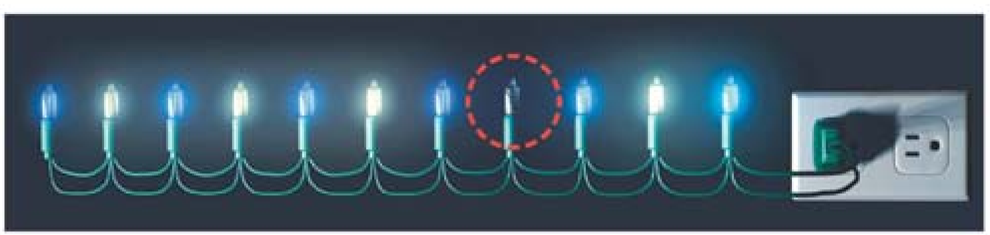
Comparing Circuits

Think about the electricity in your home. Does your home use parallel or series circuits? Suppose for a moment that it has only series circuits. What would happen when you turned off your bedroom light? The whole house would go dark!

Like most buildings, your home, your school, and the grocery store all have parallel circuits. Of course, a series circuit is simpler to make. But parallel circuits are much more practical for our everyday use of lights and appliances. Since parallel circuits have branches for each light or outlet, you can turn any one of them off without opening the circuit.



Here you see why parallel circuits are used instead of series circuits for wiring buildings.



Trace your finger along the parallel circuit shown in the string of lights at the bottom of page 16. How many paths can the electric current follow?

Parallel circuits can deliver different amounts of energy to different resistors. This makes them useful for different kinds of resistors. Resistors in a parallel circuit take as much electricity as they need. Other resistors are not affected, because each resistor has its own branch. So a small appliance, such as an alarm clock, can be used on the same circuit as a larger appliance, such as an oven. This is another reason parallel circuits are better than series circuits for wiring buildings. In a series circuit, each resistor receives the same amount of current.

A radio needs little electricity. An appliance such as a hair dryer needs more.

Staying Safe with Electricity

Circuit breakers are switches that turn off the electricity on a circuit. Many buildings have circuit breakers for all the circuits in the building. Circuit breakers switch off and break the circuit if too much current is flowing.

If electricity can travel a shorter path, it will. This is a *short circuit*. This happens when electricity travels on a path other than the circuit that was meant for it.

Short circuits occur because something interferes with the circuit. Damaged insulation can cause a short circuit. Short circuits also happen when wires touch a good conductor, such as water. Salt water conducts electricity very well. The salts in our body fluids make us conductors. Because of that, we need to stay safe around electricity!

This circuit breaker box (right) controls a home's circuits.

Fuses (above) are resistors. They wear out if too much electricity passes through them.

Do	Do Not
Always unplug appliances by grasping the plug.	Do not pull at an electrical cord.
Have an adult replace cords with damaged insulation.	Never touch a bare wire.
Call 911 if you see a damaged or downed power line.	Never go near a downed power line.
Be safe with electricity when you are around water.	Never touch any appliance or cord that touches water.
Plug your appliance into the outlet correctly.	Do not try to force a plug into an outlet.

Glossary

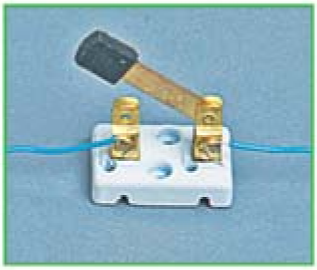
electric charge	a property of some parts of matter, described as positive or negative
electric current	electric charges in motion
parallel circuit	a circuit with two or more paths through which electric current can flow
resistance	the property of a material that does not allow electric current to flow easily through it
series circuit	a circuit in which an electric charge can flow only in one path
static electricity	the buildup of positive or negative electric charges

Did you understand?

Write or **draw** your answers.

1. How does an object become charged with static electricity?

2. Which switch is part of an open circuit? Which is part of a closed circuit?



A

B

3. What other forms of energy can electricity change into after passing through a resistor?

4. How are series circuits and parallel circuits the same? How are they different?

After Reading

Lightning

In this book, you learned that lightning is caused by a release of static electricity. Learn about rules for staying safe in a lightning storm.

Write about what you learn. **Draw** pictures that show how to stay safe during a lightning storm.

Show your drawings to a partner. Explain what you learned.

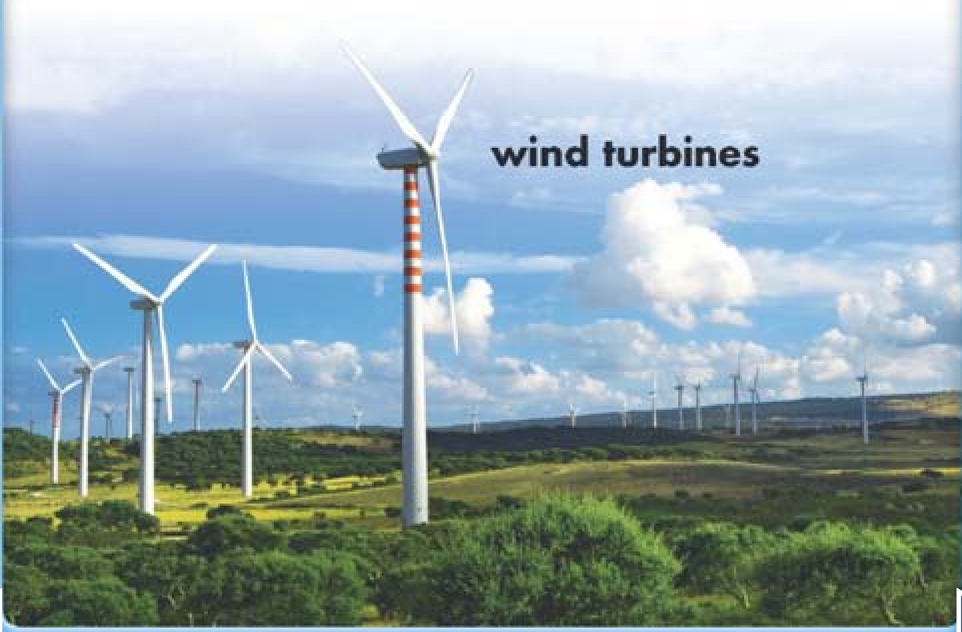
Do the math!

Producing Electricity

The energy of the wind can be used to produce electricity. A machine called a wind turbine produces electricity in this way. Electricity is measured in kilowatts.

1. A wind turbine can produce 275 kilowatts in one hour. Suppose the turbine runs for one day. How many kilowatts can the turbine produce in one day? Show your work.

2. How many kilowatts can the turbine produce in one week? Show your work.


wind turbines

Science

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Cause and Effect	• Captions • Chart • Diagram • Glossary	Electricity

Interactive Science 4

ELL Reading Support

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