CALIFORNIA Standards Preview

California Science

Standard Set 1. Physical Sciences

1. Electricity and magnetism are related effects that have many useful applications in everyday life. As a basis for understanding this concept:

1.a. *Students know* how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.

1.e. *Students know* electrically charged objects attract or repel each other.

1.g. *Students know* electrical energy can be converted into heat, light, and motion.

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Cause and Effect	• Captions • Labels • Charts • Glossary	Electricity

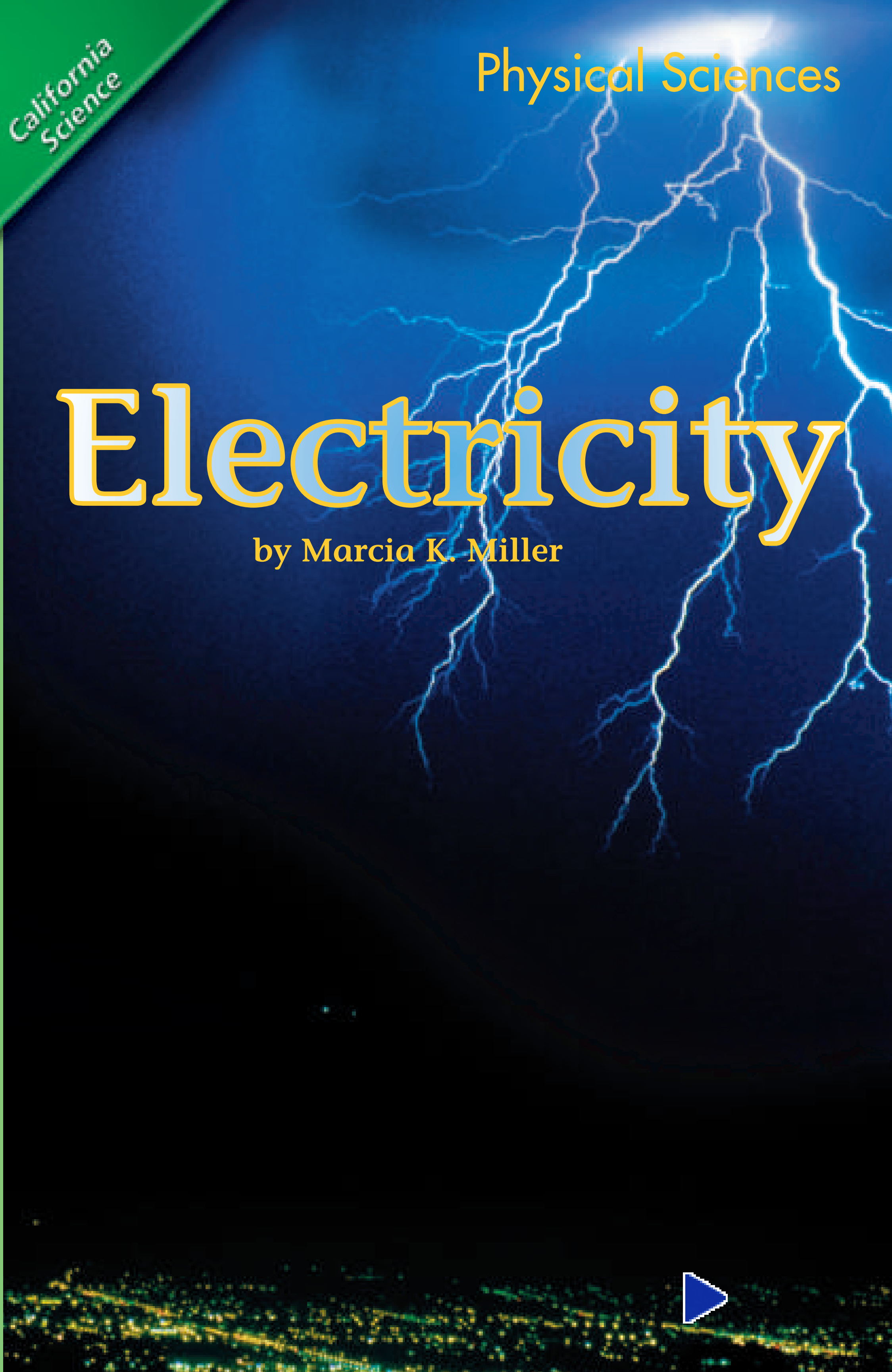
Scott Foresman Science 4.1

PEARSON Scott Foresman

scottforesman.com

ISBN 0-328-23540-7

9 780328 235407 90000



California Science

Physical Sciences

Electricity

by Marcia K. Miller

Vocabulary

electric charge
electric current
parallel circuit
resistance
series circuit
static electricity

Picture Credits
Every effort has been made to secure permission and provide appropriate credit for photographic material. The publisher deeply regrets any omission and pledges to correct errors called to its attention in subsequent editions.

Unless otherwise acknowledged, all photographs are the copyright of Dorling Kindersley, a division of Pearson.

Opener: ©Byron Aughenbaugh/Getty Images; 2 ©Byron Aughenbaugh/Getty Images; 6 ©DK Images; 8 ©Byron Aughenbaugh/Getty Images; 12 ©Amy Trustram Eve/Photo Researchers, Inc.; 19 ©Tony Freeman/PhotoEdit.

ISBN: 0-328-23540-7

1 2 3 4 5 6 7 8 9 10 V010 13 12 11 10 09 08 07 06

Electricity

by Marcia K. Miller

PEARSON
Scott Foresman

How do charged objects behave?

Matter is made up of atoms. Atoms are made up of even smaller parts, which can have an electric charge. An **electric charge** is a property of some parts of matter that is described as positive or negative.

An electric charge can be positive. It can also be negative. Positive matter has more positive charges. Negative matter has more negative charges.

A charge can also be *neutral*. Its positive and negative charges balance. They equal zero. Objects with the same, or *like*, charge push away from each other. They *repel*. Objects with unlike charges pull toward each other. They *attract*.

Static Electricity

Electrons are the negative parts in atoms. They can move between objects that are close together. Objects that gain electrons become negatively charged. Objects that lose electrons become positively charged. Built-up charges cause **static electricity.**

Static electricity causes lightning. First, drops of ice and water rub against each other inside clouds. This causes electrons to move. Positive charges build up near the top of clouds. Negative charges build up near the bottom of clouds. After a while, the static electricity is released. This energy heats the air. You then see a glow called lightning!

You can see the effects of static electricity by watching a lighting storm.

How Charged Objects Behave

The girl's hair pulls toward the balloon. Her hair and the balloon have unlike charges. Why?

Rub a balloon on your hair. Electrons move from your hair to the balloon. This gives the balloon a negative charge. It gives your hair a positive charge.

Hold the balloon near your head. Your hair moves toward it. The unlike charges attract each other.

Look at how the girl's hairs stand apart from each other. Like charges repel. Each hair has a positive charge. So each hair pushes away from the others.

The girl's hair is attracted to the balloon's negative charge. Each hair is repelled by the other hairs.

Electrons on the Move

If you wear a hat, electrons can move from the hat to your hair. Then the hat has a negative charge, and your hair has a positive charge. Attraction makes your hair stand up when you take the hat off. Repulsion makes each hair stand apart from the other hairs.

Scuff, Scuff, Zap!

Did you ever get a shock from a doorknob? Electric charges made this happen. As you walk along a rug, you pick up extra electrons. Your body gets a negative charge. But you don't know it until you touch the doorknob. When you do, electrons move from your hand to the metal. You might even see a spark. It is like a tiny flash of lightning!

Walking on a carpet while wearing socks gives your body a negative charge.

Charging a Neutral Object

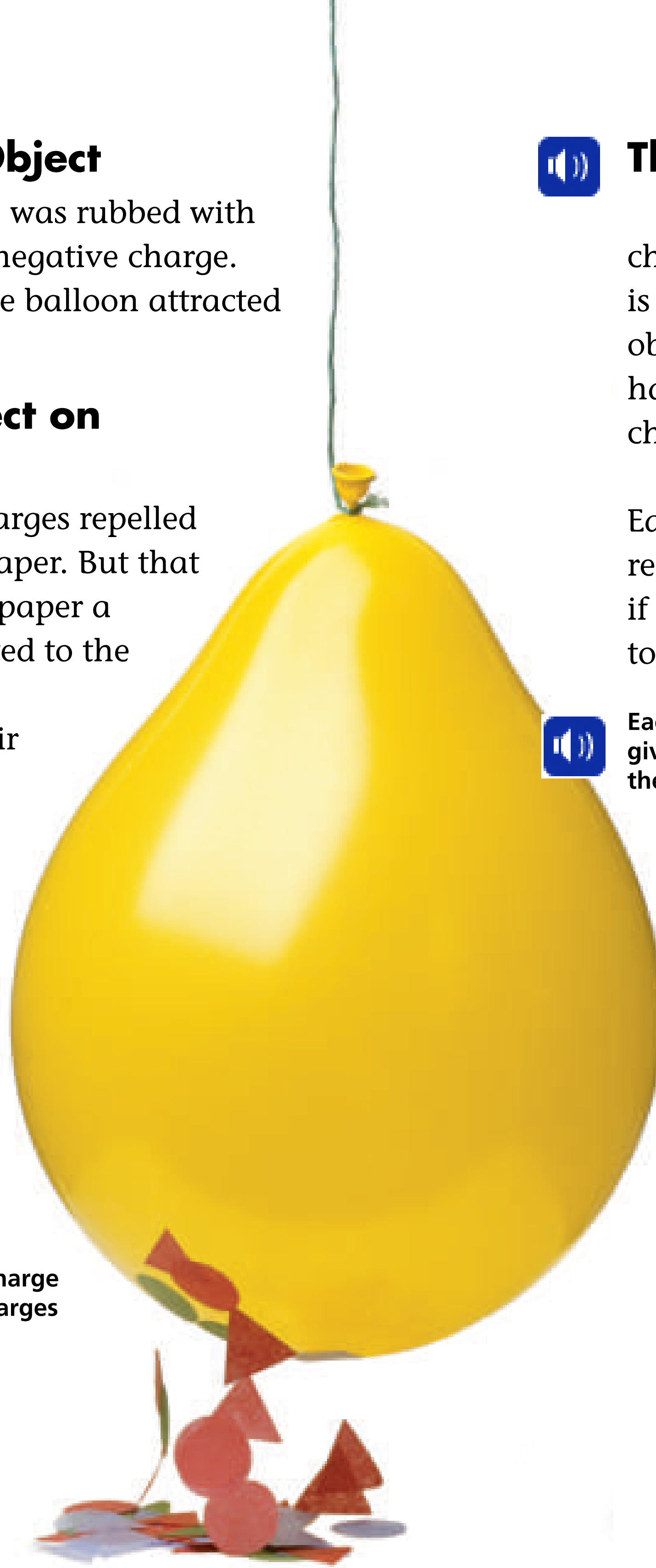
In the picture, the balloon was rubbed with silk. This gave the balloon a negative charge. The paper was neutral. Yet the balloon attracted the paper. Why?

Charged Objects' Effect on Neutral Objects

The balloon's negative charges repelled the negative charges in the paper. But that gave the top of each piece of paper a positive charge. It was attracted to the balloon.

Rub a balloon on your hair and then hold it near a wall. The balloon sticks because of its extra negative charge. The wall is neutral. But the balloon's negative charge attracts the positive charges in the wall.

Eventually the balloon will lose its negative charge and become neutral. Then it will fall to the floor.



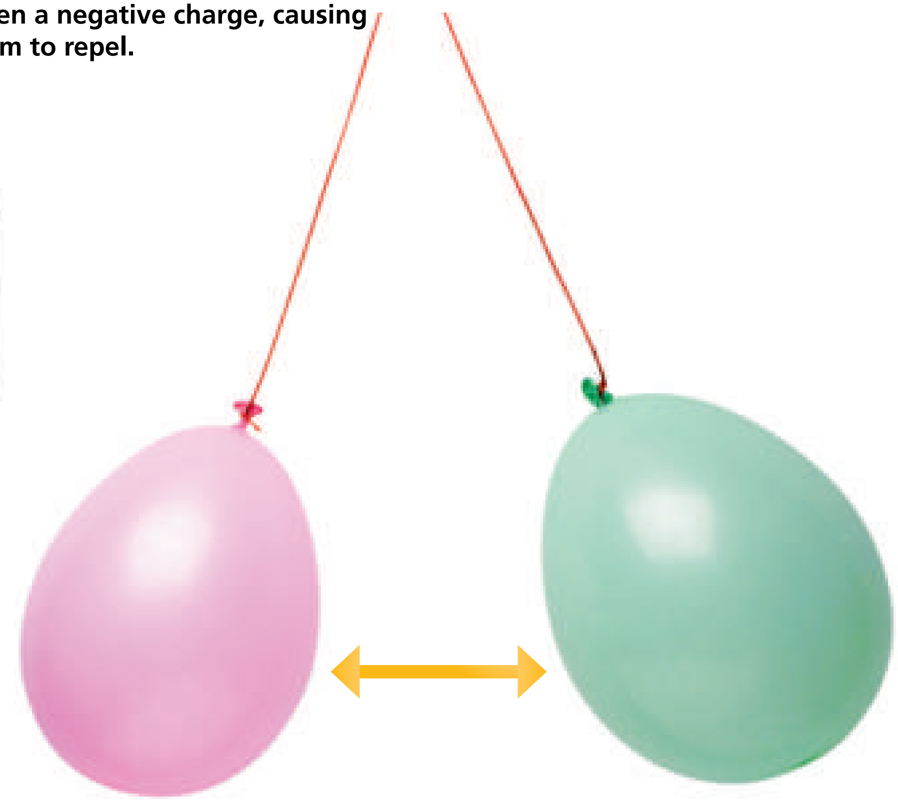
The balloon's negative charge attracted the positive charges on each piece of paper.

The Force Between Charged Objects

The force between electric charges pulls unlike charges together. It pushes like charges apart. The force is strongest nearest to the charged object. It weakens as objects get farther apart. A charged balloon pulls your hair to it as long as the balloon is near your head. The charge isn't strong enough if the balloon is far away.

Rub two balloons on your hair or on a wool sock. Each balloon gets a negative charge. The balloons repel each other when you bring them near. What if the balloons had unlike charges? They would pull toward each other as you moved them together.

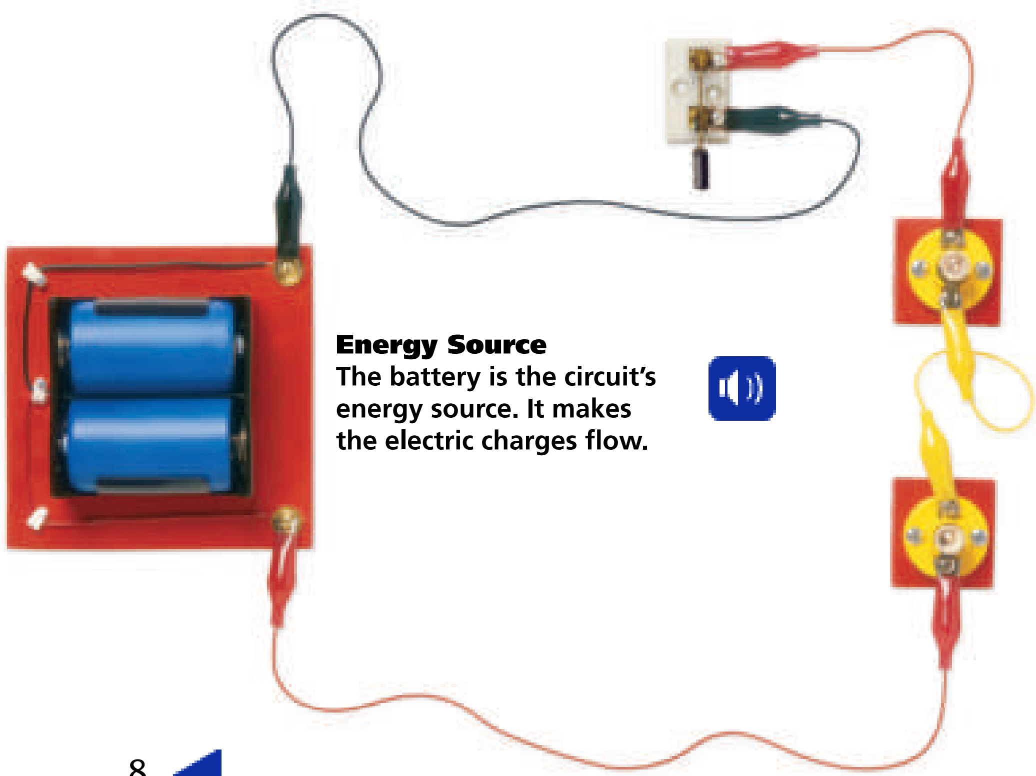
Each of these balloons has been given a negative charge, causing them to repel.



How do electric charges move?

Flip on a light switch on the wall. A bulb in the ceiling glows. How did electricity get to the bulb? Electric charges in motion are called **electric current.** You can make current flow in a path. This path is called an *electrical circuit*.

An electrical circuit must make a complete loop for current to flow. The current cannot flow if the loop has any break or gap. A circuit with no breaks is a *closed circuit*. An *open circuit* has at least one break. Follow the path of the closed circuit to see its parts.



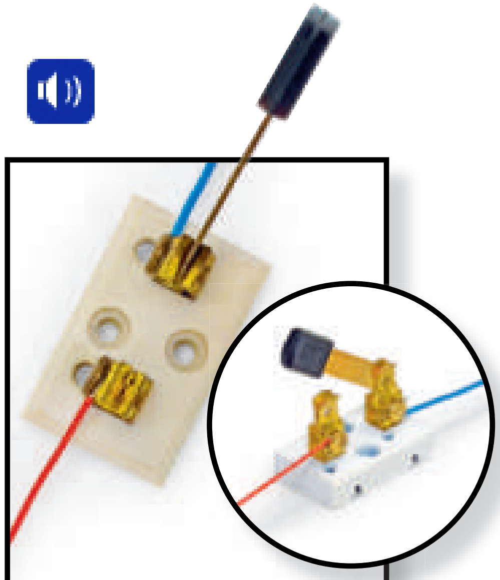
Energy Source
The battery is the circuit's energy source. It makes the electric charges flow.

Conductors, Resistors, and Insulators

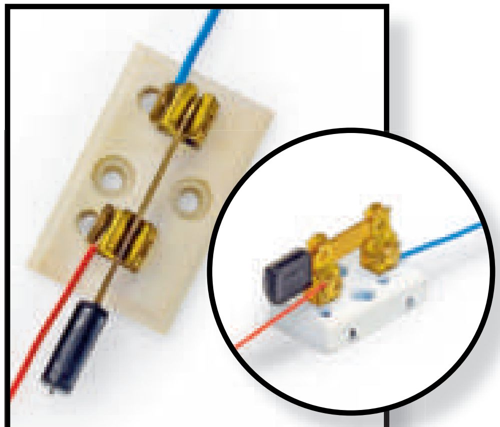
Current flows through parts of the loop. The loop has conductors. A *conductor* helps electricity flow. The conductors on this circuit are wires, clips, and switches.

Most circuits have at least one resistor. A *resistor* pushes against the flow of electricity. **Resistance** makes electric current flow less easily. Resistors change electricity into light, heat, and other types of energy.

Insulators stop the current from flowing. An *insulator* has enough resistance to stop current.



Open Switch
The switch is open. The circuit is broken. Electricity cannot flow.

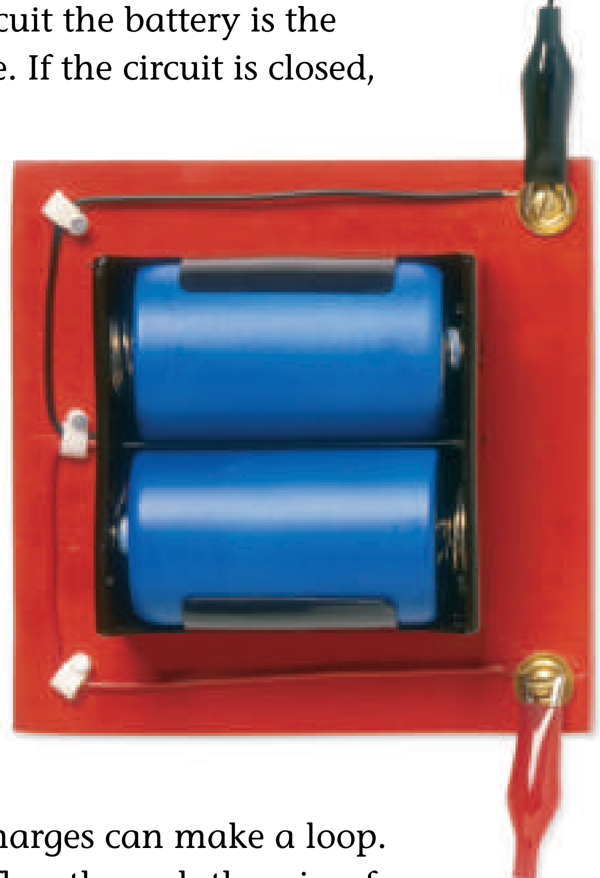


Closed Switch
The switch is closed. The circuit makes a full loop. Electricity can flow.

Series Circuits

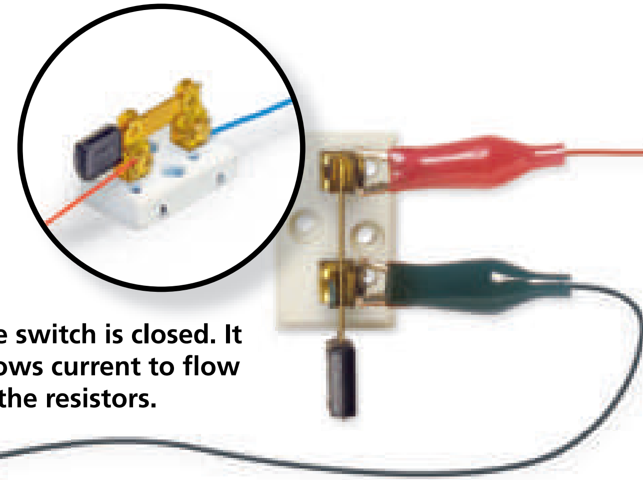
In a **series circuit,** electric charge can only flow in one circular path. Any break in the path stops the current. This picture shows a series circuit.

In this circuit the battery is the energy source. If the circuit is closed,



These batteries provide energy to move electric charges through a circuit.

the electric charges can make a loop. The charges flow through the wires from the battery. They pass through the closed switch to the resistors. Then they flow back to the battery. The resistors change some of the electrical energy into other forms of energy.



The switch is closed. It allows current to flow to the resistors.

Electrical energy is shared equally among all the resistors in the series circuit. This series circuit has two identical bulbs. They will give off the same amount of light. But what if one resistor burns out? The circuit is then broken. The other resistors won't get any current. So they won't light.

Most electric devices we use need different amounts of current. If one device in a series circuit breaks, the other devices on the circuit will not work. These are two reasons that most buildings are not wired with series circuits.

A series circuit can have more than one resistor.

Energy Changing Form

The light bulbs on pages 10 and 11 are resistors. Resistors put electrical energy to work. They change electrical energy into energy of heat, light, and motion.

Energy is never lost. But it can change form. When current flows through a resistor, some energy flows on to the rest of the circuit. But much of it becomes heat.

The part of a light bulb with the highest resistance is the filament. This is a thin coiled wire inside the bulb. Most of the energy that passes through the filament changes into heat. The heat makes it glow and give off light.

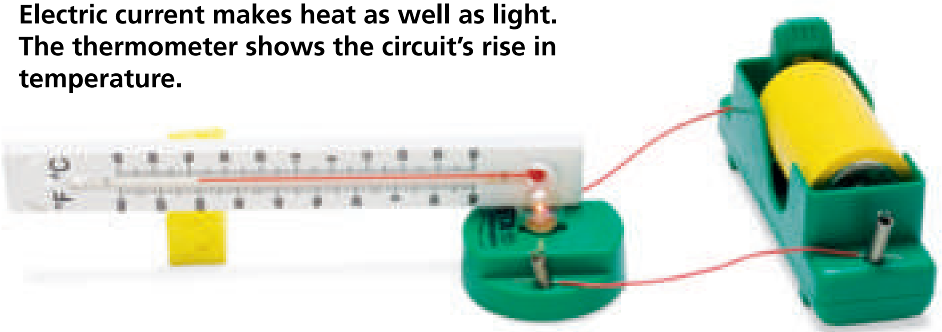
Light bulbs are resistors. They change electricity into light and heat. When they glow, they are too hot to touch.

Producing Heat and Light

You use electric devices every day. Some are made to give off light. They always give off heat as well. Others are meant to give off heat. They may also give off light. And others are meant to give off heat and light.

You can see how energy changes in a simple circuit. The circuit shown here uses a flashlight bulb and its holder, two pieces of wire, and a battery.

Electric current makes heat as well as light. The thermometer shows the circuit's rise in temperature.

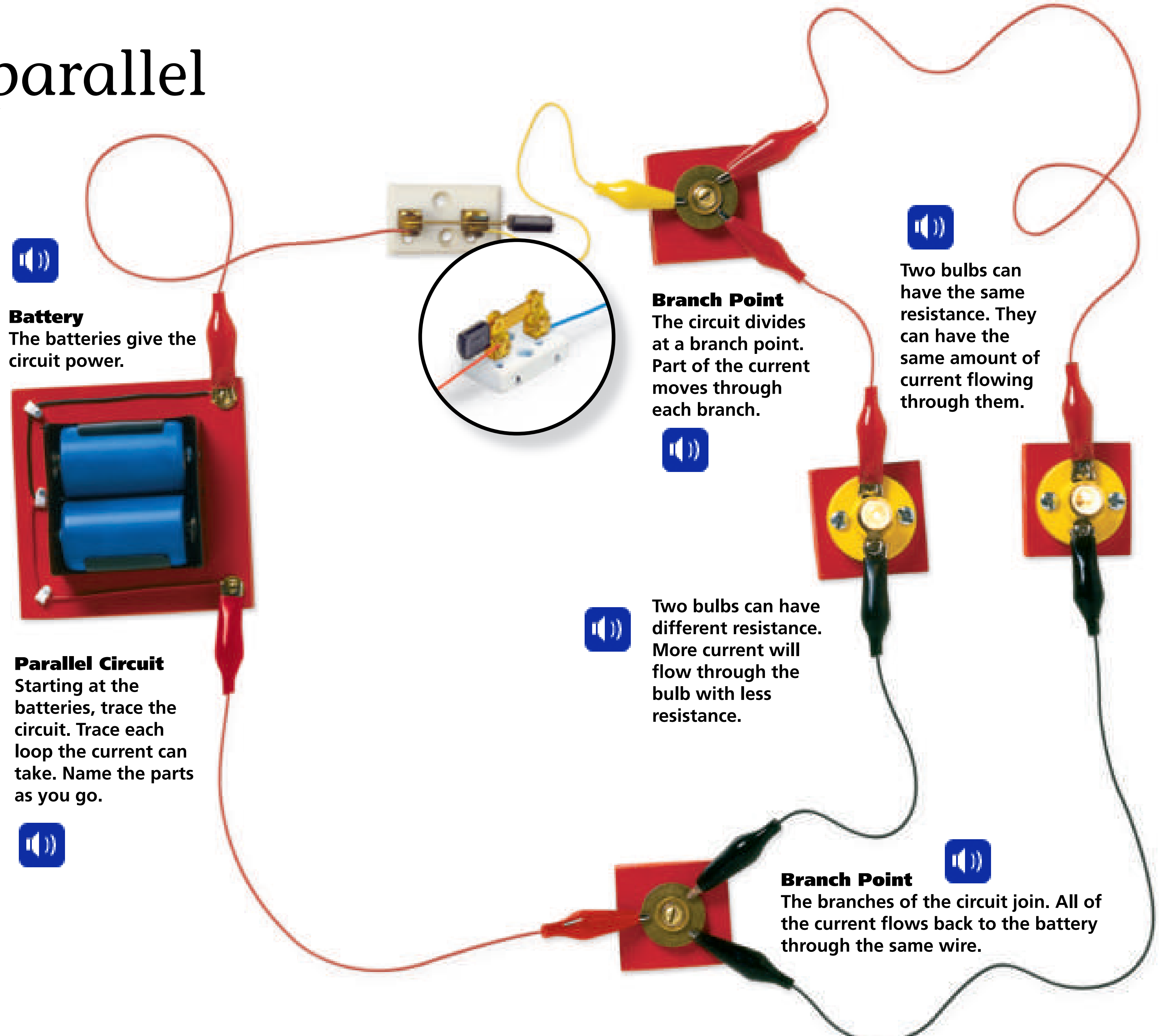


The bulb lights when the circuit is closed. It shows electrical energy changed into light. You can't see the heat energy. But you can measure it. Put a thermometer on the bulb after it lights. It will show the temperature rising. The electrical energy changed into light and heat.

What are parallel circuits?

Parallel Circuits

A **parallel circuit** has two or more paths. Current may flow along any or all of the paths. The main path leaves from and goes back to the power source. Smaller loops branch off from the main path. Then they connect back. Electric charges can flow anywhere along the circuit. If one loop is broken or turned off, the current will still flow through the other paths.



Battery
The batteries give the circuit power.

Parallel Circuit
Starting at the batteries, trace the circuit. Trace each loop the current can take. Name the parts as you go.

Branch Point
The circuit divides at a branch point. Part of the current moves through each branch.

Two bulbs can have the same resistance. They can have the same amount of current flowing through them.

Two bulbs can have different resistance. More current will flow through the bulb with less resistance.

Branch Point
The branches of the circuit join. All of the current flows back to the battery through the same wire.

Series and Parallel Circuits

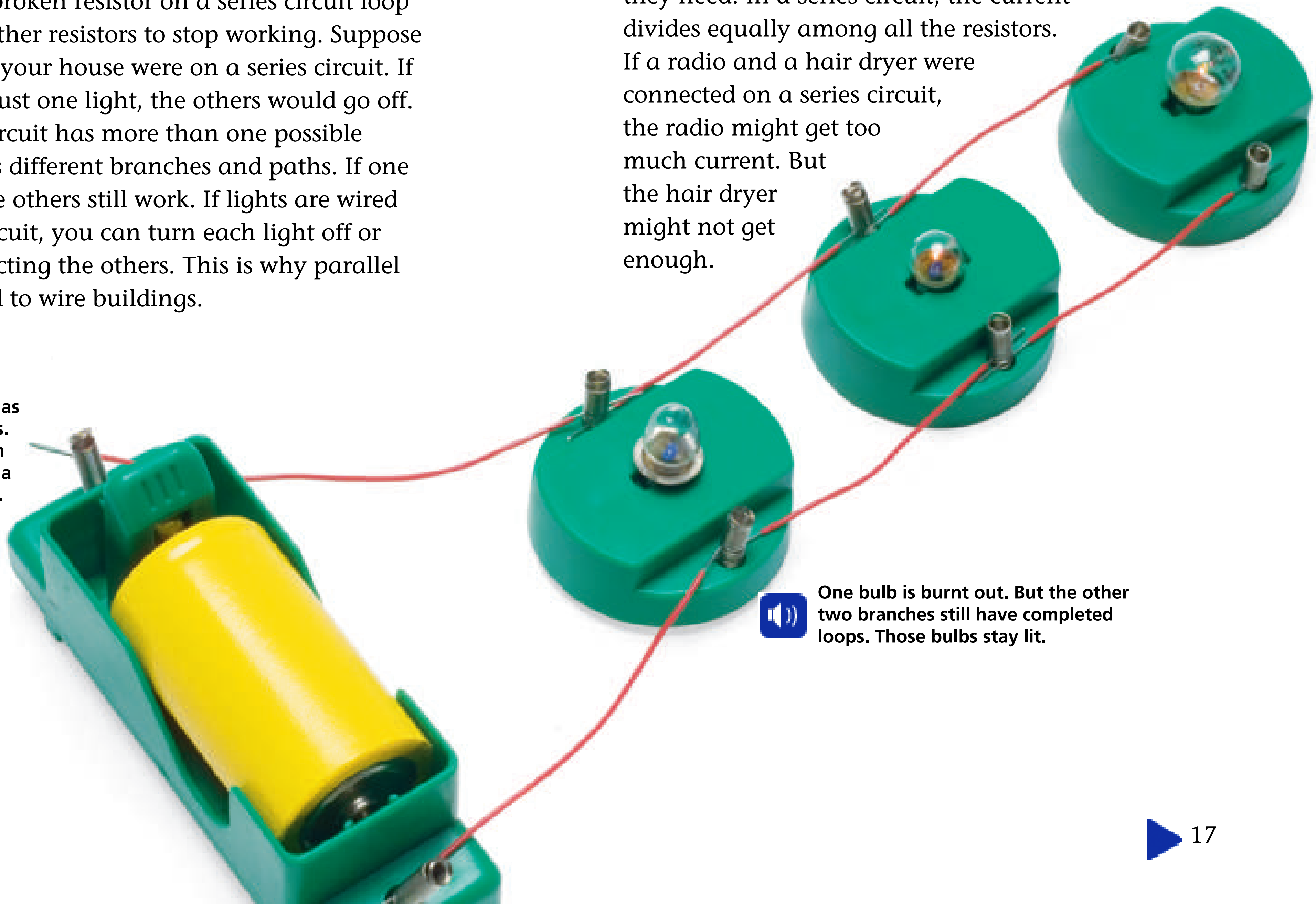
Your home and school have parallel circuits. Why are they used instead of series circuits?

Please Keep the Lights On

A closed or broken resistor on a series circuit loop will cause the other resistors to stop working. Suppose all the lights in your house were on a series circuit. If you turned off just one light, the others would go off.

A parallel circuit has more than one possible loop. It also has different branches and paths. If one path breaks, the others still work. If lights are wired in a parallel circuit, you can turn each light off or on without affecting the others. This is why parallel circuits are used to wire buildings.

Parallel circuits have other benefits. The resistors in radios and clocks use only a small amount of current. But the resistors in an iron, a space heater, or a hair dryer use much more current. The branches in a parallel circuit take only as much current as they need. In a series circuit, the current divides equally among all the resistors. If a radio and a hair dryer were connected on a series circuit, the radio might get too much current. But the hair dryer might not get enough.



This parallel circuit has three different paths. Trace each path from the battery through a bulb and back again.

One bulb is burnt out. But the other two branches still have completed loops. Those bulbs stay lit.

Electrical Safety

Electric current can be dangerous. It is important to stay safe around electricity.

Electric current always flows through the path that has the least resistance. A *short circuit* occurs when current follows a path it was not supposed to take. This can happen when a frayed or broken wire touches a conductor. Salt water is a very good conductor. Your body's fluids are salty, so never touch a bare wire!

These are fuses. The thin metal strip inside a fuse melts if too much current flows. This breaks the circuit, preventing damage. Fuses with melted strips need to be replaced.

Here are a few simple rules for staying safe around electricity. First, do not touch electrical outlets. Second, always unplug appliances by pulling the plug, not the cord.

Third, a cord with damaged insulation needs to be replaced. Fourth, never touch a power line. Stay away from downed power lines. Fifth, never touch an electrical appliance, switch, cord, plug, or outlet if you are touching water. Don't touch any appliance that is in water itself. Finally, do not use cord-operated appliances near a bathtub, pool, or lake.

Circuit breakers are switches that shut off circuits if too much current flows. The switch needs to be flipped back on for current to flow again.

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 property of a material that does not allow electric current to flow easily through it

series circuit a circuit in which electric charge can flow only in one path

static electricity the buildup of positive or negative electric charges

What did you learn?

1. How does the movement of electrons lead to static electricity?
2. What does it mean if a charge is neutral?
3. What makes your body a good conductor?
4. **Writing in Science** Describe what happens when you rub a full balloon with silk, and then place pieces of paper near the balloon. Make sure that your description is in the proper order.
5. **Cause and Effect** What causes parallel circuits to have advantages over series circuits? What is an effect of this?