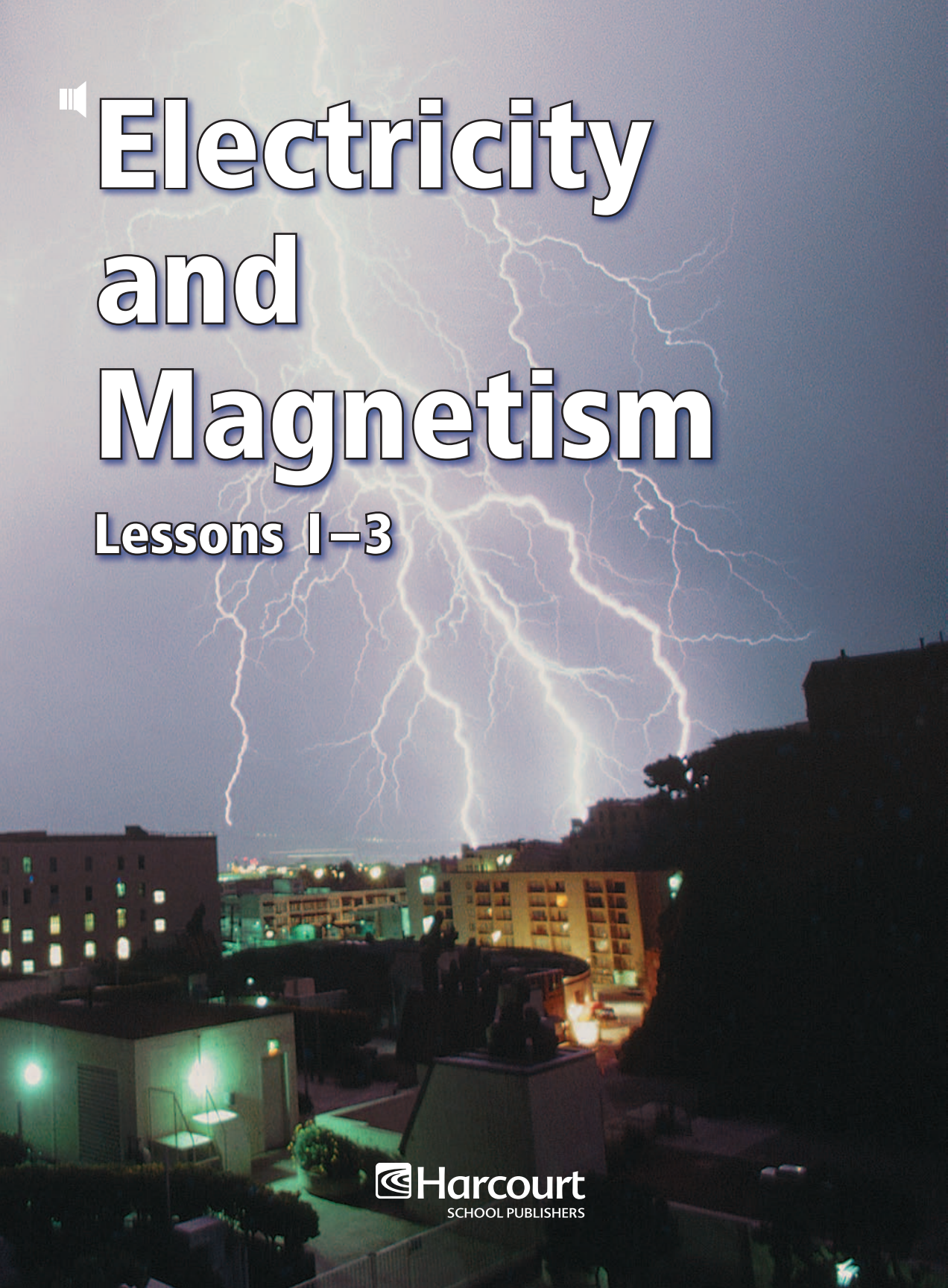
Electricity and Magnetism

Lessons 1–3



Harcourt
SCHOOL PUBLISHERS

Printed in the United States of America

ISBN-13: 978-0-15-349173-3
ISBN-10: 0-15-349173-6

1 2 3 4 5 6 7 8 9 10 179 15 14 13 12 11 10 09 08 07 06

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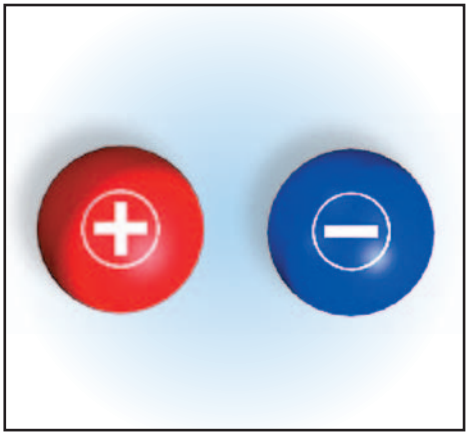
Lesson 1

What Is Static Electricity?

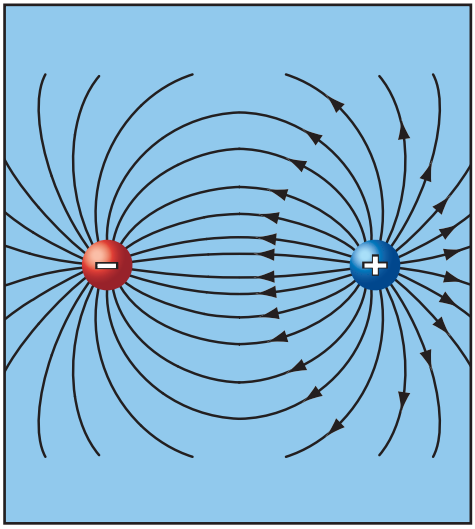
VOCABULARY

- electric charge
- static electricity
- electric field



A plus sign or a minus sign stands for an **electric charge**. Matter can have either a positive (plus sign) or a negative (minus sign) electric charge. Some matter does not have either charge.

This girl has a buildup of electric charges in one place. This is why the socks stick to her sweater. Such a buildup is called **static electricity**.



The area around an electric charge is called the **electric field**. It is where electric forces act.

Focus Skill

READING FOCUS SKILL

CAUSE AND EFFECT

A **cause** is something that makes another thing happen. An **effect** is the thing that happens.

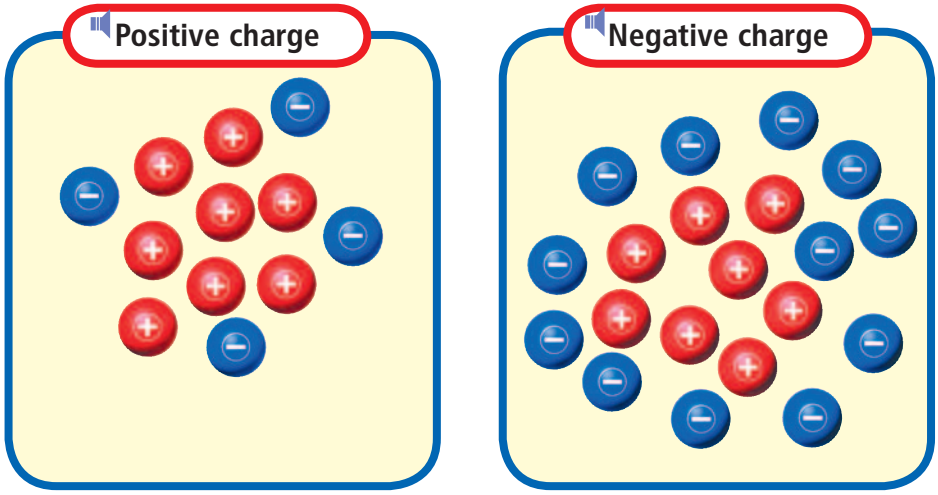
Look for things that **cause** electric charges to build up. Look for the **effect** this has on objects.

Two Kinds of Charge

You already know the word *electricity*. Electricity is a kind of energy. This energy depends on properties of matter. Many of the tiny particles that make up matter have an **electric charge**. These charges can be positive or negative.

Positive and negative charges can cancel each other out. Matter is usually *neutral*, not positive or negative. The charges are usually in balance.

Rubbing the balloon causes a charge.

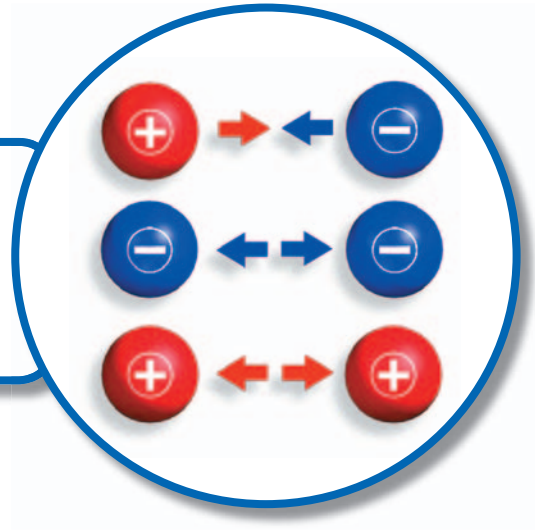


Positively charged objects and negatively charged objects affect each other. Opposite charges attract, or pull toward each other. Charges that are the same repel, or push away from each other

The buildup of charges in one place is called **static electricity**. When clothes rub against each other in the dryer, they cause static electricity.

Focus Skill What causes static electricity?

Objects that have the same charge push away from each other. Objects with different charges pull toward each other.



Separating Charges

Most of the time, you, a balloon, and a doorknob are *neutral*. This means that the numbers of positive and negative charges are equal. When the numbers are not equal, you can see electric forces act. To make the numbers not equal, you must separate negative charges from positive charges.

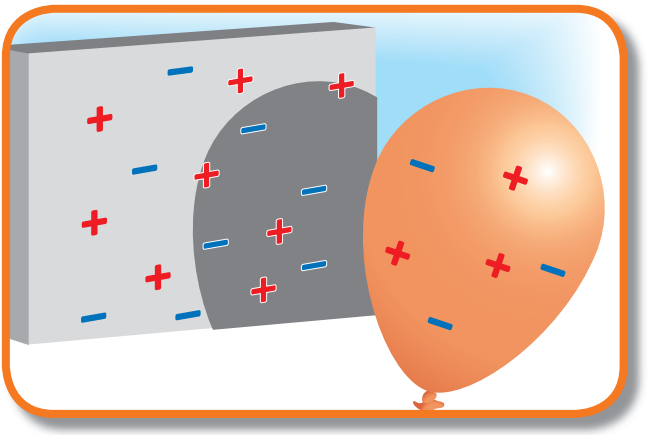
Rubbing can pull negative particles from one object and put them onto the other. Rubbing does not cause positive charges to move.

As clothes tumble in the dryer, different fabrics rub against one another. Negative charges move from one piece of clothing to another. When this happens, the clothes stick together.

What causes a negatively charged balloon to stick to a neutral wall? This happens because there is another way to separate charges. The balloon's negative charges repel negative charges in the wall. The wall's negative charges move away a little. They are now separated from the wall's positive charges. The balloon's negative charges are then attracted to the wall's positive charges. The balloon sticks to the wall.

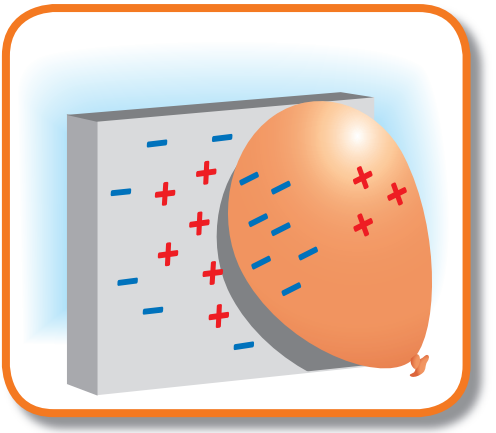
Focus Skill

What are two ways you can cause charges to separate?



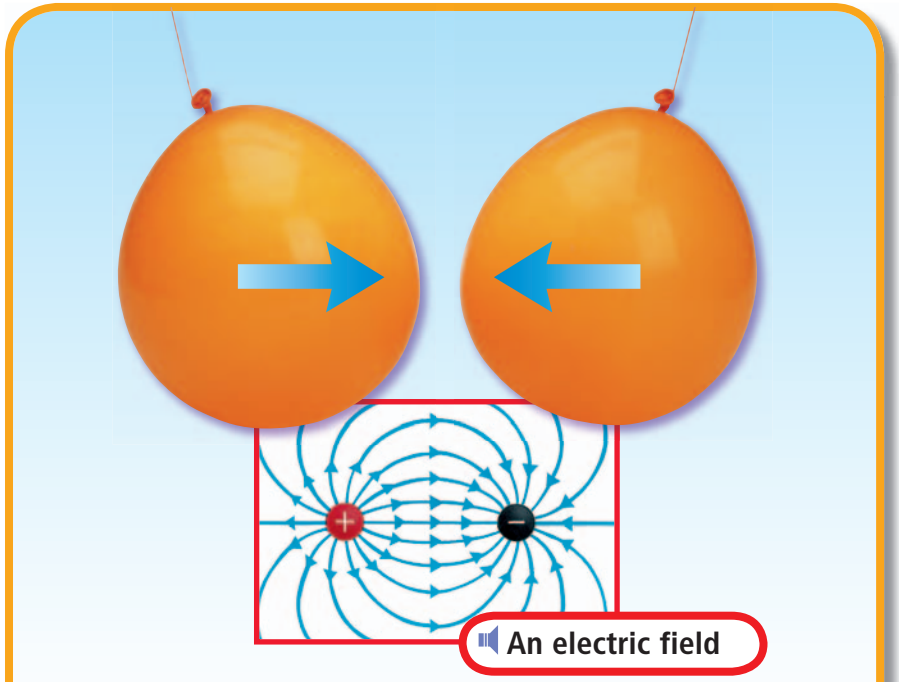
◀ **The balloon is neutral. It has the same number of positive and negative charges.**

The balloon is negatively charged. The negative charges on the wall are pushed away. The balloon is attracted to the wall's positive charges. It sticks to the wall. ▶



Electric Forces

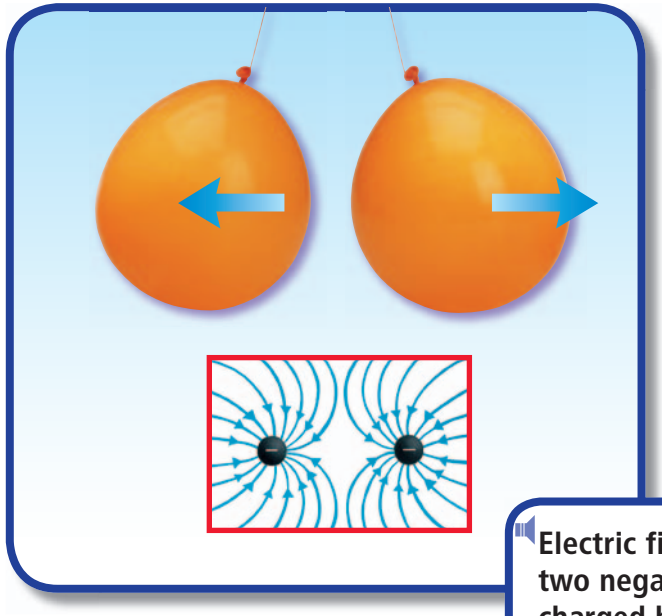
Positive and negative electric charges have electric fields around them. An **electric field** is the space in which an electric force acts. An electric field extends in all directions from the charge. A positive charge's field attracts any nearby negative charge. It repels any nearby positive charge.



One balloon has a positive charge. The other has a negative charge. The pattern of lines shows the electric field between them.

The diagram on this page shows what the electric fields around two negatively charged balloons look like. The lines show that the balloons repel each other.

What causes an electric force?



Electric field around two negatively charged balloons

Review

Complete the following cause and effect statements.

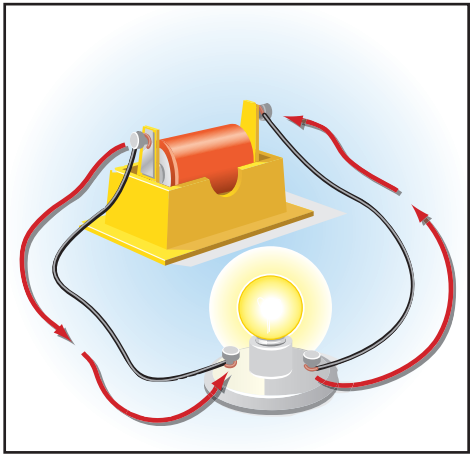
1. An _____ _____ is a property of some matter.
2. Charges can be _____ or _____.
3. The buildup of charges in one place is called _____ _____ .
4. An _____ _____ is the space in which an electric force acts.

Lesson 2

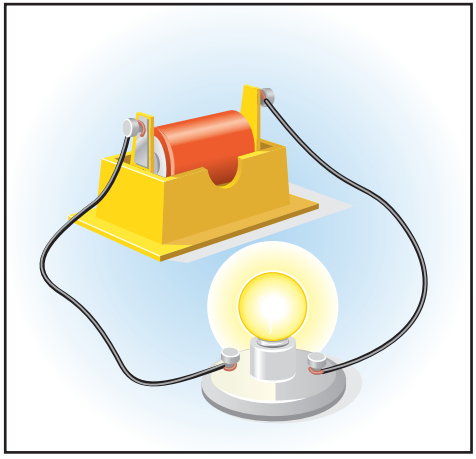
What Makes a Circuit?

VOCABULARY

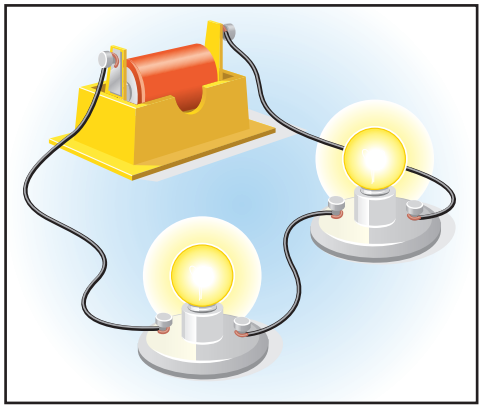
- electric current
- electric circuit
- series circuit
- parallel circuit
- resistance
- short circuit



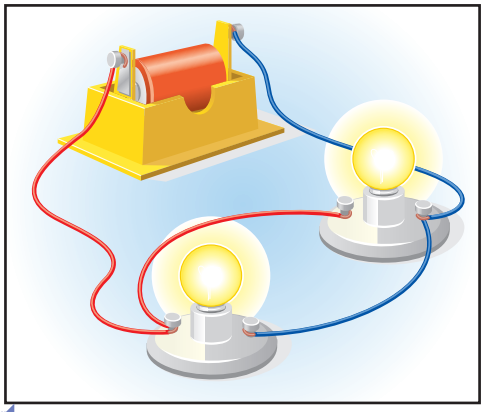
An **electric current** brings electric energy to light the bulb.



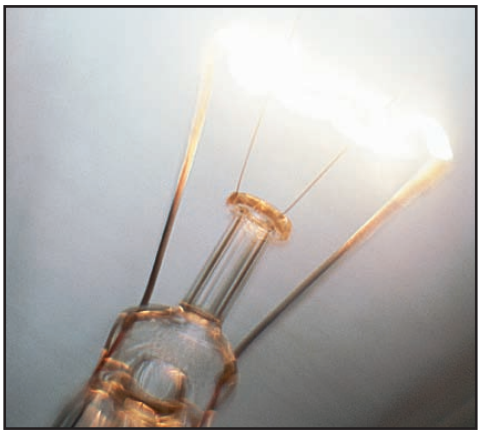
The bulb lights because it has a steady flow of electric current. The continuous pathway is called an **electric circuit**.



Both bulbs light because there is one path that allows current to flow. This is called a **series circuit**.



A **parallel circuit** has two or more paths where current can flow. If one bulb goes out, the others stay on.



The filament in this light bulb has a high **resistance**. This means it reduces the flow of electric current.

In this picture, electricity is flowing where it should not. That creates a **short circuit**.

Focus Skill

READING FOCUS SKILL

CAUSE AND EFFECT

A **cause** is something that makes another thing happen. An **effect** is the thing that happens.

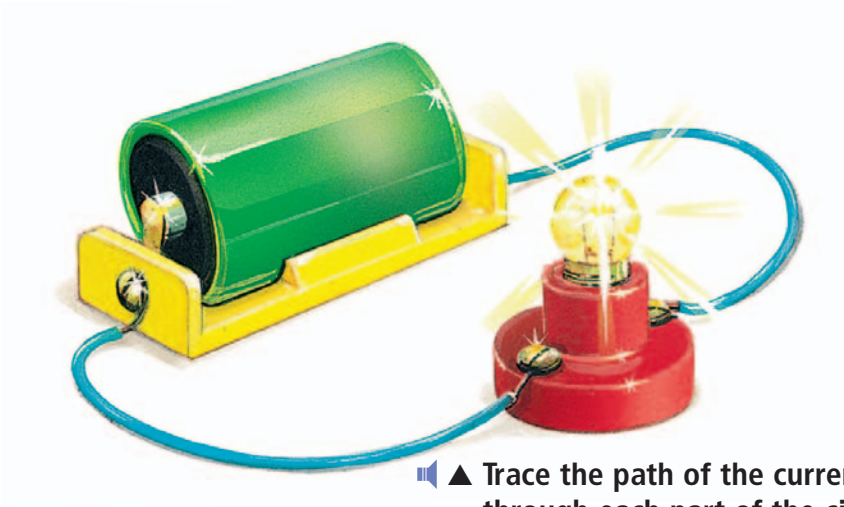
Look for what **causes** an electric circuit.

Look for the **effect** a type of circuit has on electricity.

Moving Charges

One form of electricity is current electricity. When electric charges have a path to follow, they move, or *flow*. The flow of electric charges is called **electric current**. *Current electricity* is a steady flow of charges.

An **electric circuit** is a closed path through which electric current flows. A battery is an important part of a circuit. It provides energy. The energy moves electric charges through the circuit.

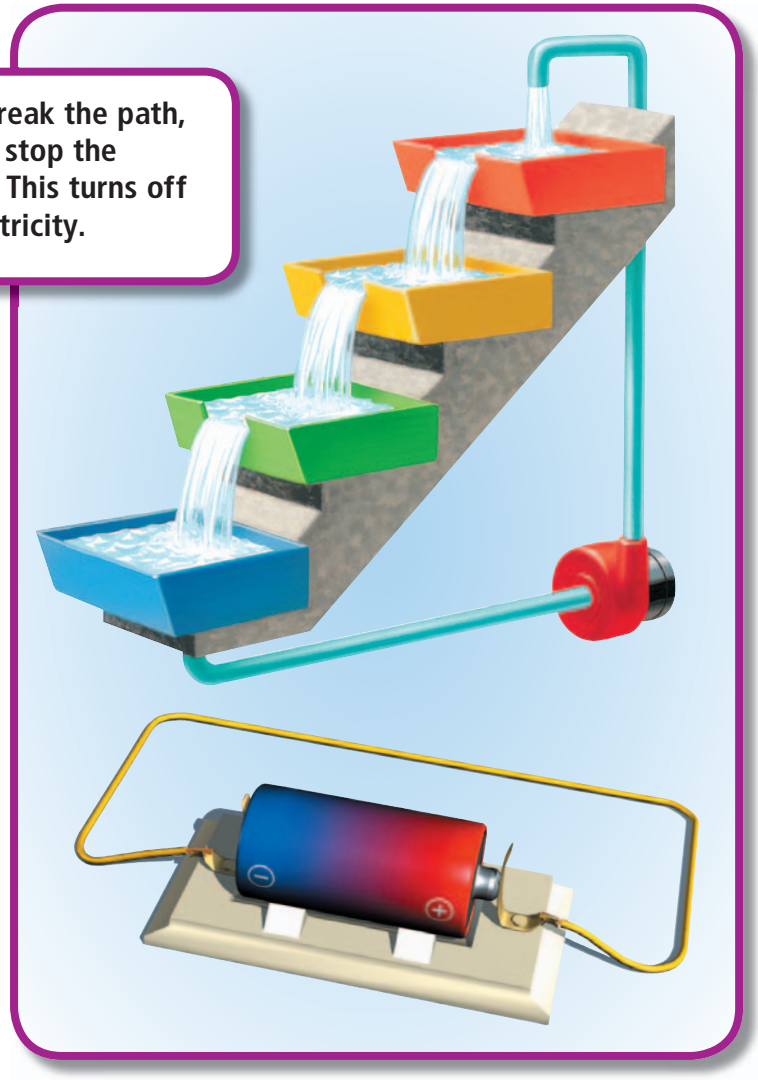


▲ **Trace the path of the current through each part of the circuit.**

Current flows through the circuit below. It flows like water through the trays of the fountain. You control a fountain by closing off a pipe. You control the path of current electricity by opening a switch. This breaks the path of the current flow.

What causes electric charges to flow?

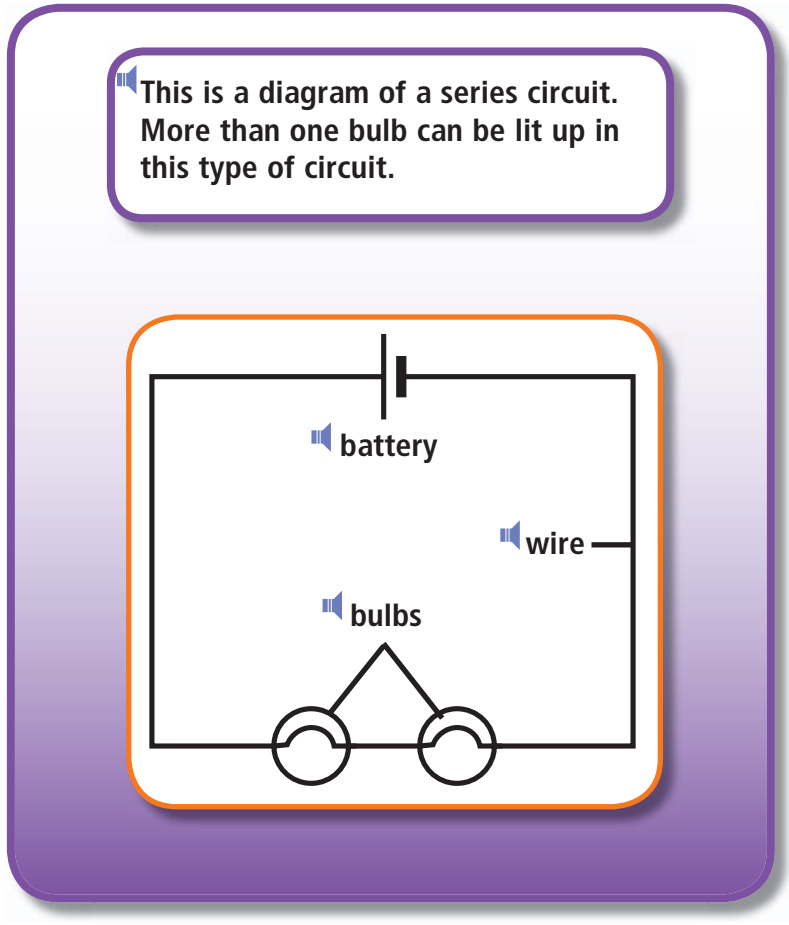
If you break the path, you can stop the current. This turns off the electricity.



Series Circuits

A **series circuit** has only one path for current to follow. It's like riding on a Ferris wheel. You have to go all the way around to get back to the start.

A series circuit can have more than one bulb. The electric current moves from the battery through the wire. It passes through each bulb. Then it returns to the battery.

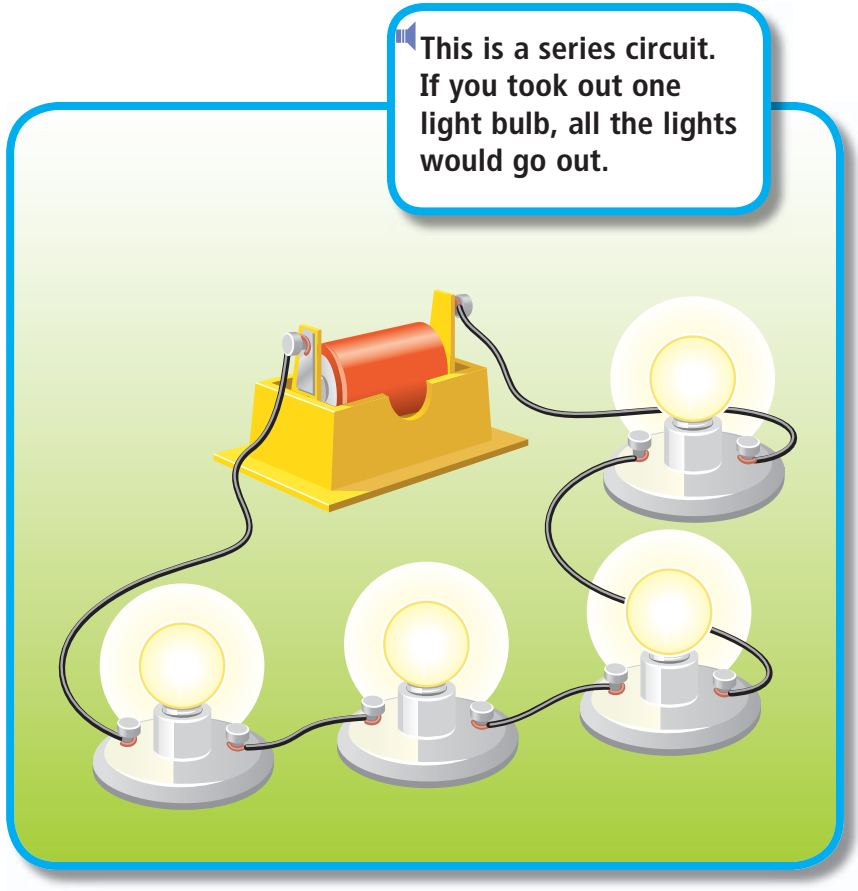


This is a diagram of a series circuit. More than one bulb can be lit up in this type of circuit.

In a series circuit, taking out any part stops the flow of electricity. The bulb will not light. Current flows only when everything is connected.

A series circuit works well in a simple device such as a flashlight. You would not use a series circuit for your whole home. To make one light work, you'd have to turn them all on!

Focus Skill How does a series circuit turn off?



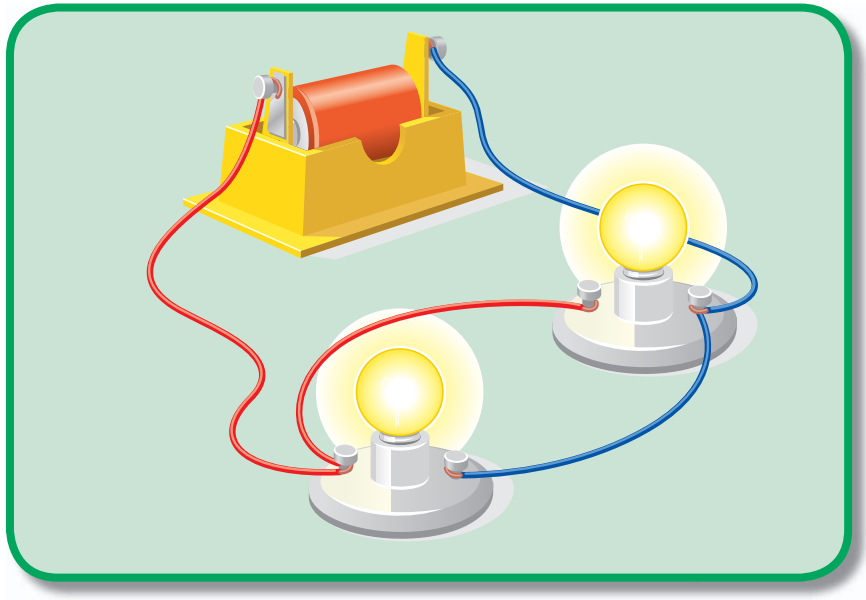
Parrallel Circuits

A better way to wire your home is to use parallel circuits. A **parallel circuit** has more than one path for the current to follow. If something blocks one path, the charges can flow along another path. At least one light stays lit.

In a parallel circuit, the current splits among different paths. People can turn devices on or off at different times. Plugging in more devices does not change how the circuit works.

Focus Skill

You have three devices turned on along a parallel circuit. If you remove one device, what happens to the others?



▲ **This is a parallel circuit. There is more than one path for the current to flow along. You can block one path, or remove a bulb. The other bulbs will still light.**

Resistance

The flow of electricity is like car traffic. If there are many lanes, cars can move easily. If cars must share one lane, traffic slows down. The amount of current that can flow through a circuit depends on resistance. **Resistance** is how much a material slows down the flow.

Sometimes a wrong connection is made. The current takes a short cut. The short cut is called a **short circuit**. In a short circuit, current flows where it isn't wanted. Short circuits prevent the rest of a circuit from working properly.

Focus Skill

What can cause the flow of electricity to slow down?

Review

Focus Skill

Fill in the cause and effect statements.

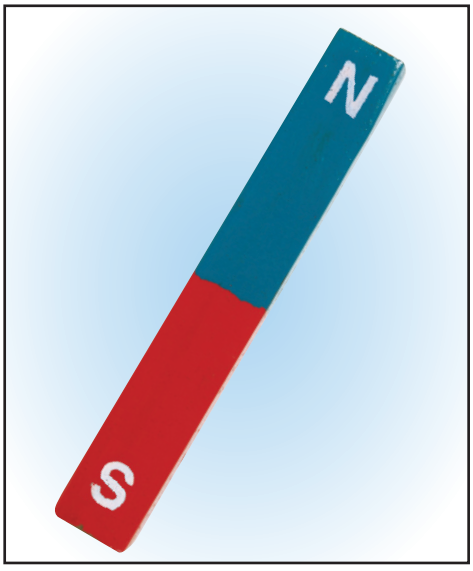
1. A battery moves energy through an _____ _____ .
2. If one light is disconnected in a _____ circuit, they all go out.
3. A _____ circuit allows current to flow along more than one path.
4. _____ slows down the flow of current.

Lesson 3

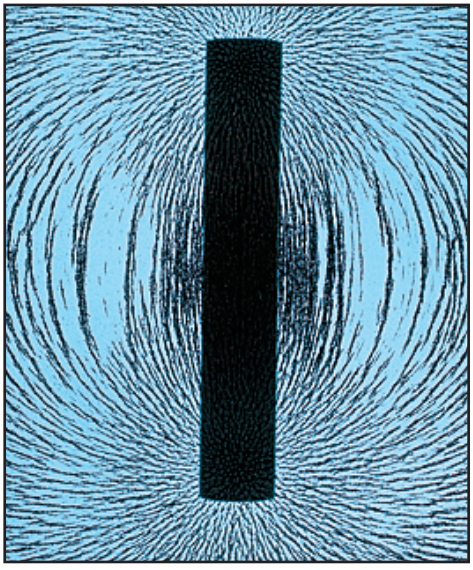
What Are Magnetic Poles?

VOCABULARY

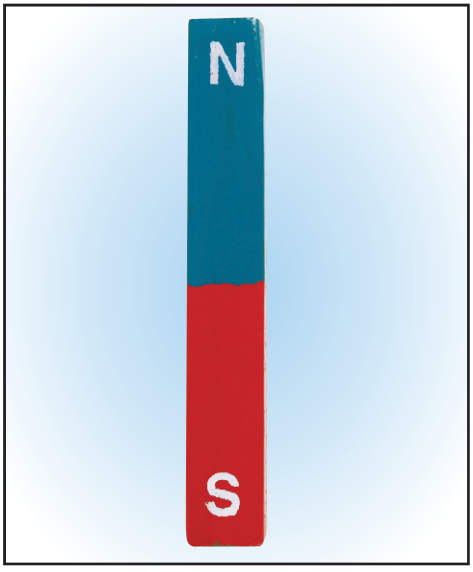
- magnet
- magnetic poles
- magnetic field



A **magnet** attracts iron and some other metals. This large magnet attracts a paper clip through three sheets of paper.



The metal filings are affected by the magnet. They show where **magnetic field** is located.



Every magnet has two **magnetic poles**. The N and S ends of the magnet are where it can pull with the largest force.

Focus Skill

READING FOCUS SKILL
MAIN IDEA AND DETAILS

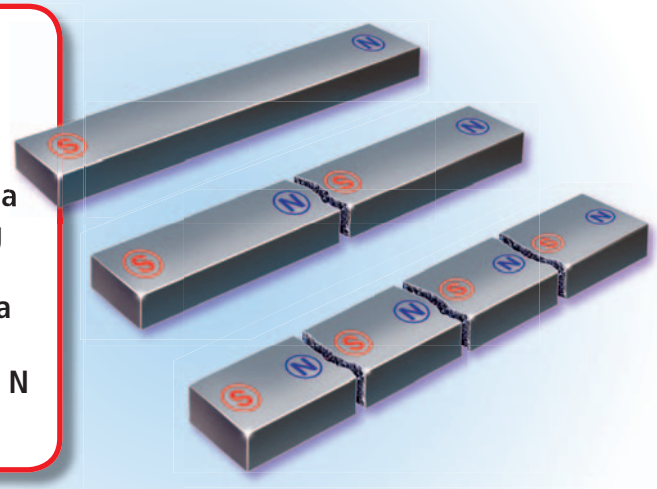
The **main idea** is what the text is mostly about. **Details** are pieces of information about the main idea.

Look for details about magnetic fields and magnetic poles.

Two Poles

A **magnet** is an object that attracts certain materials. These materials usually contain iron. The two ends of a magnet are called **magnetic poles**. The magnetic force is strongest near the two poles.

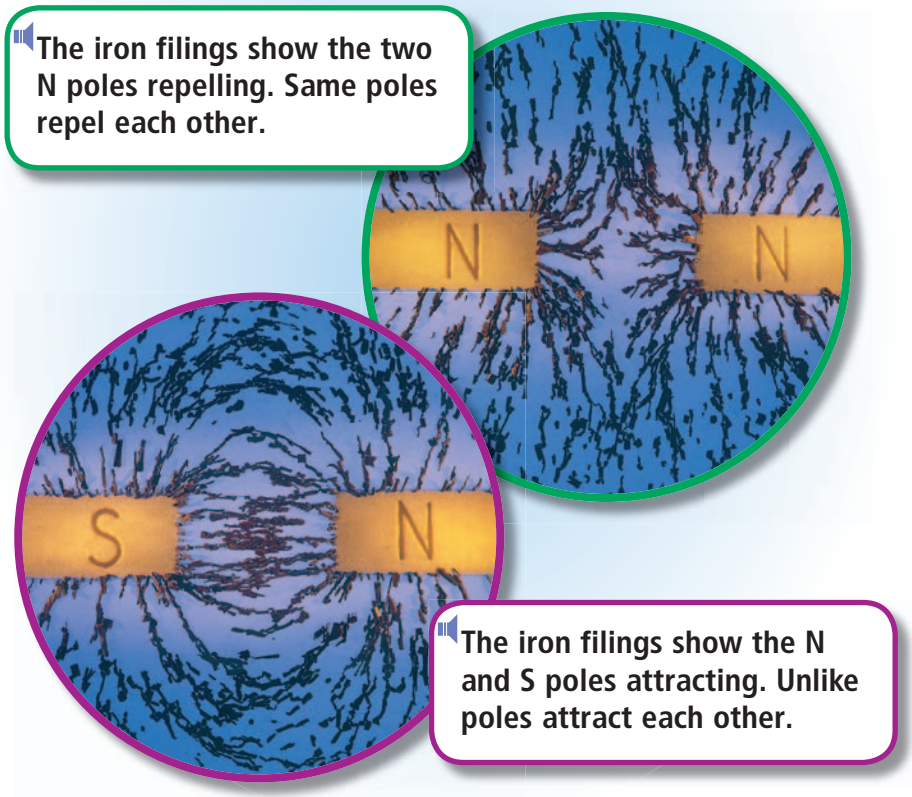
When you hang a bar magnet and let it turn, one end points north. This end is called the *north-seeking pole* (N). The other end is the *south-seeking pole* (S).



A magnet always has a north-seeking pole, labeled N. It also has a south-seeking pole, labeled S. If you cut a magnet, each piece still has N and S poles.

Magnetic poles act like electric charges. Opposite poles attract. Same poles repel. Opposite poles placed near each other will pull toward each other. When same poles are placed near each other, they push apart.

How are all magnets alike?



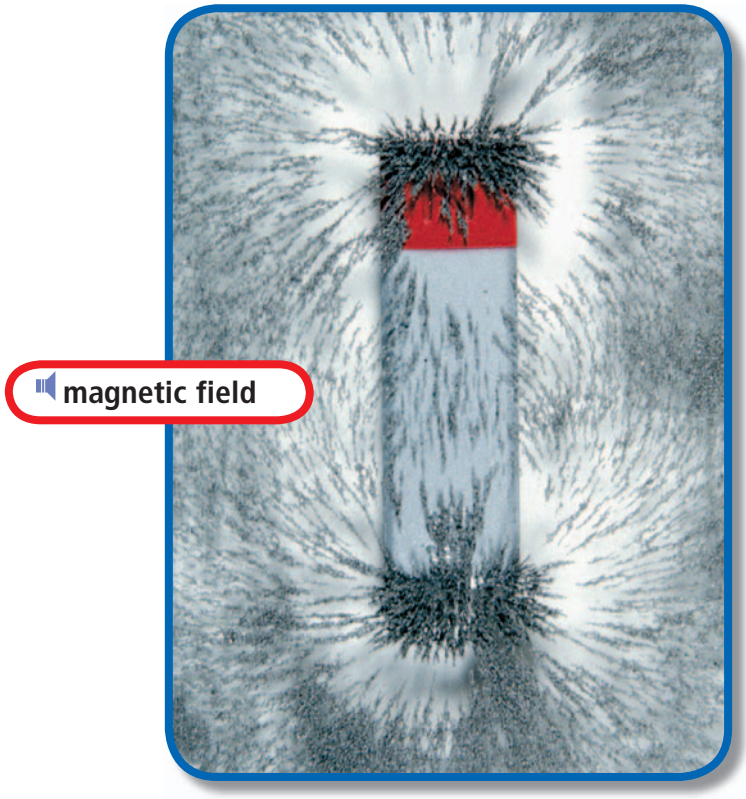
Magnetic Forces

A **magnetic field** is the area in which the magnetic force of a magnet acts. In the picture, a bar magnet moves iron filings into the shape. The shape shows the magnet's magnetic field. Lines form between the North and South poles of the magnet. These lines are called magnetic field lines. They show lines of magnetic force.

Magnetic force gets stronger as the magnetic object gets closer. The force of the magnet is strongest at the poles. The iron filings are attrated to the magnet mostly near the poles.

Focus Skill

Where on the bar magnet is the force the strongest?

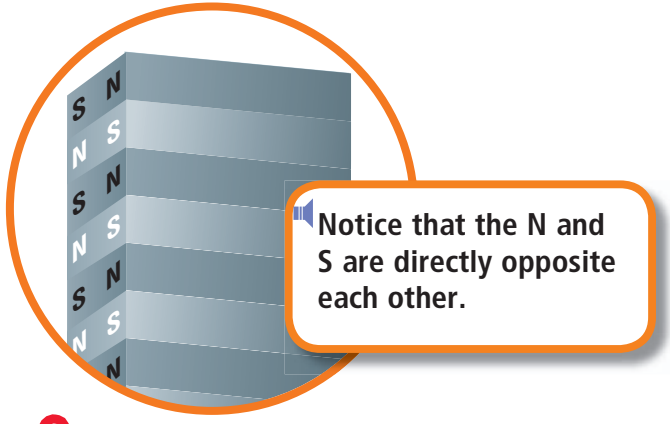


Magnet Shapes

Magnets come in many shapes and sizes. They are made for different uses. Some are shaped like horseshoes. If you straightened the horseshoe out, the poles would be at the ends. You might have a flat rubber magnet at home. These magnets are made up of stripes of magnetic material. The material bends.

Focus Skill

Why do magnets have different shapes?



Review

Focus Skill

Complete this main idea statement.

1. A _____ _____ is the place on a magnet where the force is the strongest.

Fill in the detail statements about magnets.

2. A _____ is an object that attracts iron and some other metals.

3. The space in which the magnetic force acts around a magnet is called the _____ _____ .

4. Even if a magnet has different shapes, it will always have a _____ and a _____ pole.

GLOSSARY

electric charge [ee•LEK•trik CHARJ] A basic property of the tiny particles that make up matter; it can be positive or negative.

electric circuit [ee•LEK•trik SER•kit] A continuous pathway that can carry an electric current.

electric current [ee•LEK•trik KER•uhnt] A flow of electric charges.

electric field [ee•LEK•trik FEELD] The area around electric charges in which electric forces can act.

magnet [MAG•nuht] An object that attracts iron and some other metals.

magnetic field [mag•NET•ik FEELD] The area around a magnet in which magnetic forces can act.

magnetic pole [mag•NET•ik POHL] One of the two areas on a magnet where it exerts the strongest force.

parallel circuit [PAIR•uhl•el SER•kit] An electric circuit with two or more paths that current can follow.

resistance [ree•ZIS•tuhns] The measure of how much a material slows down the flow of electric current.

series circuit [SIR•eez SER•kit] An electric circuit with only one path that current can follow.

short circuit [SHAWRT SER•kit] A problem in a circuit that enables current to flow where it is not wanted.

static electricity [STAT•ik ee•lek•TRIS•ih•tee] The buildup of electric charges in one place.

Think About the Reading

1. What can you do to help you remember what you have learned in this chapter?
2. What questions do you have after reading this book? How can you find the answers to your questions about electricity and magnetism?

Hands-On Activity

1. Demonstrate for your family what static electricity is. Show what you have learned about positive and negative charges.
2. Find a magnet in your home. Test things with your magnet. See how many things in your house are are attracted to it. List things that are attracted and things that aren't.

School-Home Connection

Explain to your family that you are learning about electricity and magnets. Invite family members to join you in "inventing" a household tool that uses electricity or magnets. Be creative! Your household tool can be practical or completely fantastic!