THE PULL OF MAGNETS

Harcourt
SCHOOL PUBLISHERS

Photo/Illustration Credits: Cover: PhotoDisc/Getty; p. 2: Hemera Photo-Objects Volume 1; p. 3: Harcourt; p. 4: Jonathan Massie/Wilkinson Studios, Inc.; p. 5: Jonathan Massie/Wilkinson Studios, Inc.; p. 6: Hemera Photo-Objects Volume 1; p. 7: Image Source Limited/Index Stock Imagery; p. 8: Erich Schrempp/Photo Researchers, Inc.; p. 9: Royalty-Free/Corbis; p. 10: Hemera Photo-Objects Volume 1; p. 11: Stockdisc/PictureQuest; p. 12: John Coletti/Index Stock Imagery; p. 13: EyeWire Collection/PictureQuest; p. 14: Kevin Phillips/PictureQuest; p. 15: Hemera Photo-Objects Volume

Printed in Mexico

ISBN-13: 978-0-15-352344-1

ISBN-10: 0-15-352344-1

1 2 3 4 5 6 7 8 9 10 050 15 14 13 12 11 10 09 08 07 06

Harcourt
SCHOOL PUBLISHERS

Visit *The Learning Site!*
www.harcourtschool.com

Marvelous Magnets

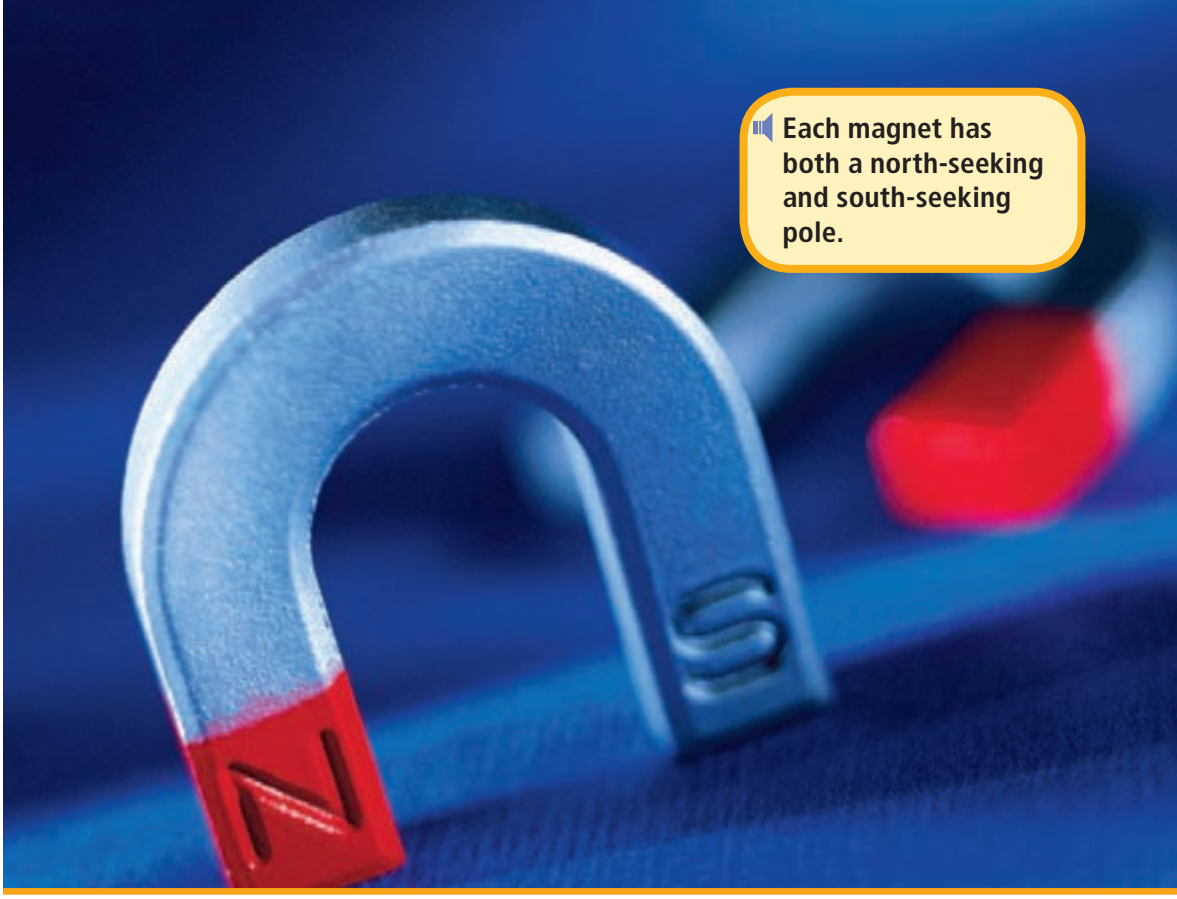
A **magnet** is an object that attracts iron, steel (which has iron in it), and a few other metals. You can test to see if something is a magnet by holding it near a steel paper clip. If the paper clip moves toward the object, it is a magnet.

Also, you can test an object to see if it has iron or steel by holding it near a magnet. If the object doesn't move toward the magnet, it is not made of iron or steel.

A magnet's pull becomes stronger as it gets closer to metal objects. If you hold it far away from the object, it will not work as well. Also, some magnets are weaker than others.

Sometimes you can use a magnet to make other objects magnetic. If you take a nail and rub it against a magnet, the nail becomes a temporary magnet.

If an object moves toward a magnet, the object contains iron or steel.



Each magnet has both a north-seeking and south-seeking pole.

Magnets have two ends called **magnetic poles**. The poles are called N (north-seeking) and S (south-seeking). Opposite poles (N and S) will move toward each other. They attract. Like poles (N and N or S and S) will move away from each other. They repel. Sometimes you can feel the like poles pushing apart.

Fast Fact

Earth has a magnetic field, which is strongest near the North and South Poles. Compasses work by aligning a magnetic needle with Earth's magnetic poles.

Focus Skill

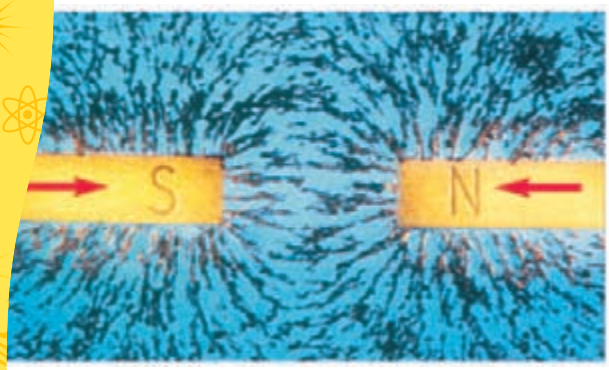
COMPARE AND CONTRAST **What is the difference between how magnetic poles behave when they are placed N to N and when they are placed N to S?**

Detecting Magnetic Fields

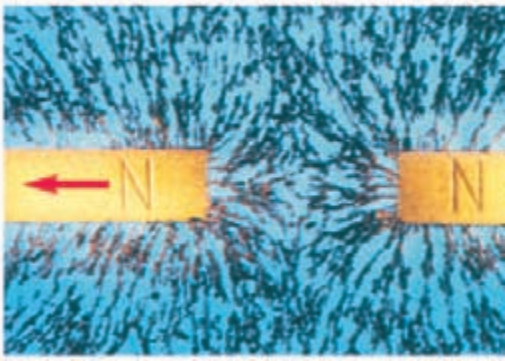
On page 2, you saw a photograph of a U-shaped magnet with iron filings, or bits of iron, in a design around it. The iron filings are lying in a shape that shows the magnet's magnetic field. A magnetic field is the area around a magnet where the magnet's force can act. The shape of a magnet's field depends on the shape of the magnet.

Magnets aren't the only things with magnetic fields. Earth also has a magnetic field. Its force goes thousands of miles into space. Early sailors used a material called lodestone to detect Earth's magnetic field. Finding north helped them find their way at sea.

Focus Skill **COMPARE AND CONTRAST** **How does the magnetic field between two S poles compare to the field between an S and an N pole?**

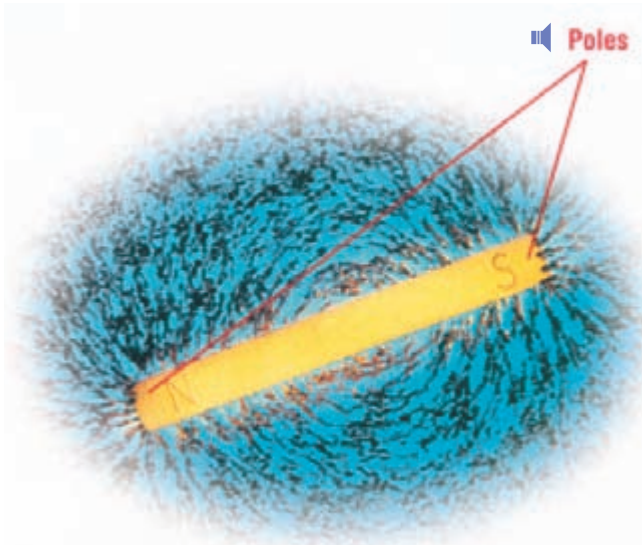


The iron filings between an S pole and an N pole show a pattern of lines that connect the poles. This shows that the two poles attract, or pull.



The iron filings between two N poles form a pattern in which lines curve away from each pole. This shows that these two poles repel, or push one another.

Earth's magnetic field is not centered on the true North Pole and South Pole. The magnetic force extends far beyond Earth.

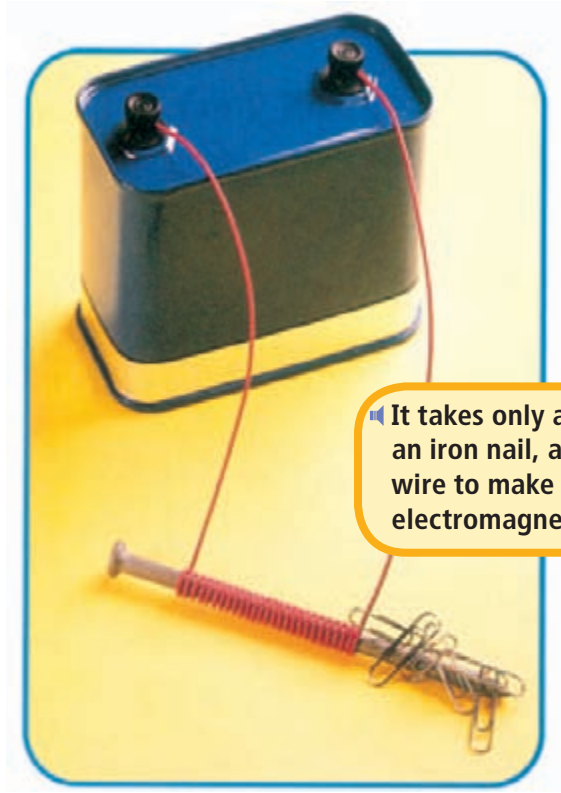


Electricity and Magnets

The space around a magnet where magnetic forces act is called a magnetic field. Electric currents also make magnetic fields. A single wire that carries current has a weak magnetic field. The magnetic field of many wires bound together is strong.

If you take wire coils and wrap them around a solid piece of iron, the inside piece—the core—becomes an electromagnet. An **electromagnet** is a temporary magnet that is made by an electrical current. Regular magnets are always on, but an electromagnet works only when there is electric current.

Focus Skill **COMPARE AND CONTRAST** **How are electric currents and magnetic fields alike?**



It takes only a battery, an iron nail, and some wire to make a simple electromagnet.

One of the most important everyday uses of electromagnets is in making motors. In fact, if there were no electromagnets, there would be no electric motors. Electromagnets are also used in switches, telephone receivers, and doorbells.

Focus Skill

COMPARE AND CONTRAST **How is a bar magnet different from an electromagnet? How is it the same?**

Industries that need to move large amounts of iron use powerful electromagnets such as this one.

Motors and Generators

You have read that an electromagnet has coils of wire wrapped around a core. Inside an electric motor is a wire coil. When the power is on, electricity produces a magnetic field around the coil. The poles of the electromagnet are pushed and pulled by the poles of a permanent magnet. The coil spins. The motor uses the spinning to do work. Electric motors are used in hundreds of things, including CD players, computer hard drives, refrigerators, and washing machines.

Important places such as hospitals can use generators to provide power if the regular power supply fails.

Not only can an electric current make a magnetic field, but a magnetic field can be used to produce electricity. If you put a wire coil near a magnet, electricity moves through the wire coil. **Generators** are machines that produce electric current in this way.

Many different energy sources can move the coil inside generators to produce electricity. Oil, coal, and gas are used as energy sources. People can also be used! A person can turn a crank and produce enough energy to turn the coil of a generator.

Switching the fan on makes electric current flow through the coils of the electromagnet. The pushing and pulling of the electromagnet makes the motor spin a shaft, which spins the blades of the fan.

Different Kinds of Energy

Some objects have potential energy. **Potential energy** is energy that exists because of an object's position or condition. Suppose a tree is about to fall. It has potential energy.

What happens when the tree falls? Then it has **kinetic energy**—the energy of motion.

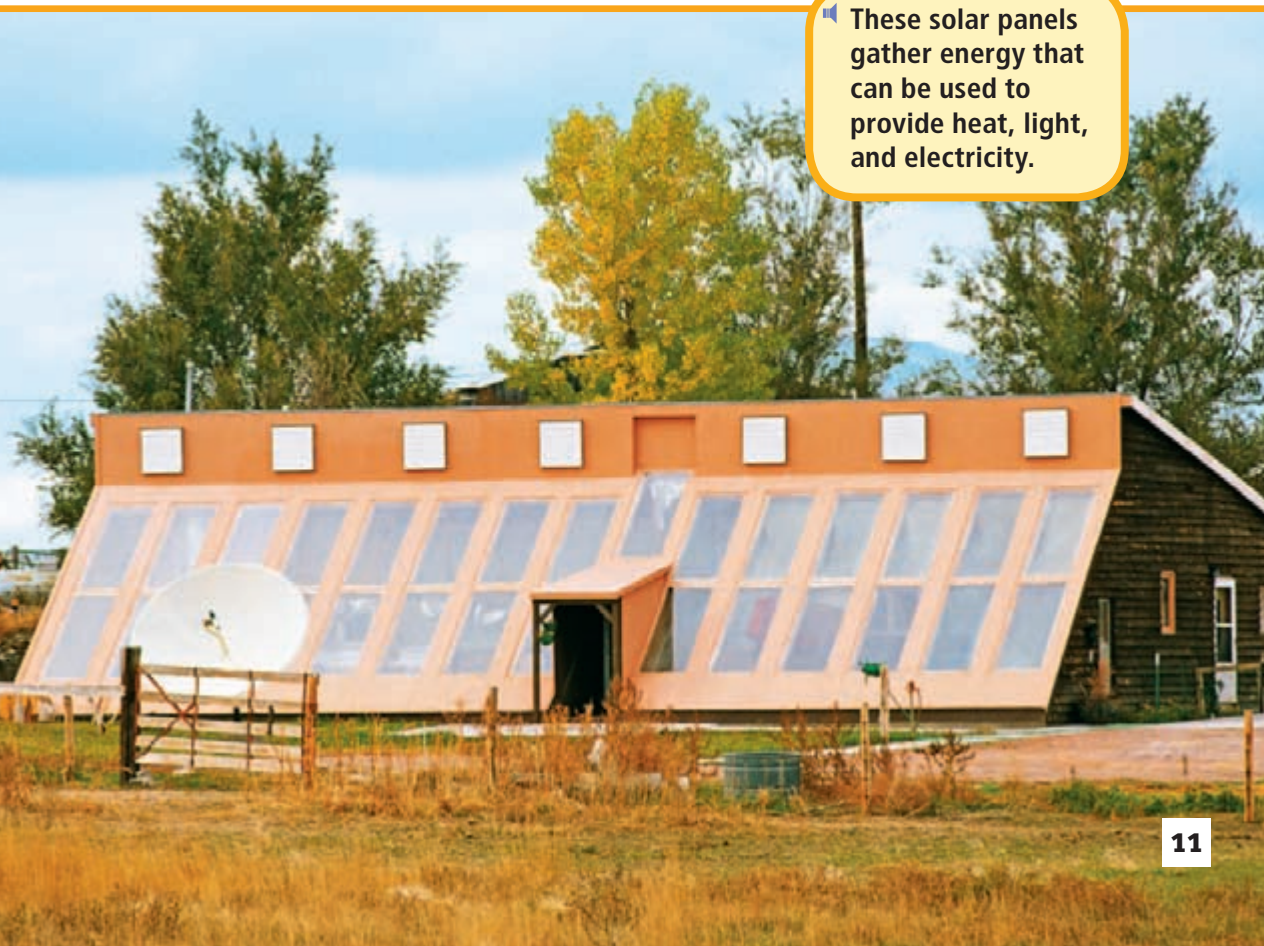
Whenever an object gets warmer, gets cooler, or moves, energy is being changed from one form to another.

When this tree is standing up, it has potential energy. As it falls, it will have kinetic energy.

Another important source of energy is heat from deep under Earth. This energy is stored in hot water located miles below Earth's surface. It can be brought to the surface and used to generate electricity for use in different situations.

Direct sunlight can provide the electricity to run many devices. Some people use sunlight to supply all the electricity in their home. Energy from the sun can be stored in large panels on roofs and used to provide electricity, heat, and light.

Other sources of energy are nuclear power and the wind. The wind's energy can be captured by windmills.



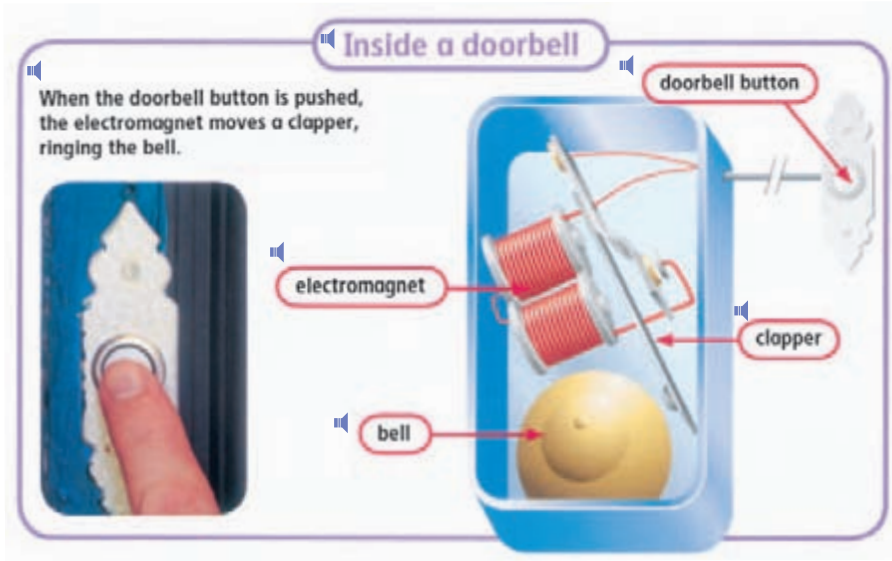
These solar panels gather energy that can be used to provide heat, light, and electricity.

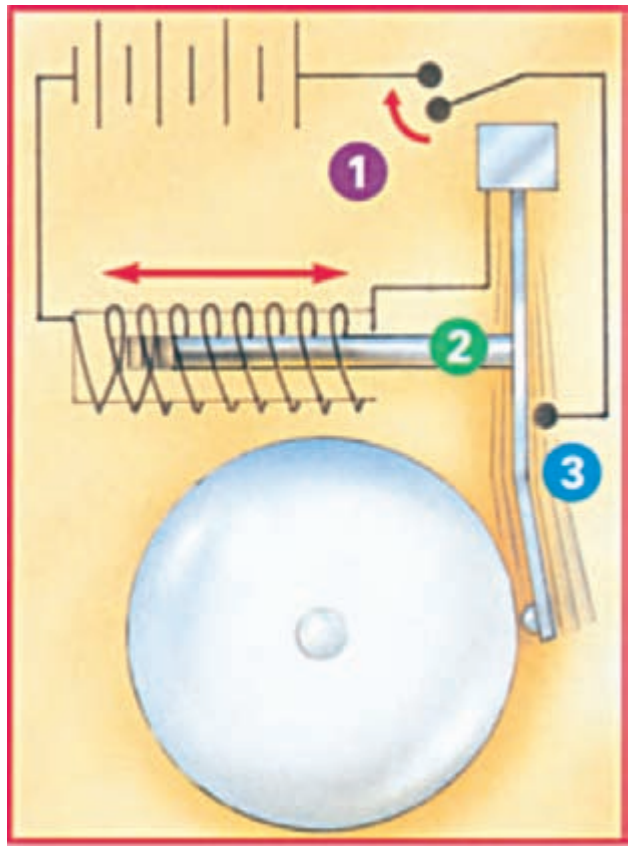
Doorbells and Buzzer

Electromagnets are useful in smaller machines. They are used in small devices, such as electric clocks, alarms, and doorbells. When someone presses a doorbell button, current flows through an electromagnet. The electromagnet pulls an iron rod. The rod hits a bell and you hear a ding.

Buzzers work in much the same way as doorbells. The clapper, or part that hits, strikes quickly again and again. You hear a buzz rather than a single bell sound.

Focus Skill **MAIN IDEA AND DETAILS** **What parts of a doorbell make the sound?**





The bell turns on. Electric current flows into the electromagnet, which pulls the long iron rod into the coils.

The rod is connected to a clapper. The clapper strikes the bell, and the bell rings.

When the clapper moves to strike the bell, a gap opens in the electric circuit. Electricity in the circuit stops flowing, and the electromagnet turns off. The clapper returns to where it started.

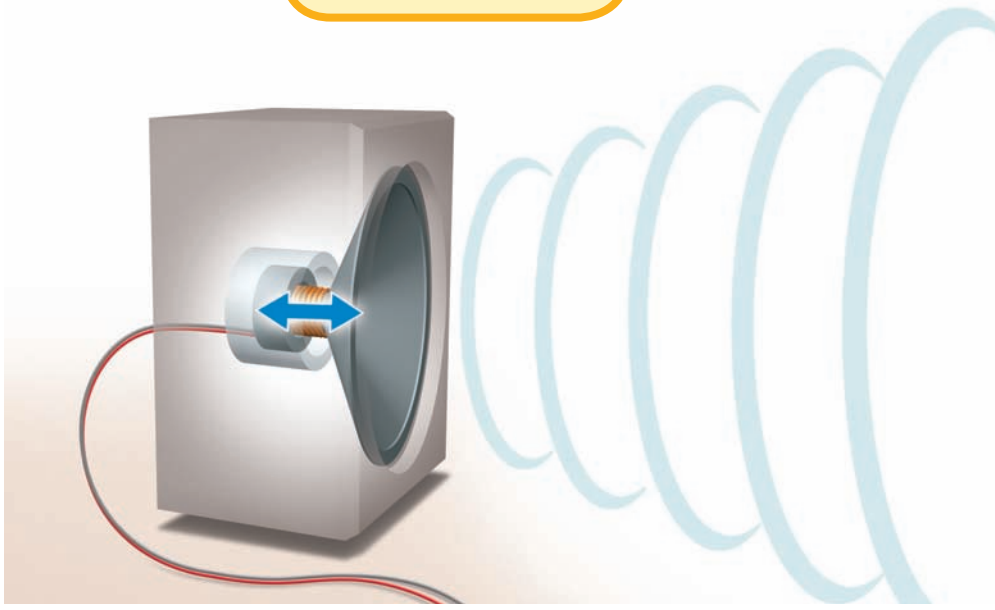
Speakers and Headphones

Speakers use electromagnets. They change electricity to sound. Each speaker has a coil of wire. The coil goes around a permanent magnet. The magnet is attached to a diaphragm, or thin plastic disk.

A radio or music player sends electric signals to the speaker. The signals flow through the coil. This pulls the magnet in and out. The diaphragm moves as well. This movement makes sound. Headphones work in the same way. However, the coils and magnets are much smaller.

Focus Skill **MAIN IDEA AND DETAILS** **How do speakers use electricity?**

A stereo speaker uses an electromagnet to change electrical signals to sound. Notice the coil in the middle of the speaker.



Summary

Magnets work by pulling and pushing metals such as iron and steel. A magnet has a north-seeking pole and a south-seeking pole. Magnets have fields in which their forces can act. Electricity and magnets work together in electromagnets, which are used in motors and generators. Doorbells, buzzers, speakers, and headphones are some things that make use of electromagnets. Two types of energy are potential energy and kinetic energy.

The speakers in headphones use electromagnets. So does the motor in a CD player.

Glossary

- **electromagnet** (ee•lek•troh•MAG•nit) A temporary magnet caused by an electrical current (6)
- **generator** (JEN•er•ayt•er) A device that produces an electric current (9)
- **kinetic energy** (kih•NET•ik EN•er•jee) Energy of motion (10)
- **magnet** (MAG•nit) An object that attracts iron and a few other (but not all) metals (2)
- **magnetic field** (mag•NET•ik) The area around a magnets where the magnet's force can act (3)
- **magnetic poles** (mag•NET•ik POHLZ) The parts of a magnet at which its force is strongest (3)
- **potential energy** (poh•TEN•shuhl EN•er•jee) Energy that an object has because of its position or its condition (10)

Think and Write

1. What are the two forces that magnets use?
2. **SEQUENCE** Why does a doorbell stop ringing when you take your finger off the button?

School-Home Activity

Gather as many different magnets from home as you can find, or borrow some magnets from your teacher. Place them together in different ways. See if you can tell where the poles are. Draw and label what you discover, and share it with the class.