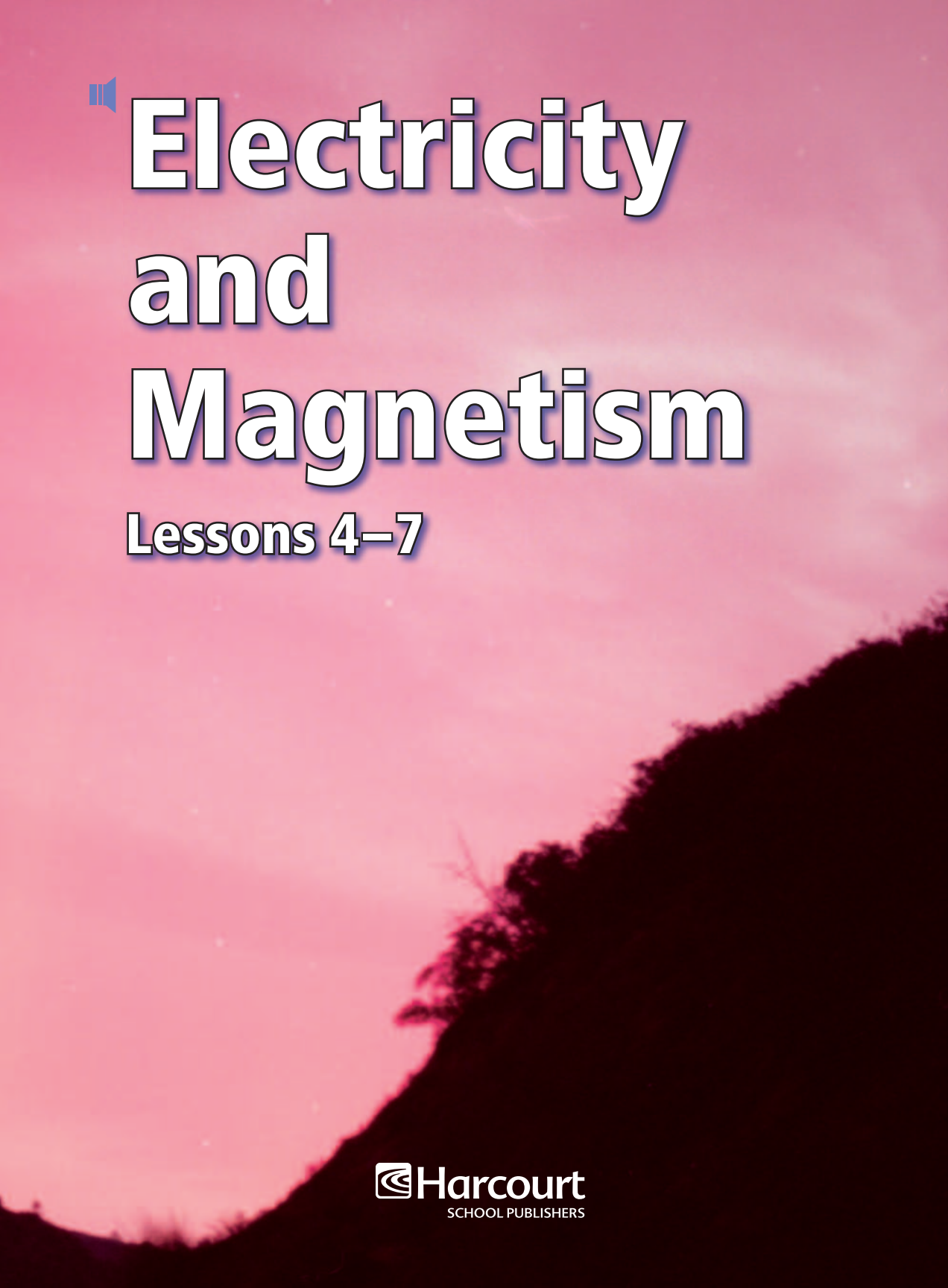
Electricity and Magnetism

Lessons 4–7



Harcourt
SCHOOL PUBLISHERS

Printed in the United States of America

ISBN-13: 978-0-15-349174-0
ISBN-10: 0-15-349174-4

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 4

How Can You Detect a Magnetic Field?

VOCABULARY

compass

A **compass** helps you find directions. It tells you which way is north.

Focus Skill

READING FOCUS SKILL

CAUSE AND EFFECT

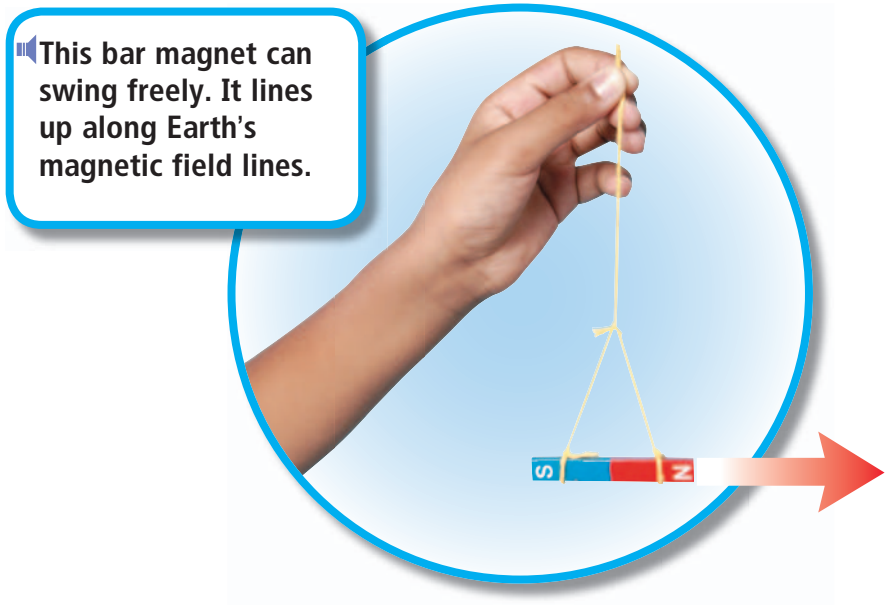
A **cause** is something that makes another thing happen. An **effect** is the thing that happens.

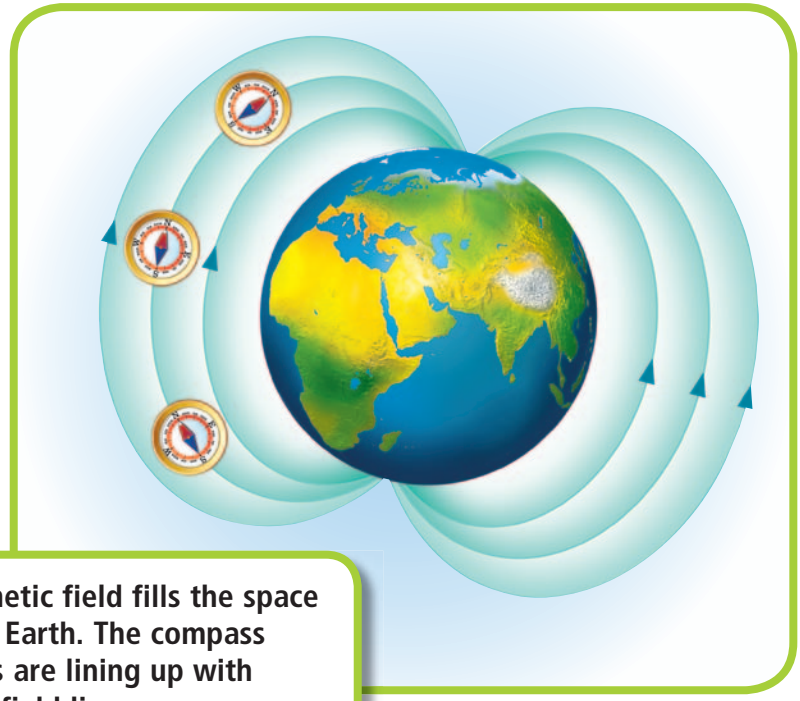
Look for what **causes** a compass to point north.

Look for the **effect** a magnet has on another magnet.

Finding the North Pole

Earth has a North pole and a South pole. You might think of them as the "top" and "bottom" points of Earth. They are the imaginary points that do not move as Earth rotates. Earth's core is a huge magnet. Because of this, Earth also has magnetic poles. It has a giant magnetic field.





A magnetic field fills the space around Earth. The compass needles are lining up with Earth's field lines.

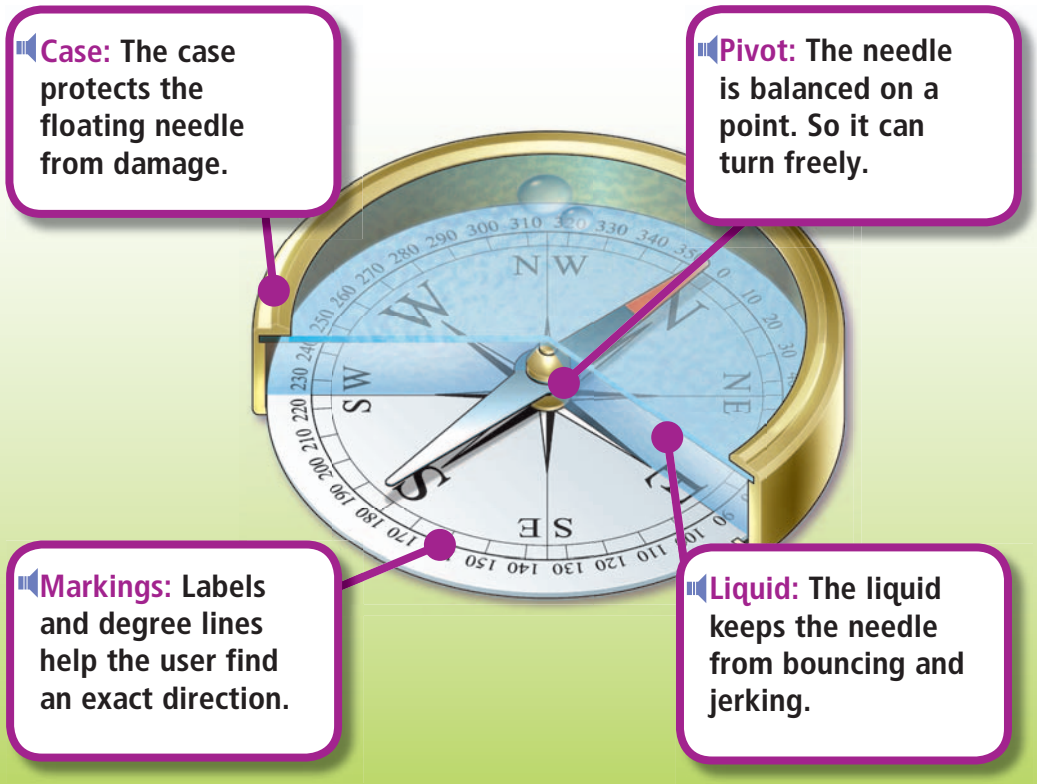
A magnetic field fills the space around Earth. You saw the way iron filings lined up around a magnet. They showed that the magnetic field was strongest at the magnet's poles. This is also true of Earth's poles. A magnet hanging near one of Earth's poles would line up with the field. It would point into the ground.

Focus Skill **What causes a compass needle to move?**

Compasses

A **compass** is a tool used to find direction. Compasses help sailors and others find their way in bad weather. The needle in the compass is magnetic. It turns freely on top of a point. The needle lines up with Earth's magnetic field. To use a compass, hold it level and turn your body until the needle points at the N. You are now facing north. The face of the compass shows the four main directions—north, south, east, and west. East is to your right. West is to your left. South is behind you.

Focus Skill **What might be the effect of having a compass with you if you were lost in the woods?**



Magnetic Interference

Magnets or large metal objects interfere with a compass. If they are nearby, the compass may not work correctly. The best place to use a compass is outdoors. Stay away from other magnets, buildings, power lines, and cars, and your compass will work correctly.

Focus Skill **How can magnets cause problems with the way a compass works?**

The compass is not pointing to Earth's magnetic north. It is pointing to the magnet instead. ▶

Review

Focus Skill **Fill in the blank to answer the following cause and effect statements.**

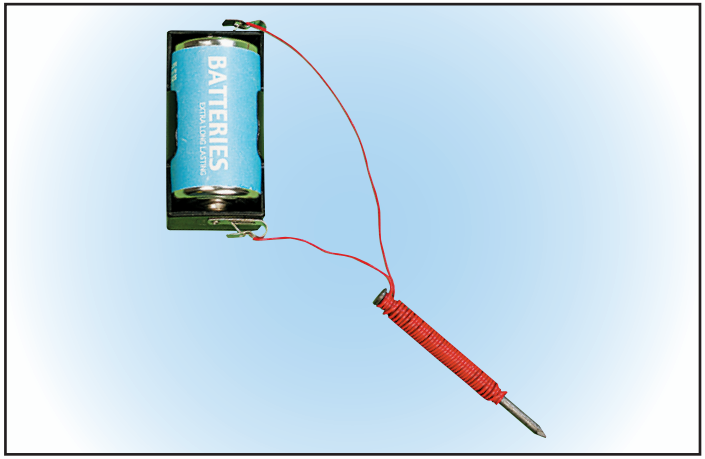
1. Earth's core acts like a giant _____ .
2. A compass needle turns to line up along _____ magnetic field lines.
3. If you are lost, a _____ is a tool that can help you find your way.
4. Other a _____ or a _____ can interfere with the way a compass works.

Lesson 5

What Makes an Electromagnet?

VOCABULARY

electromagnet



You can make an **electromagnet** with a nail, some covered wire, and a battery. The wire will carry current. The nail will become a magnet.

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.

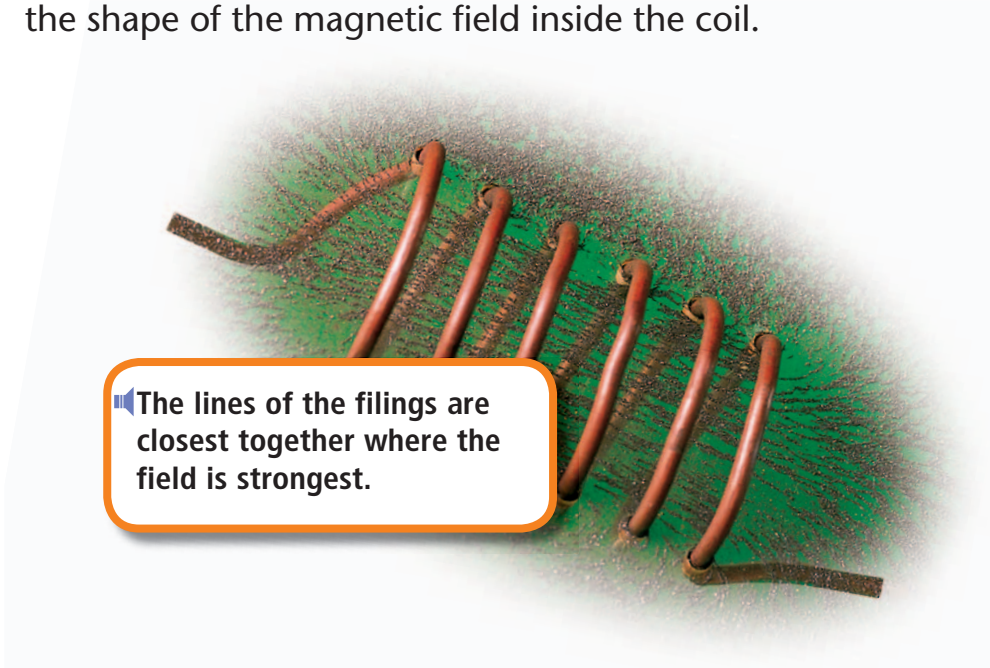
Read about what an electromagnet is.

Look for details about how you would control an electromagnet.

Making a Magnetic Field

You know that electric charges can push or pull. Magnets also have a force that can push or pull. Are magnetism and electricity related?

Nothing happens when you put iron filings near a copper wire. Now run a current through the wire. A weak magnetic field forms. The picture shows a wire coil that carries a current. Notice what the iron fillings show. It is the shape of the magnetic field inside the coil.



The lines of the filings are closest together where the field is strongest.

Electric current from the battery runs through the wire around the iron nail. The current makes the nail magnetic. Taking out the battery stops the current. The iron filings would no longer stick to the nail.

The magnetic field around a current-carrying wire can move a compass needle. You can make the field stronger. You can wrap the wire around an core, such as a nail.

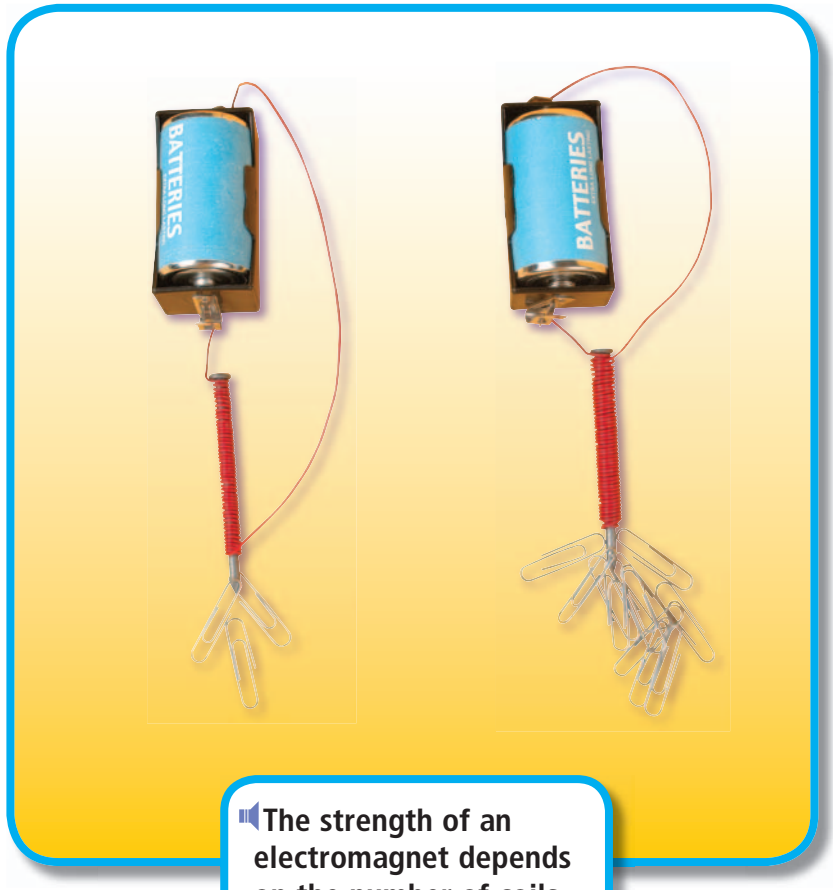
You can make an **electromagnet**. Wrap a coil of wire around an iron nail. Attach a battery to the wire. The nail becomes a magnet when electric current flows in the wire. The nail is a magnet only when current is flowing.

Focus Skill

How can electricity be used to make a magnet?

Controlling Electromagnets

An electromagnet is a *temporary* magnet. You can turn it on and off. How could a magnet like this be useful? A powerful electromagnet can pick up tons of iron scrap. A worker could turn on the electromagnet to pick up the iron. The worker simply turns off the electromagnet to drop the iron.

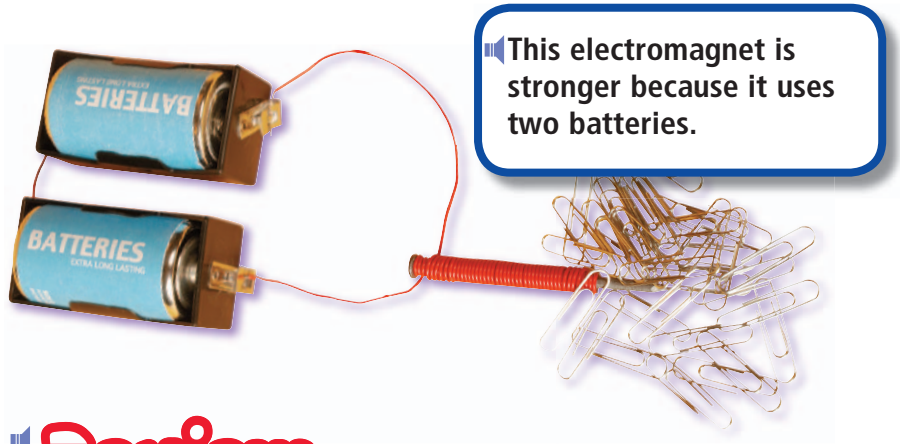


The strength of an electromagnet depends on the number of coils.

There are two ways to make an electromagnet stronger. One is by adding more coils. The other is increasing the electric current. For example, you could add more batteries.

We use electromagnets in many ways. They are found everywhere. Some are inside your telephone. Some are outside at the automobile junkyard!

How can you control electromagnets?



Review

Fill in this main idea statement.

1. An _____ is a magnet that has coils of current-carrying wire around an iron core.

Fill in these detail statements about electromagnets.

2. An electromagnet is a _____ magnet. It can be turned on and off.
3. Magnets produce a force that can push or _____ , just as electric charges can.
4. The strength of an electromagnet depends on the number of its _____ .

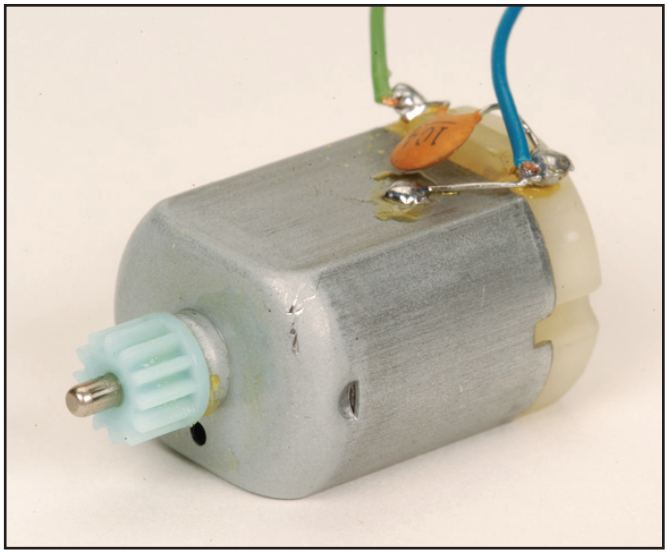
Lesson 6

How Are Electro-magnets Used?

VOCABULARY

- kinetic energy
- electric motor
- generator

This wind farm is changing **kinetic energy**, or energy of motion, to electricity.



A small toy car has a small **electric motor**. The motor makes it move.

People use portable **generators** when their power goes out.

Focus Skill

READING FOCUS SKILL

COMPARE AND CONTRAST

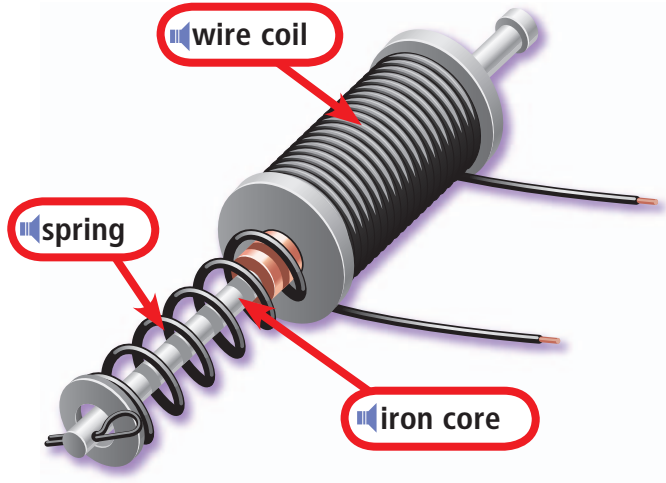
You **compare** things by looking for ways they are similar. You **contrast** things by looking for ways they are different.

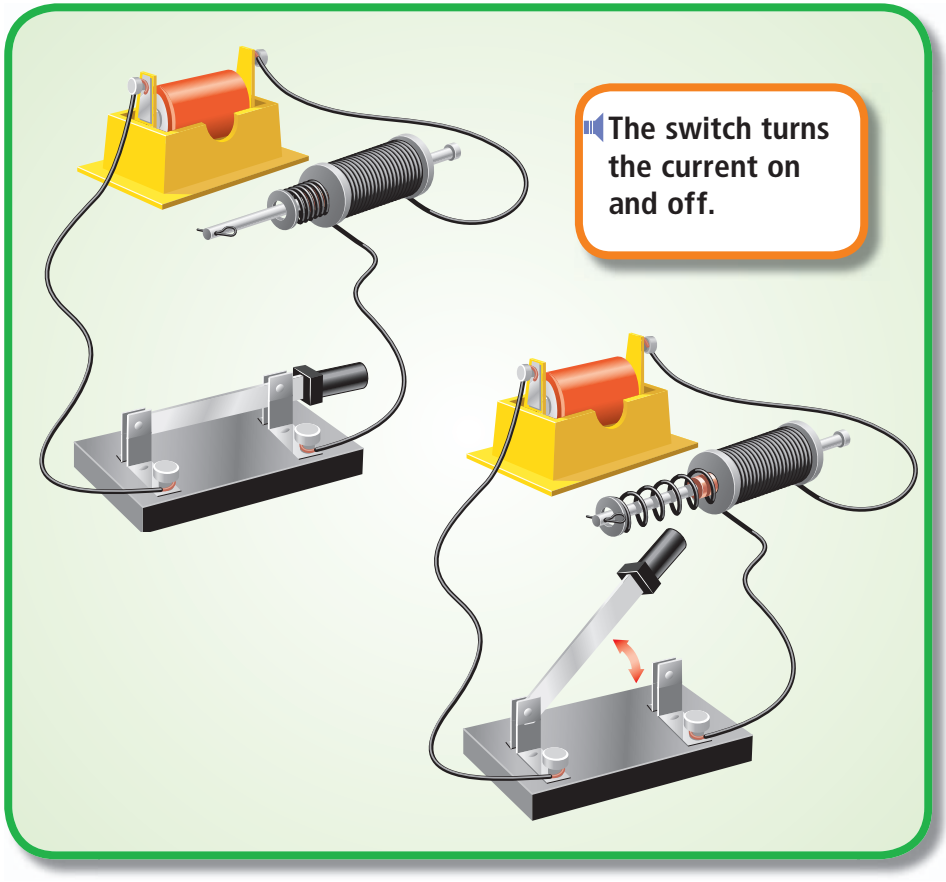
Look for devices that use electromagnets. Look for ways they are alike and different.

Electromagnetism and Motion

You can create a device that changes battery electricity into motion. Take a plastic drinking straw and wrap many coils of wire around it. Leave the ends of the wire free. Lay the straw on the table, and slide an iron nail partway inside. Now attach the ends of the wire to a battery. The nail will move! The magnetic field inside the coil produces a force. The force moves the nail.

This device changes energy from the battery to motion. Energy of motion is called **kinetic energy**.





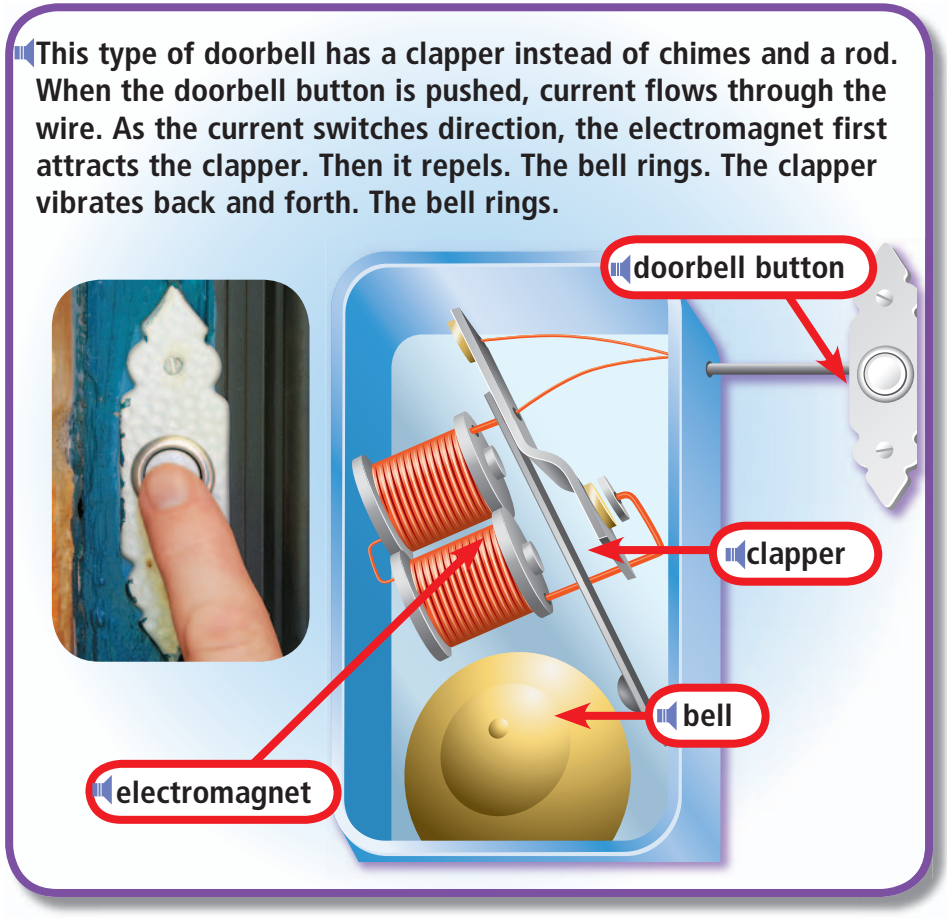
The device in the picture works the same way the nail in the straw did. Turning the current on and off produces motion, or kinetic energy.

Changing electricity to kinetic energy is useful. One way is in starting a car. The driver turns the key. This closes a switch. A tiny current to travels through a relay. The relay closes a switch in a different circuit. The relay moves a rod to touch another piece of metal . Now electricity can flow and start the car.

What is kinetic energy?

Doorbells and Speakers

A doorbell is another example of an electromagnet. Pushing the button turns the current on. When the current is on, a rod moves into the coil. The rod strikes a bell. Ding! When you release the button, the current goes off. A spring pushes the rod quickly out of the coil. Dong! The rod strikes a different bell.

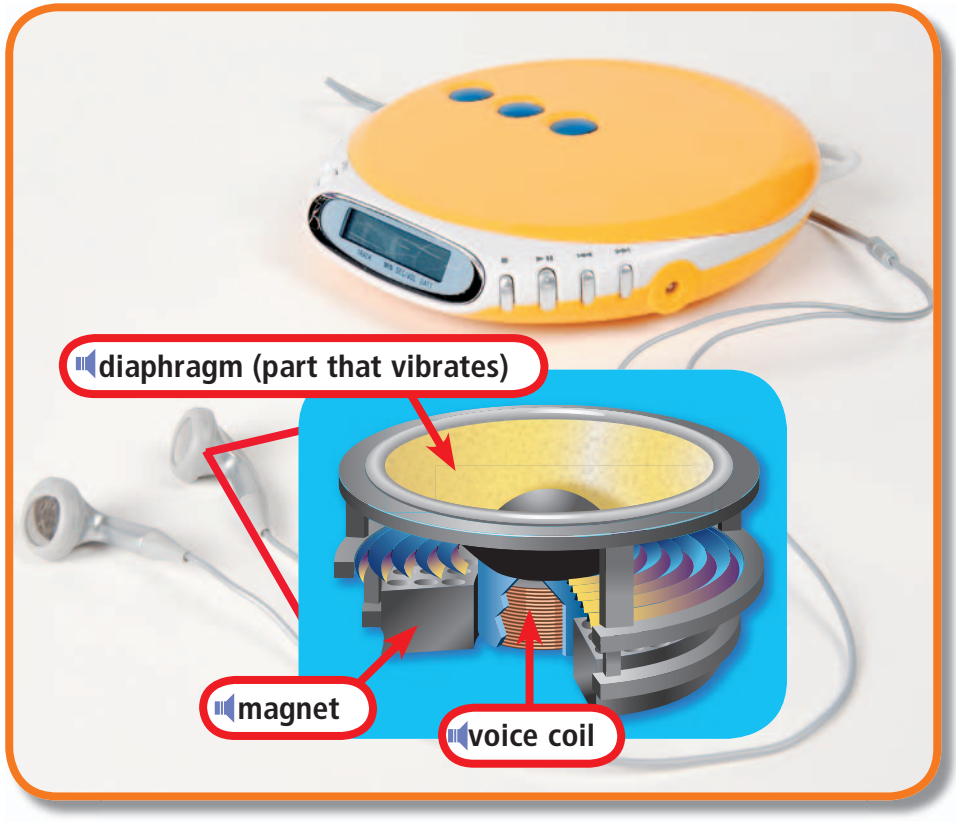


This type of doorbell has a clapper instead of chimes and a rod. When the doorbell button is pushed, current flows through the wire. As the current switches direction, the electromagnet first attracts the clapper. Then it repels. The bell rings. The clapper vibrates back and forth. The bell rings.

Speakers and headphones also use electromagnets. Microphones change sounds into electrical signals. When the signals reach a speaker, they are turned back into sounds.

Every speaker has a flexible diaphragm. The diaphragm is attached to a magnet. A wire coil wraps around the magnet. Electric signals pass through the coil. This causes the coil to push and pull on the magnet. The diaphragm vibrates, causing sound waves. You hear the music!

Focus Skill **How is the electromagnet in a doorbell different from the ones in speakers?**

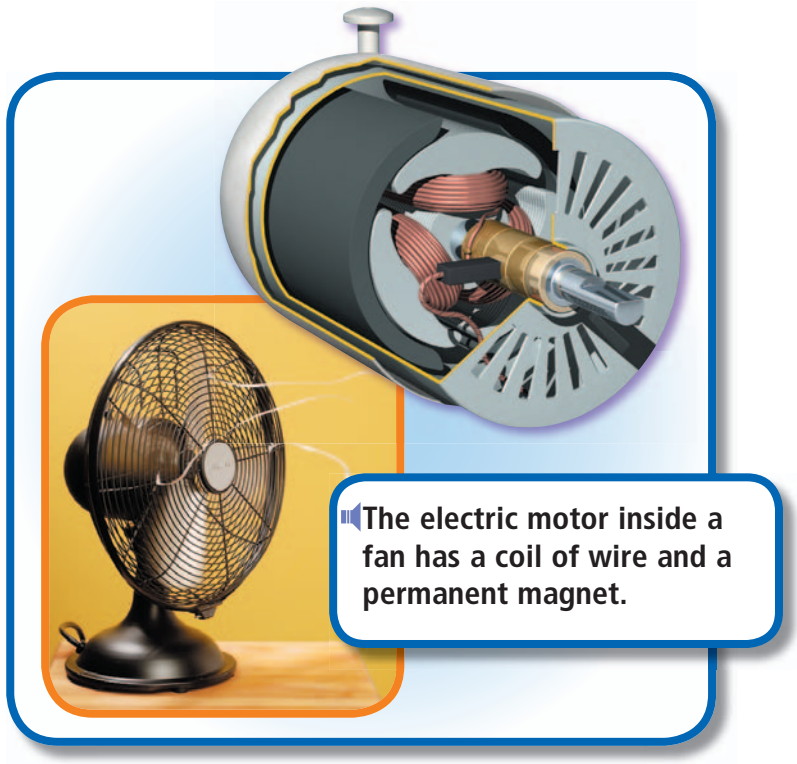


Electric Motors

Have you ever cooled off with an electric fan? A fan contains a small motor. An **electric motor** changes electrical energy into kinetic energy. Motors usually cause things to rotate, or spin.

A simple motor has a wire coil and a permanent magnet. Current flows through the wire. The magnet pulls on the coil. The coil turns halfway. The current switches direction. Now the magnet pushes on the coil. The coil turns halfway again. This pattern repeats again and again. The motor spins.

Focus Skill **Compare the way an electric motor works with a magnet's push and pull.**



The electric motor inside a fan has a coil of wire and a permanent magnet.

Generators

A **generator** converts other forms of energy into electrical energy. In an emergency, electricity can go out. People can get electricity by running a generator with gasoline. It can provide electricty for lights. It can provide electricity for keeping food cold.

Energy plants have huge generators that contain electromagnets. The energy plants burn fuel. The fuel heats water to change it to steam. The steam pushes against fan blades, which turn a shaft. The shaft turns electromagnets inside heavy coils of copper wire. The spinning magnets cause current in the wire.

Focus Skill

How are the ways generators and speakers work alike?

Review

Focus Skill

Fill in the blank to answer the following compare and contrast statements.

1. Energy of motion is called _____ _____ .
2. Electrical energy can be changed into kinetic energy with an _____ _____ .
3. A _____ is a machine that converts other forms of energy into electrical energy.
4. Speakers, headphones, and doorbells use _____ .

Lesson 7

How Is Electrical Energy Used?

VOCABULARY

insulate

A wire is **insulated** to protect you from electric current.

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 examples of ways people use electricity.
Look for details about how to use electricity safely.

Converting to Heat and Light

Can you picture a world without electricity? We use electricity every day in many ways. Today, we don't think about electricity until the power goes out. Then we realize how much we use electricity. We use it to cook, make light, and keep food cool.

Many uses of electricity make both light and heat. A stove burner produces both heat and light. The filament in a light bulb also produces light and heat.

What are three ways we use electricity?

Bumper cars use electricity to make them move.

Converting to Motion

Many devices use electricity to produce motion. For example, a hair dryer uses electricity to move air. An elevator uses electricity to move up and down. Some cars run on electricity from batteries.

Factories build cars or computers appliances on an assembly line. The assembly line uses electricity. So do the tools the workers use.

Focus Skill

What are three ways electricity is used to produce motion?

Electrical Safety

Electricity can be very dangerous. Touching wires that carry electric current can cause serious injury. This is why electrical devices must be insulated. To **insulate** means to protect from electricity. Insulation is a material that does not carry current.

Plastic is a good insulator. Outlet covers, cords and plugs are covered with plastic. This protects people from the electric current. When you plug in something, hold only the insulated plug. Never pull on the cord to unplug the device.

Remove a cord by holding onto the plug.

Do not pull on a cord. This could break the insulation. The electricity could shock you.

A microwave oven uses a lot of current. So does a space heater. When a lot of current flows through wires, they become very hot. These devices have thicker wires with thicker insulation. This wire stays cooler.

Home wires can carry only a certain amount of current. Plugging more than three devices into one socket is dangerous. Too much current may flow. The wires could overheat and cause a fire. Use a power strip instead.

What is an insulator?

A power strip should have a built-in circuit protector.

Review

Fill in this main idea statement.

1. We use _____ in many ways every day.

Fill in these detail statements.

2. Light bulbs change electricity to _____ and _____ .
3. Electricity motors can produce _____ in devices such as a car or a ceiling fan.
4. Electric wires are _____ , or covered, to protect people from dangerous electricity.

GLOSSARY

compass [KUHM•puhs] A tool that is used to find direction.

electric motor [ee•LEK•trik MOHT•er] A device that converts electric energy to kinetic energy.

electromagnet [ee•LEK•troh•mag•nuht] A device made up of a current-carrying wire coil around an iron core.

generator [JEN•uh•ray•ter] A device that converts other forms of energy into electricity.

insulate [IN•suh•layt] To protect from electricity by covering with rubber or another material that does not carry current.

kinetic energy [kih•NET•ik EN•er•jee] The energy of motion.

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 about electricity and magnetism after reading this book? How can you find the answers to your questions?

Hands-On Activity

1. Make your own magnet. Rub a paper clip 25 times in the same direction with a magnet. Put a piece of foam in a bowl of water. Put the paper clip on top of the foam. Watch to see what the paper clip does. Move the bowl. What happens to the paper clip?
2. Make your own electromagnet with household items. What will you need?

School-Home Connection

Talk with a family member about electromagnets. Together, look for an item in your home that uses electromagnets. Search the Internet together to find more information about how electromagnets work.