Science

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

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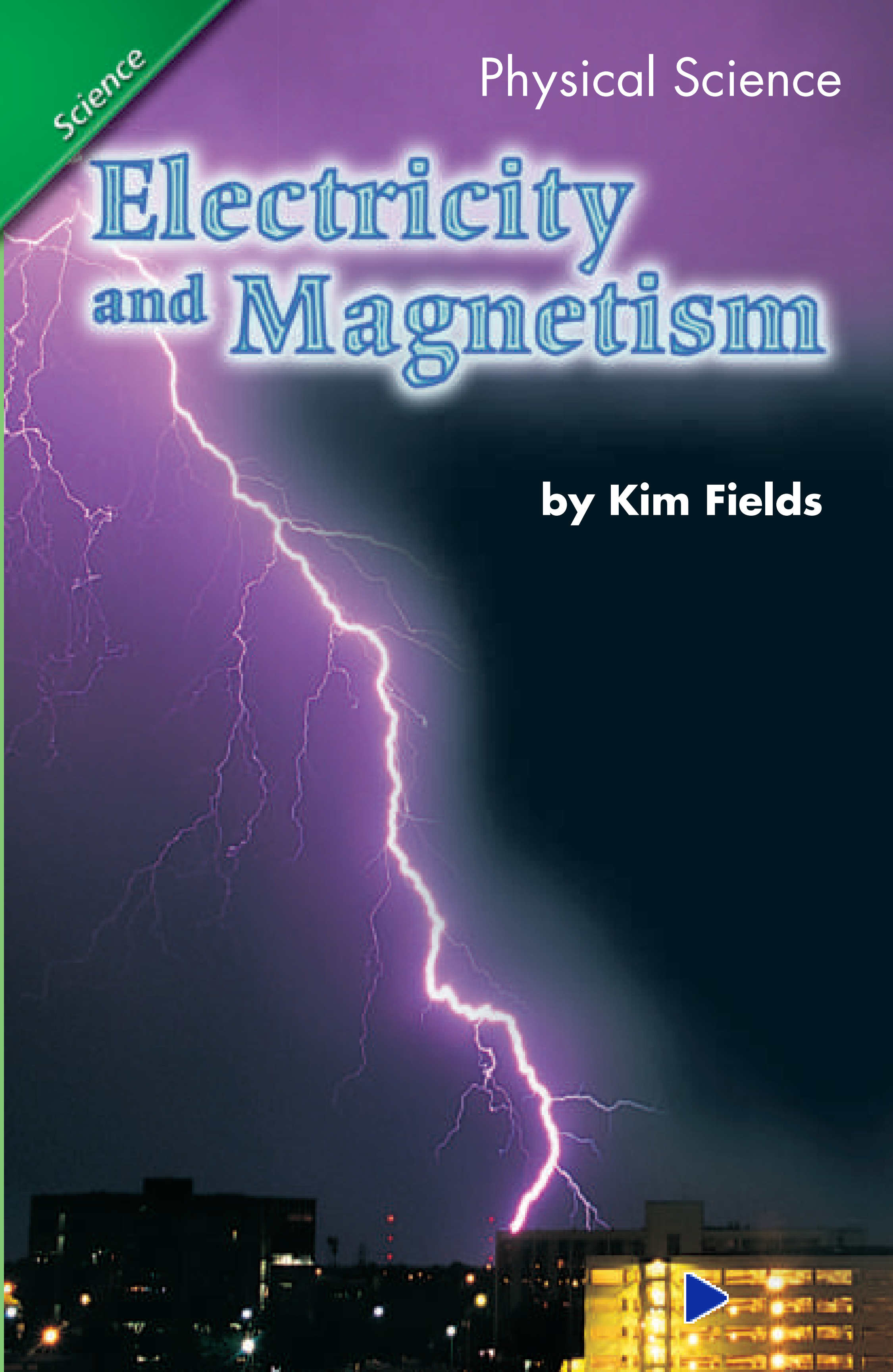
Science

Physical Science

Electricity and Magnetism

by Kim Fields



Vocabulary

electric current

electromagnet

magnetic field

magnetism

parallel circuit

resistance

series circuit

static electricity

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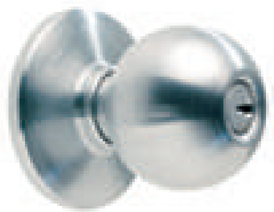
Electricity and Magnetism

by Kim Fields

How does matter become charged?

Electric Charges

Touch a metal doorknob after running across a carpet. A spark of static electricity might give you a shock.



Atoms are the tiny building blocks of matter. Almost all atoms have three kinds of particles. Some particles have a negative charge. Some have a positive charge. Some particles have no charge. The number of negative and positive particles in matter is usually the same.

Sometimes an atom has more of one kind of particle than another kind. **Static electricity** is the result. *Static* means "not moving," and static electricity usually stays in one place. But eventually, it does move. It may move slowly or very quickly. Moving charges make electrical energy. This energy changes into heat, light, and sound energy.

Static Electricity

Storm clouds become charged when particles move between atoms. The positive particles usually gather near the top of the clouds. The negative particles move toward the bottom of the clouds. The static electricity is released as lightning. Lightning heats the air around it. The heated air glows. Lightning makes the sound that we call thunder.

How Charged Objects Behave

Objects with opposite charges are attracted to each other. An object with a positive charge and an object with a negative charge will pull toward each other. This attraction makes an electric force. An electric force is the push or pull between objects with opposite charges.

An object with a charge can attract something without a charge. Rub a blown-up balloon on your head. It picks up negative particles from your hair. This gives the balloon a negative charge. Then hold the balloon near lightweight objects that are neutral, such as small pieces of paper. The pieces of paper stick to the balloon! Eventually, the balloon loses its negative charge. The pieces of paper fall off.

An Electric Field

An electric field is the space around electrically charged objects. It is invisible. The electric field is strongest close to the charged object. It gets weaker as it gets farther away.

A negative electric field attracts positive charges. It pushes away, or repels, negative ones. A positive electric field attracts negative charges and pushes away positive ones.

These balloons have the same charge. They repel each other.

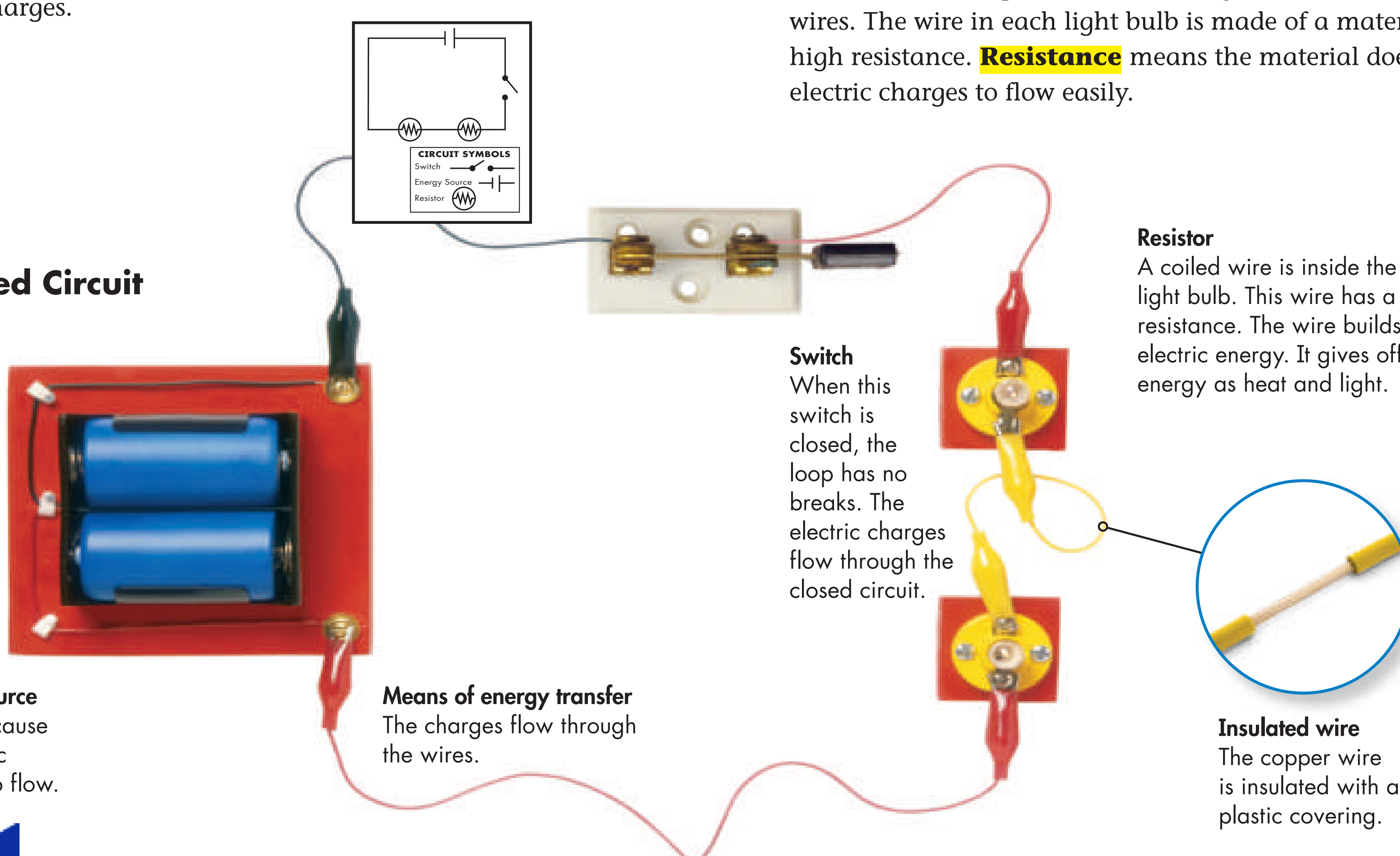
These balloons have opposite charges. They attract each other.

How do electric charges flow?

How Electric Charges Move

Most electricity moves. An electric charge in motion is called an **electric current.** An electric current travels quickly Electricity can be very dangerous. You cannot see it. Look at the circuit below. A circuit is a loop. Charges cannot flow through a circuit that has any breaks, or openings. The circuit must be closed. An open circuit has at least one break that stops the flow of charges.

A Closed Circuit



Energy source
Batteries cause the electric charges to flow.

Means of energy transfer
The charges flow through the wires.

Switch
When this switch is closed, the loop has no breaks. The electric charges flow through the closed circuit.

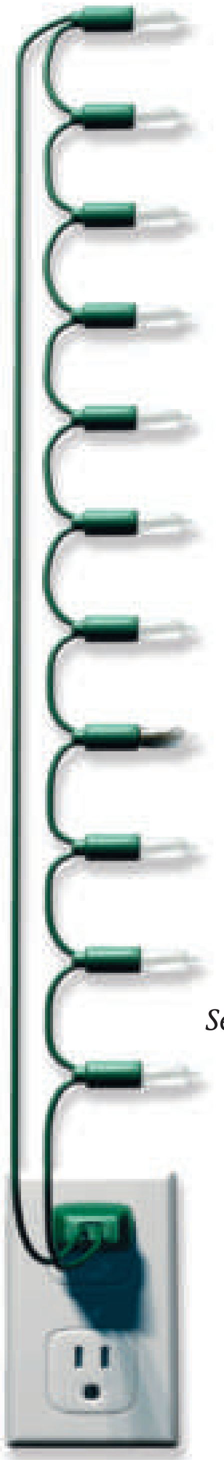
Resistor
A coiled wire is inside the light bulb. This wire has a high resistance. The wire builds up electric energy. It gives off this energy as heat and light.

Insulated wire
The copper wire is insulated with a plastic covering.

Going with the Flow

An electric charge does not flow the same way through all materials. The atoms of some materials are charged more easily than others. These materials are called conductors. Most metals are good conductors. The copper wire in the circuit below is a good conductor. Silver is also a good conductor.

Electric charge moves through the atoms of some materials slowly. These materials are called insulators. Dry wood, rubber, plastic, and glass are good insulators. The wire in the picture is insulated. This stops the electric charges from traveling to other wires. The wire in each light bulb is made of a material with high resistance. **Resistance** means the material does not allow electric charges to flow easily.



Series circuit

Types of Circuits

In a **series circuit,** an electric charge can flow in only one path. Look at the string of lights. A power source is turned on. The charged particles in the wire flow in one direction around a loop. Each light bulb around the path receives the same amount of electrical energy. If all the bulbs are the same, each will have the same brightness.

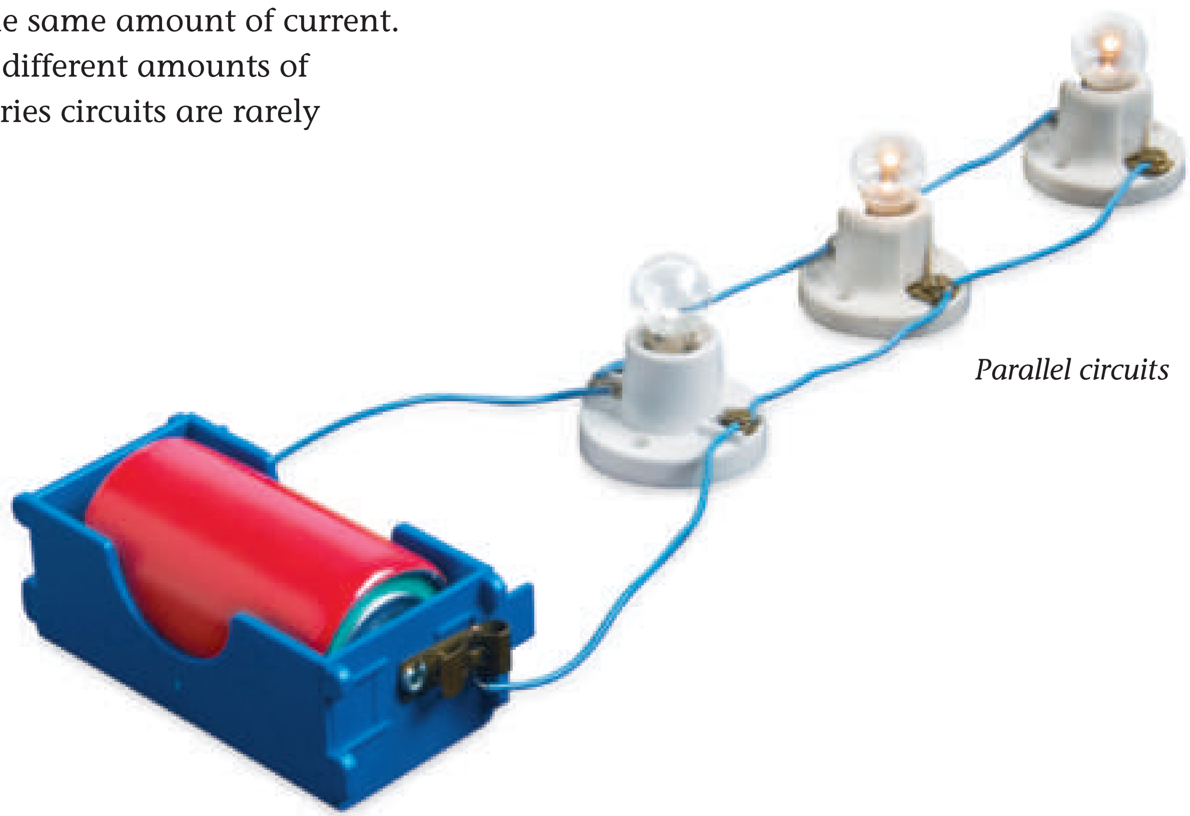
If one bulb burns out, it opens the circuit. The electricity cannot cross the break in the circuit. The other bulbs won't receive the energy they need. So no bulbs are able to light.

In a series circuit, all items wired into the circuit share the electric current equally. Each item gets the same amount of current. Appliances need different amounts of current. Today series circuits are rarely used.

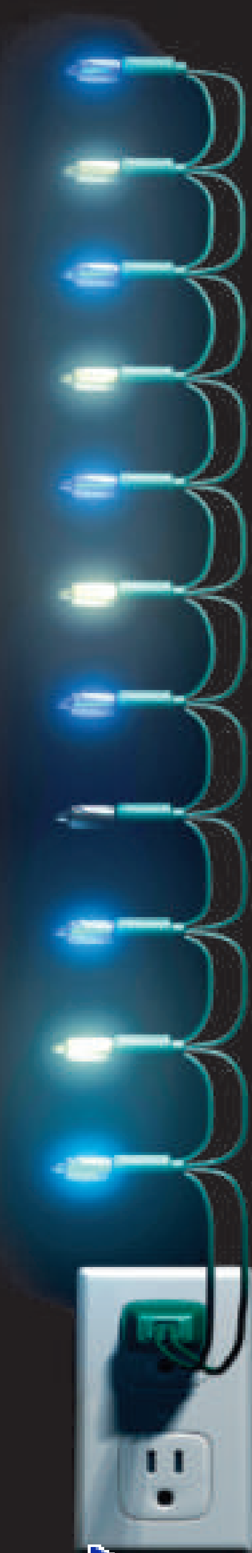
Parallel Circuits

A **parallel circuit** has two or more paths for electric charges to take. All the lights in a circuit don't go out when one light burns out. In a parallel circuit the main loop starts and stops at the power source. Along the loop there are smaller loops. Each smaller loop is a separate path for the electric charges. If electricity stops flowing through one of the smaller loops, it can still flow through the large loop.

Circuits used in buildings are parallel circuits. A parallel circuit can handle electric devices that need different amounts of current.



Parallel circuits



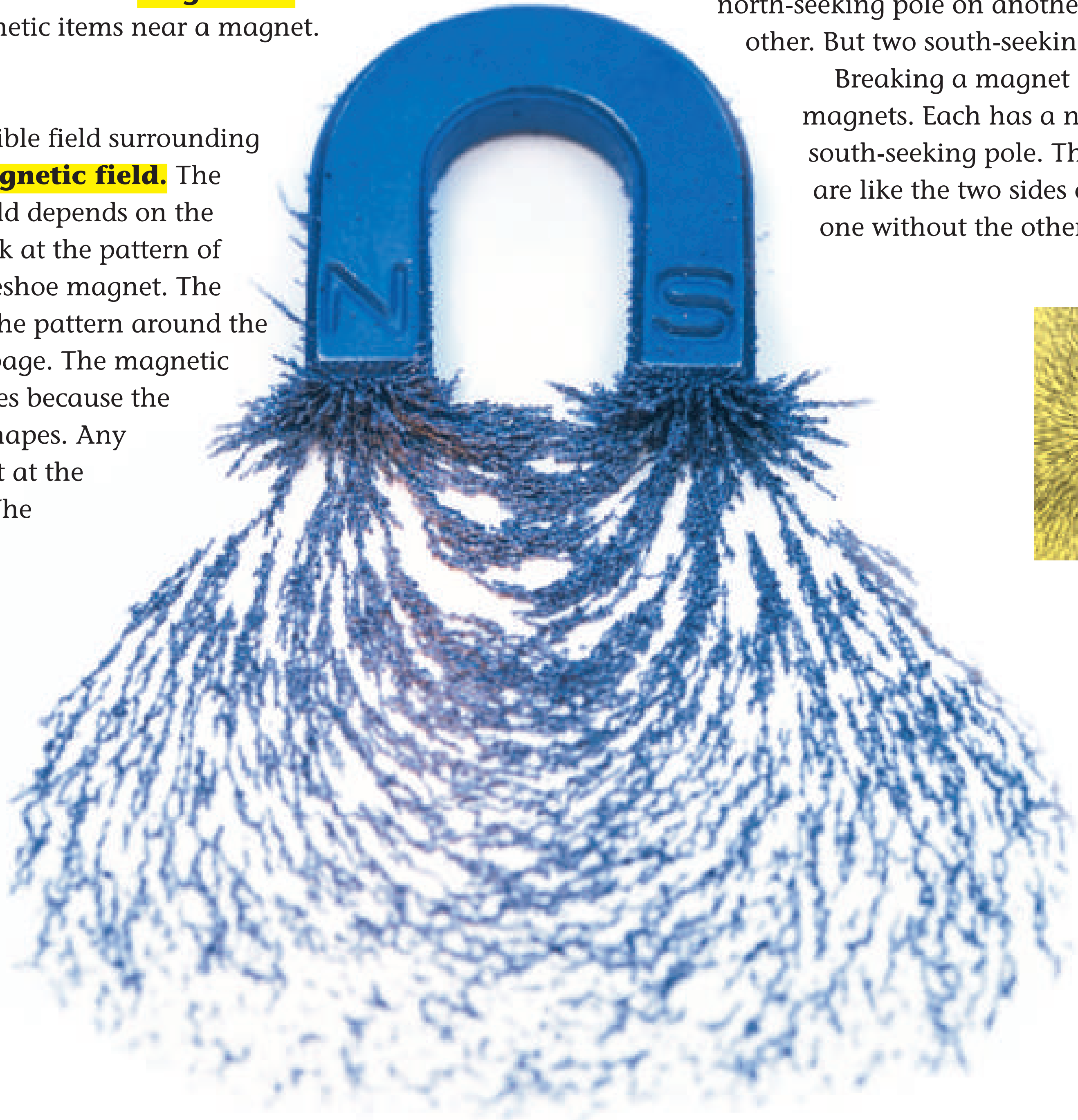
What are magnetic fields?

Magnetism

A magnet is an object that attracts other objects made of steel, iron, and certain other metals. **Magnetism** is the force that pushes or pulls magnetic items near a magnet.

Magnetic Fields

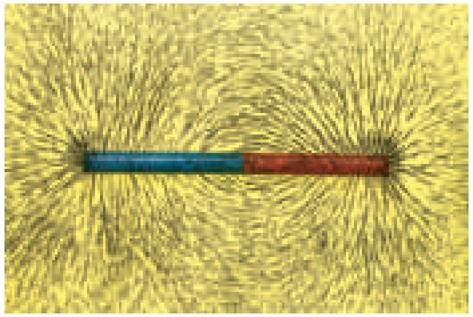
Magnets have an invisible field surrounding them. This is called a **magnetic field.** The shape of the magnetic field depends on the shape of the magnet. Look at the pattern of iron filings near the horseshoe magnet. The pattern is different from the pattern around the bar magnet on the next page. The magnetic fields have different shapes because the magnets have different shapes. Any magnetic field is strongest at the magnet's ends, or poles. The pushing or pulling force is also strongest at the poles.



Magnetic Poles

All magnets have a south-seeking pole and a north-seeking pole. Opposite poles have opposite charges. Opposite charges pull toward each other. Like charges push away from each other. The south-seeking pole on one magnet and the north-seeking pole on another magnet pull toward each other. But two south-seeking poles push apart.

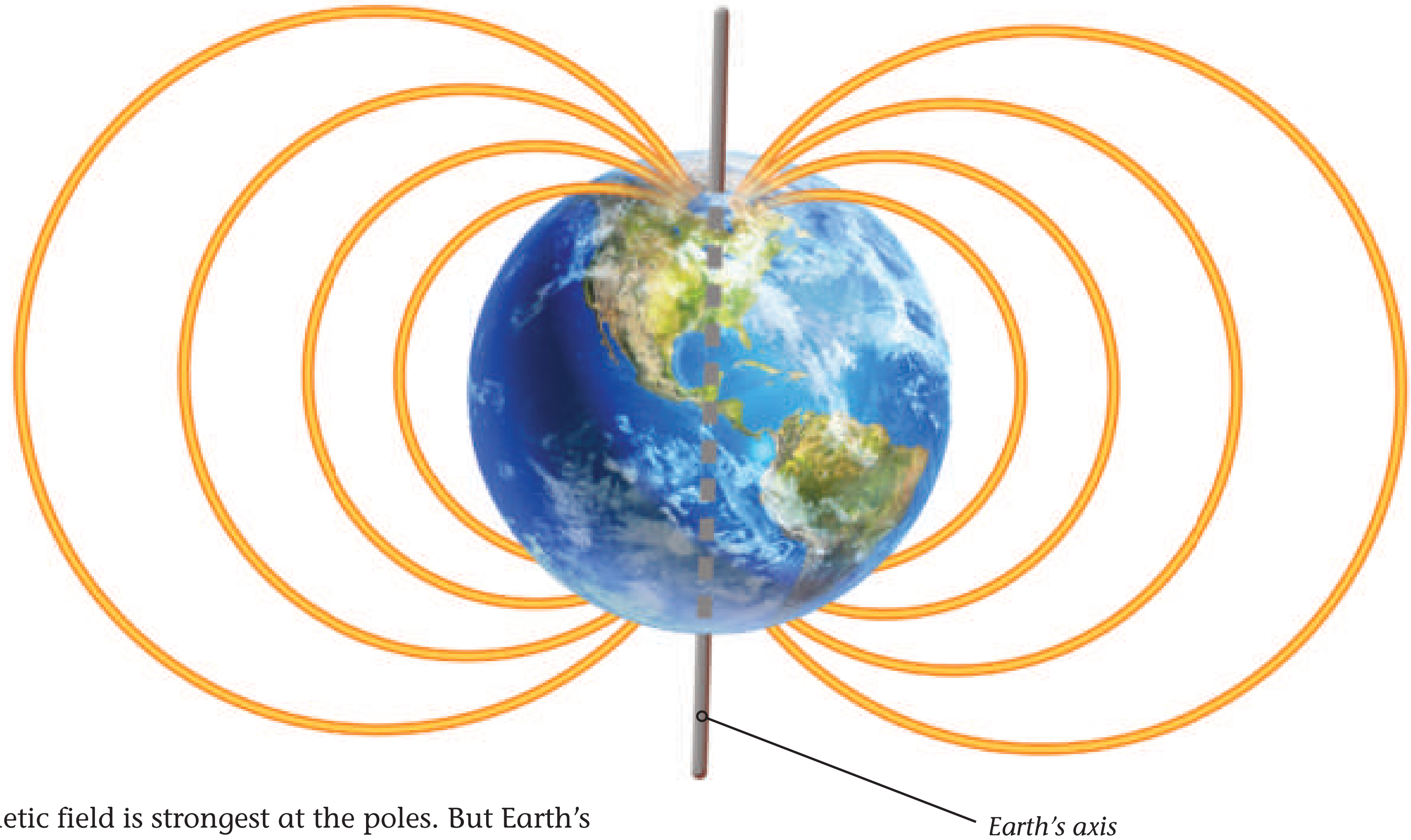
Breaking a magnet into two parts makes two magnets. Each has a north-seeking pole and a south-seeking pole. The two poles of a magnet are like the two sides of a coin. You cannot have one without the other.



The Largest Magnet in the World

Ancient sailors used compasses. But they didn't know why the compasses worked. Then around 1600 a British scientist named William Gilbert claimed that the world's largest magnet is Earth! The huge magnetic field that surrounds Earth makes one end of a compass needle point north.

Scientists don't know why Earth acts as a magnet. But they have an idea. Scientists think that Earth's outer core is made of iron. They think that this iron is so hot that it has melted. As Earth rotates, the liquid iron flows. The moving iron makes a magnetic field. The inner core is probably solid iron. It doesn't melt because it is under extremely high pressure.



Earth's magnetic field is strongest at the poles. But Earth's magnetic poles are not the same as its geographic poles. The geographic poles are on Earth's axis. This is the invisible line that Earth rotates around. Earth's magnetic north pole is in Canada. It is about 1,000 kilometers (600 miles) from the geographic North Pole. The magnetic south pole is in the Southern Ocean near Antarctica.

How Compasses Work

A compass is a small, handy tool. No matter where you are on Earth, one end of a compass needle will always point north. It is drawn to the pull of Earth's magnetic north pole. When you know which direction is north, you can easily find east, west, and south.

A compass needle has to be light. It must turn easily to work properly. The compass cannot be near a magnet. If it is, the needle will be pulled by the magnet. The needle will respond to the magnet's pull instead of Earth's pull.

The Northern Lights

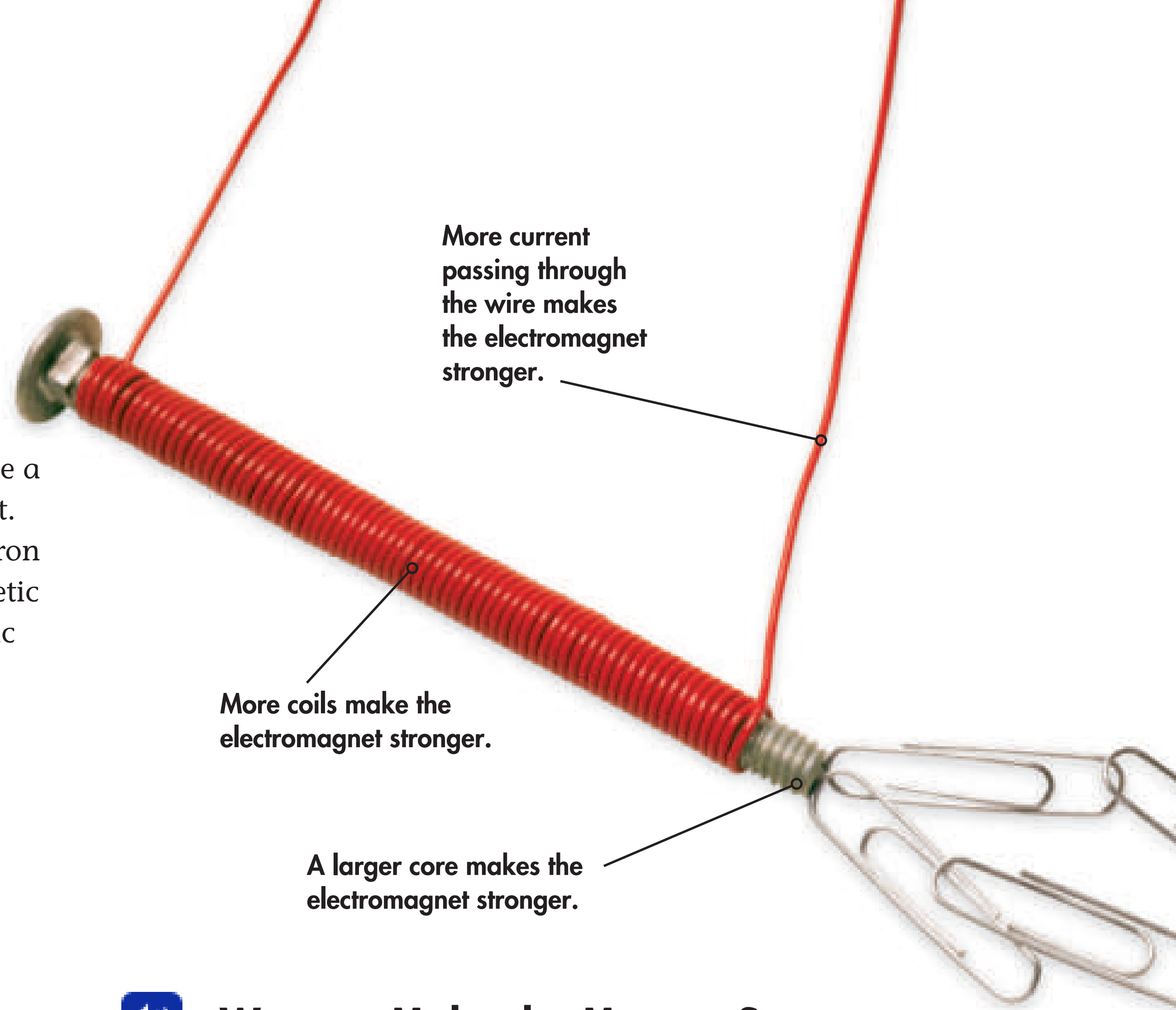
The Aurora Borealis, or the Northern Lights, is a natural light show that is visible at different times during the year. Auroras come from charged particles given off by the Sun. These charged particles are pulled to Earth's magnetic north and south poles. The poles are the strongest parts of Earth's magnetic field. The particles crash into particles of gas in Earth's atmosphere. The crashes produce colorful light. Scientists have also seen auroras in Jupiter's atmosphere.

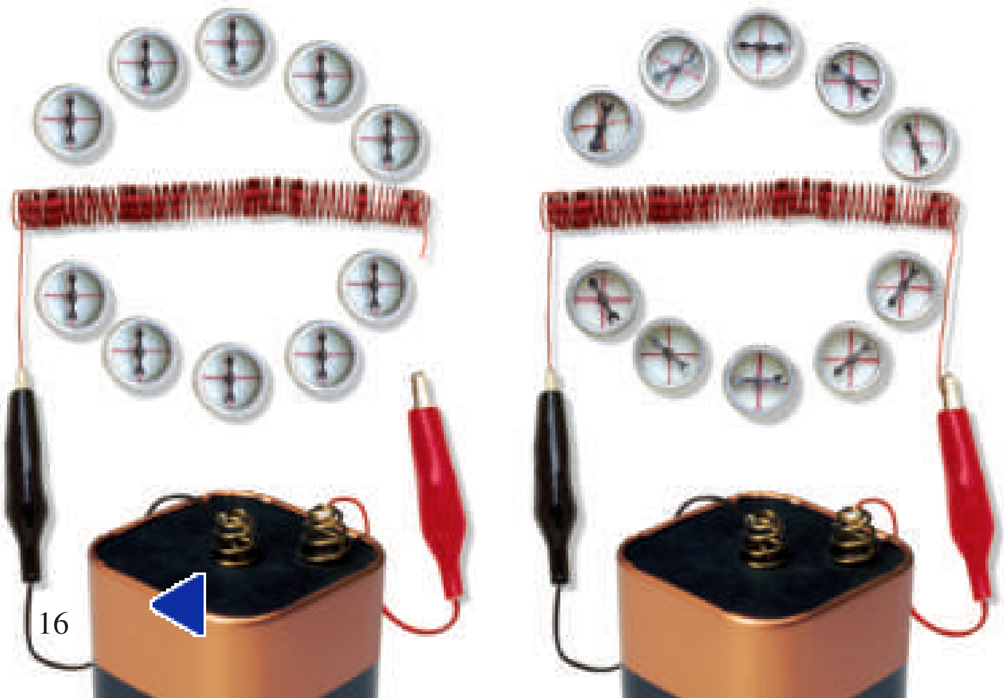
How is electricity transformed to magnetism?

Electromagnets

In 1820 scientist Hans Christian Oersted was showing how electric current flowed through a wire. He saw that the needle on a nearby compass moved each time he turned on the electric current. Oersted realized the flowing current made a magnetic field. This led to the invention of the electromagnet.

An **electromagnet** is a coil of wire wrapped around an iron core. An electromagnet changes electrical energy into magnetic energy. A current moving through the wire causes a magnetic field around the electromagnet. The wire loses its magnetic power when the current stops.





Ways to Make the Magnet Stronger

An electromagnet has a south and north pole, just as a natural magnet has. You can change the strength of an electromagnet. To make an electromagnet stronger, you can increase the amount of current moving through the wire. You can add turns to the metal coil. A third way to make the electromagnet more powerful is to make the magnetic core larger.

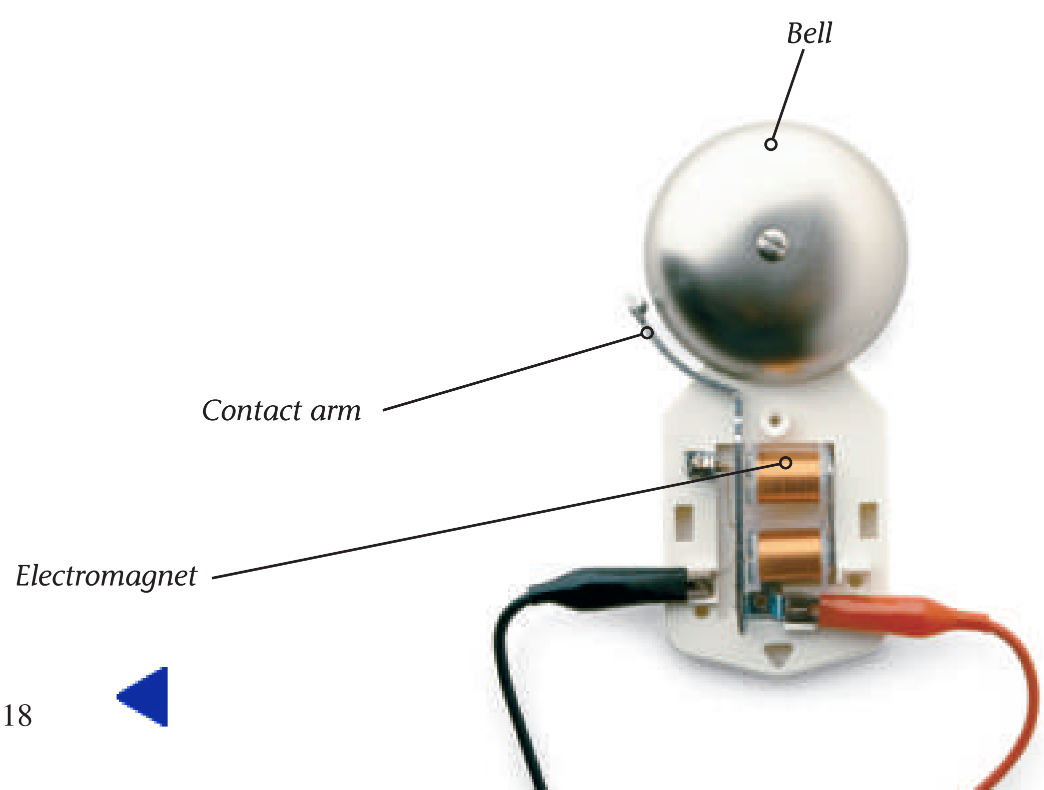
Uses for Electromagnets

Electromagnets are used to lift heavy objects. Electromagnets are also in many machines that scientists and doctors use.

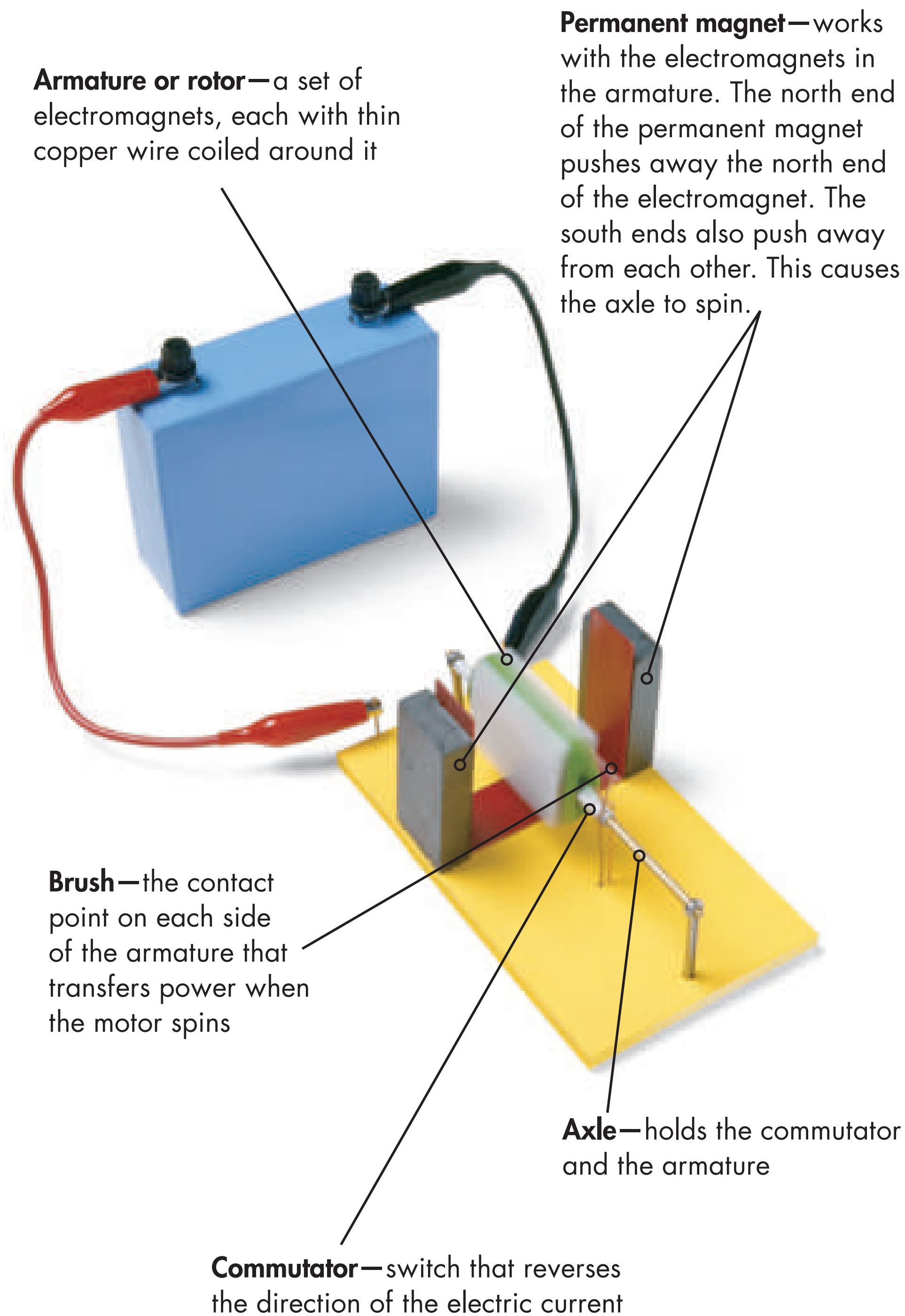
Electronic devices that you use each day have electromagnets. DVD players, fans, computers, and televisions work because of electromagnets. Electromagnets help change electric energy into magnetic energy and then into other kinds of energy.

How a Doorbell Works

Press the button on a doorbell. This closes the electrical circuit. The current flows to a part called the transformer. The transformer controls how much current is sent to the electromagnet. Electricity flowing into the coil of wire causes the electromagnet to become magnetized. This magnetism pulls up the contact arm. The arm is attached to the metal clapper. The clapper hits the bell. The bell rings. Magnetic energy has been changed into the sound you hear.



Simple Electric Motor

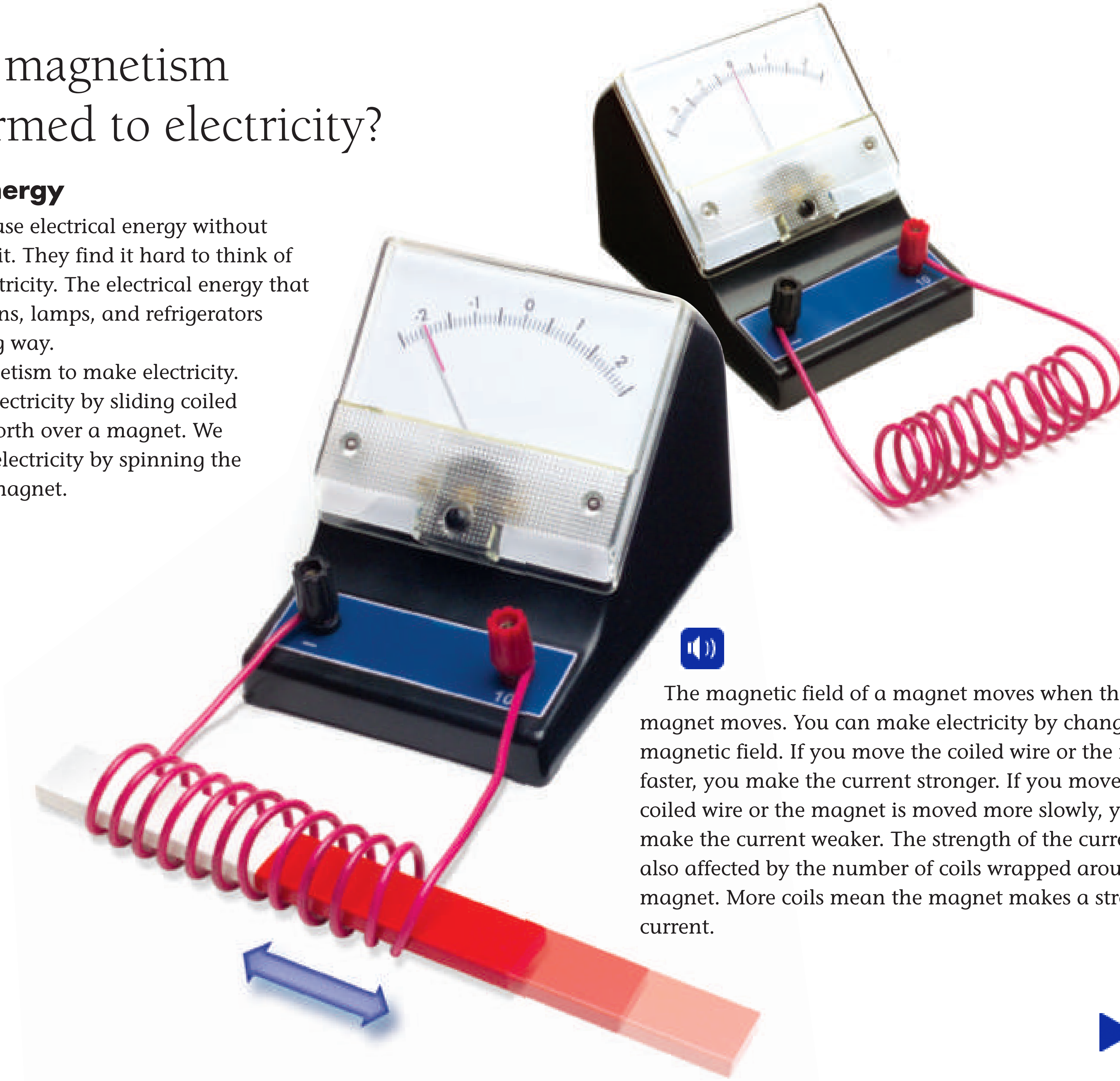


How is magnetism transformed to electricity?

Electrical Energy

Most people use electrical energy without thinking about it. They find it hard to think of life without electricity. The electrical energy that powers televisions, lamps, and refrigerators has come a long way.

We use magnetism to make electricity. We can make electricity by sliding coiled wire back and forth over a magnet. We can also make electricity by spinning the wire around a magnet.



The magnetic field of a magnet moves when the magnet moves. You can make electricity by changing a magnetic field. If you move the coiled wire or the magnet faster, you make the current stronger. If you move the coiled wire or the magnet is moved more slowly, you make the current weaker. The strength of the current is also affected by the number of coils wrapped around the magnet. More coils mean the magnet makes a stronger current.

A Flashlight Without Batteries

Michael Faraday was a British scientist. In 1831 he invented a machine that used magnets to change motion into an electric current. He made electrical energy by turning a crank on the machine. He called this a dynamo. This is the same technology that is used today in an emergency flashlight. It does not use batteries. It makes electricity when you squeeze the handle.

Currents Currently

A generator makes electric energy by turning coils of wire around powerful magnets. It uses magnets and wires to produce electrical energy. Most businesses, homes, and schools use electricity from generators.

Discoveries in Using Electrical Energy

Many people have made many discoveries about electricity. In the 1740s Benjamin Franklin and Ebenezer Kinnersley described electric charges as positive or negative. Zenobe Gramme developed the electric generator in 1870. Thomas Edison demonstrated the first light bulb in 1879. And those are just a few examples!

How Generators Are Powered

Some generators make electrical energy by using the energy of the wind. Others use falling water. Some generators are powered by steam. This steam may be from the hot temperatures deep below Earth's surface or from nuclear energy heating water. In each kind of generator, a coil of wire spins around a magnet. Electricity and magnetism work together in generators to provide energy for many things.

Glossary

electric current an electric charge in motion

electromagnet a core of iron with wire coiled around it; when electricity goes through the wire, it causes a magnetic field

magnetic field an invisible field around a magnet where the force of magnetism can be felt

magnetism a force that pushes or pulls magnetic materials near a magnet

parallel circuit a circuit in which an electric charge can follow two or more paths

resistance the ability of a substance to keep an electric charge from flowing through it easily

series circuit a circuit in which electric charge flows in one path

static electricity the result of positive and negative particles not in balance

What did you learn?

1. How do like charges behave? unlike charges?
2. How are magnets used to make electricity?
3. How can you make an electromagnet stronger?
4. **Writing in Science** In a series circuit, if one bulb burns out, it opens the circuit and the other bulbs won't receive the energy they need. On your own paper, write to explain why this does not happen in a parallel circuit. Include details from the book to support your answer.
5. **Cause and Effect** What causes lightning?