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

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Science Science

Physical Science

Electricity and Its Uses

by Sam Brelsfoard

Vocabulary

circuit diagram
conductor
current
electromagnet
insulator
resistor
volt

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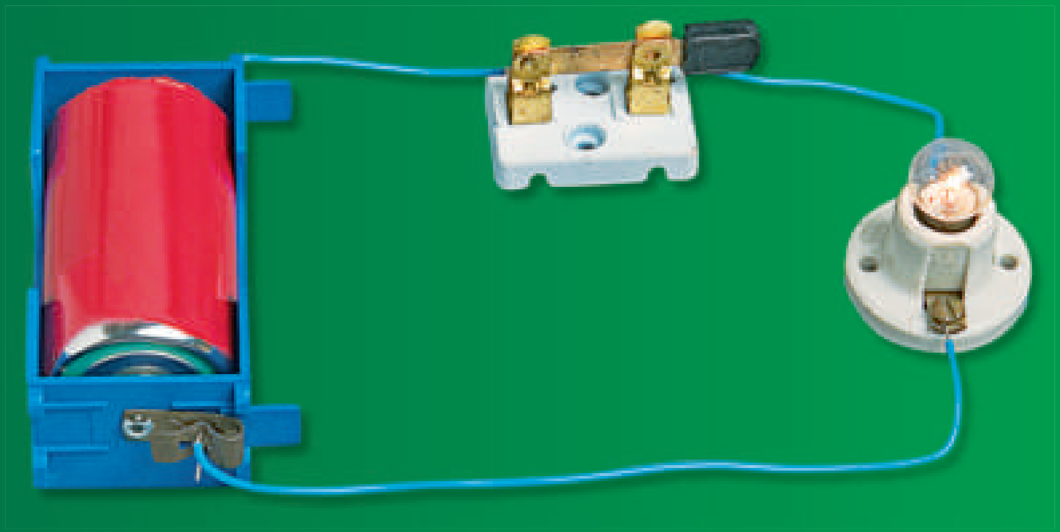

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Moving Charges

Electric Charges

Most atoms have a neutral charge. This means they have the same number of protons and electrons. Protons have a positive charge. Electrons have a negative charge. As long as there is an equal number of protons and electrons, these charges will cancel each other out, and the atom will remain neutral. The number of protons in an atom usually stays the same. But the number of electrons can change. Atoms can gain or lose electrons. If this happens, the atom no longer has a neutral charge.

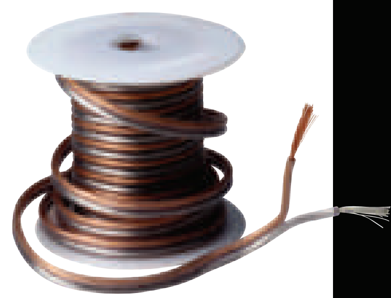
You may have experienced charges moving from one object to another. Maybe you have walked across a carpet in your socks on a dry day. You reach for the doorknob to leave the room. Zap! A spark leaps from your finger to the metal knob.

The spark you saw was the result of an electric charge. As your socks rubbed on the carpet, electrons from the carpet's atoms flowed into you. Since your body gained electrons, it received a negative charge. As long as the charge stays with you and doesn't move, it is called static electricity. Opposite charges are attracted to each other. This means that when you touched the doorknob, electrons jumped to the positively charged protons in the metal. This flow of an electrical charge is called a **current.** Many of the devices we use every day are powered by an electrical current running through metal wires.

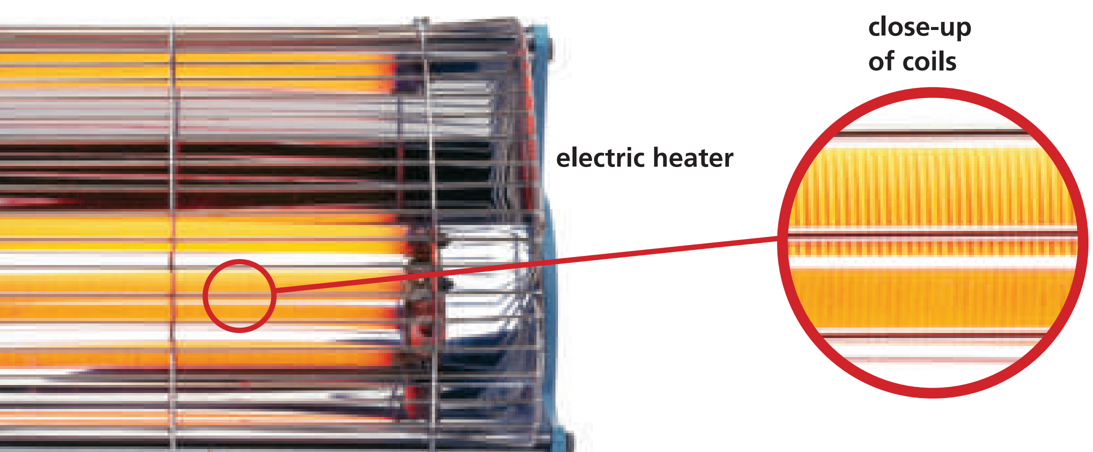
Conductors

In some materials, electrons are not held tightly to their atoms. This allows electrical charges to move through them easily. Such a material is called a **conductor.** Good conductors include copper, gold, silver, and aluminum. Electrical wires and computer parts are often made from these metals. They conduct the best when they are not mixed with other metals. There are other good conductors that are not metals. Conductors may be solids, liquids, or gases.

Resistors are materials that resist the flow of an electrical charge. These materials cause some electrical energy to change into thermal energy. When electricity passes through the coils of a portable electric heater, electricity is converted into heat. **Insulators** are very strong resistors that stop most electrical currents. Plastic and rubber are good insulators. They are often used as an outer coating for electric wires, so that the wires may be handled safely.

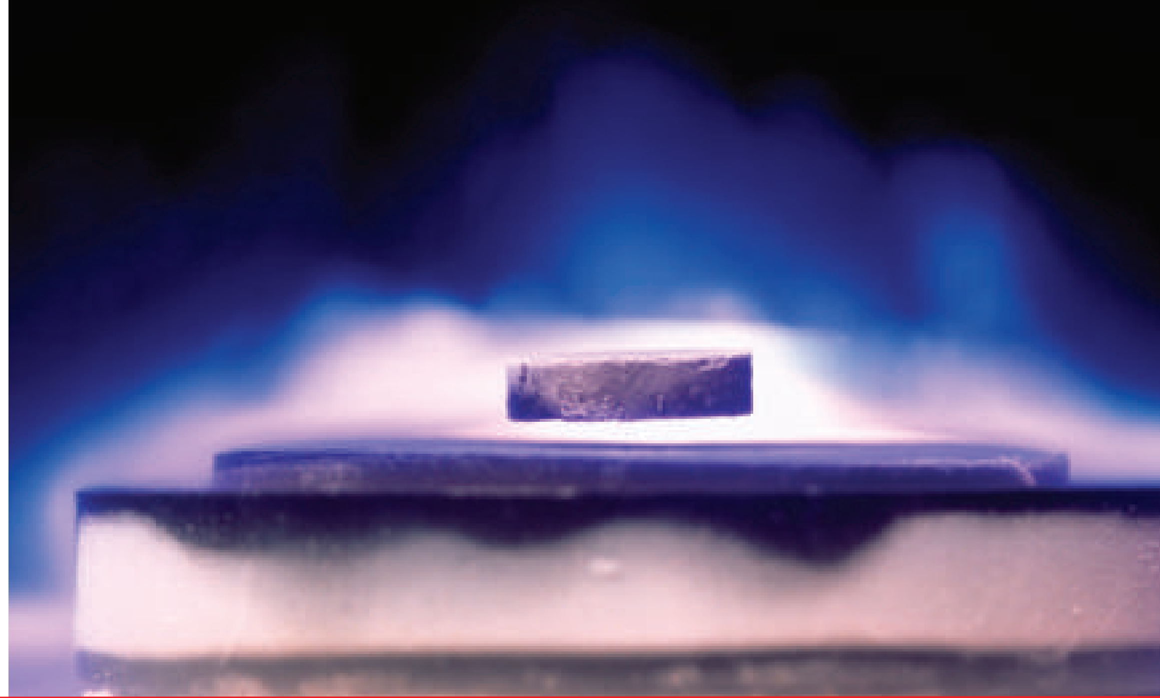


This copper wire is a conductor. The plastic coating around it is an insulator.



All materials, even strong conductors, have some resistance most of the time. Materials with no resistance are called superconductors. Some materials, including many metals and some ceramics, can become superconductors under certain conditions. This usually happens at very low temperatures. Unfortunately, it is difficult to produce these super-cold conditions. Scientists are looking for ways to make superconductors work at warmer temperatures. These materials could then be used to make very efficient electrical devices.

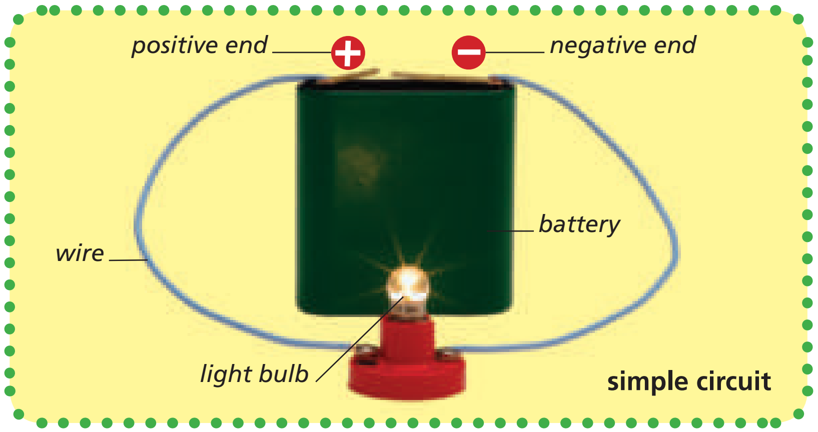
This magnet is floating above a piece of superconducting ceramic material.



Simple Circuits

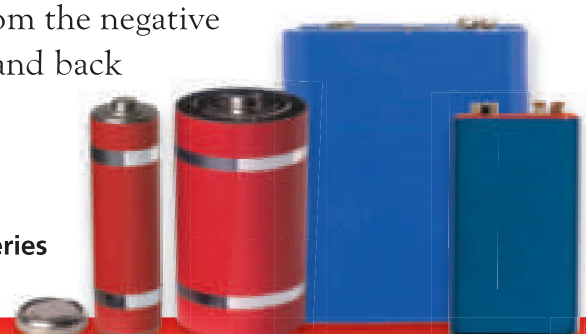
Parts of a Circuit

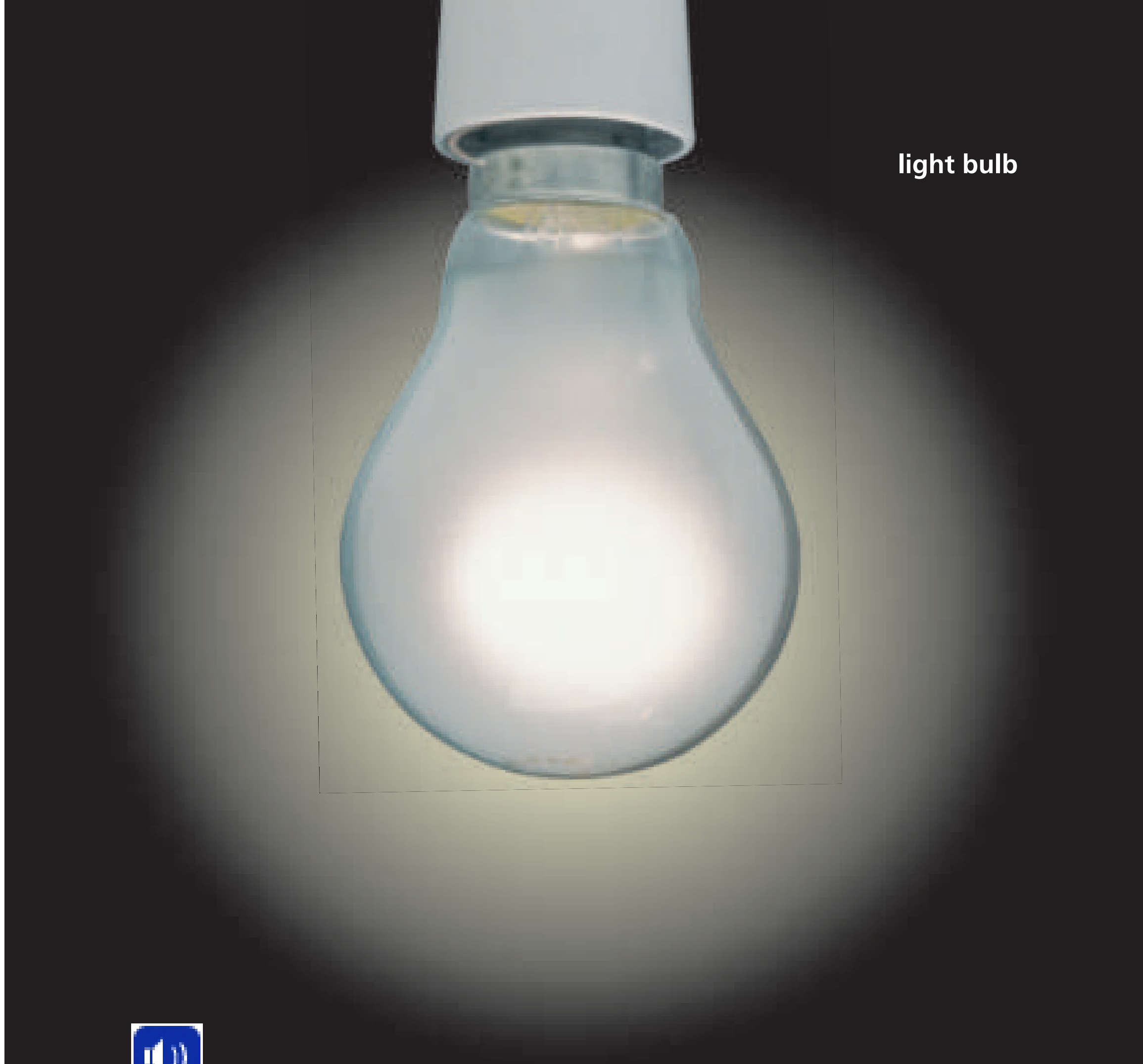
A circuit is a looped path that carries an electrical charge. A circuit must have a source of electricity and at least one conductor. The conductor is usually a wire. There may be a gap in the conductor, which can be opened or closed with a switch. Opening the gap stops the flow of electricity. Circuits often have resistors as well. Circuits transfer electrical energy from one place to another. They can send this energy over very long distances.



simple circuit

A battery is one type of energy source that can be used in a circuit. A battery has a negative end and a positive end. It has chemicals inside of it that react to produce a current. The current flows out from the negative end, around the circuit, and back to the positive end.


batteries

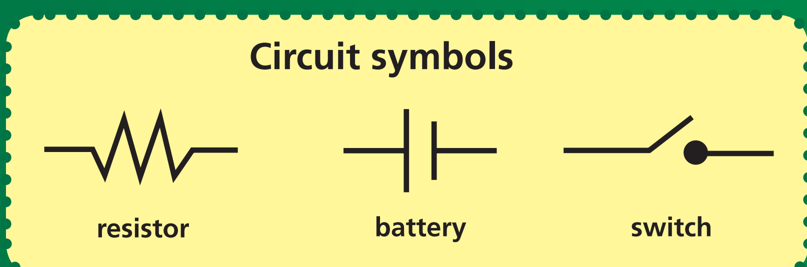


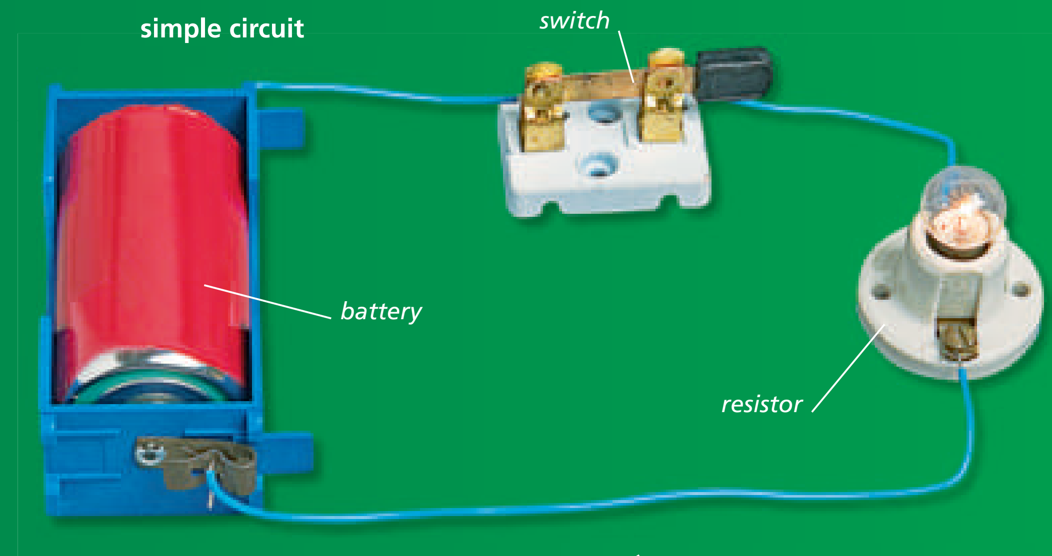
Some of the electrical energy in a circuit changes into heat as it passes through the conductor. Resistors can change electrical energy into other types of energy. Light bulbs, for example, are resistors that can change electrical energy into light and heat energy.

Circuit Diagrams

A road map can show you the streets you need to follow to get somewhere. It may also tell you what stores and restaurants can be found along the way. A **circuit diagram** is a map of a circuit. It shows the path that the current takes and any power sources, switches, or resistors along the way. There are symbols for each of these things.

A circuit diagram may also contain electrical measurements. It may show the amount of electrical energy provided by the power source. This is measured in a unit called a **volt.** Different types of batteries deliver different numbers of volts. The AAA, AA, C, and D batteries that we use in compact disc players and flashlights each deliver about 1.5 volts. Another common battery is the small rectangular type, which delivers about 9 volts.





Resistance to electrical current is measured in units called ohms. A normal household light bulb has about 240 ohms of resistance.

Current is measured in units called amperes. The word *ampere* is usually abbreviated to *amp*. Amps tell the amount of charge moving past a given spot each second.

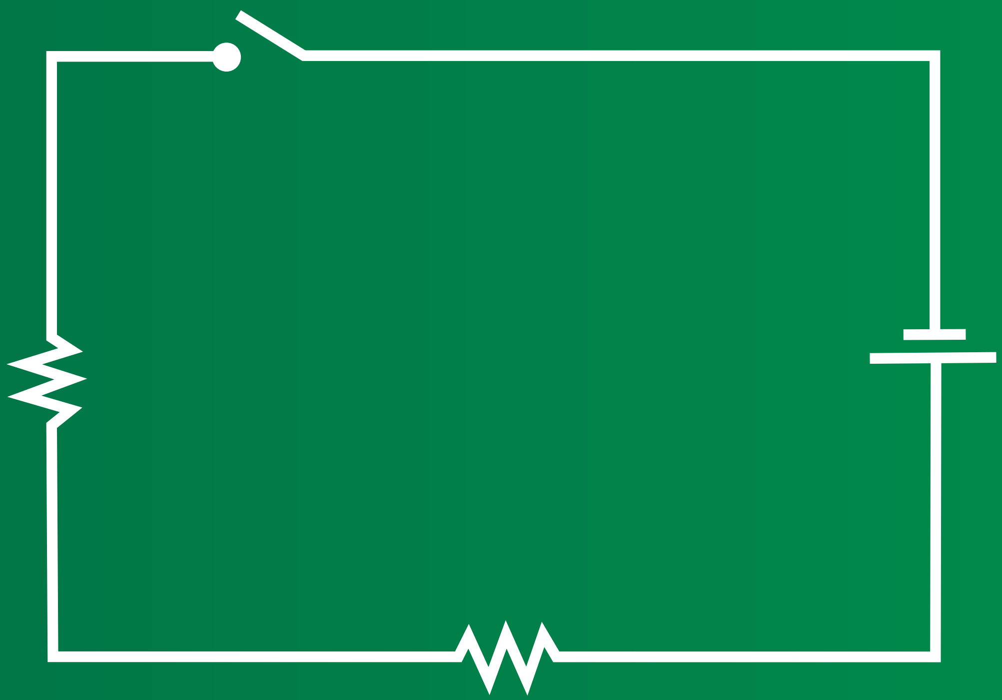
Series Circuits

Look at the circuit diagram below. Notice that it has more than one resistor on it. Circuits such as this one are known as series circuits.

Now look at the three circuits in the photographs on the opposite page. Look at the number of light bulbs on each circuit. Also notice where the light bulbs, the switches, and the battery are in relation to each other. Compare each picture with the circuit diagram. Which one matches it?

Series circuits can cause problems. Look at the circuits in the photos again. Suppose the switches were closed. What do you think would happen if one of the light bulbs blew out or was removed? It would stop the flow of electricity. This would turn off the other light bulbs.

circuit diagram



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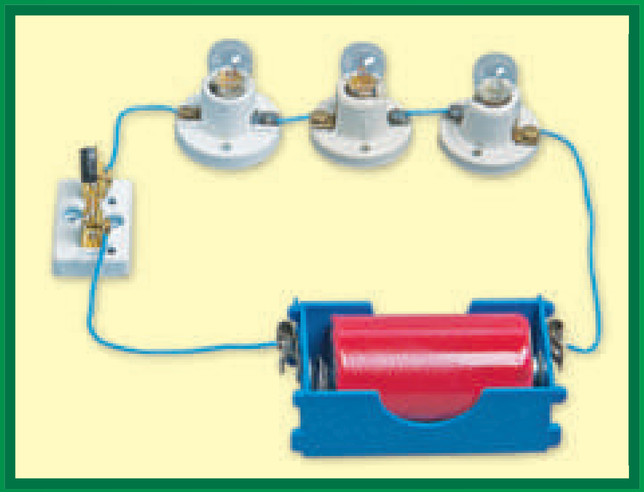

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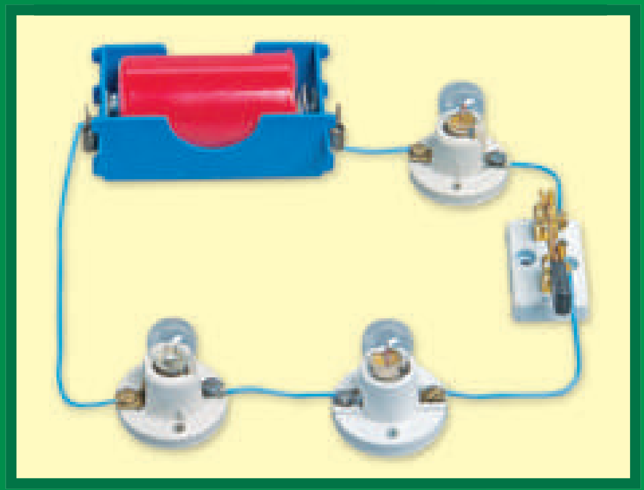

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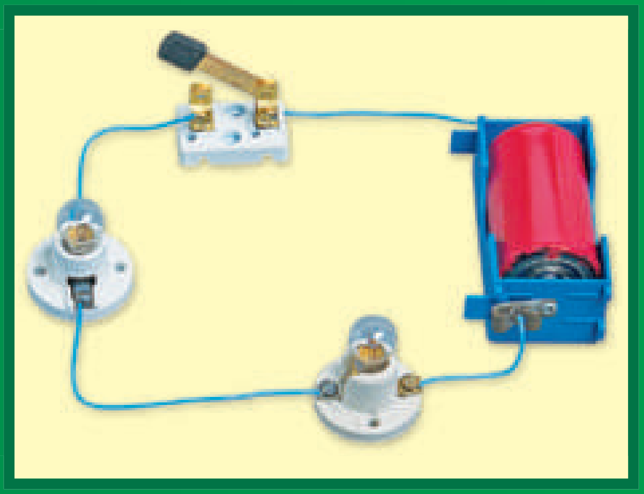
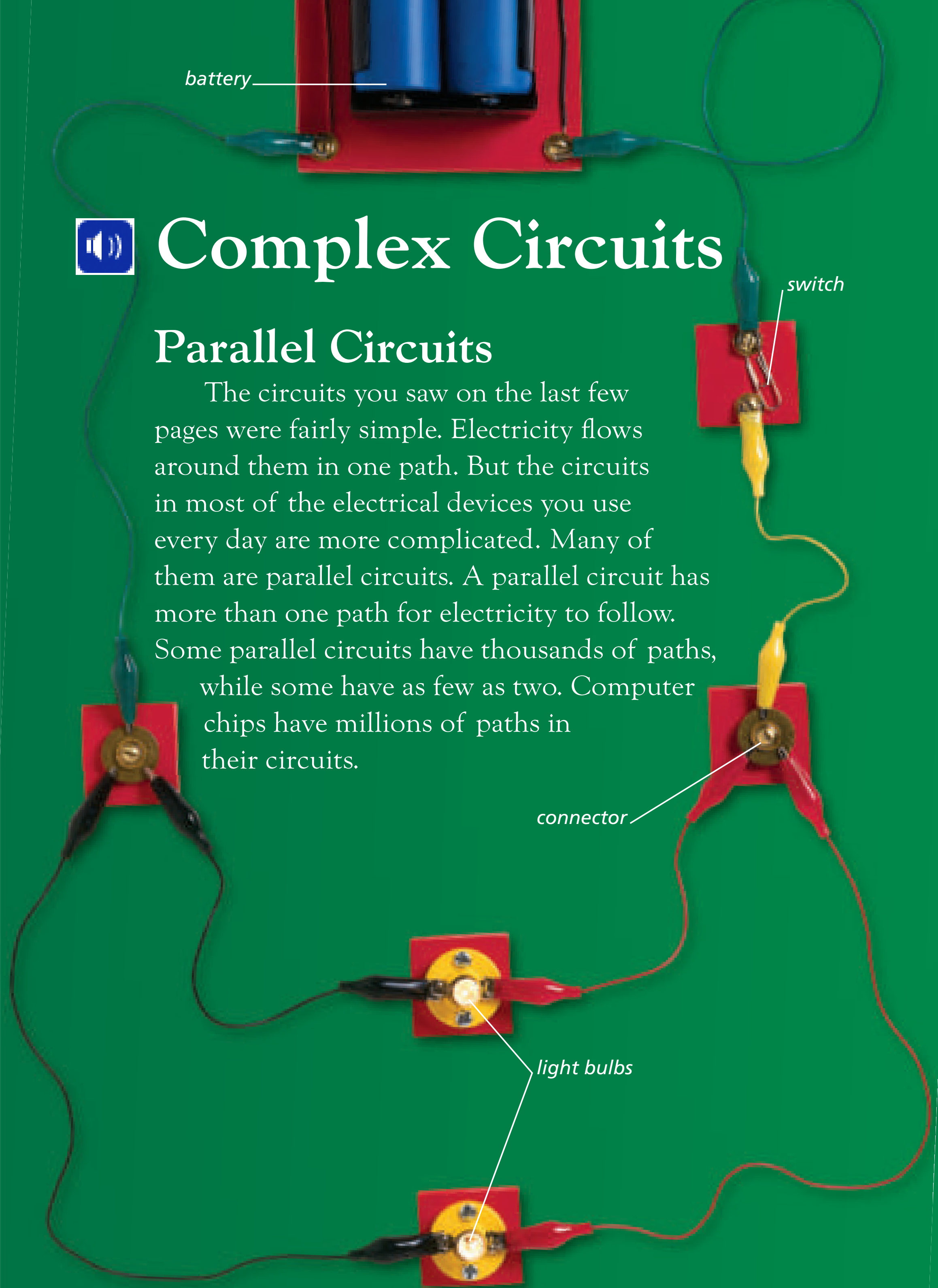


Complex Circuits



Parallel Circuits

The circuits you saw on the last few pages were fairly simple. Electricity flows around them in one path. But the circuits in most of the electrical devices you use every day are more complicated. Many of them are parallel circuits. A parallel circuit has more than one path for electricity to follow. Some parallel circuits have thousands of paths, while some have as few as two. Computer chips have millions of paths in their circuits.

A parallel circuit has many branches. Each branch may contain one or more resistors. If there is a break in any of the branches, the current will continue to flow through the other branches. For example, in your living room, you may have a lamp and a television plugged in. Both of these things are on the same parallel circuit. What happens to the television when you turn off the lamp? Nothing! This is because the current keeps flowing through the television, even though the current has stopped flowing to the lamp.

Electromagnets

An electromagnet can lift iron filings.

When you think of magnets, you probably think of the ones that hold papers onto your refrigerator. These small magnets are made of special materials that are attracted to certain metals. But magnets don't have to be made from special materials. In fact, they can be made from ordinary items found in any hardware store. If you wrap a piece of copper wire many times into a coil and then attach the two ends of the wire to the two poles of a battery, you will make a magnet.

The type of magnet described above is called an electromagnet. An **electromagnet** is a magnet that carries an electrical current. Every electrical current produces a magnetic force. You can make this force stronger by making more coils in the wire or by coiling the wire around a piece of metal.

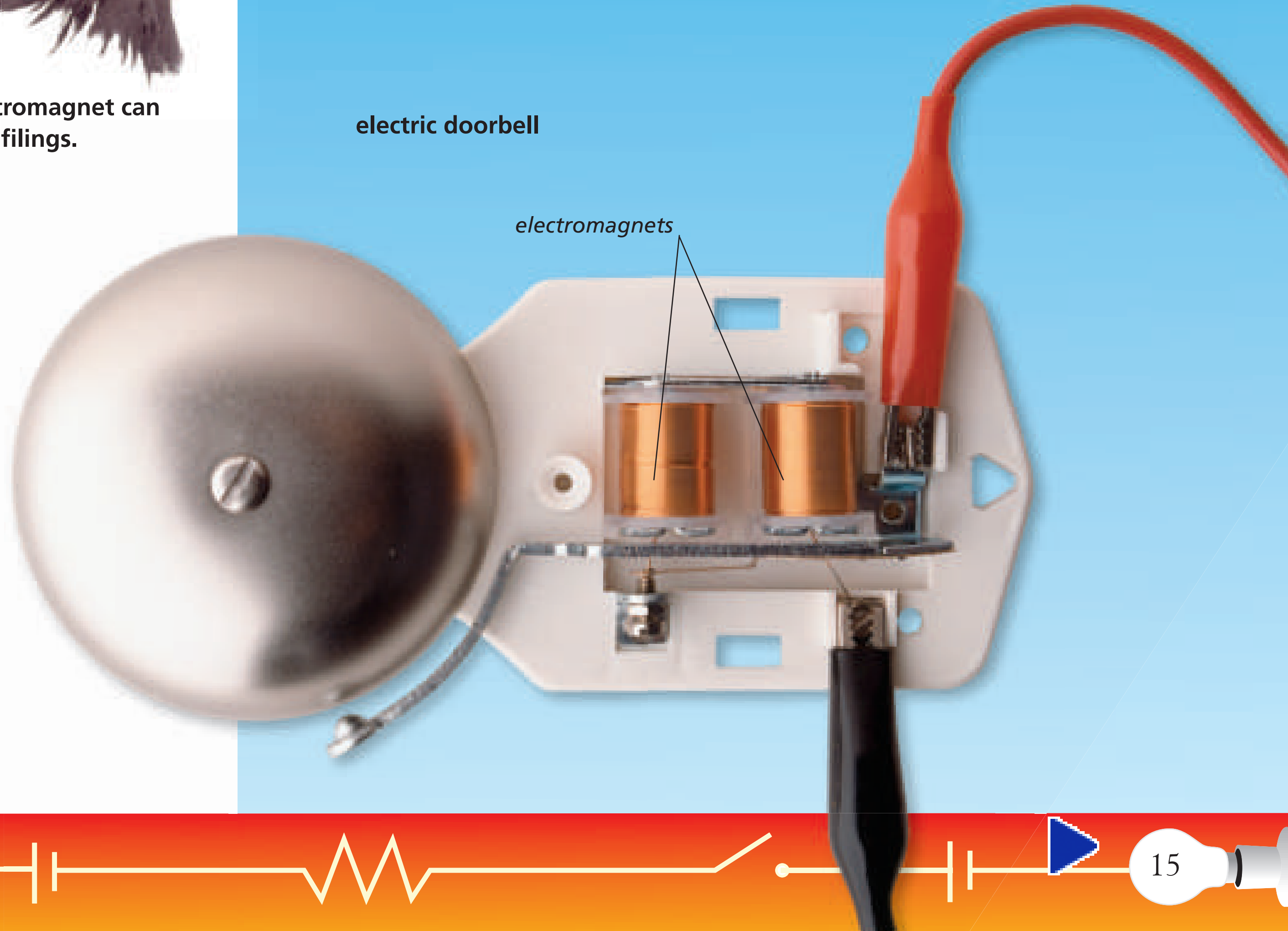
Just like a regular magnet, an electromagnet has a north and a south pole. It is stronger at its poles than in the middle. But unlike a regular magnet, an electromagnet can be turned off by disconnecting it from its power source.

Uses of Electromagnets

Electromagnets are found in many of the devices we use every day. They are found in motors, microphones, loudspeakers, and doorbells. In a speaker, patterns of electrical pulses are sent through a magnet. This causes the speaker to move, which produces vibrations. These vibrations are the sounds you hear when you listen to a compact disc or the radio. The pattern of electrical pulses controls what you hear.

From compact disc players to computers to light bulbs, electricity is a part of almost everything we do. What would your life be like without electricity?

electric doorbell



Glossary

circuit diagram a map of a circuit

conductor a material through which an electrical charge can move easily

current the flow of electrical charges through a material

electromagnet an object that becomes magnetic when an electrical current passes through it

insulator a material that can stop the flow of an electrical charge

resistor a material that resists the flow of an electrical charge

volt the measure of the electrical energy provided by an energy source

What did you learn?

1. What materials are good conductors? What materials are good insulators?

2. What are some things a circuit diagram can tell you?

3. How is an electromagnet different from a regular magnet?

4. **Writing** in Science If two items are plugged into the same parallel circuit, and one is turned off, nothing happens to the other. Write to explain why this happens. Use details from the book to support your answer.

5. **Cause and Effect** If one light bulb on a string of lights in a series circuit blows out, what will happen to the other bulbs?