The Physical Setting

Electricity and Magnetism

Advanced Level

Electrical Energy

LOOK INSIDE FOR:

- Core Curriculum Covered
- Student Book
- Assessments and Reading Activities

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Electrical Energy

What are the properties of electricity and magnetism?

CORE CURRICULUM STATEMENTS

Energy exists in many forms, and when these forms change energy is conserved.

Energy exists in various forms: heat, electric, sound, chemical, mechanical, light.

Energy can be transferred from one place to another.

Some materials transfer energy better than others (heat and electricity).

Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.

Electricity travels in a closed circuit.

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FOCUS ON SCIENCE

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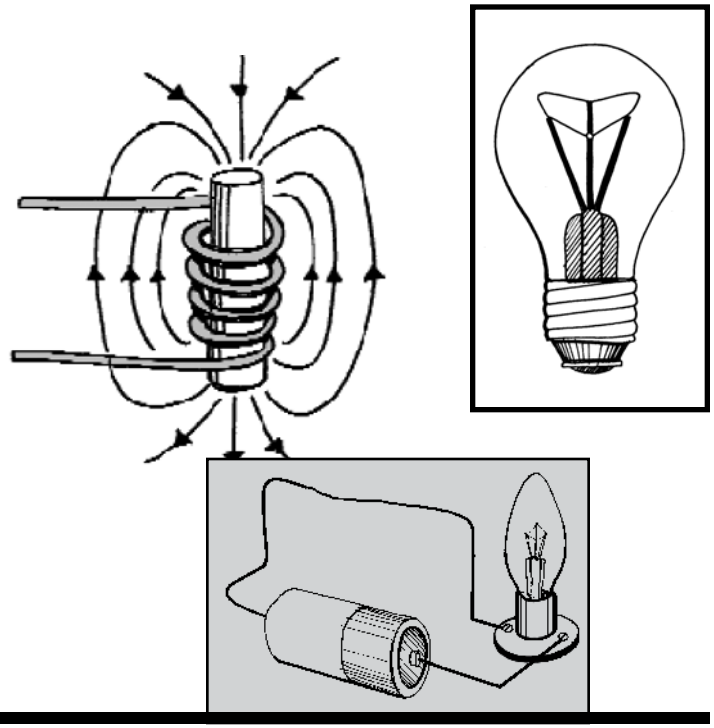
by Ken Sibila



FOCUS ON SCIENCE

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Curriculum materials for **your** content standards

Table of Contents

– Predict –
What do you think you will learn from this book?

INTRODUCTION

Electricity Is Energy

You can't hear it or smell it. You can't taste it or hold it. You can't even see it. But you know it exists. Everyday you use electricity to power something. Electricity lights up your home, cooks your food, and powers your computer. It is hard to imagine living without electricity.

Look around the room you are in right now. How many things in that room are using electricity to make them operate? Walk around the building you are in and count the number of items that are using electricity. Now imagine there is no electricity. What would it be like in that room and building?

You know electricity is important to your life. But what is electricity? How does it work? Where does it come from? Read on to find out.

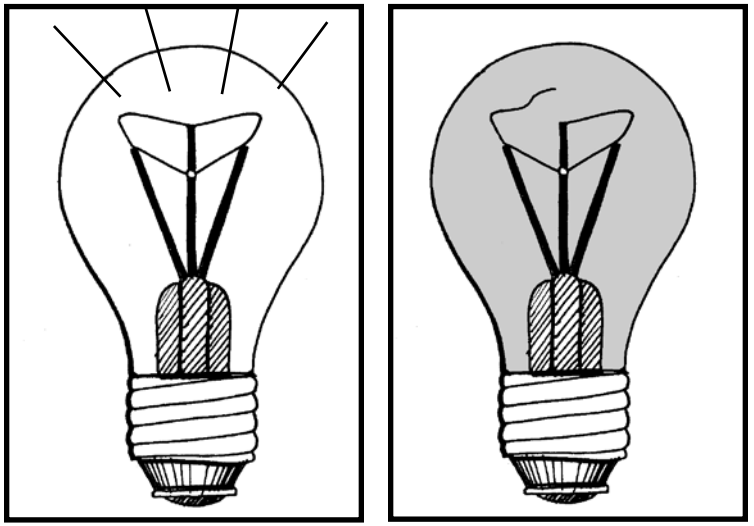
CHAPTER 1

Electrical Circuits

You turn a switch on a lamp. Suddenly, light appears. How does that happen?

A light bulb has a tiny wire, or filament, in it. Electricity enters the light bulb and passes through the filament. It heats up and glows, creating light.

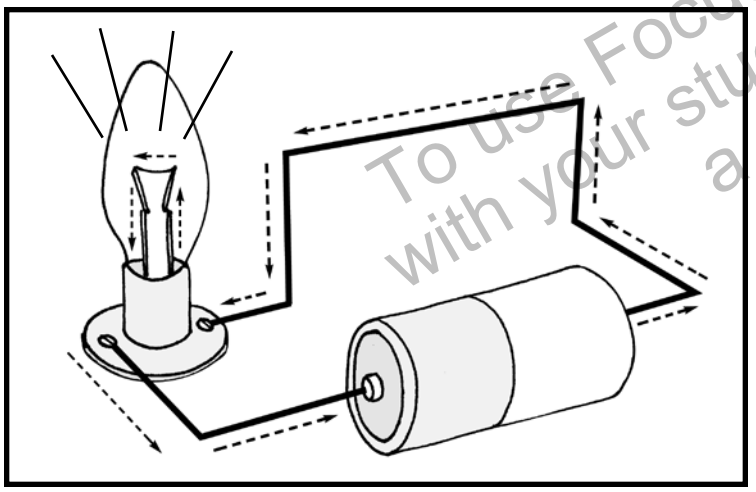
After a while, the wire wears out and breaks. The electric circuit is now also broken. Electricity can no longer flow through the filament. Now, you have to buy a new light bulb with an unbroken filament.



Closed Circuit

How does electricity get to the light bulb? Electricity needs a link, or connection, in order to flow. This link is called a circuit. The word *circuit* comes from the word *circle*. This makes it easy to remember that electricity travels in a complete circle, also known as a closed circuit.

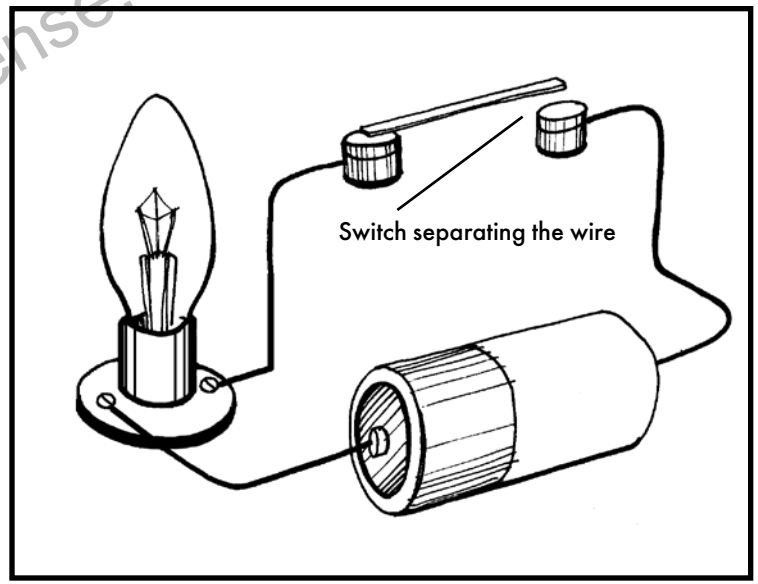
Look at the diagram below. It shows a closed circuit. Electricity flows freely from the battery, through the wire, through the light bulb, and back to the battery. Nothing stops the flow of electricity. It follows a connected, circular path.



A battery is one type of electric power source. Electricity flows from the battery to the light bulb. Electricity then flows back to the battery.

Open Circuit

How do you turn a light bulb off? You turn a switch. Look at this diagram. It also shows an electrical circuit. A switch has been placed between a section of the wire. The switch breaks or separates the wire so the electricity has no place to go. The electricity stops flowing through the circuit when the switch is open. This is why a lamp turns off when you flip the switch to the off position.

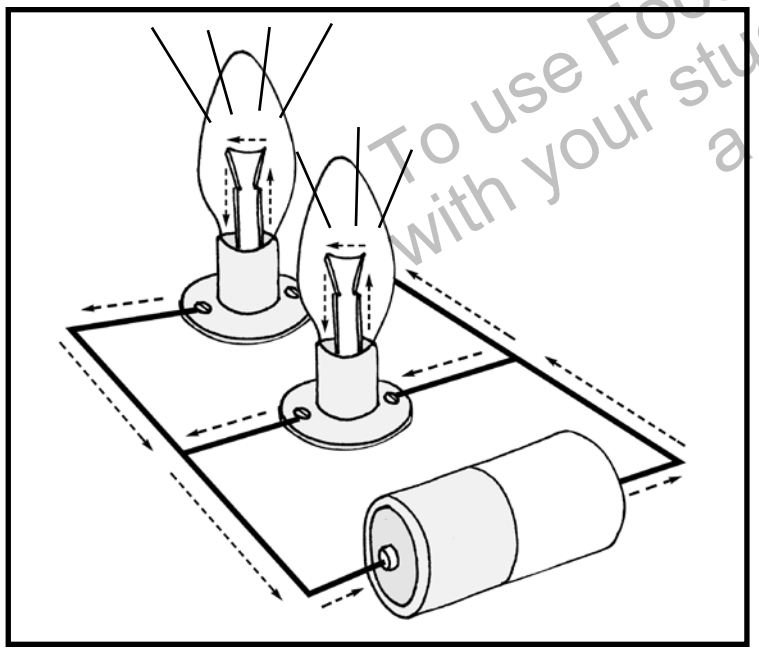


This light bulb will not produce light. The flow of electricity has been stopped by a switch.

Parallel Circuit

When there is only one circuit for electricity to flow through, you have what is called a series circuit. The diagram on page 6 shows a closed series circuit.

Two or more circuits connected together is called a parallel circuit. Look at the diagram below. It shows two circuits connected to each other. One circuit powers a light bulb, the other powers a second light bulb. Notice that both circuits are closed. That is, electricity can flow freely through an uninterrupted path.



Conductors and Insulators

To turn your TV on, you must first plug the cord into an electrical outlet. The cord is made of copper wire on the inside and rubber on the outside. Copper is a good **conductor** of electricity. That means copper allows electricity to easily flow through it, creating an electric current.

Why is there rubber on the outside of the copper wire? Some types of material do not allow electricity to flow through them. Therefore, they do not carry an electric current. These types of materials are called **insulators**. The measure of how well a material allows electricity to move is called resistance.

Rubber is an insulator. It does not allow electricity to move through it. Rubber has a high **resistance**. When you touch an electrical cord, the rubber prevents the electricity from flowing from the copper wire to you.

conductor: a material that carries electricity
insulator: a material that keeps electricity from flowing
resistance: a measure of the power of a material to resist the flow of electricity

CHAPTER 2

Static Electricity

Electricity not only flows through material, it can also jump from one object to another. Have you ever touched a doorknob and received an electric shock? This occurred because you walked across a carpet and your body picked up an electrical charge. When you reached for the metal doorknob, the electricity jumped from your fingertip to the doorknob creating a spark before you even touched it. This is an example of static electricity.

Lightning in the sky is also caused by static electricity. Ice crystals in clouds rub up against each other exchanging electrical charges. These electrical charges can jump from the clouds to the ground. This creates a huge spark in the sky called lightning.

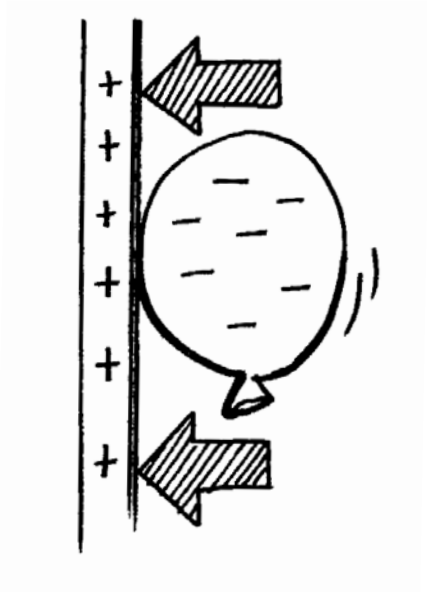
–Explain–
What causes static electricity?

Electrically Charged Objects Can Attract

Electrical charges in objects can attract or repel each other. Here is an activity to prove this.

Rub a balloon full of air against your hair or a piece of wool. Then hold it against a wall. When you let go of the balloon, it sticks to the wall. Why does this happen?

When you rubbed the balloon against your hair or wool, the balloon picked up an electrical charge. The electrically charged balloon becomes attracted to a different electrical charge in the wall causing the balloon to stick to the wall.

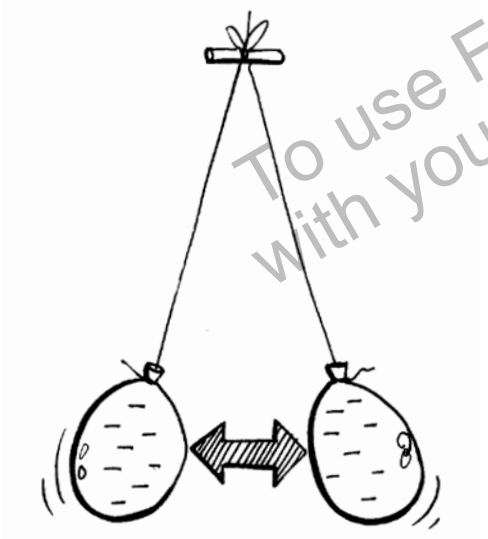


Electrically Charged Objects Can Repel

Objects with similar charges will **repel** each other. Try this.

Take two balloons and tie a string to each one. Rub the two balloons together. Then hold them by the strings and put them next to each other. The balloons will move apart.

Rubbing the two balloons gave each of them the same electrical charge. Objects with the same electrical charge always repel each other, so the balloons pushed each other away.

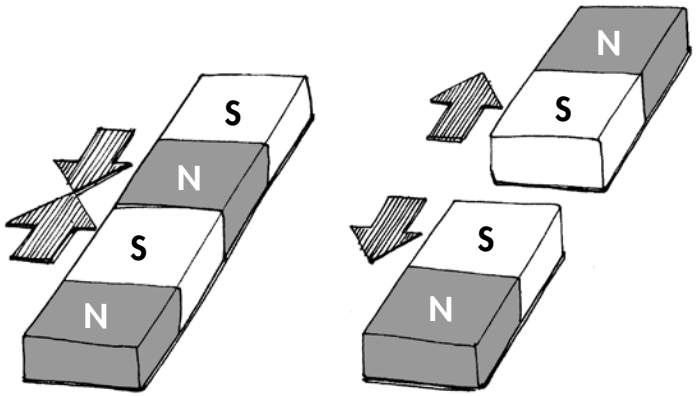


repel: to drive or force away

Magnets

Magnets are objects that attract some metals such as iron. There is a strong connection between electricity and magnetism. With electricity, objects can attract or repel each other. The same goes for magnets. They have north and south pole. Similar magnetic poles repel each other, while unlike poles attract.

To attract magnets to each other, place opposite ends of two magnets near each other; they will attract each other. Placing like ends of two magnets near each other causes the two magnets to repel each other.



CHAPTER 3

Electricity Creates Heat and Motion

You just learned how electrical energy can be used to create light energy. It can also be used to create heat, which is called thermal energy. A hair dryer is an example.

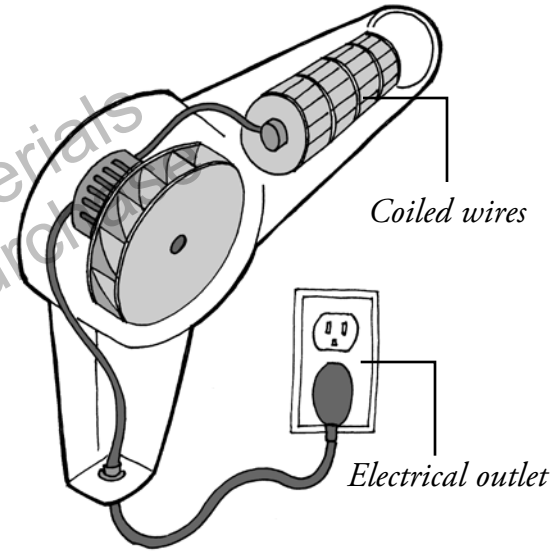
When you want to dry your hair, you plug a hair dryer into an electric outlet. The outlet is the power source. However, the hair dryer does not turn on. Why?

The hair dryer has a switch which opens and closes the electrical circuit. When you flip the switch, it closes the circuit. Electricity can now flow through the hair dryer.

The electricity passes through coiled wires. This causes the wires to become hot, similar to a filament in a light bulb. Electrical energy is now being turned into thermal energy.

Electricity is also being turned into something else—motion. A hair dryer has a fan powered by a motor. When electricity passes through the motor, it converts the electricty into motion. The fan spins, blowing hot air out.

How a Hair Dryer Works



The cord is plugged into an electric outlet.

Electricity flows through the wire to the fan's motor, causing the fan to move.

Electricity flows to coiled wires, causing the coils to heat up.

Hot air blows out of the hair dryer.

CHAPTER 4

Electricity Creates Sound

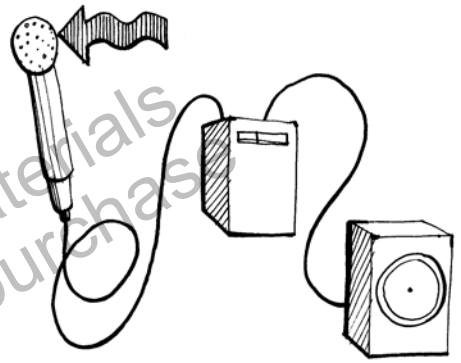
How does a voice travel from the principal's office to other rooms in your school during morning announcements?

When you listen to the morning announcements at school, you hear the principal's voice through a speaker. Your principal speaks into a microphone. The sound waves from his or her voice cause vibrations in the air. These vibrations are picked up by the microphone, which converts the vibrations to tiny **pulses** of electricity.

These pulses of electricity travel through copper wire connected to the speaker. The speaker receives the pulses of electricity, which cause a paper cone in the speaker to vibrate. The vibrations from the paper cone push against the surrounding air, creating sound waves.

pulse: a regular beat

How a Microphone and Speaker Work



The principal speaks into a microphone.

Sound vibrations are picked up by the microphone and turned into pulses of electricity.

Pulses of electricity pass through a wire connected to a speaker.

The speaker receives the electric pulses, causing the speaker to vibrate.

The vibrations create sound waves.

CHAPTER 5

Studying Electricity

The word *electricity* came from the ancient Greek word *elektor* which means "beaming sun." The word *elector* was used by the Greeks to describe amber. Amber is tree sap that hardens into stone over millions of years. The Greeks noticed that when they rubbed amber against a piece of fur, the amber attracted dust, feathers, and other objects. They could not explain why this happened.

Dr. William Gilbert

Around 1600, a scientist named Dr. William Gilbert studied this effect that the Greeks had discovered. Gilbert determined that amber, when rubbed against fur, could be made "electric." He thought that the friction of rubbing the two materials together created the electricity.

Benjamin Franklin

In 1747, Benjamin Franklin had similar ideas. He thought that all materials contained a single kind of electrical fluid and that rubbing moves this unseen fluid from one material to another. Franklin defined the electrical fluid as positive and the lack of fluid negative. He proposed that the direction of electricity moves from positive to negative.

Hans Christian Oersted

Hans Christian Oersted was a professor of science at Copenhagen University in Denmark. In 1820 he set up demonstrations for friends and students. In one **demonstration**, he planned to show how an electric current heats a wire. He also planned a demonstration about magnetism. So he had a compass on hand.

While performing his demonstration about electricity, Hans Christian Oersted noticed that every time the electric current was switched on, the compass needle moved. This surprised him.

Hans Christian Oersted worked hard in the months that followed, trying to make sense out of what had happened. However, he could not explain why. He did not know it, but he discovered by accident that an electric current creates a magnetic field.

demonstration: showing how something works

Johnstone Stoney

During the 1800s scientists discovered that an electric charge had a natural unit, which could not be divided any further. In 1891, Johnstone Stoney called this unit an *electron*. Later J.J. Thomson discovered the particle which carried that charge and the name *electron* was applied to it.

All of these scientists were partially right. This was a good example of scientific research. A person thinks of why something occurs, studies it, and suggests an explanation. Each person learns from the next and challenges the explanation with new ideas and investigations. Over time, these scientific theories are proven correct or incorrect.

In this case, instead of electricity being caused by friction or being a fluid, over time we learned that it is the movement of electrical particles.

Thomas Edison

Thomas Edison was another person who studied electricity. In fact, he is the one who made the electric light bulb possible.

Scientists had learned that when electricity passes through a thin wire, the wire heats up and begins to glow. The problem was the wire kept burning up fairly quickly. In 1879, Edison focused on inventing a light bulb that would last longer and be more useful. Edison needed to find a material for the filament that would be strong enough to not burn up.

Edison tried several materials. The one that worked was ordinary cotton that had been soaked in carbon. He discovered that when electricity flowed through this filament, it glowed over a much longer period of time. Today's light bulbs are descendents of Edison's discovery.

Glossary

conductor—a material that carries electricity

demonstration—showing how something works

insulator—a material that keeps electricity from flowing

pulse—a regular beat

repel—to drive or force away

resistance—a measure of the power of a material to resist the flow of electricity

To Find Out More . . .

Want to learn more about electrical energy?

Try these books

Electricity (DK Eyewitness Books) by Steve Parker and Laura Buller. Dorling Kindersley, 2005.

What Is Electricity? (Rookie Read-About Science) by Lisa Trumbauer. Children's Press, 2004.

The Science of Electricity & Magnetism: Projects and Experiments With Electricity And Magnets (Tabletop Scientist) by Steve Parker. Heinemann, 2005.

Access these Web sites

NASAs Kids Science News Network
http://ksnn.larc.nasa.gov/home.html

The NASA Sci Files
http://scifiles.larc.nasa.gov/text/kids/D_ Lab/acts_ electric.html

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The Physical Setting

Electricity and Magnetism

Advanced Level

Assessments

Electrical Energy

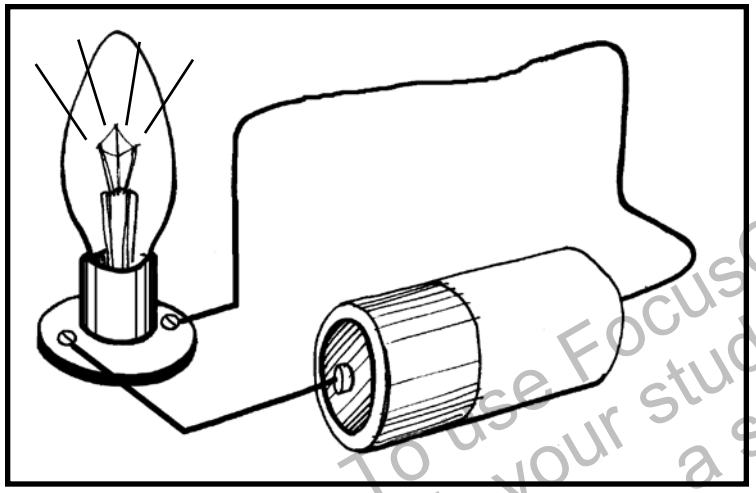
Print pages 20–22 of this PDF for the assessments.

Electrical Energy

Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

Use the diagram below to answer questions 1 and 2.



1. Energy flows through a filament in a light bulb. The flow of energy causes the filament to glow and give off light. Which type of energy produces the light?

Ⓐ thermal

Ⓑ sound

Ⓒ magnetic

Ⓓ electromagnetic

2. The diagram on the left shows an electric circuit using a battery, copper wire, and light bulb. The purpose of the copper wire is to

Ⓐ produce electricity

Ⓑ conduct electricity

Ⓒ store electricity

Ⓓ change the form of electricity

3. Some materials allow electricity to flow through them easily while other materials do not. What are materials that allow electricity to flow easily called?

_____

Provide an example of such a material.

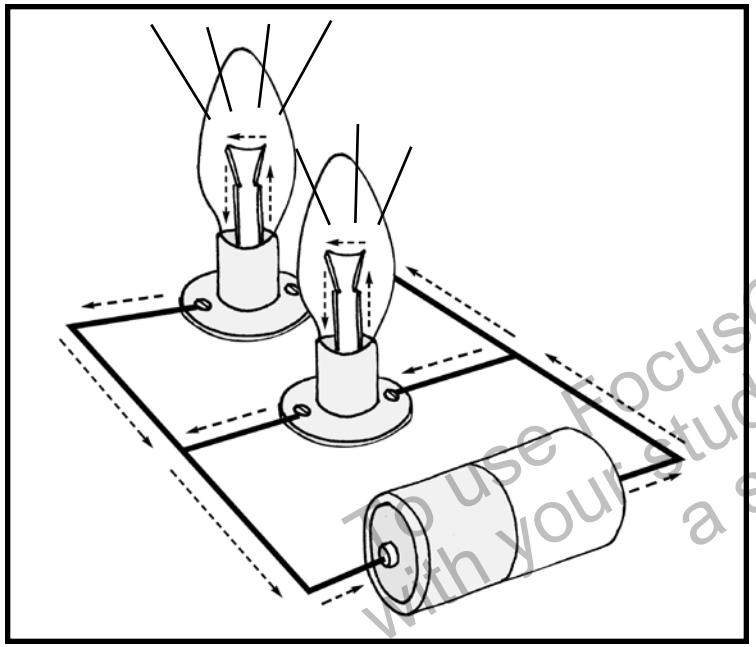
_____

Electrical Energy

Check Understanding

Write your answer on the lines provided.

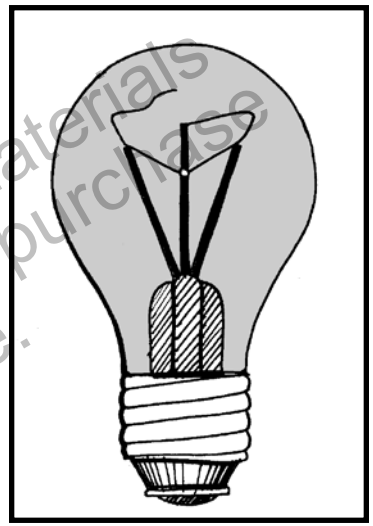
4. The diagram below shows and electric circuit.



Chemical energy from the battery is changed into electrical energy. Electrical energy is then changed into what other forms of energy?

_____ energy

5. Below is a diagram of a light bulb.



If you were to connect a battery and wires to this light bulb, would it light up? Circle your answer.

Circle one: Yes No

What forms of energy would be transfered by doing this?

_____

Electrical Energy

Assessment Scoring Guidelines

1. Answer A is correct. The filament heats up and starts to glow creating light.

2. Answer B is correct.

3. Conductor
Metals such as copper

4. Light and heat energy.

5. No

Energy would not be transfered because it is a closed circuit. Electricity cannot flow through the circuit.

The Physical Setting

Electricity and Magnetism

Advanced Level

English Language Arts Activities

Electrical Energy

Print pages 24–28 of this PDF for the reading activities.

Cause and Effect

TRY THE SKILL

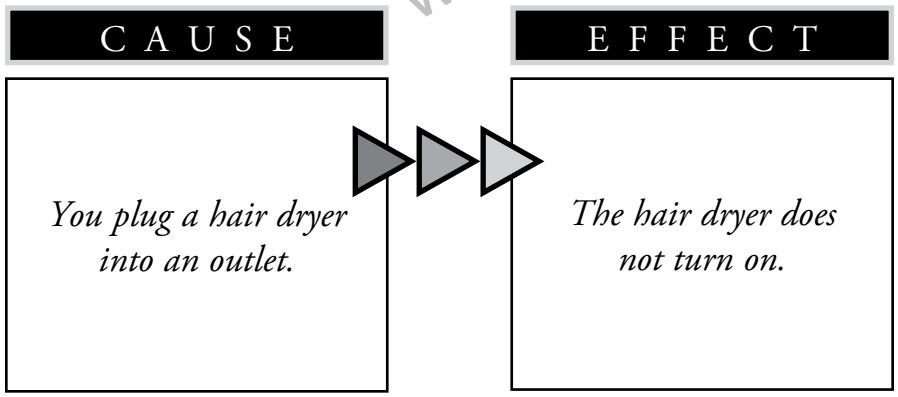
Causes and effects are related. To find an effect, you ask, "What happened?" To find a cause, you ask, "Why did that happen?" Read this passage from the book:

When you want to dry your hair, you plug a hair dryer into an electric outlet. The outlet is the power source. However, the hair dryer does not turn on. Why?

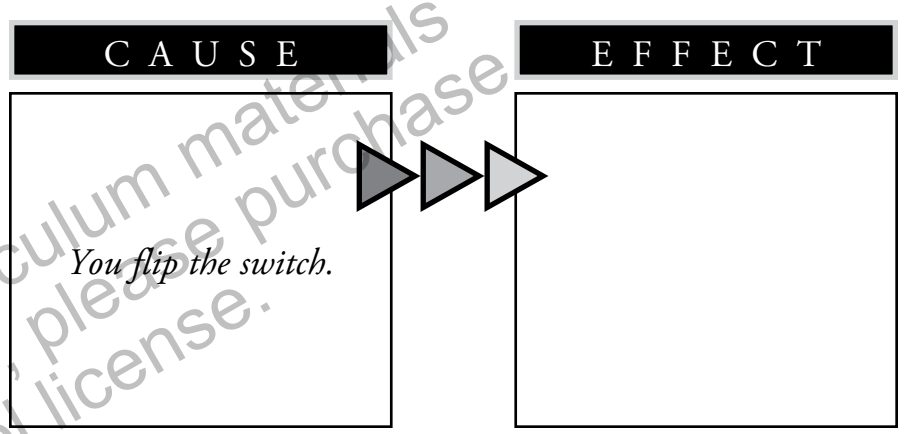
The hair dryer has a switch which opens and closes the electrical circuit. When you flip the switch, it closes the circuit. Electricity can now flow through the hair dryer.

The electricity passes through coiled wires. This causes the wires to become hot, similar to a filament in a light bulb. Electrical energy is now being turned into thermal energy.

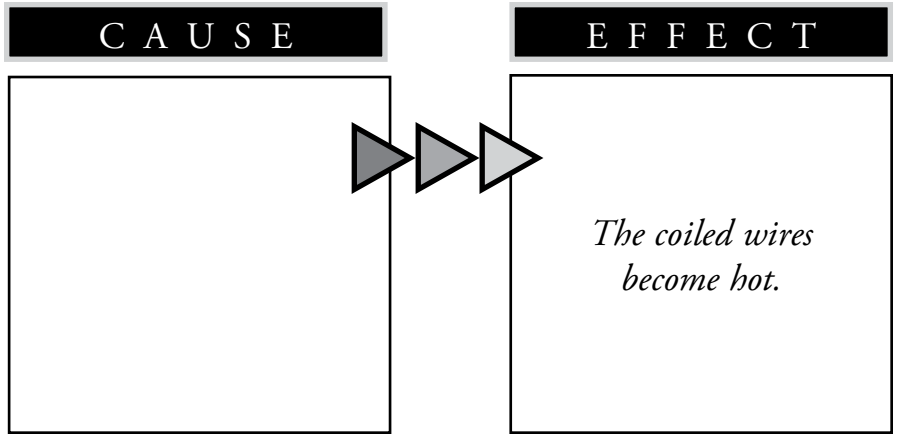
This graphic explains what happened.



Read the passage again. Then complete this graphic. Tell how the cause affects the electrical circuit.



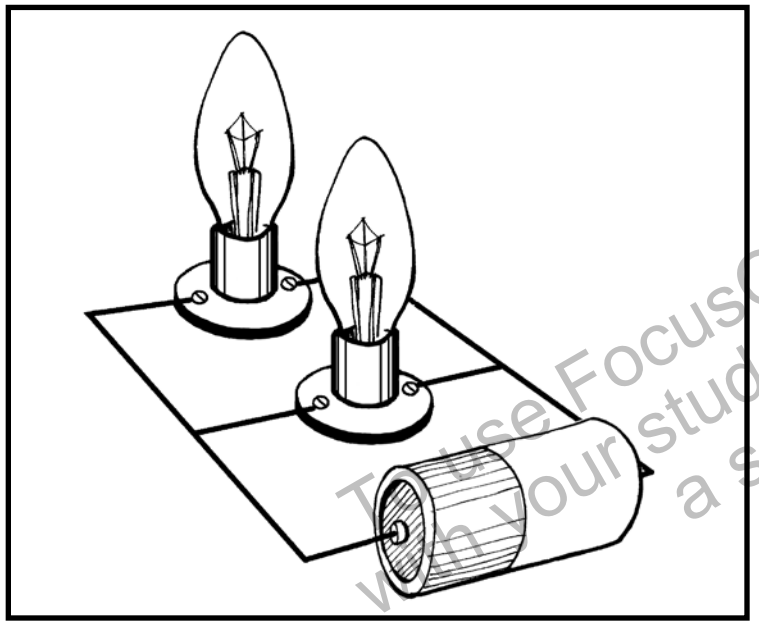
Now complete this graphic. Tell why the coiled wires become hot.



Interpret Graphic Information

TRY THE SKILL

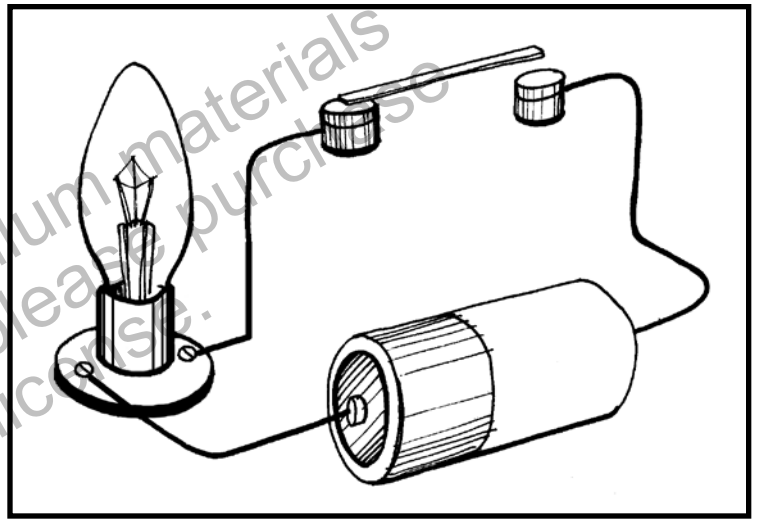
Graphic information is presented in diagram or chart form. For example, look at the following diagram of a parallel circuit.



What is a parallel circuit?

Two or more closed circuits connected together is called a parallel circuit.

Look at the diagram. Then answer the question.



1. What is an open circuit? How is it different from a closed circuit?

Multiple Meaning Words

The definition of a word can often be determined from the words that surround it in either the same sentence or nearby sentences. These words provide context clues. Context clues can help you learn new words.

Read these sentences from *Electrical Energy* and look for context clues to help you define *resistance*.

> Rubber is an insulator. It does not allow electricity to move through it. Rubber has a high resistance. When you touch an electrical cord, the rubber prevents the electricity from flowing from the copper wire to you.

Is this a good definition?

***Resistance* means to refuse to give in.**

No! This paragraph does not describe a person or group refusing to do something.

Is this a good definition?

***Resistance* means preventing the flow of electricity.**

Yes! *Resistance* means "the measure of how well a material allows electricity to move through it."

TRY THE SKILL

Read the sentences. Answer the question by shading the circle next to the correct answer.

1. When a switch is flipped, electricity can flow through the circuit, creating an electric current. Which word helps define the word current?

Ⓐ creating Ⓒ electrons
Ⓑ flow Ⓓ switch

2. Negative charges always repel each other, so the magnets pushed each other away. Which word helps define the word repel?

Ⓐ negative Ⓒ pushed
Ⓑ always Ⓓ charges

3. The switch breaks or separates the wire so the electricity has no place to go. What does the word switch mean?

Ⓐ something that changes a flow or path
Ⓑ a thin twig or stick
Ⓒ to move sharply
Ⓓ to change

Summarize Main Ideas

Summarizing means retelling what you have read. Summaries are often shorter than the text you read. Summarizing helps you understand what you read.

Read this paragraph from *Electrical Energy*. Then try to summarize it.

The magnetic field only exists when the electricity is flowing. When electricity stops, the magnetic field is gone. The discovery of this magnetic field was made by accident by Hans Christian Oersted in 1820. You'll read more about him in Chapter 5.

Is the following a good summary?

The discovery of magnetic fields happened by accident.

No! The statement is an interesting detail. It does not summarize the main idea. Is the following a good one?

The magnetic field only exists when electricity is flowing.

Yes! This is the main idea of the paragraph. You could also explain that when electricity stops flowing, the magnetic field is gone.

TRY THE SKILL

Read each paragraph. Then shade the circle next to its main idea.

1. How does electricity get to the light bulb? Electricity needs a link, or connection, in order to flow. This link is called a circuit. The word circuit comes from the word *circle*. This makes it easy to remember that electricity travels in a complete circle, also known as a closed circuit.

Ⓐ The word *circuit* comes from the word *circle*.

Ⓑ The link in electricity is called a circuit.

Ⓒ Electricity travels in a complete circle.

Ⓓ Electricity travels to the light bulb.

2. A light bulb has a tiny wire or filament in it. Electricity enters the light bulb and passes through the filament. It heats up and glows, creating light. After a while, the filament wears out and breaks. The electric circuit becomes open. Electricity can no longer flow through the filament. You have to buy a new light bulb with an unbroken filament.

Ⓐ When the wire is broken, the circuit in the light bulb becomes open.

Ⓑ The wire heats up and glows, creating light.

Ⓒ Electricity enters the light bulb and passes through a wire.

Ⓓ Wires can wear out and break.

Answer Key

Cause and Effect

Cause: You flip the switch.

Effect: The circuit becomes closed.

Cause: Electricity flowed through the coiled wires.

Effect: The coiled wires became hot.

Interpret Graphic Information

1. An open circuit contains a break in the wire so electricity can no longer flow freely through the wire. Electricity stops flowing in an open circuit. A closed circuit is one with an unbroken continuous path that electricity can freely flow through.

Context Clues

1. B

2. C

3. A

Summarize

1. C

2. A