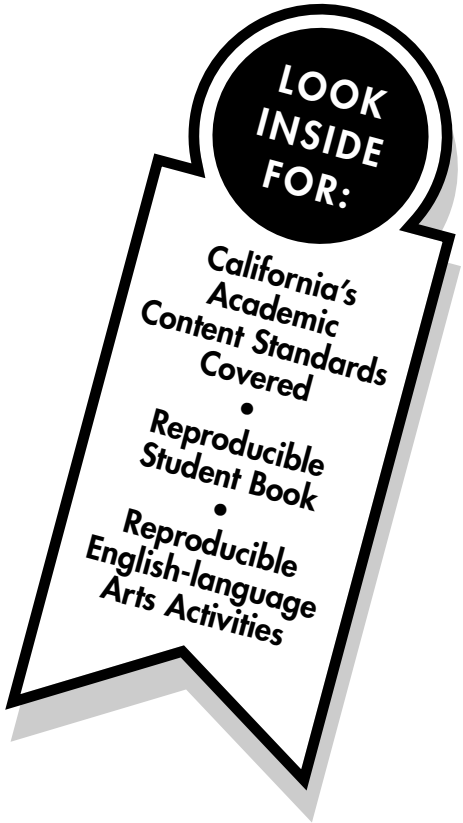
SCIENCE • GRADE 4

Above Level

California Content Standards
Physical Sciences: 1.A
Physical Sciences: 1.E
Physical Sciences: 1.F
Physical Sciences: 1.G

Electrical Energy



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Electrical Energy
California's Content Standards Met

GRADE 4 SCIENCE

PHYSICAL SCIENCES: 1—Electricity and magnetism are related effects that have many useful applications in everyday life. As a basis for understanding this concept:

a. Students know how to design and build simple series and parallel circuits by using components such as wires, batteries, and bulbs.

e. Students know electrically charged objects attract or repel each other.

f. Students know that magnets have two poles (north and south) and that like poles repel each other while unlike poles attract each other.

g. Students know electrical energy can be converted to heat, light, and motion.

GRADE 4 ENGLISH LANGUAGE ARTS

1.0 WORD ANALYSIS, FLUENCY, AND SYSTEMATIC VOCABULARY DEVELOPMENT

***Vocabulary and Concept Development 1.6*—**Distinguish and interpret words with multiple meanings.

2.0 READING COMPREHENSION

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.2*—**Use appropriate strategies when reading for different purposes (e.g., full comprehension, location of information, personal enjoyment).

***Comprehension and Analysis of Grade-Level-Appropriate Text 2.6*—**Distinguish between cause and effect and between fact and opinion in expository text.

1.0 WRITING STRATEGIES

***Organization and Focus 1.3*—**Use traditional structures for conveying information (e.g., chronological order, cause and effect, similarity and difference, posing and answering a question.

Above Level

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Student Book

Electrical Energy

Print pages 5–18 of this PDF for the student book.

How to Make the Student Book

- **The student book is contained on pages 5–18 of this PDF. It begins on the next page.**
- **To make one student book, or a two-sided master copy that can be photocopied, you will print on both sides of seven sheets of 8.5" x 11" paper.**
- **Do a test printout of one book first to familiarize yourself with the procedure.**
- **Follow these instructions carefully.**

First–Select the Paper

Since you will be printing on both sides of the sheets of paper, select a good quality white paper. We recommend using at least a 22lb sheet.

Second–Check Printer Settings

Be sure you have the correct page setup settings for your computer and printer. You will print these pages in landscape format.

Third–Print EVEN Pages

Open the PDF of the book you want to print. Select print from your file menu. In your printer's dialogue box enter pages 5–18 to print. Then select EVEN pages only. It is important to print only the EVEN pages first. Click "Print" to print the even pages. (**Important note**: The first page that prints will be blank. DO NOT discard this page. It will be needed to print the cover in the next step.)

Forth–Print ODD Pages

When the even pages have printed, flip the stack of pages over to print the odd pages. Place the stack back in your printer. Select print from the file menu again. In your printer's dialogue box, select pages 5–18 to print. Then select ODD pages. Click "Print" to print the odd the pages.

Fifth–Fold the Book

You now have a complete book. Check to be sure the pages are in the correct order with the book's cover as the top page. Then fold the stack of paper in half.

Sixth–Staple the Book

Use an extended-length stapler to staple the pages together. Place two staples in the spine of the book.

Please Note

Printers vary in how they output pages. Do a test printing of one book and adjust the procedure as necessary.

If you want to make a one-sided master copy, print ALL pages 5–18 at once. Then select "one-sided to two-sided" on the copy machine.

AL

Electrical Energy
California's Content Standards Met

GRADE 4 SCIENCE

PHYSICAL SCIENCES: 1—Electricity and magnetism are related effects that have many useful applications in everyday life. As a basis for understanding this concept:

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GRADE 4 ENGLISH LANGUAGE ARTS

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SCIENCE • GRADE 4

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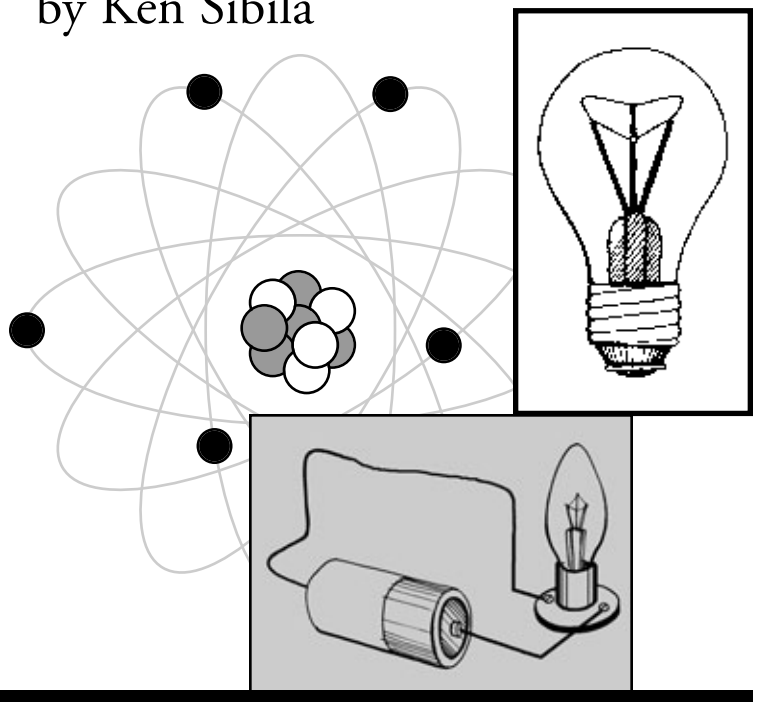
Electrical Energy

by Ken Sibila



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Electrical Energy

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Table of Contents

INTRODUCTION

What Is Electricity?

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? To answer these questions, you must first understand the building block of the universe—the atom.

CHAPTER 1

The Atom

All matter in the universe is made up of atoms. Every star, every planet, every animal—even you—are made of atoms. Atoms are very, very tiny particles. Millions of atoms can fit on the head of a pin.

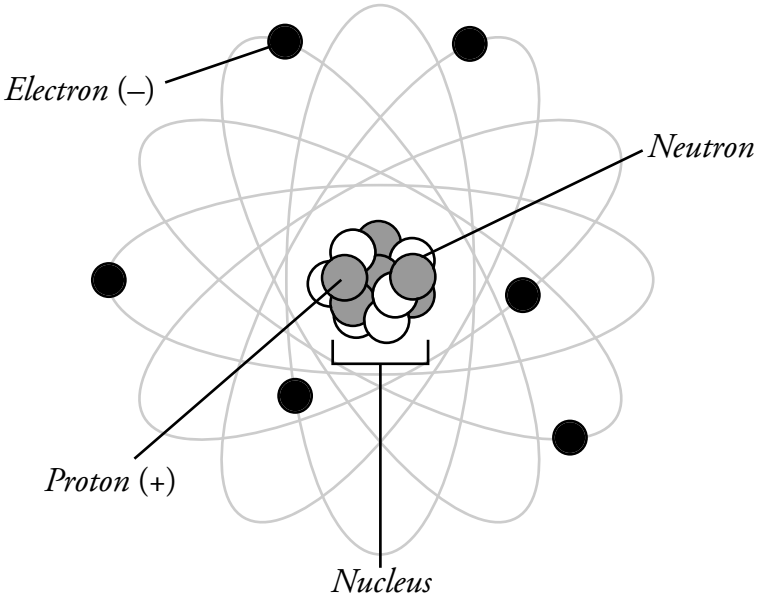
Imagine you have a piece of aluminum. Cut it into halves. Then cut it in half again. Keep cutting it again and again. Soon you will have a piece so small you can't see it without a **microscope**. The piece is very small, but it is still aluminum. If you could keep dividing it into smaller pieces, you would finally get to the smallest piece of aluminum possible. That would be an atom. If you divided the atom into smaller pieces, it would no longer be aluminum.

Scientists have so far discovered over 100 different atoms. Everything you see (and many things you don't see) are made of different combinations of these atoms.

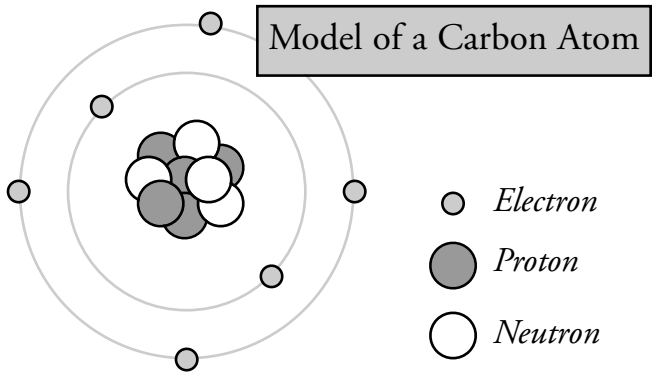
microscope: a tool that makes very tiny objects look larger so they can be seen and studied

Parts of an Atom

An atom looks sort of like our solar system with the sun in the center and the planets spinning around the sun. The center of an atom is called the nucleus. The nucleus is made of tiny, tightly packed particles called protons and neutrons. Spinning around the nucleus, like planets spinning around the sun, are electrons. These electrons spin around in clouds, or shells, away from the nucleus. Each atom has a specific number of protons, neutrons, and electrons.



For example, carbon is an **element** that can be found in coal and diamonds. A carbon atom has six protons, six neutrons, and six electrons.



Protons, neutrons, and electrons are different from each other. One way they are different is their electrical charge. Protons have a positive charge. Electrons have a negative charge. Neutrons have no charge. They are said to be neutral.

The positive charge of one proton is equal in strength to the negative charge of one electron. Therefore, when an atom has the same number of protons and electrons, the atom has no charge. The atom is said to be electrically balanced or neutral. All atoms want to be balanced.

element: any substance which cannot be broken down into another substance except by splitting its atom

Electrons Can Move

So, what do atoms have to do with turning your TV on? Some atoms hold their spinning electrons very tightly, especially the electrons nearest the nucleus. Some atoms allow electrons farther away from the nucleus to leave the atom easily.

An atom that loses an electron has one more proton and becomes positively charged. An atom that gains electrons is negatively charged. An atom that has a positive or negative charge is called an **ion**.

Since atoms want to be balanced, a positively charged ion will accept an electron to fill the place of the missing one. Free electrons find unbalanced ions to hook up with.This movement of electrons creates a flow of electricity. That is what electricity is—the flow of electrons from one atom to another.

Explain what creates the flow of electricity.

ion: an atom or group of atoms that has a positive or negative electrical charge

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 atoms do not hold their electrons tightly to their nucleus. The electrons in copper easily flow from one atom to another creating an electric current.

Why is there rubber on the outside of the copper wire? Some types of material hold their electrons tightly to their nucleus. Electrons do not move through these materials well. 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 electrons to leave its atoms. 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 electrons

CHAPTER 2

Static Electricity

Electrons not only flow through material, they 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 additional electrons. The electrons spread through your body, creating a slight negative charge. When you reached for the metal doorknob, electrons 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 electrons. Parts of the clouds become negatively charged. The electrons seek out positive charges and jump from the clouds to the ground. This creates a huge spark in the sky called lightning.

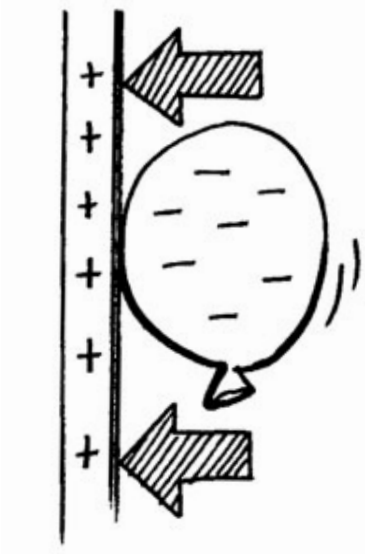
Explain what causes static electricity.

Atoms Attract

You know that positively charged atoms are attracted to negatively charged atoms. The atoms want to balance themselves by exchanging electrons. Here is a way 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 extra electrons from your hair. The balloon becomes negatively charged. The negatively charged atoms in the balloon were attracted the positive charged atoms in the wall causing the balloon to stick to the wall.

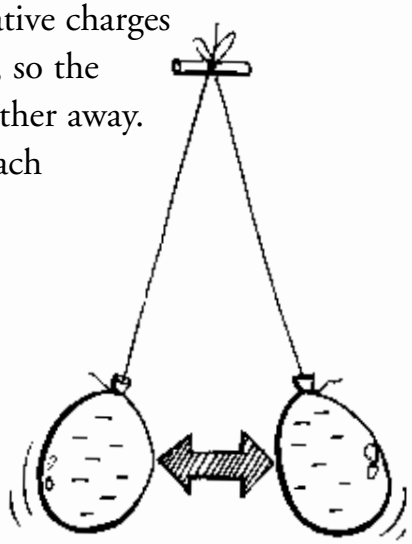


Atoms Repel

Atoms also repel. Atoms of similar charge will repel each other. For example an atom with a negative charge will repel another atom with a negative charge.

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 a negative charge. Negative charges always repel each other, so the balloons pushed each other away. Positive charges repel each other as well.

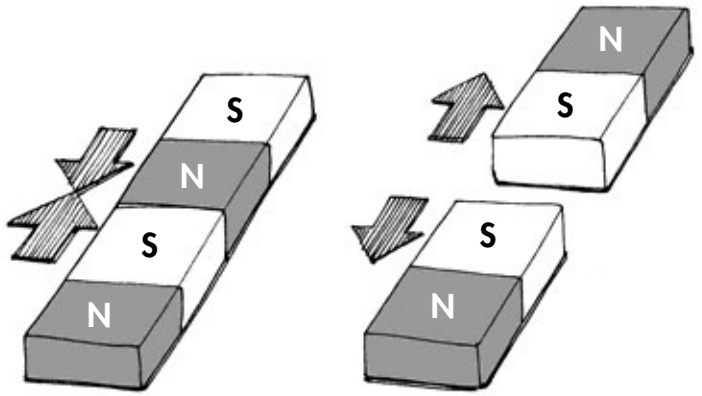


repel: to drive or force away

Magnets

Magnets are objects that attract some metals such as iron. There is a strong connection between electricity and magnetism. With electricity, two negative or two positive charges repel each other. A negative and positive charge attract each other. Magnets have north and south poles. 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.



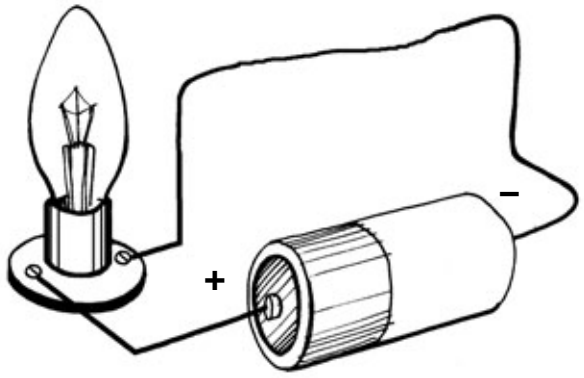
CHAPTER 3

Electric Circuits

Closed Circuit

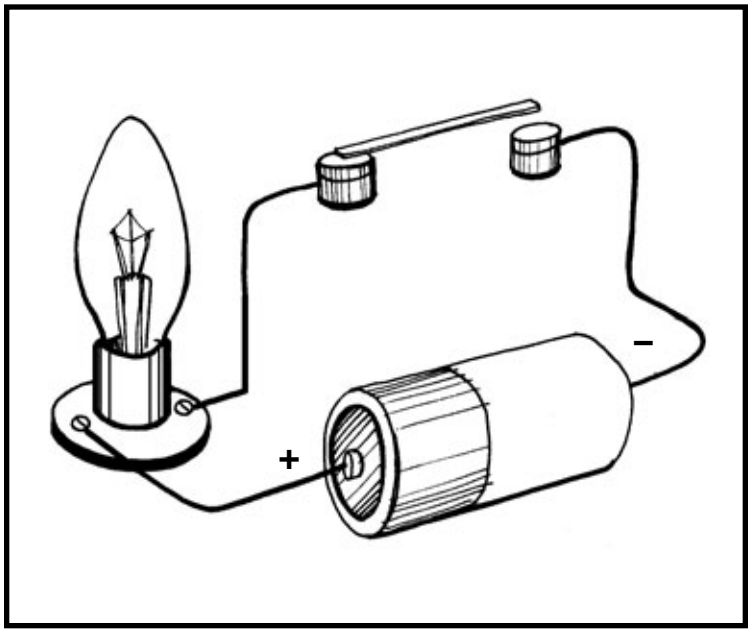
Electrons need a link, or connection, in order to flow from negative to positive. This link is called a circuit. The word *circuit* comes from the word *circle*. This makes it easy to remember that electricity travels in a complete circle, also known as a closed circuit.

Look at the diagram below. It shows a closed circuit. Electrons flow freely from the battery, through the wire, through the light bulb, and back to the battery. Nothing stops the flow of electrons. The electrons follow a connected, circular path.

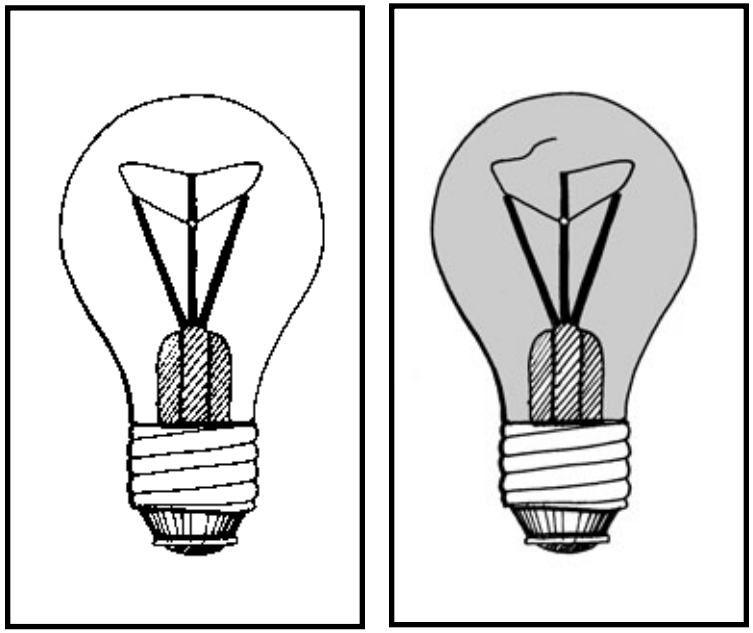


Open Circuit

Now 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 electrons have 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.



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

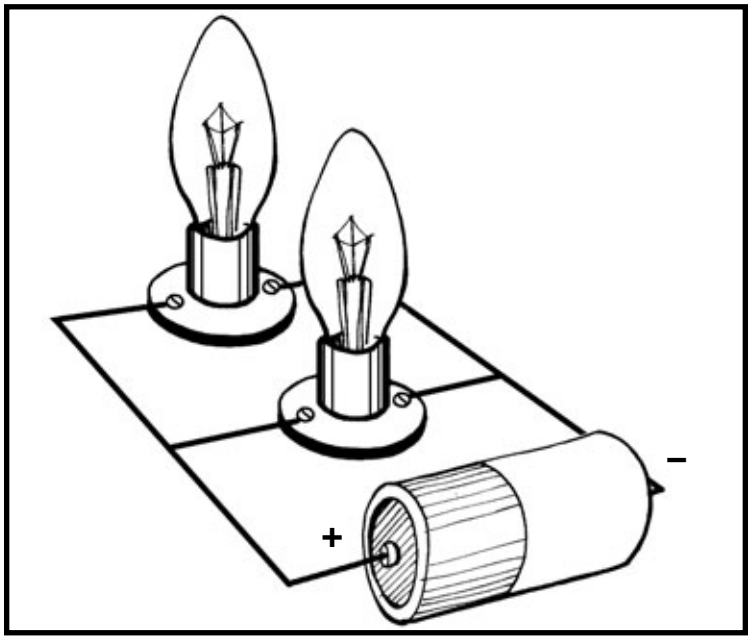


Which light bulb has a closed circuit?

Parallel Circuit

When there is only one circuit for electrons to flow through, you have what is called a series circuit. The diagram on page 14 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, the electrons can flow freely through an uninterrupted path.



CHAPTER 4

Electricity Is Energy

Electricity can be transformed into many other forms of energy including heat, light, sound, motion, as well as magnetic forces. Electrical energy is partially converted to heat and light when it flows through wires because the wires resist this flow.

Heat

You plug a hair dryer into an electric outlet and heat blows out. How does that happen? Electrons flow through a coiled piece of metal in the hair dryer. As the electrons zip along through the metal, they bump into the atoms that make up the metal. The friction, or resistance, of each impact heats up the atoms. The higher the resistance of the metal used, the more friction is created and the hotter the hair dryer gets.

Light

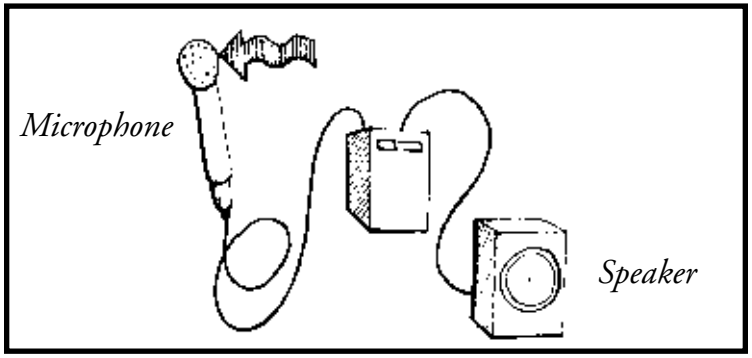
You already know how a light bulb works. An electric current passes through a thin wire. The electrons excite the atoms in the metal creating heat. When enough heat builds up, some of the heat energy turns into light energy.

Sound

When you listen to the morning announcements at school, you hear the principal's voice through a speaker. How does the voice travel from the office to other rooms in the school?

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 and causes 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

CHAPTER 5

Using Electricity Safely

What do you think would happen if a very strong current of electrons flowed through a tiny wire such as a filament in a light bulb? The wire would become very hot causing it to break. The wire is not thick enough to carry the strong current.

This is why electrical extension cor ds come in different sizes. High-current appliances, such as space heaters and microwave ovens have thicker wires to carry the strong current. Extension cords used for a desk lamp or radio can have thinner wires because these appliances do not use as much electric current.

Fuses and Circuit Breakers

You might not think that breaking a wire in an electric circuit is a good thing, but sometimes it is. Have you ever plugged several appliances into one electrical outlet? Maybe you plugged a lamp, a TV, your stereo, and your hair dryer into one outlet using an outlet expander. An outlet expander plugs into one outlet and allows you to plug more than one appliance into the single outlet.

If you used all four appliances at the same time, what might happen? They would create a strong current of electricity. If the wires in the outlet or the outlet expander are not thick enough to carry the current, heat would build up because of resistance. If the wires become overheated, they might catch on fire.

Fuses and circuit breakers attempt to prevent wires from overheating. If too much electrical power passes through a fuse or circuit breaker, they stop the flow of electricity.

For example, fuses are designed to burn up when too much electric current flows through them. They create a weak link in the electrical circuit. Because they burn up, they stop the flow of electricity preventing other wires from overheating and possibly catching on fire.

Electricity provides us with many benefits, however it must be used safely. Never plug too many appliances into one outlet. Be sure extension cords you use are the proper size for the appliance. Do not use extension cords or any appliances with wires that are worn or frayed.

Glossary

conductor—a material that carries electricity

element—any substance which cannot be broken down into another substance except by splitting its atom

insulator—a material that keeps electricity from flowing

ion—an atom or group of atoms that has a positive or negative electrical charge

microscope—a tool that makes very tiny objects look larger so they can be seen and studied

pulse—a regular beat

repel—to drive or force away

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

To Find Out More . . .

Want to learn more about electricity?

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, Childrens 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

Kid Zone: Electric Avenue
http://www.aecl.ca/kidszone/atomicenergy/electricity/index.asp

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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Above Level

ENGLISH-LANGUAGE ARTS • GRADE 4

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Comprehension and Analysis of Grade-Level-Appropriate Text: 2.6
Organization and Focus: 1.3

English-language Arts Activities

Electrical Energy

Print pages 20–24 of this PDF for the reading activities.

Cause and Effect

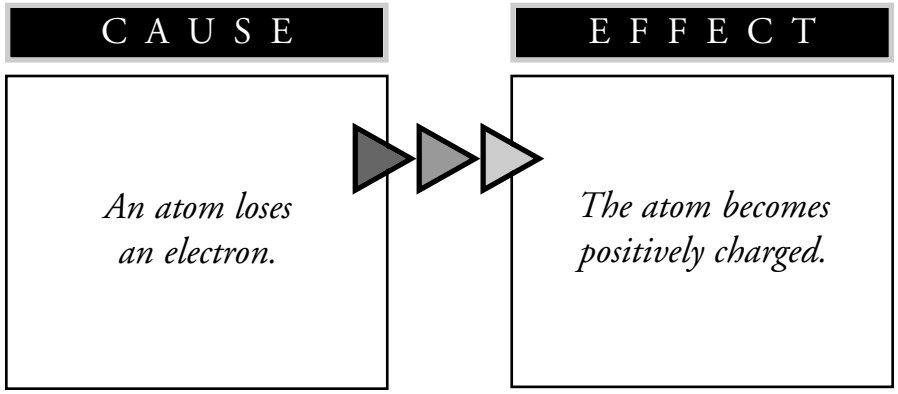
TRY THE SKILL

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

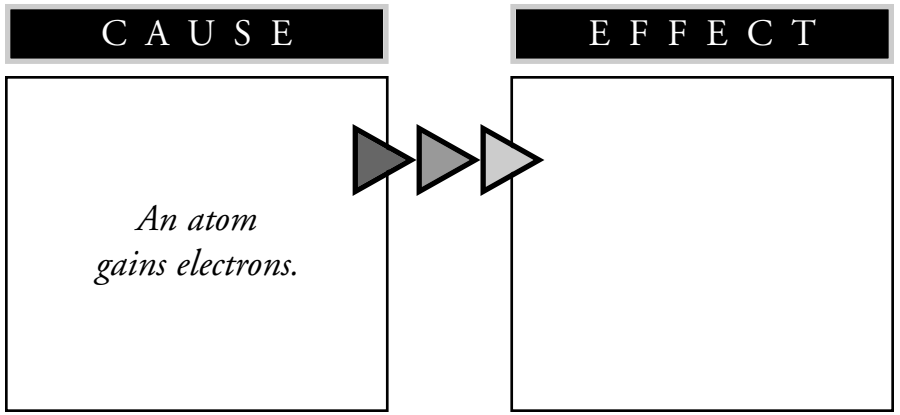
An atom that loses an electron has one more proton and becomes positively charged. An atom that gains electrons is negatively charged. An atom that has a positive or negative charge is called an ion.

Since atoms want to be balanced, a positively charged ion will accept an electron to fill the place of the missing one. Free electrons find unbalanced ions to hook up with.This movement of electrons creates a flow of electricity. That is what electricity is—the flow of electrons from one atom to another.

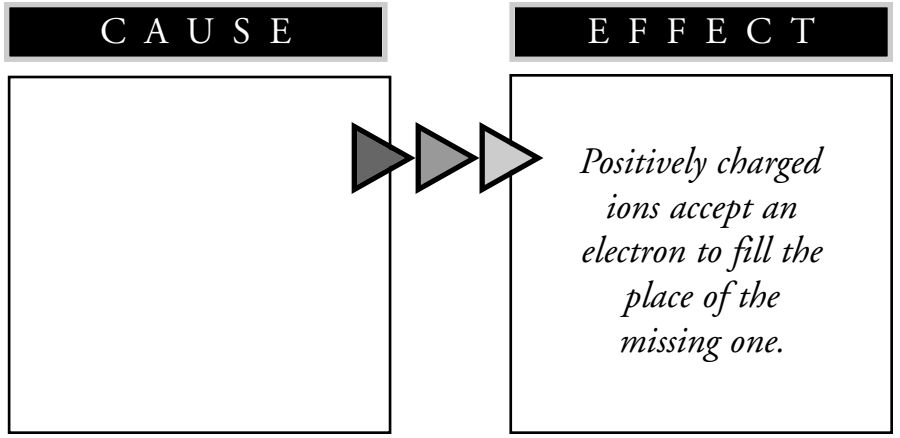
This graphic explains what happened.



Read the passage again. Then complete this graphic. Tell how the cause affects the charge of the atom.



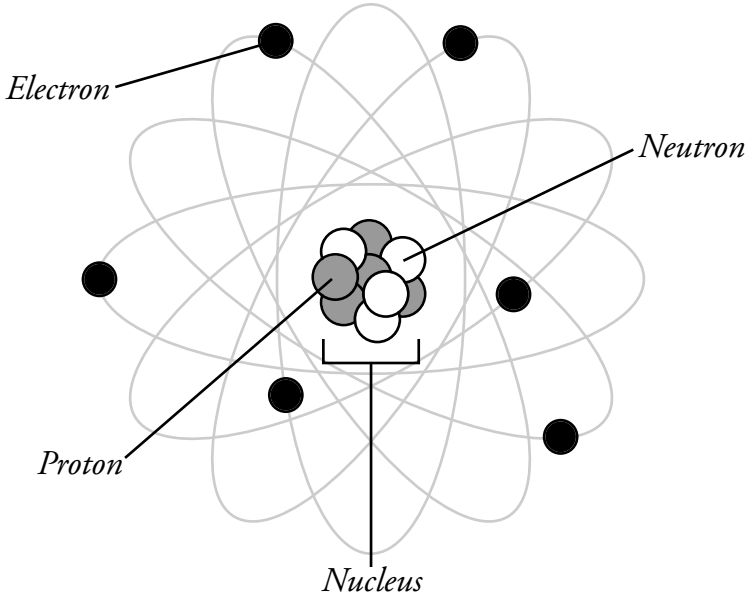
Now complete this graphic. Tell why positively charged ions accept missing electrons.



Interpreting Graphic Information

TRY THE SKILL

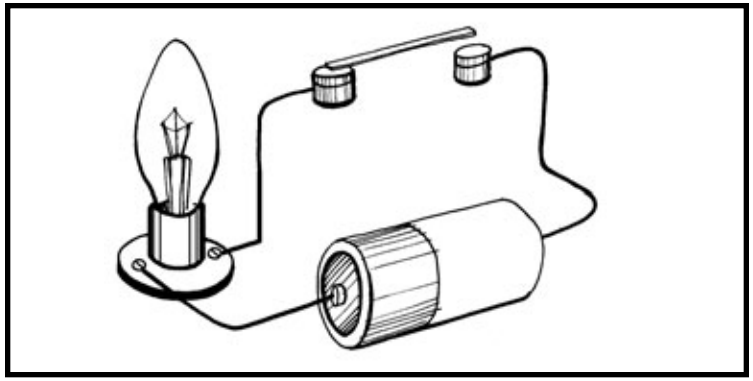
Graphic information is presented in diagram or chart form. For example, look at the following diagram of an atom.



What are the parts of an atom?

An atom contains a nucleus which is located in the center of the atom. The nucleus is comprised of protons and neutrons. Orbiting around the nucleus are electrons.

Look at the diagram. Then write a paragraph to answer the question. Use the back of this page if you need more space.



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 *balanced*.

> The positive charge of one proton is equal in strength to the negative charge of one electron. Therefore, when an atom has the same number of protons and electrons, the atom has no charge. The atom is said to be electrically balanced or neutral. All atoms want to be balanced.

Is this a good definition?

Balanced means the ability to keep steady.

No! This paragraph does not describe the ability of a body or object to not fall down.

Is this a good definition?

Balanced means equal in amount.

Yes! A balanced atom has an equal amount of protons and electrons.

TRY THE SKILL

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

1. The electrons in copper easily flow from one atom to another creating an electric current. Which word helps define the word *current*?

Ⓐ creating
Ⓑ flow
Ⓒ electrons

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

Ⓐ negative
Ⓑ always
Ⓒ pushed

3. The switch breaks or separates the wire so electrons have 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

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.

> Protons, neutrons, and electrons are different from each other. One way they are different is their electrical charge. Protons have a positive charge. Electrons have a negative charge. Neutrons have no charge. They are said to be neutral.

Is the following a good summary?

Protons, neutrons, and electrons are different from each other.

No! The statement is too vague. It does not summarize the main idea. Is the summary below a good one?

Protons, neutrons, and electrons are different because of their electrical charge.

Yes! This is the main idea of the paragraph. You could also explain the charge that each has to add more detail to your summary.

TRY THE SKILL

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

1. Since atoms want to be balanced, a positively charged ion will look for an electron to fill the place of the missing one. Free electrons look for unbalanced ions to hook up with.This movement of electrons creates a flow of electricity. That is what electricity is—the flow of electrons from one atom to another.

Ⓐ Free electrons look for unbalanced atoms.

Ⓑ Atoms want to be balanced.

Ⓒ Electricity is the flow of electrons from one atom to another.

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

Ⓐ 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.

Answer Key

Cause and Effect

Cause: An atom gains electrons.

Effect: The atom becomes negatively charged.

Cause: Atoms want to be balanced.

Effect: Positively charged atoms accept an electron to fill the place of the missing one.

Interpreting Graphic Information

1. An open circuit contains a break in the wire so electrons 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 electrons can freely flow through.

Multiple Meaning Words

1. B

2. C

3. A

Summarize Main Ideas

1. C

2. A