On Level

SCIENCE • GRADE 4

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

Electrical Energy

LOOK INSIDE FOR:

- California's Academic Content Standards Covered
- Reproducible Student Book
- Reproducible English-language Arts Activities

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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

2.0 READING COMPREHENSION

Structural Features of Informational Materials: 2.1—Understand how text features (e.g., format, graphics, sequence, diagrams, illustrations, charts, maps) make information accessible and useable.

Comprehension and Analysis of Grade-Level-Appropriate Text: 2.2—Ask questions and support answers by connecting prior knowledge with literal information found in, and inferred from, the text.

Comprehension and Analysis of Grade-Level-Appropriate Text: 2.4—Draw inferences, conclusions, or generalizations about text and support them with textual evidence and prior knowledge.

Comprehension and Analysis of Grade-Level-Appropriate Text: 2.5—Distinguish the main idea and supporting details in expository text.

On Level

SCIENCE • GRADE 4

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Physical Sciences: 1.A
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Physical Sciences: 1.G

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 22 lb 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.)

Fourth–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 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.

OL

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.

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GRADE 4 ENGLISH LANGUAGE ARTS

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FOCUS ON CALIFORNIA STANDARDS

SCIENCE • GRADE 4

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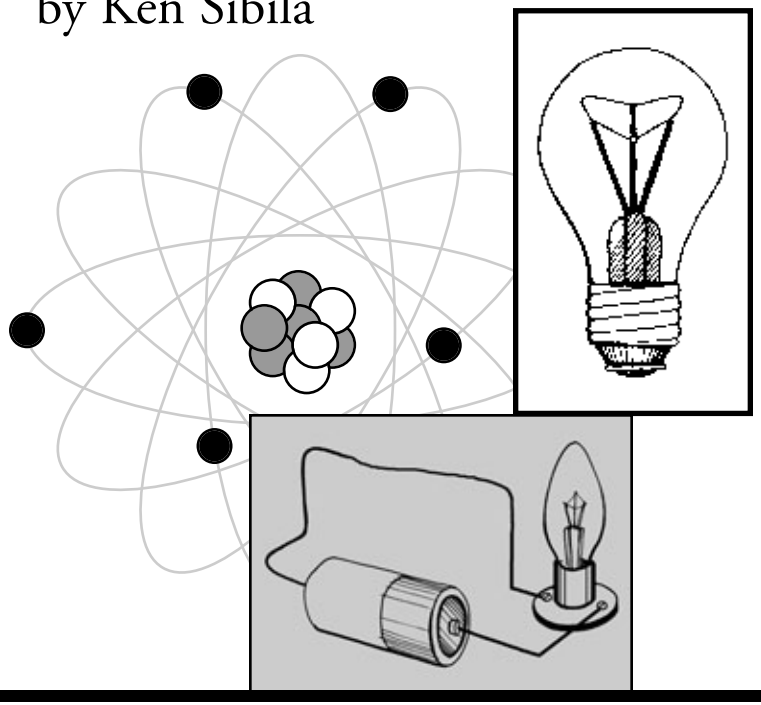
Physical Sciences: 1.F
Physical Sciences: 1.G

Electrical Energy

by Ken Sibila



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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

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

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

The appliances would create a strong current of electricity. If the wires are not thick enough to carry the current, heat would build up. If too much heat builds up, the wires might catch on fire.

Fuses attempt to prevent wires from overheating. If too much electrical power passes through a fuse, the wire in the fuse breaks and stops the flow of electricity.

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.

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.

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. If you used all four appliances at the same time, what might happen?

CHAPTER 1

The Atom

All matter in the universe is made up of atoms. Atoms are very, very tiny particles. Millions of atoms can fit on the head of a pin.

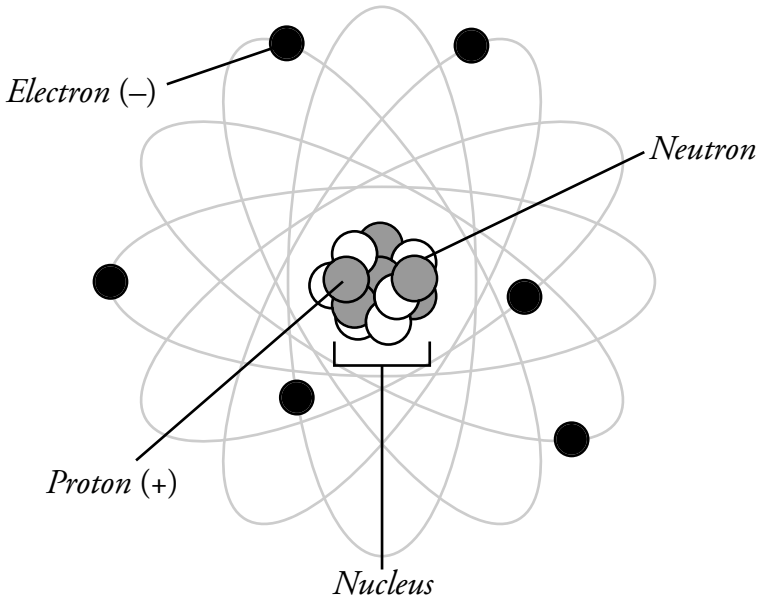
Imagine you have a piece of aluminum. Cut it into halves. Then cut it in half again. Keep cutting it again and again. Soon you will have a piece so small you can't see it without a **microscope**.

The piece of aluminum 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.

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

Parts of an Atom

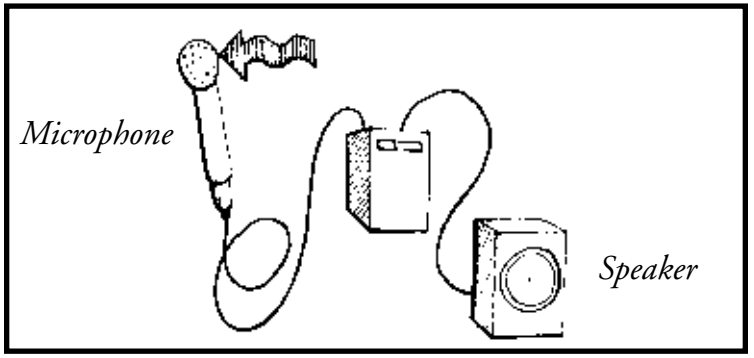
Think of atoms like our solar system with the sun in the center and the planets spinning around the sun. The center of an atom is called the nucleus. The nucleus is made of tiny, tightly packed particles called protons and neutrons. Spinning around the nucleus, like planets spinning around the sun, are electrons. Each atom has a specific number of protons, neutrons, and electrons.



Sound

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

When your principal speaks, sound waves from his or her voice cause vibrations in the air. These vibrations are picked up by a microphone and converted 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 4

Electricity Is Energy

Electricity can be transformed into many other forms of energy including heat, light, and sound as well as magnetic forces.

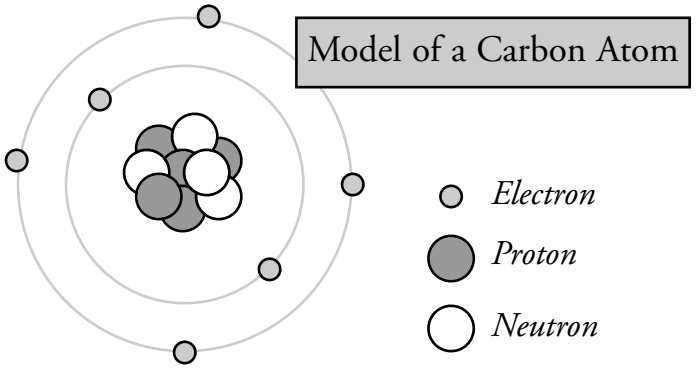
Heat

How does a hair dryer work? Electrons flow through a coiled piece of metal in the hair dryer and bump into the atoms that make up the metal. The friction of each impact heats up the atoms. Electrical energy converts to heat energy.

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.

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 have different electrical charges. Protons have a positive charge. Electrons have a negative charge. Neutrons have no charge.

The positive charge of one proton is equal in strength to the negative charge of one electron. When an atom has the same number of protons and electrons, the atom has no charge. The atom is said to be balanced. 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

Some atoms hold their spinning electrons very tightly. Some atoms allow electrons 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**.

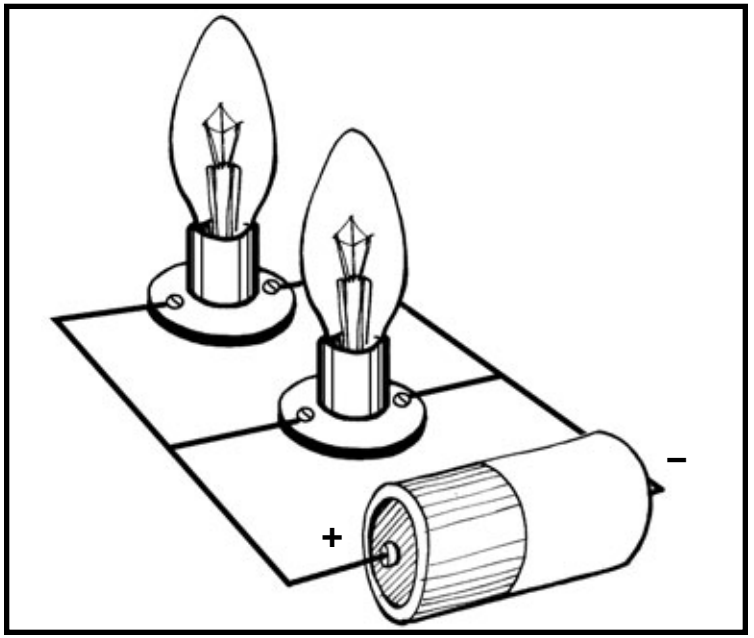
Since ions want to be balanced, a positively charged ion will accept an electron to fill the place of the missing one. Free electrons find unbalanced ions. This movement of electrons creates a flow of electricity. That is what electricity is—the flow of electrons from one atom to another.

Explain what creates the flow of electricity.

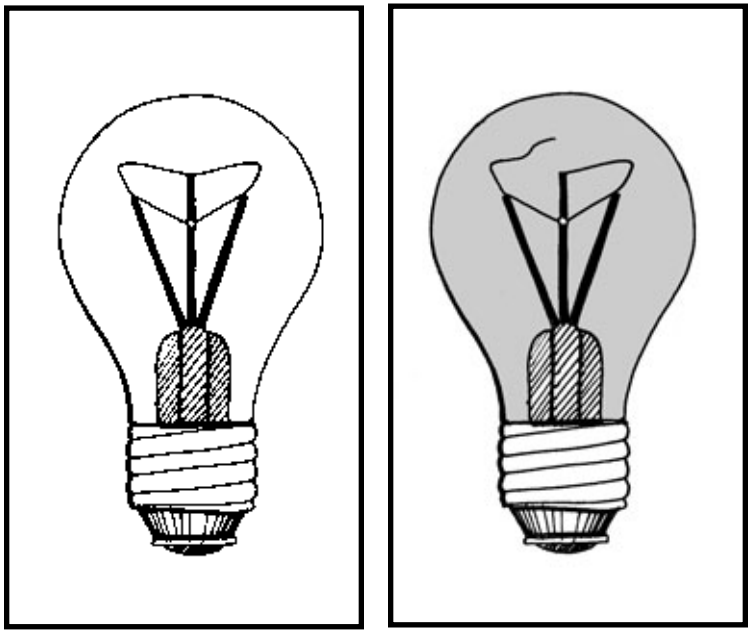
ion: an atom or group of atoms that has a positive or negative electrical charge

Parallel 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.



Here is another example of a circuit. 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?

Your TV has an electric cord that you plug into an outlet. The cord is made of copper wire on the inside and rubber on the outside. Copper is a good **conductor** of electricity. The electrons in copper easily flow from one atom to another creating an electric current.

The rubber on the outside of the cord is an **insulator**. Insulators do not allow electrons to leave their atoms. Therefore, they do not carry an electric current.

The measure of how well a material allows electricity to move is called **resistance**. Rubber has a high resistance. When you touch an electric 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

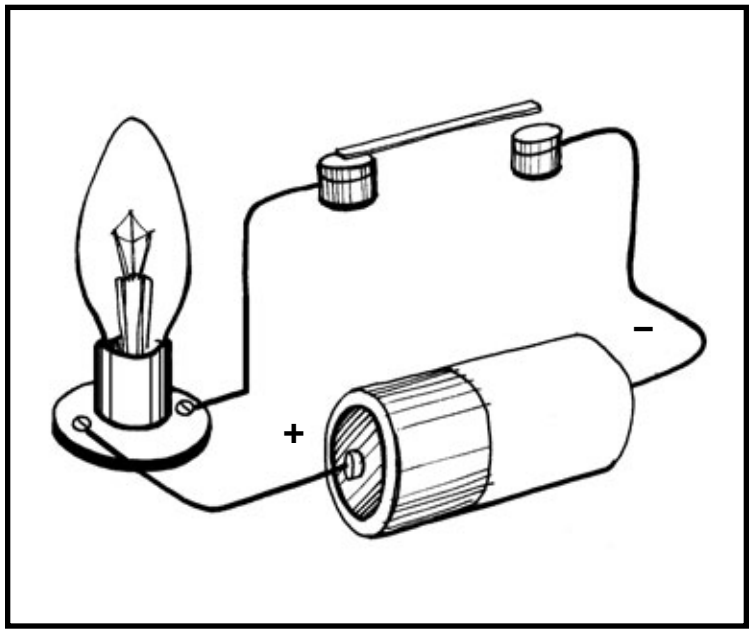
Electrons not only flow through material, they can also jump from one object to another.

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.

Explain what causes static electricity.

Open Circuit

Now look at this diagram. It also shows an open circuit. A switch has been placed between a section of the wire. The switch 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.



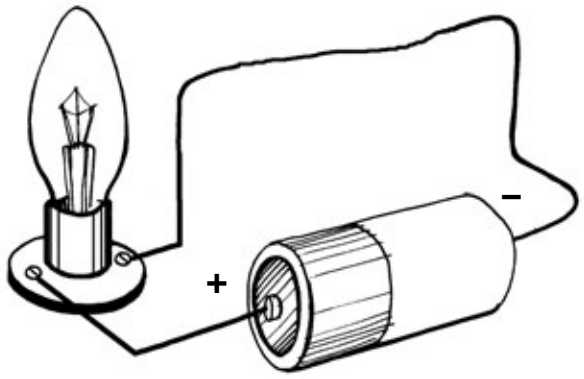
CHAPTER 3

Electric Circuits

Closed Circuit

Electrons need a link in order to flow from negative to positive. This link is called a circuit. 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.

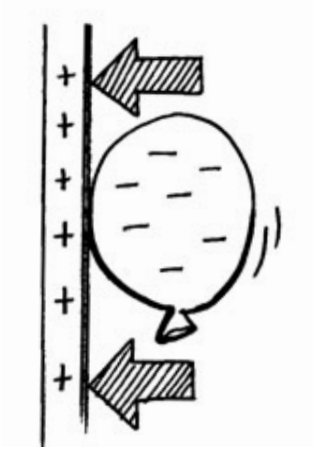


Atoms Attract

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. 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, the balloon picked up extra electrons from your hair. The balloon becomes negatively charged. The negatively charged atoms in the balloon were attracted to the positive charged atoms in the wall causing the balloon to stick to the wall.

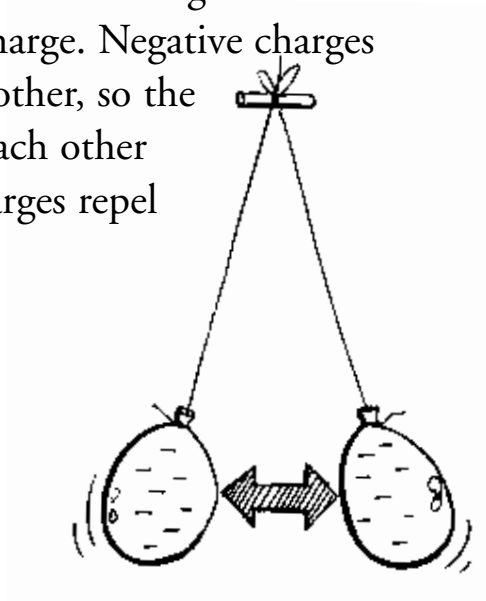


Atoms Repel

Atoms also repel. 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.

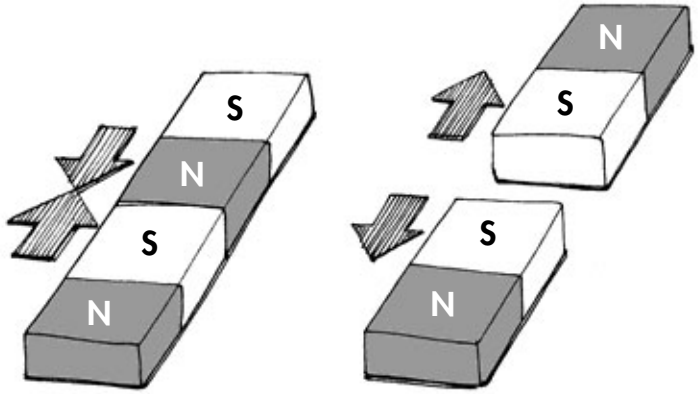
Rubbing the two balloons gave each of them a negative charge. Negative charges always repel each other, so the balloons pushed each other away. Positive charges repel each other as well.



repel: to drive or force away

Magnets

Magnets are objects that attract some metals. 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.



ENGLISH-LANGUAGE ARTS • GRADE 4

On Level

California Content Standards
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.2
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.4
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.5
Structural Features of Informational Materials: 2.1

English-language Arts Activities

Electrical Energy

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

Make Inferences

When you read, it is important to think about what you read and make inferences based on what you already know. You should be able to support your inferences with details from the book.

Here is a paragraph from *Electrical Energy*. The graphic organizer below shows one inference you can make and the details that support it.

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. Electricity lights up your home, cooks your food, and powers your computer. It is hard to imagine living without electricity.

Inference

Electricity is important in our lives.

Supporting Details

- Electricity lights up our homes.
- Electricity cooks our food.
- Electricity powers our computers.

TRY THE SKILL

Read this passage.

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 or disproven correct.

Now complete this graphic.

Inference

Supporting Details

Question and Answer

You can monitor your understanding of what you read by asking questions about the topic and then reading to find the answer. Sometimes authors will even write a question in the text and then answer it. Read the paragraph from *Electrical Energy*.

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.

What question could you ask?

What causes static electricity?

What is the answer?

Static electricity is caused by electrons jumping to an object with a positive charge.

TRY THE SKILL

1. **Read the question. Then write an answer in your own words.**

   What is a parallel circuit?

2. **Now think of another question you could ask based on *Electrical Energy*. Write the question. Then, write an answer in your own words.**

   Question:

   Answer:

Main Idea and Supporting Details

The main idea is the writer's main point. Supporting details give more information about this main idea.

Here is a paragraph. The graphic organizer shows the main idea and supporting details.

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.

Main Idea

Dr. Gilbert believed that friction created electricity.

Supporting Details

- He studied findings from the ancient Greeks.
- He investigated the effect of rubbing amber against fur.

TRY THE SKILL

Read this paragraph from *Electrical Energy*.

Here is another example of a circuit. 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.

Now complete this graphic.

Main Idea

Supporting Details

Graphic Organizers

Graphic organizers help you organize information. You can use graphic organizers to help explain main points in your reports. You can also create a graphic organizer to help yourself understand and remember what you read.

Here are some common graphic organizers.

- **Time lines** show events in the order they occurred. One might show a time line of scientific discoveries.
- **Line graphs** show changes over time. For example, a line graph could show changes in the temperature over the past 100 years.
- **Charts** can classify information into groups or categories. For example, a chart could show annual, biennial, and perennial plants. Charts can also help you record observations during an experiment.
- **Venn diagrams** are two overlapping circles. They help you compare and contrast two things. You describe each thing in one circle. Then you tell how they are alike in the overlapping part.

TRY THE SKILL

Use the words below to complete this chart. Write the words that go under each heading.

conductor	open	neutrons	nucleus	insulator
parallel	resistance	electrons	closed	protons

Parts of Atoms	Properties of Materials	Types of Circuits

Answer Key

Make Inferences

Inference: Ideas change as new knowledge is gained.

Supporting Details: People think of ideas to explain our world and investigate their ideas. They then suggest why things occur or how things work. Others test those ideas and either prove them correct or suggest other ideas. Each person learns from the next.

Question and Answer

1. A parallel circuit is one in which two or more circuits are connected together.

Main Idea and Supporting Details

Main Idea: A working light bulb is a closed circuit.

Supporting Details: Electricity enters the light bulb and passes through a filament. The filament heats up and glows creating light. If the filament breaks, the circuit becomes open and the bulb no longer works.

Graphic Organizers

Parts of Atoms

electrons neutrons protons nucleus

Properties of Materials

conductor insulator resistance

Types of Circuits

open closed parallel