

On Level



SCIENCE • GRADE 4

California Content Standards
Physical Sciences: 1.B
Physical Sciences: 1.C
Physical Sciences: 1.D
Physical Sciences: 1.E
Physical Sciences: 1.F
Investigation and Experimentation: 6.F

Electromagnetic Energy

FOCUScurriculum

Curriculum materials for **your** content standards

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LOOK
INSIDE
FOR:

California's
Academic
Content Standards
Covered

•
Reproducible
Student Book

•
Reproducible
English-language
Arts Activities

Electromagnetic 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:

- b.** Students know how to build a simple compass and use it to detect magnetic effects, including Earth's magnetic field.
- c.** Students know electric currents produce magnetic fields and know how to build a simple electromagnet.
- d.** Students know the role of electromagnets in the construction of electric motors, electric generators, and simple devices, such as doorbells and earphones.
- 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.

INVESTIGATION AND EXPERIMENTATION: 6—Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- f.** Follow a set of written instructions for a scientific investigation.

GRADE 4 ENGLISH LANGUAGE ARTS

1.0 WORD ANALYSIS, FLUENCY, AND SYSTEMATIC VOCABULARY DEVELOPMENT

Vocabulary and Concept Development 1.2—Apply knowledge of word origins, derivations, synonyms, antonyms, and idioms to determine the meaning of words and phrases.

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 2.3—Make and confirm predictions about text by using prior knowledge and ideas presented in the text itself, including illustrations, titles, topic sentences, important words, and foreshadowing clues.

Comprehension and Analysis of Grade-Level-Appropriate Text 2.5—Compare and contrast information on the same topic after reading several passages or articles.

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Student Book

Electromagnetic 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.

Electromagnetic Energy

California's Content Standards Met

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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:

- b. Students know how to build a simple compass and use it to detect magnetic effects, including Earth's magnetic field.
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- 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.

INVESTIGATION AND EXPERIMENTATION: 6—Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- f. Follow a set of written instructions for a scientific investigation.

GRADE 4 ENGLISH LANGUAGE ARTS

1.0 WORD ANALYSIS, FLUENCY, AND SYSTEMATIC VOCABULARY DEVELOPMENT

Vocabulary and Concept Development 1.5—Use a thesaurus to determine related words and concepts.

2.0 READING COMPREHENSION

Structural Features of Informational Materials 2.1—Identify structural patterns in informational text (e.g., compare and contrast, cause and effect, sequential or chronological order, proposition and support) to strengthen 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.

SCIENCE • GRADE 4

California Content Standards

Physical Sciences: 1.B

Physical Sciences: 1.C

Physical Sciences: 1.D

Physical Sciences: 1.E

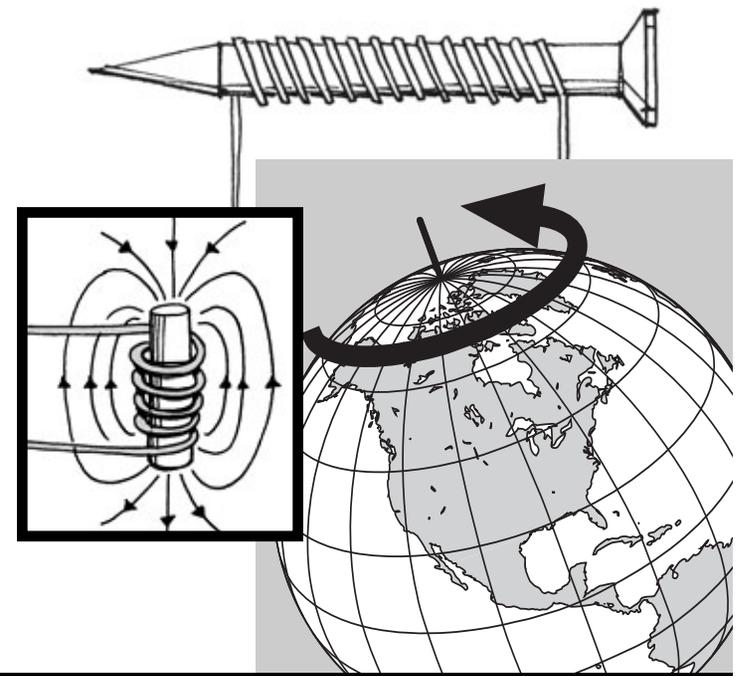
Physical Sciences: 1.F

Investigation and Experimentation: 6.F



Electromagnetic Energy

by Ken Sibila





SCIENCE • GRADE 4

California Content Standards

Physical Sciences: 1.B

Physical Sciences: 1.C

Physical Sciences: 1.D

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Electromagnetic Energy

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INTRODUCTION

Electrical Charges

Electricity and magnetism are related. Electricity is the movement of charged particles. The particles that move are negatively charged electrons.

For example, rub a balloon full of air against your hair. Then hold it against a wall. It sticks to the wall. Why?

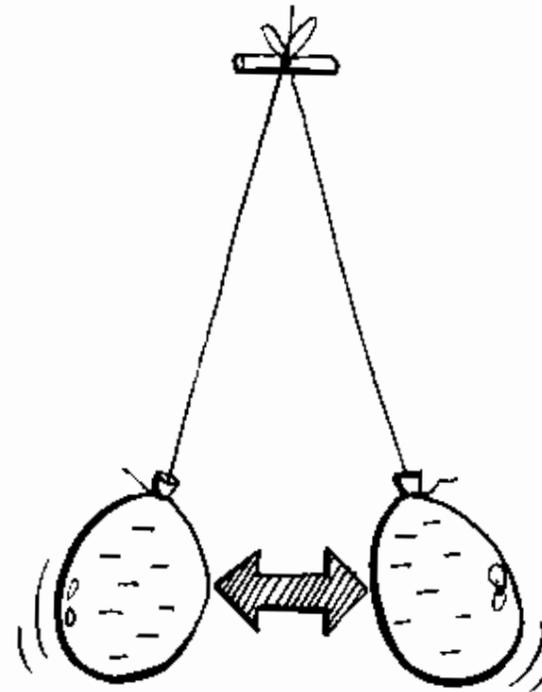
When you rubbed the balloon against your hair, the balloon picked up extra electrons and a negative charge. The negatively-charged balloon **repels** other negative particles in the wall leaving positively charged particles near its surface of the wall. The balloon is attracted to those positive particles and sticks to the wall. Opposites attract!



repel: to drive or force away

Objects with a similar charge repel each other. Take two balloons and tie a string to each one. Rub each balloon on wool or your hair. Then hold them by the strings and put them next to each other. The balloons will move apart.

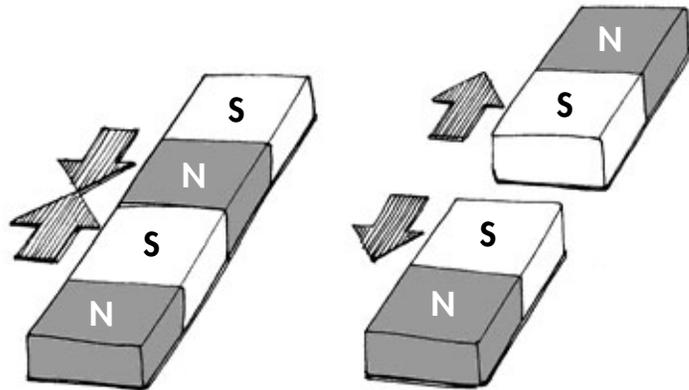
Rubbing the two balloons gives each of them a negative charge. Negative charges always repel each other. Likes repel!



What Are Magnets?

Magnets are objects that attract certain metals, such as iron. Magnets also have electrical charges. Every magnet has two ends, called poles. One pole is the magnetic north pole (N). The opposite end is the magnetic south pole (S).

If you put opposite poles of two magnets close together, they will pull each other together. If you put similar poles close together, they will repel each other.

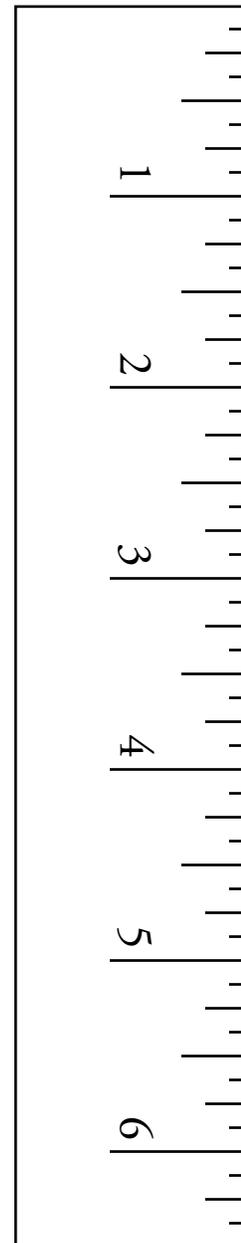


Opposite poles attract each other.

Like poles repel each other.

Try It Yourself!

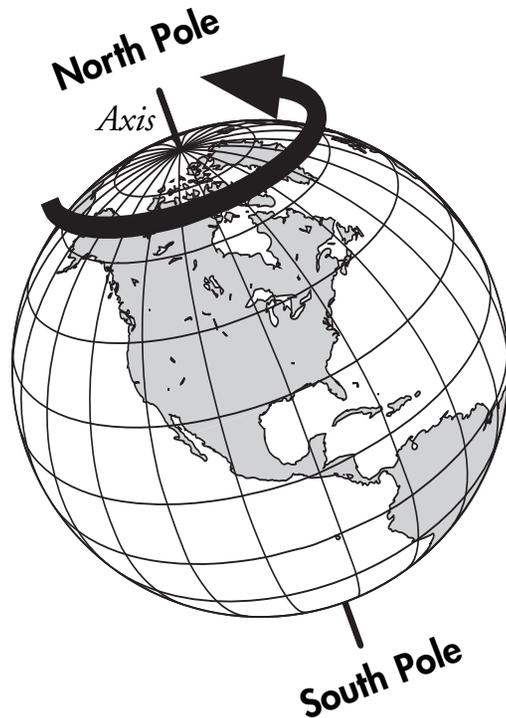
Gather different sized bar magnets. Place one magnet at the end of this ruler. Place the other magnet several inches away. Slide the magnet toward the one at the end of the ruler. Record and compare the distance between the magnets when the one at the end moves.



Distance 1
Distance 2
Distance 3

Earth Is a Magnet

Earth is one giant magnet. The core of Earth is **molten** iron and nickel. These melted metals move as Earth rotates on its **axis**. This movement is believed to be the cause of Earth's magnetic field. Earth has north and south poles, just like magnets.

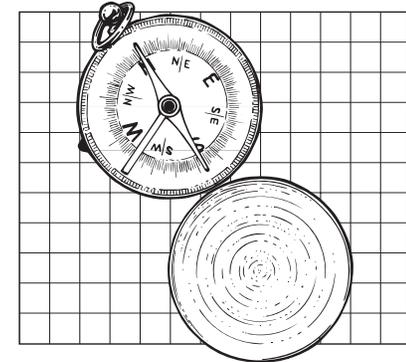


molten: melted by heat
axis: a real or imaginary line about which something turns

How a Compass Works

We can sense Earth's magnetism when we use a compass. A compass is a simple **device**. A small magnet is placed on a **pivot** point. This magnet is called the needle. The magnet in the compass lines up with the huge but weak magnet in Earth. The south pole of the needle is attracted to the north pole of Earth.

A compass has a magnet which rests on a pivot point. The tip of one end of the magnet is attracted to Earth's north pole.



device: something made or invented for a special use
pivot: a point upon which something turns

Try It Yourself!

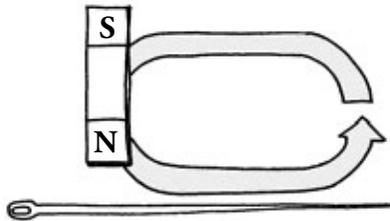
You can make your own compass. To create one, you will need the following:

Materials

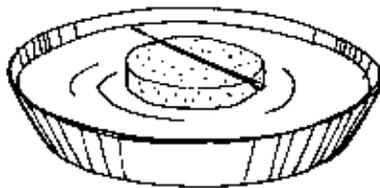
- craft needle
- cork or sponge
- magnet
- bowl filled with water

Procedure

1. Rub the magnet in the same direction along the needle 25 times.



2. Place the cork or sponge in the the bowl. Rest the needle on top.



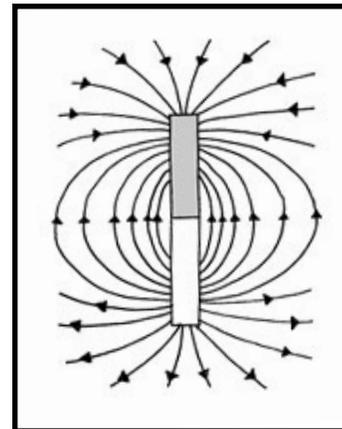
3. Observe what happens and record your observations in a journal.

Electromagnets

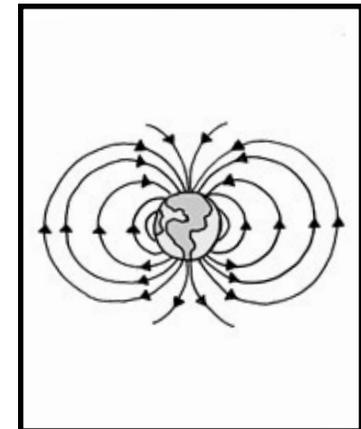
Magnetic Fields

A magnetic field is an area in which magnetic forces can be **detected**. The space surrounding a bar magnet is a magnetic field. The force of the magnetic field is strongest at the north and south pole. Earth also has a magnetic field.

Magnetic field of a bar magnet



Magnetic field of Earth



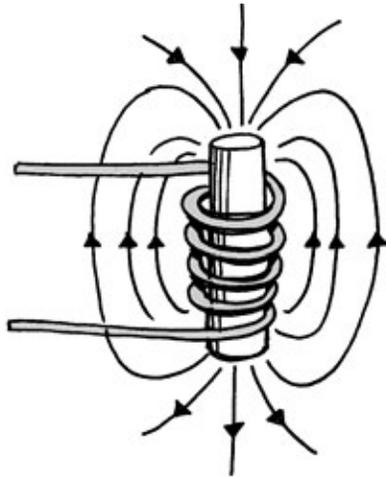
detected: discovered; noticed

Electricity Creates Magnetic Fields

When electricity flows through a wire, a weak magnetic field forms around the wire. The magnetic field can be made stronger if the wire is coiled around an iron bar. This creates a **temporary** magnet called an electromagnet.

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.

An electromagnet has a magnetic field similar to a bar magnet and Earth.



temporary: lasting only for a short time

Hans Christian Oersted

Hans Christian Oersted was a professor of science in Denmark. In 1820, he set up two **demonstrations**.



In one, he planned to show how an electric current heats a wire. The other was about magnetism, so he had a compass on hand.

Oersted was performing his demonstration about electricity. He noticed that every time the electric current was switched on, the compass needle nearby moved. For months, he tried to figure out why the compass needle moved, but he never could. He did not know it, but he discovered that an electric current creates a magnetic field.

demonstration: the act of showing, proving, or explaining

Try It Yourself!

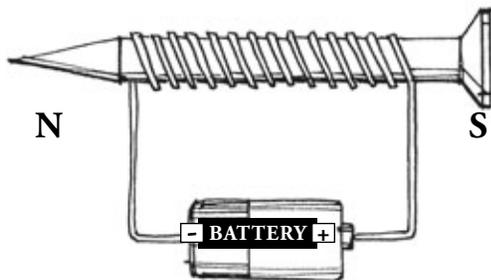
You can make your own electromagnet.

Materials

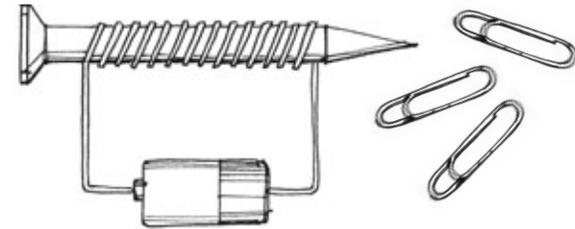
- copper wire with insulation
- 8d iron nail
- D battery
- tape
- small metal items such as paper clips, staples, and thumbtacks
- compass

Procedure

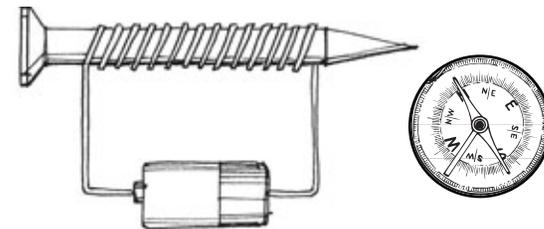
1. Wrap the copper wire around the nail ten or more times. Strip the insulation off both ends of the copper wire.
2. Attach one end of the wire to the negative (–) side of the battery with tape. Attach the other end to the positive side (+).



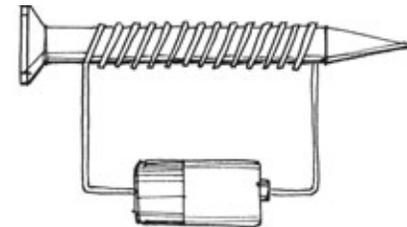
3. Place the nail close to the small metal objects. Record what happens.



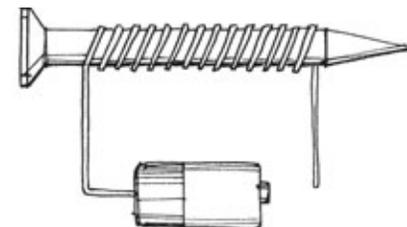
4. Place the compass close to the nail. Move the compass around the nail. Record what happens.



5. Reverse the wires on the battery. Repeat step 3.



6. Disconnect one wire from the battery and repeat steps 3 and 4.



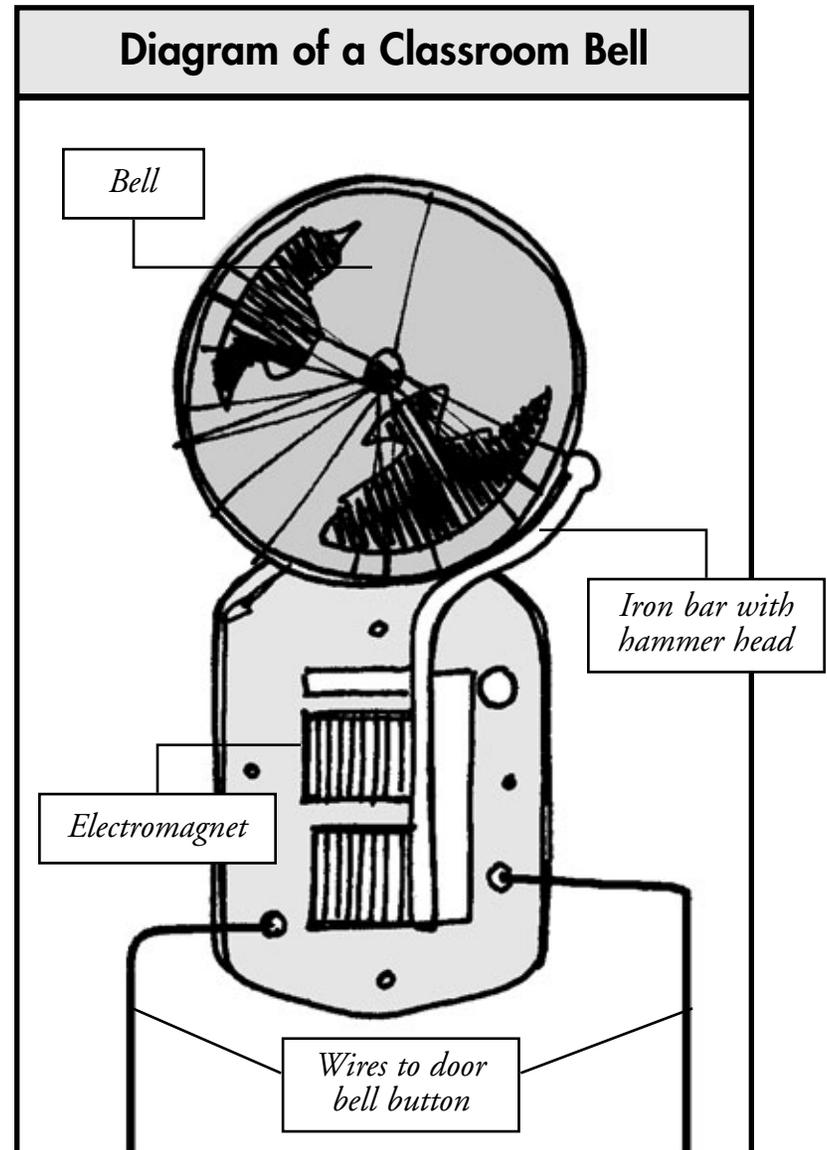
Electromagnets in Use

Electromagnets Are All Around Us

Electromagnets are very useful. If you look around, you will find electromagnets in your school and at home.

The bell on your classroom wall is a device that works due to an electromagnet. It converts electrical energy into sound energy.

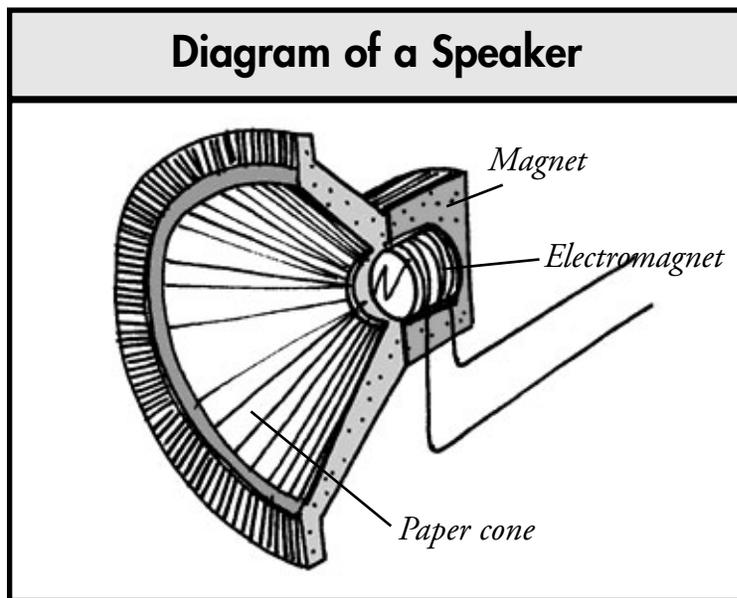
When you push the button attached by wires to the bell, you close the circuit and send an electric current to the electromagnet in the bell. An iron bar with a hammer head is attracted to the magnetic field created by the electromagnet. This causes the hammer head to strike the bell.



Brainstorm a list of things you use or have seen that have an electromagnet.

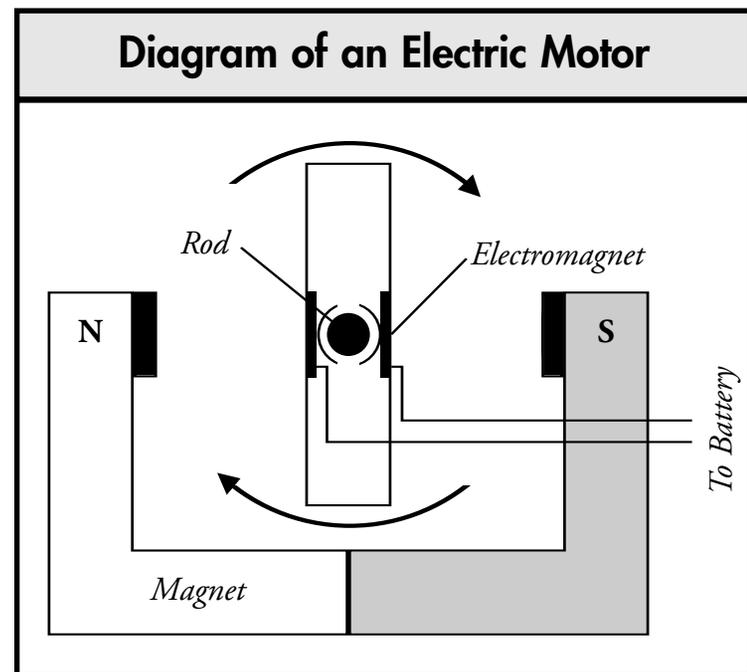
The speaker in your classroom is an electromagnet. It also converts electrical energy into sound energy.

A speaker has a paper cone, a magnet, and an electromagnet. When an electrical current passes through, magnetic forces between the electromagnet and the magnet push or pull the paper cone inward or outward. The vibrations of the cone form sound waves.



The electromagnet in a speaker helps convert electrical energy into sound energy.

A motor uses an electromagnet to convert electrical energy into motion. A motor's electromagnet is surrounded by a magnet. The electromagnet is connected to a rod allowing it to rotate on an axis. When an electric current passes through, the magnetic force causes the electromagnet to spin.



Try It Yourself!

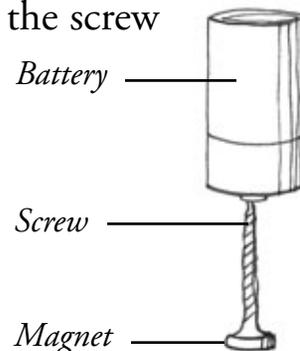
You can make your own electric motor.

Materials

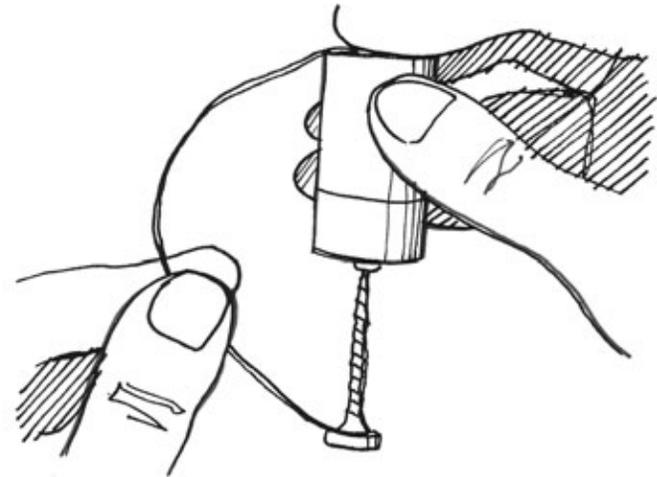
- safety glasses
- 6 inches of copper wire
- 1.5 V battery
- small neodymium disk magnet
- iron screw with flat head such as a drywall screw

Procedure

1. Strip the insulation off both ends of the wire.
2. Attach the magnet to the flat head of the screw.
3. Hold the battery as shown and place the tip of the screw to the button end of the battery.



4. Press and hold one end of the wire to the top of the battery.
5. Lightly touch the other end of the wire to the side of the magnet.



Caution

Objects in this experiment can fly off and hit surrounding areas. Be sure anyone nearby is wearing safety glasses.

6. Record your observations and explain what you observed.

Glossary

axis—a real or imaginary line about which something turns

demonstration—the act of showing, proving, or explaining

detected—discovered; noticed

device—something made or invented for a special use

molten—melted by heat

pivot—a point upon which something turns

repel—to drive or force away

temporary—lasting only for a short time

To Find Out More . . .

Want to learn more about electromagnetic energy?

Try these books

Electricity and Magnetism (Usborne Understanding Science) by Peter Adamczyk. Usborne Books, 2008.

Awesome Experiments in Electricity & Magnetism by Michael A. DiSpezio. Sterling, 2006.

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

Access these Web sites

Creative Kids at Home
<http://www.creativekidsathome.com/science/magnet.html>

Energy Kid's Page
<http://www.eia.doe.gov/kids/energyfacts/sources/electricity.html>

The NASA Sci Files
http://scifiles.larc.nasa.gov/text/kids/D_Lab/acts_electric.html

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ENGLISH-LANGUAGE ARTS • GRADE 4

On Level

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Vocabulary and Concept Development: 1.6
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.3
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.5

English-language Arts Activities

Electromagnetic Energy

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

Words with Multiple Meanings

TRY THE SKILL

Some words have several meanings. You can use context clues to decide which meaning is being used in a certain sentence. For example, the word *charge* can mean “to give a task or duty,” and *charge* can mean “to supply with electrical energy.” Read the sentence below and decide which meaning is being used here.

When you rubbed the balloon against your hair, the balloon picked up a negative charge.

In this sentence, *charge* means “to supply with electrical energy.” The context—the rest of the sentence—tells you which meaning is being used.

Read each word and its meanings. Then read each sentence and write the letter of the correct meaning on the line.

- sticks** A. short, thin pieces of wood
 B. attaches something to a surface

1. When you let go of the balloon, it _____ to the wall.

- poles** A. long, slender pieces of wood or metal
 B. two opposite forces

2. Every magnet has two ends, called _____.

- slide** A. to move along the length of a surface
 B. a smooth surface slanting down

3. _____ the magnet toward the one at the end of the ruler.

- rest** A. the act of being quiet and at ease
 B. to lie or lay

4. _____ the needle on top of the cork.

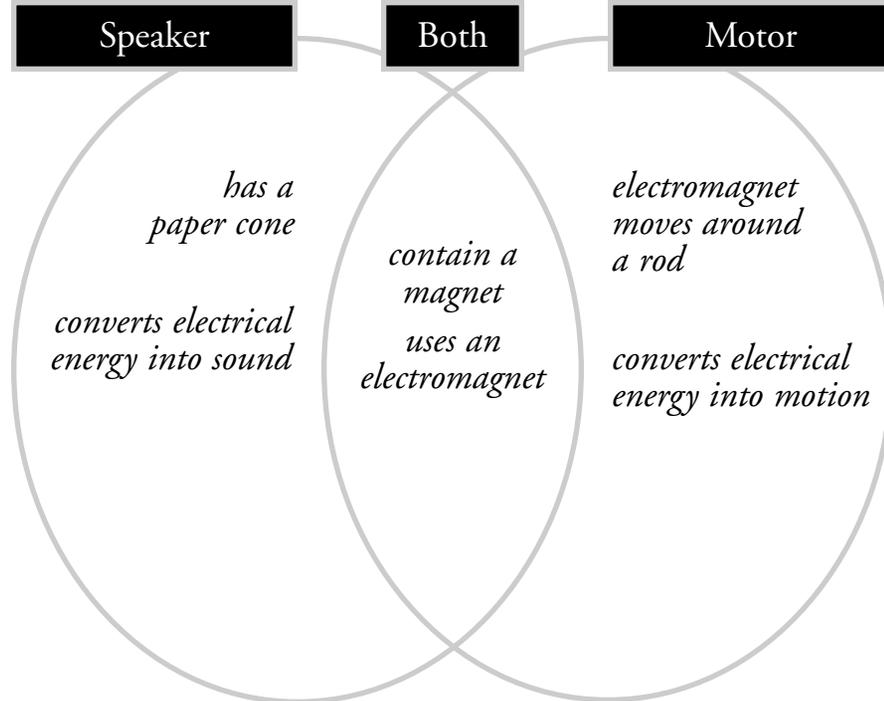
- strike** A. to hit by giving a blow
 B. to cause pain or suffering

5. This causes the hammer head to _____ the bell.

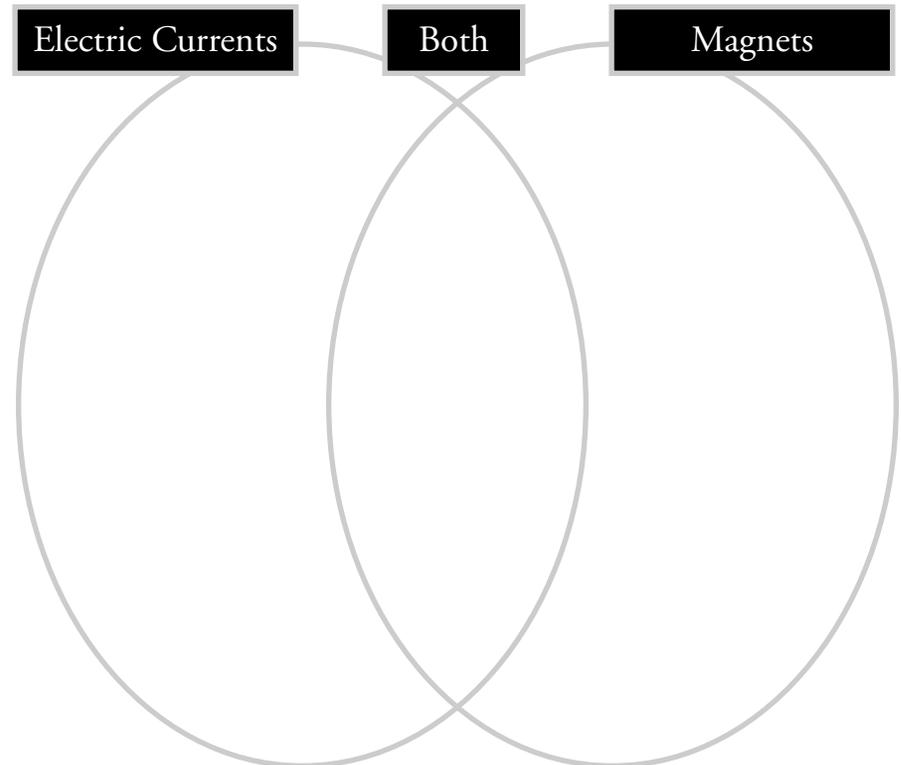
Compare and Contrast

TRY THE SKILL

When you compare two things, you tell how they are alike. When you contrast them, you tell how they are different. A Venn diagram can help you compare and contrast. For example, this Venn diagram compares motors and speakers.



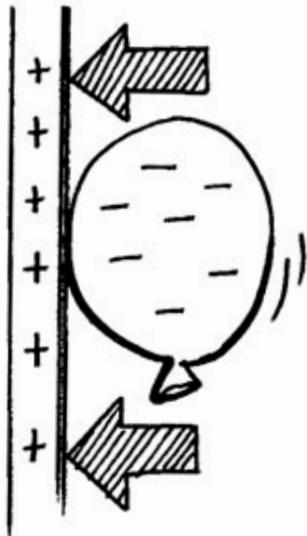
Use this Venn diagram to compare electric currents and magnets.



Make a Prediction

TRY THE SKILL

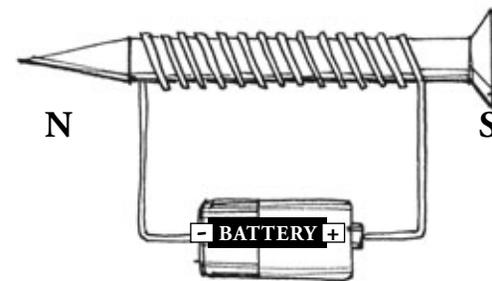
Graphics can give you information quickly and help you understand how something occurs or works. Look at the graphic showing the wall and the balloon and make a prediction.



Will the balloon fall down?

The balloon has a negative charge as indicated by the (-) symbols. The wall has a positive charge as indicated by the (+) symbols. Opposite charges attract each other so the balloon will stick to the wall.

Study this picture from *Electromagnetic Energy*. What does it tell you about electromagnets? What will happen to the nail? Write about it.



Synonyms and Antonyms

TRY THE SKILL

Words and phrases that mean the same, such as *hard* and *difficult*, are synonyms. Words and phrases that mean the opposite, such as *hot* and *cold*, are antonyms. Write the correct words from the box on the lines.

negative	helpful	adhere	rotates
center	repel	alike	destroyed
recognize	permanent	wrapped	changes
outward	fall	straightened	

1. A synonym for *stick* _____
2. An antonym for *attract* _____
3. An antonym for *positive* _____
4. A synonym for *similar* _____
5. A synonym for *core* _____
6. An synonym for *detect* _____
7. A synonym for *spins* _____
8. A synonym for *coiled* _____
9. An antonym for *temporary* _____
10. An antonym for *created* _____
11. A synonym for *useful* _____
12. An antonym for *stick* _____
13. An antonym for *coiled* _____
14. A synonym for *converts* _____
15. An antonym for *inward* _____

Answer Key

Words with Multiple Meanings

1. B
2. B
3. A
4. B
5. A

Compare and Contrast

Electric Currents: movement of charged particles; particles can be positive or negative

Both: have electric charges; have magnetic fields, opposite charges attract each other while similar charges repel each other.

Magnets: objects that attract certain metals such as iron, has two ends—north and south poles

Make a Prediction

You can make an electromagnet by coiling a piece of wire around a nail and sending an electric current through the wire from a battery. One end of the nail is the north pole and the opposite end is the south pole.

Synonyms and Antonyms

- | | | |
|-------------|---------------|------------------|
| 1. adhere | 6. recognize | 11. helpful |
| 2. repel | 7. rotates | 12. fall |
| 3. negative | 8. wrapped | 13. straightened |
| 4. alike | 9. permanent | 14. changes |
| 5. center | 10. destroyed | 15. outward |