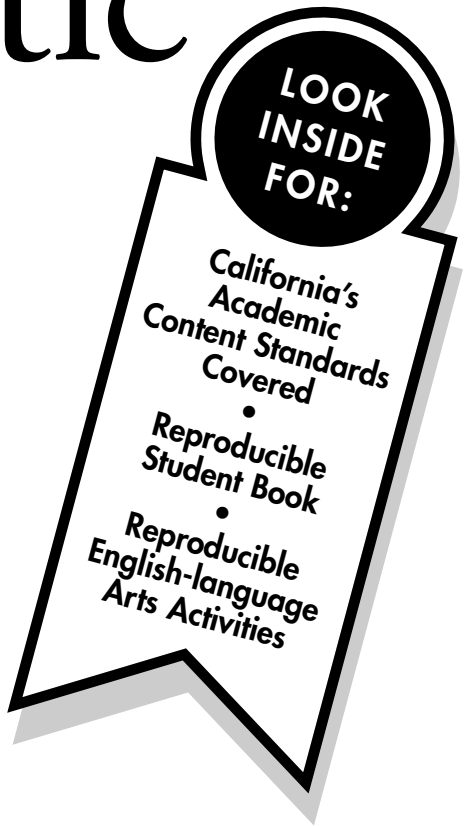
SCIENCE • GRADE 4

Above Level

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



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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 1.5*—**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.

Above Level

SCIENCE • GRADE 4

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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.

AL

Electromagnetic Energy
California's Content Standards Met

GRADE 4 SCIENCE

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GRADE 4 ENGLISH LANGUAGE ARTS

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FOCUS ON CALIFORNIA STANDARDS

SCIENCE • GRADE 4

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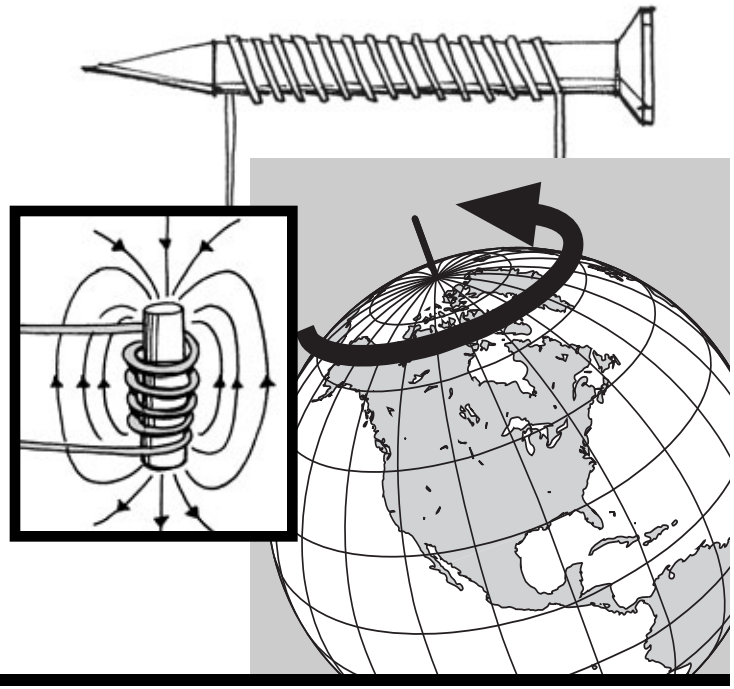
Electromagnetic Energy

by Ken Sibila



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Electromagnetic Energy

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Table of Contents

INTRODUCTION

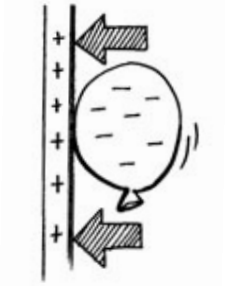
Electrical Charges

If you have already read the book *Electrical Energy*, you know there is a strong connection between electricity and magnetism.

Electricity is the movement of charged particles. The particles that move are negatively-charged electrons. They are attracted by positively-charged ions. Opposite charges attract each other while similar charges **repel** each other.

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?

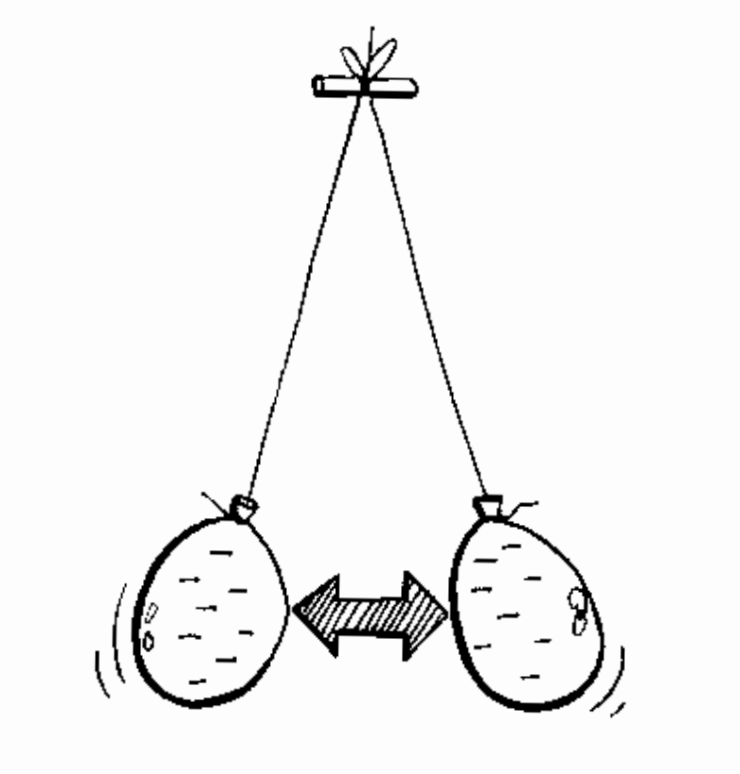
When you rub the balloon against your hair or wool, the balloon picks up electrons and a negative charge. The negatively charged balloon repels other negative particles in the wall leaving positively charged ions near the surface of the wall. The balloon is attracted to those positive particles and sticks 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, so the balloons push each other away. Remember—likes repel!

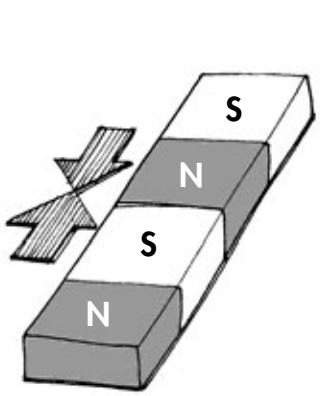


CHAPTER 1

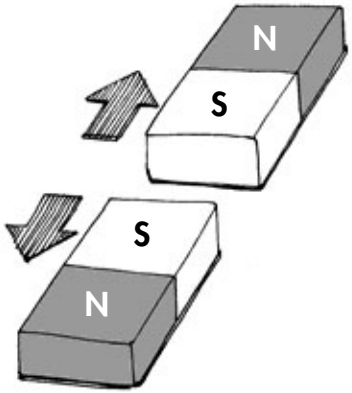
What Are Magnets?

Magnets are objects that attract certain metals such as iron. Magnets 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).

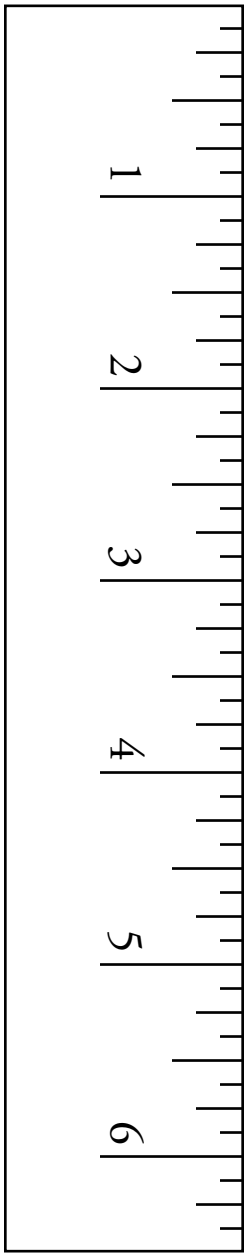
Just like electrical charges, opposite poles attract each other. Similar poles repel each other. If you put opposite poles of two magnets close together, they will pull each other together. If you put the same poles close together, they will repel each other.



Opposite poles attract each other.

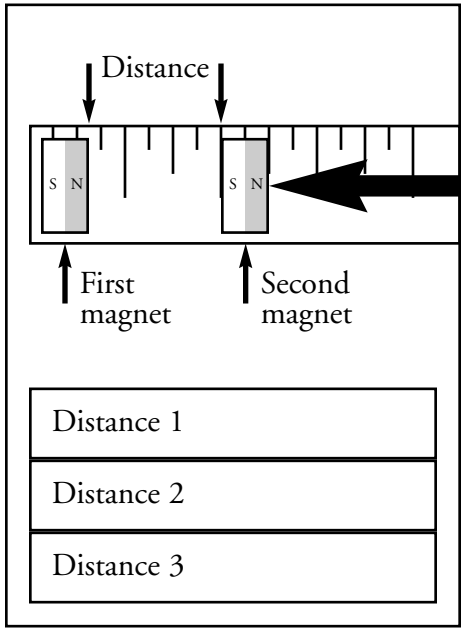


Like poles repel each other.



Try it Yourself!

Gather sets of 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 starts to move.



Earth Is a Magnet

Electricity and magnetism are all around us. In fact, 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.

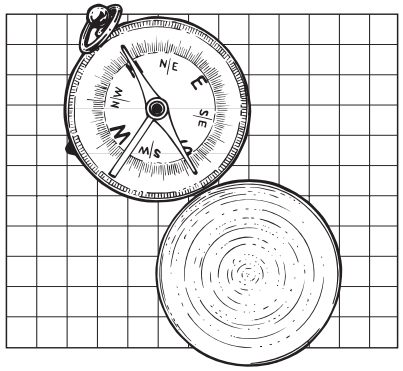
molten: melted by heat
axis: a real or imaginary line about which something turns

How a Compass Works

We can sense Earth's magnetism when we use a compass. You know that the two opposite poles of magnets attract. This magnetism is how a compass works.

A compass is a very 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!

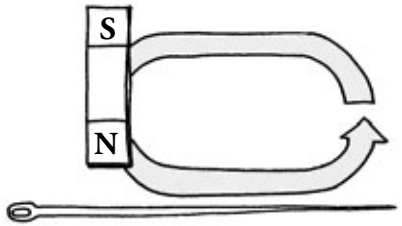
You can make your own compass. To create one, you will need the following:

Materials

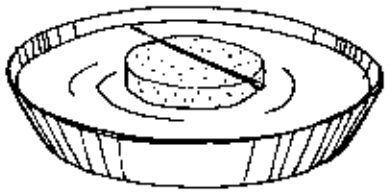
- needle
- magnet
- cork or sponge
- bowl filled with water

Procedure

1. Turn the needle into a magnet by rubbing the magnet in the same direction along the needle 25 times.



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



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

CHAPTER 2

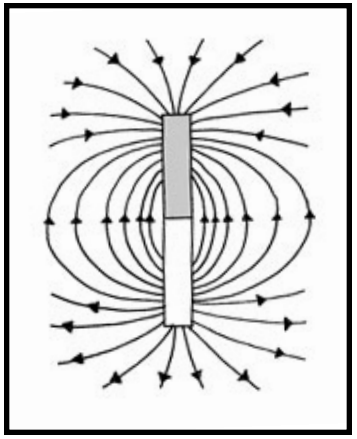
Electromagnets

Magnetic Fields

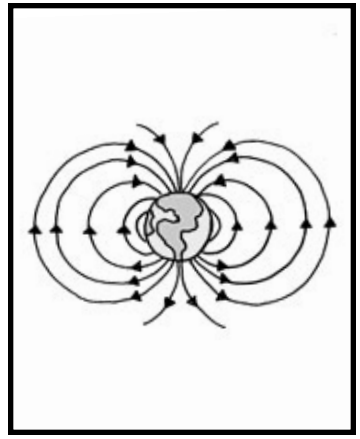
A magnetic field is a region in which magnetic forces can be detected. For example, the space surrounding a bar magnet is a magnetic field. The force of the magnetic field is strongest at the north and south pole.

Since Earth is a giant magnet, it also has a magnetic field. Scientists have determined that Earth's magnetic field reaches about 36,000 miles into space.

Magnetic field of a bar magnet

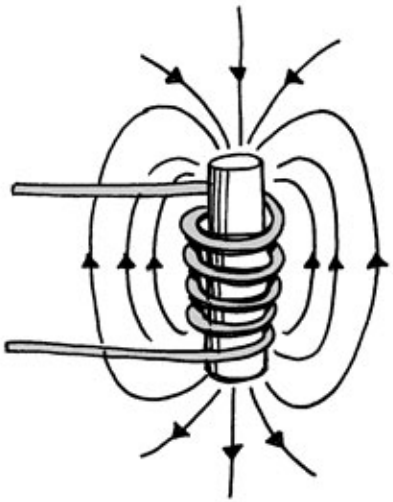


Magnetic field of Earth



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. Wrapping the wire around the iron bar creates a temporary magnet called an electromagnet. Why is it **temporary**? 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 at Copenhagen University in Denmark. In 1820 he set up **demonstrations** to 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. He worked hard in the months that followed trying to make sense out of what had happened. However, Hans Christian Oersted could not explain why. 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!

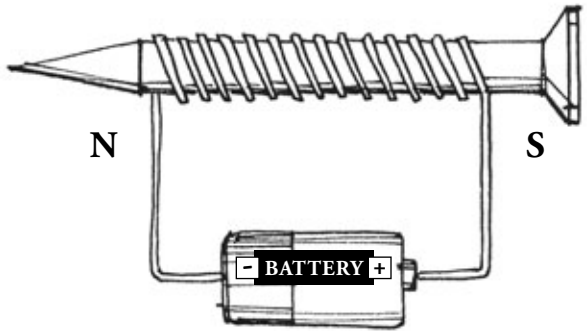
You can make your own electromagnet. To create one, you will need the following:

Materials

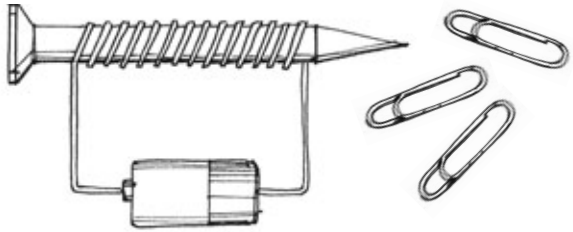
- copper wire with insulation
- 8d iron nail
- D battery
- tape
- small metal items such as paper clips, staples, and thumbtacks
- compass

Procedure

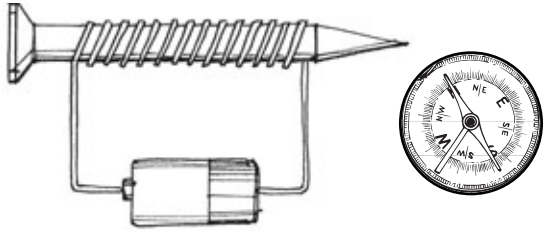
1. Wrap the copper wire around the nail ten or more times. Strip the insulation off both ends of the copper wire.
2. Attach one end the of the wire to the negative (–) side of the battery with tape. Attach the other end to the positive side (+).



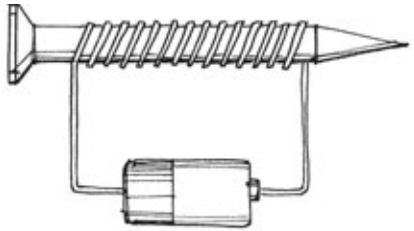
3. Place the nail close to the small metal objects. Record what happens.



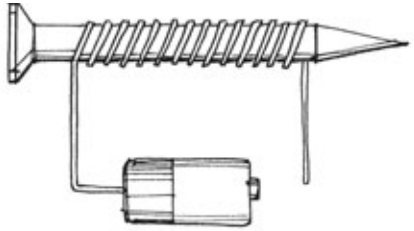
4. Place the compass close to the nail. Move the compass around the nail. Record what happens.



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



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



CHAPTER 3

Electromagnets in Use

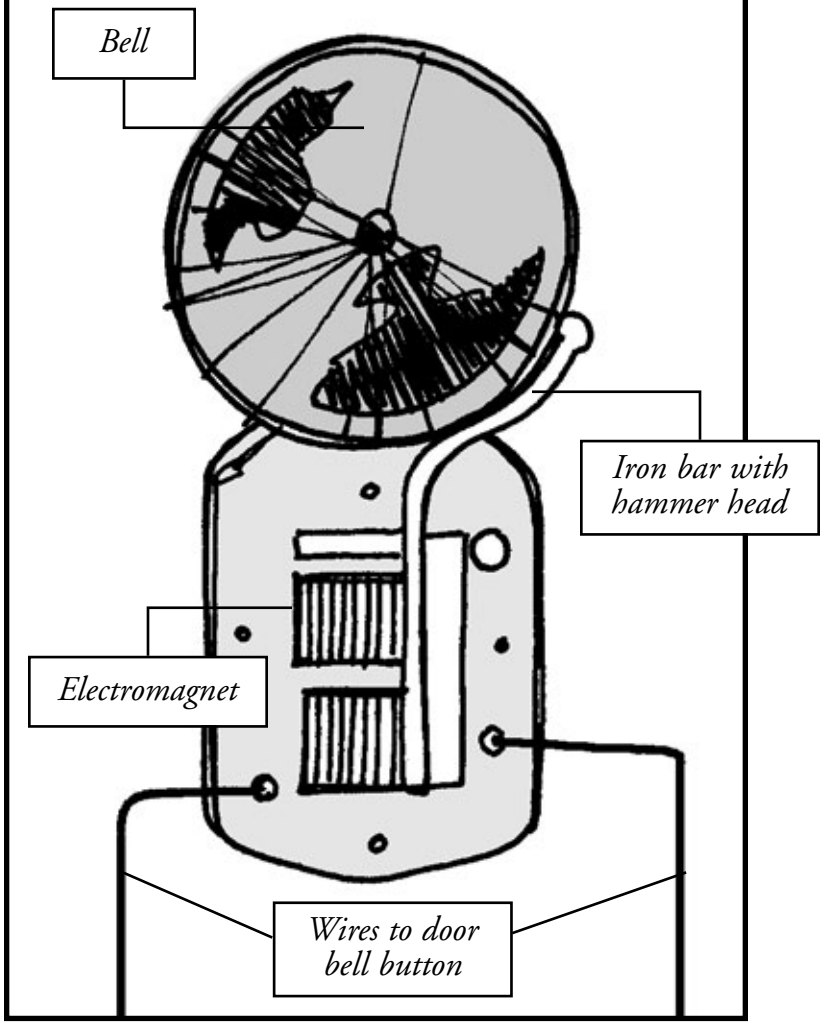
Electromagnets Are All Around Us

Electromagnets are very useful. Think of them as magnets that can be turned on and off. If you look around, you will find many examples of electromagnets in your school and at home.

A doorbell, or the bell on your classroom wall, is an example of a device that works due to an electromagnet. Both convert 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.

Diagram of a Classroom Bell

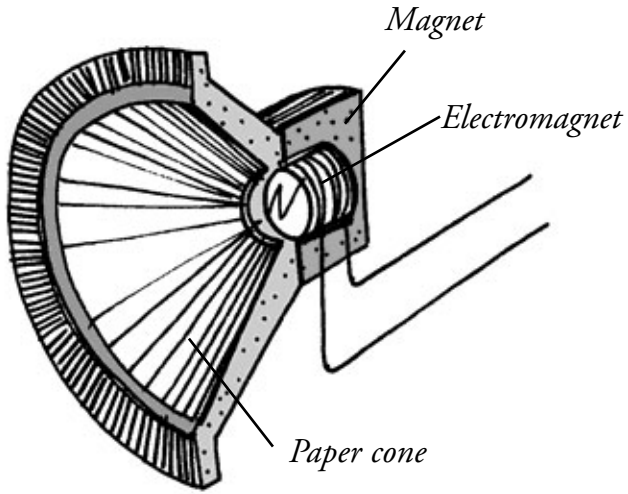


Brainstorm a list of things you use or have seen that have an electromagnet.

The speaker on your classroom wall is another example of an electromagnet. A speaker also converts electrical energy into sound energy.

A speaker consists of 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.

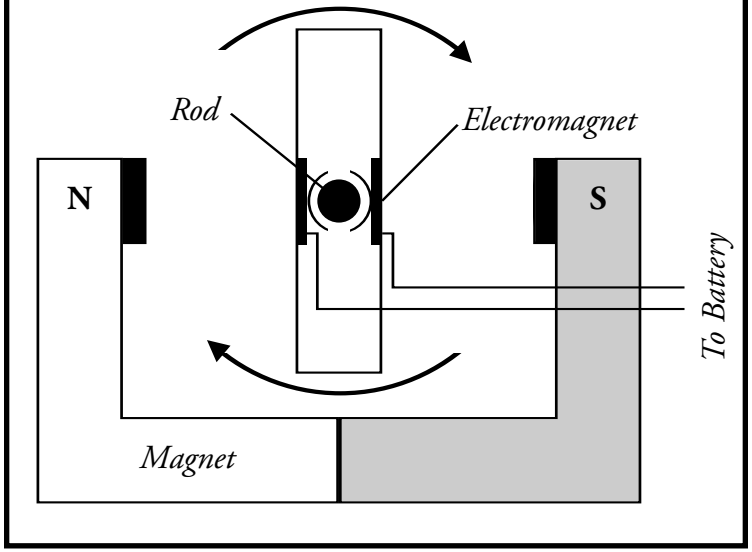
Diagram of a Speaker



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

A motor also uses an electromagnet to convert electrical energy into motion. Similar to a speaker, a motor's electromagnet is surrounded by a magnet. The electromagnet is connected to a rod allowing it to move in a circle. When an electric current passes through, the magnetic force causes the electromagnet to spin creating motion.

Diagram of an Electric Motor



Try it Yourself!

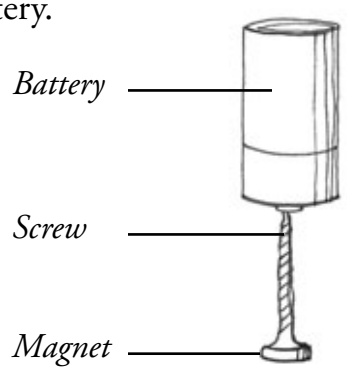
You can make your own electric motor. To create one, you will need the following:

Materials

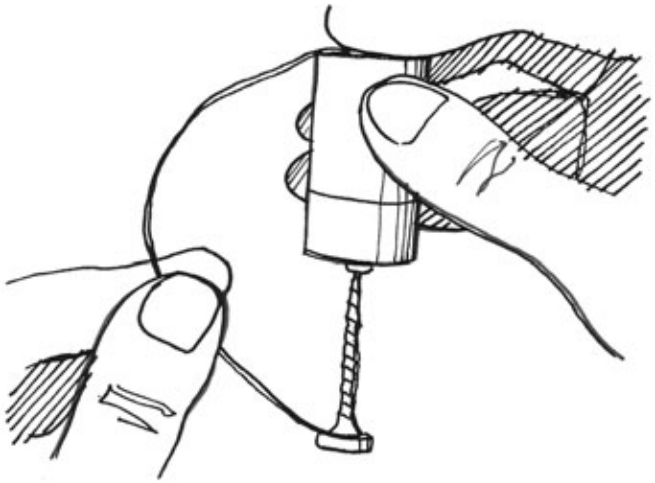
- safety glasses
- 6 inches of copper wire
- 1.5 V battery
- small neodymium disk magnet
- iron screw with flat head such as a drywall screw

Procedure

1. If the copper wire is insulated, 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 below 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 propose a reason or explanation for 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

Above Level

California Content Standards
Vocabulary and Concept Development: 1.5
Structural Features of Informational Materials, 2.1
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.2
Comprehension and Analysis of Grade-Level-Appropriate Text: 2.6

English-language Arts Activities

Electromagnetic Energy

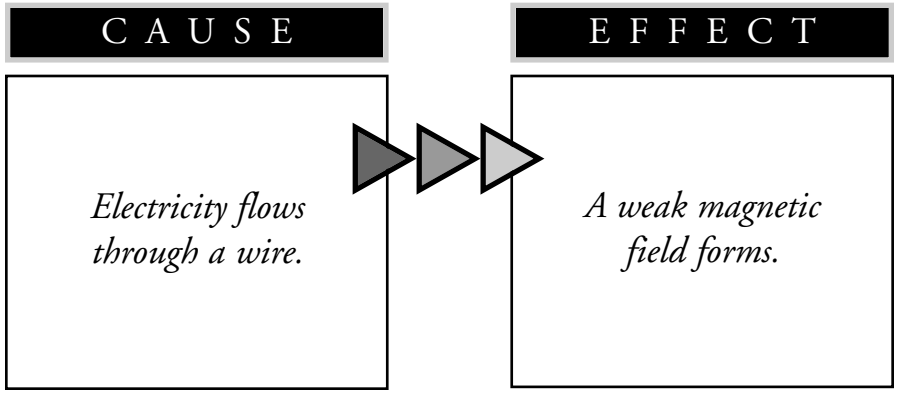
Print pages 20–24 of this PDF for the reading activities.

Cause and Effect

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:

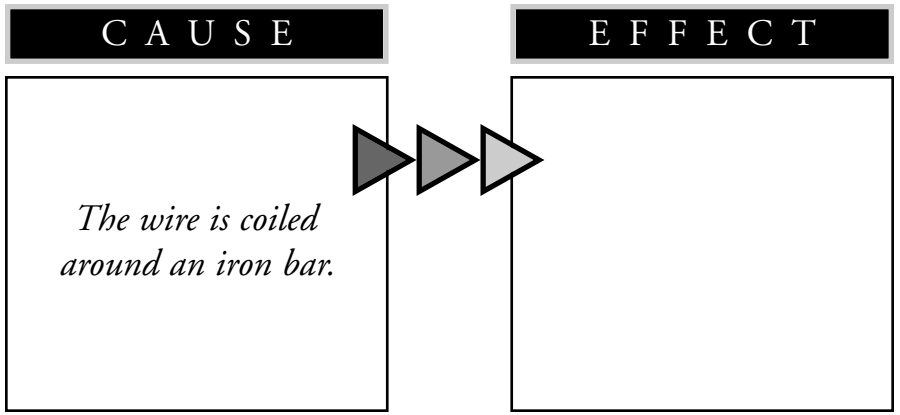
When electricity flows through a wire, a weak magnetic field forms around the wire. The magnetic field can be made stronger if the wire is coiled around an iron bar. Wrapping the wire around the iron bar creates a temporary magnet called an electromagnet. Why is it temporary? The magnetic field only exists when the electricity is flowing. When electricity stops, the magnetic field is gone. The discovery of this magnetic field was made by accident.

This graphic explains what happens.

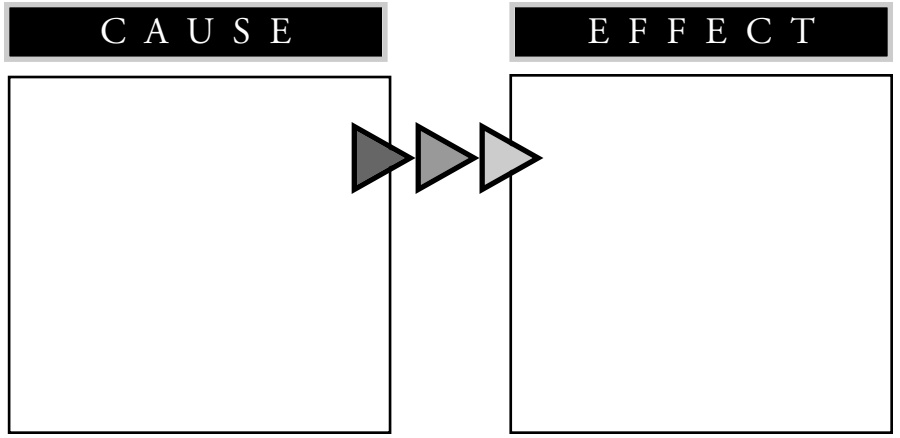


TRY THE SKILL

Read the passage again. Then complete this graphic. Tell how the cause affects the magnetic field.



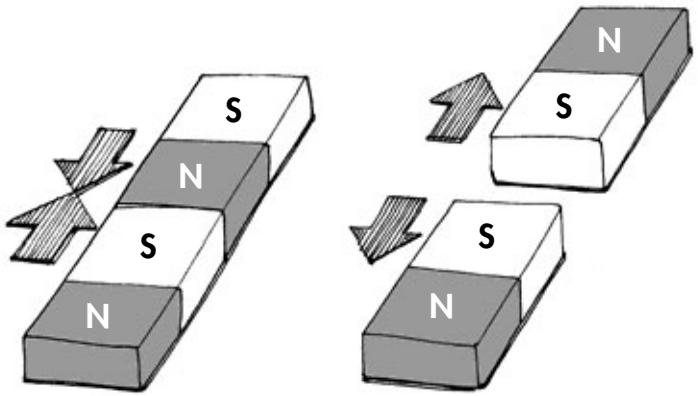
Now complete this graphic. Tell what happens to a magnetic field when the electric current stops flowing.



Interpreting Graphic Information

TRY THE SKILL

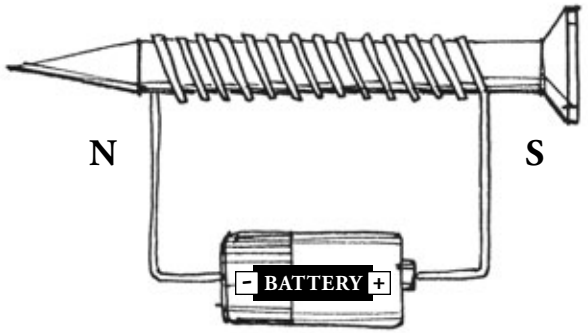
Graphic information is presented in diagram or chart form. For example, look at the following diagram about the poles on magnets.



What happens when the poles of two magnets come close together?

Similar poles of magnets repel each other, while opposite poles of magnets attract each other.

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



1. How can you create a simple electromagnet?

Compare and Contrast

When you compare two things, you tell how they are alike. When you contrast them, you tell how they are different. Authors often compare and contrast information in nonfiction text.

Read the following paragraph from *Electromagnetic Energy* and try to identify where the author compares and contrasts information.

Electricity is the movement of charged particles. The particles that move are negatively charged. Opposite charges attract each other while similar charges repel each other.

In this paragraph, the author is comparing the movement of charged particles. He says that opposite charges attract each other while similar charges repel each other. The word *while* is a signal word telling you that a comparison is being made.

TRY THE SKILL

Read this paragraph. Then explain the comparison the author is making. Indicate what signals words the author uses to indicate a comparison is being made.

Magnets are objects that attract certain metals such as iron. Magnets 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).

Just like electrical charges, opposite poles attract each other. Similar poles repel each other. If you put opposite poles of two magnets close together, they will pull each other together. If you put the same poles close together, they will repel each other.

Use a Thesaurus

A thesaurus is a book listing words with their synonyms and antonyms. It is used to help writers choose the most appropriate words to express the exact meaning they are trying to communicate. Some thesauruses are organized alphabetically. Others list words thematically, or according to related groups.

Read this sentence from *Electromagnetic Energy*. Then read the thesaurus entry for the word rub. Was *rub* the best word choice?

When you rub the balloon against your hair or wool, the balloon picks up a negative charge from it.

rub, *v.*–*Syn.* scrape, smooth, abrade, scour, grate, grind, wear away, graze, rasp, knead, massage, polish, shine, scrub

Substitute some of the synonyms for *rub* in the sentence. Would you polish the balloon? Would you scrub or massage the ballon? None of these words fit the context of the sentence, so the author chose the best word to use.

TRY THE SKILL

Read each sentence. Then use a thesaurus to find synonyms for the words in bold. Write synonyms that could be substituted for the word in bold. Then write synonyms that should not be substituted.

1. The negatively charged balloon is attracted to the positively charged wall causing the balloon to **stick** to the wall.

   Substitute words: _____

   _____

   Other synonyms: _____

   _____

2. A magnetic field is a region in which magnetic forces can be **detected**.

   Substitute words: _____

   _____

   Other synonyms: _____

   _____

Answer Key

Cause and Effect

Cause: The wire is coiled around an iron bar.

Effect: The magnetic field is made stronger.

Cause: When electricity stops,

Effect: the magnetic field is gone.

Interpreting Graphic Information

You can create a simple electromagnet by wrapping copper wire around an iron nail several times. Then, connect the ends of the wire to each end of a battery. This turns the iron nail into an electromagnet.

Compare and Contrast

The author is comparing the two poles of a magnet—the north pole and the south pole. He then contrasts what happens when different poles from two magnets come close together—opposite poles attract and similar poles repel.

Words that signal a comparison are *every* and *just like*.

Use a Thesaurus

1. Substitute words may include *adhere, attach,* or *cling*. Other words include *fasten, unite,* and *hold.*

2. Substitute words may include *identified* or *recognized*. Other words include *distinguished, exposed, caught* and *seen.*