Below 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

LOOK INSIDE FOR:

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

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

2.0 READING COMPREHENSION

Structural Features of Informational Materials 2.1—Identify structural patterns found 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.

Below Level

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California Content Standards
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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 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 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 three staples in the spine of the book.

Please note that printers vary in how they output pages. Do a test printing with 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.

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Electromagnetic Energy
California's Content Standards Met

GRADE 4 SCIENCE

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SCIENCE • GRADE 4

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Electromagnetic Energy

by Ken Sibila

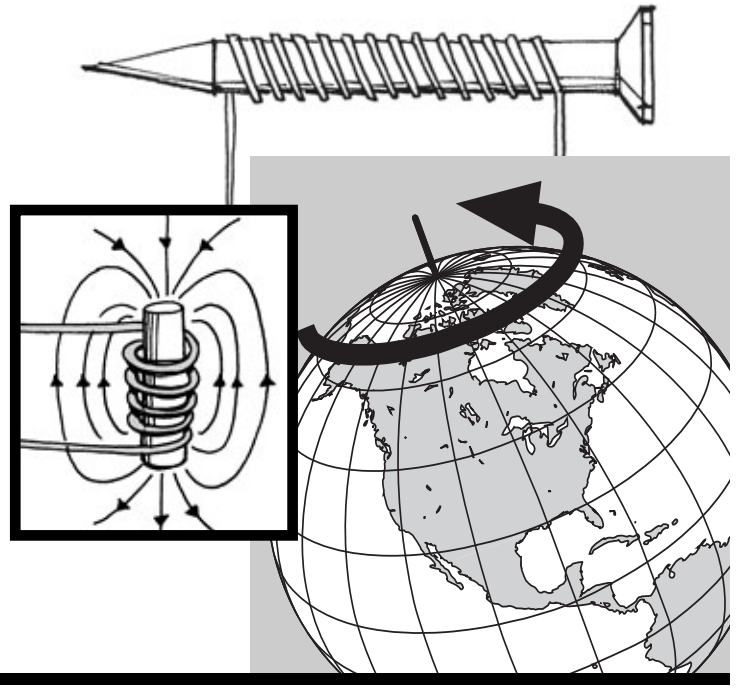

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Table of Contents

Introduction:
Electrical Charges 4

Chapter 1:
Magnets 6
Magnetic Fields 8
Earth Is a Magnet 9
How a Compass Works 10
Electricity Creates
Magnetic Fields 12
Hans Christian Oersted 13

Chapter 2:
Electromagnets in Use 11

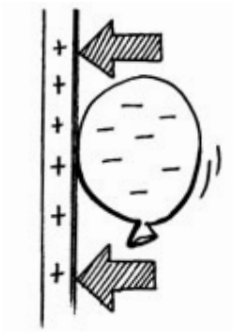
Glossary 22
To Find Out More 23
Index 24

INTRODUCTION

Electrical Charges

Everything in the world is made up of tiny pieces called atoms. Inside each atom are even tinier pieces. Some have an electrical charge. Protons have a positive charge. Electrons have a negative charge. Positive charges **attract**, or pull toward, negative charges.

For example, when you rub a balloon against your hair, the tiny pieces move. The balloon picks up electrons and gets a negative charge. The negative electrons in the balloon attract positive particles in the wall. This causes the balloon to stick to the wall.



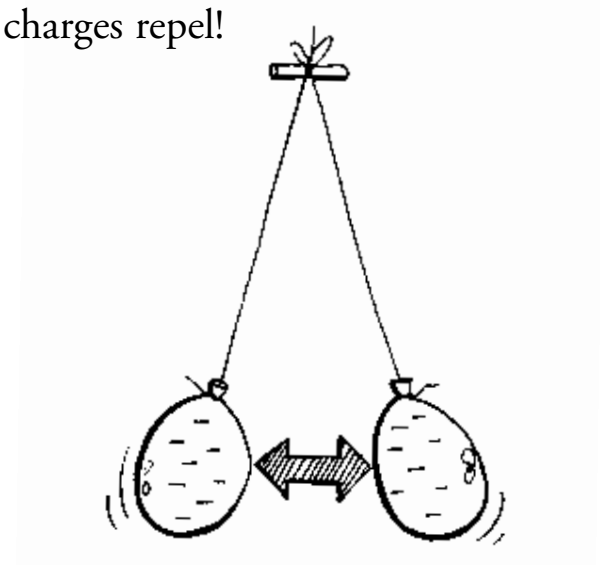
Positive charges and negative charges are opposite. Opposite charges attract!

attract: to make something come closer

Objects with a negative charge **repel**, or move away from, other objects with a negative charge.

Tie strings to two balloons. Rub each balloon on your hair. Both balloons get a negative charge. Then hold them close together by the strings. The balloons move apart. They repel each other because both charges are negative.

Negative charges repel each other. Positive charges repel each other too. Similar charges repel!



repel: to make something move away

CHAPTER 1

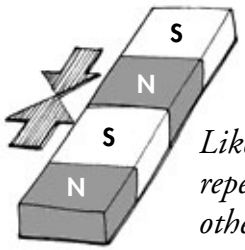
Magnets

Magnets are objects that attract certain metals. Magnets also have electrical charges. They attract and repel.

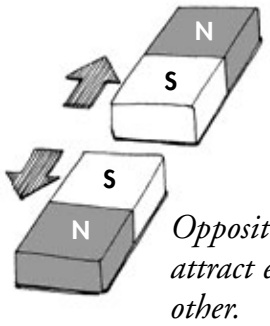
Magnets have two ends. These ends of a magnet are called poles. One end is the north pole (N). The other end is the south pole (S).

Put opposite poles of two magnets close together. They will pull each other together. Opposite poles attract!

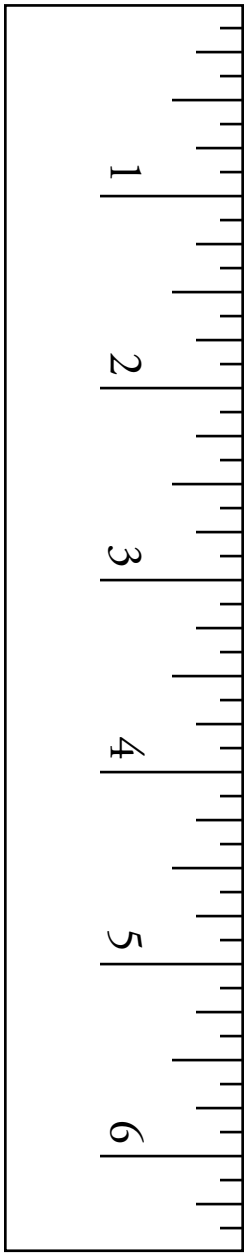
Put poles that are the same close together. They will repel each other. Like poles repel!



Like poles repel each other.

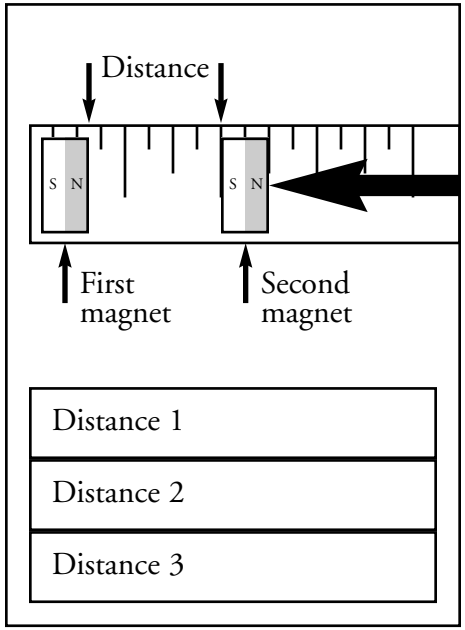


Opposite poles attract each other.



Try it Yourself!

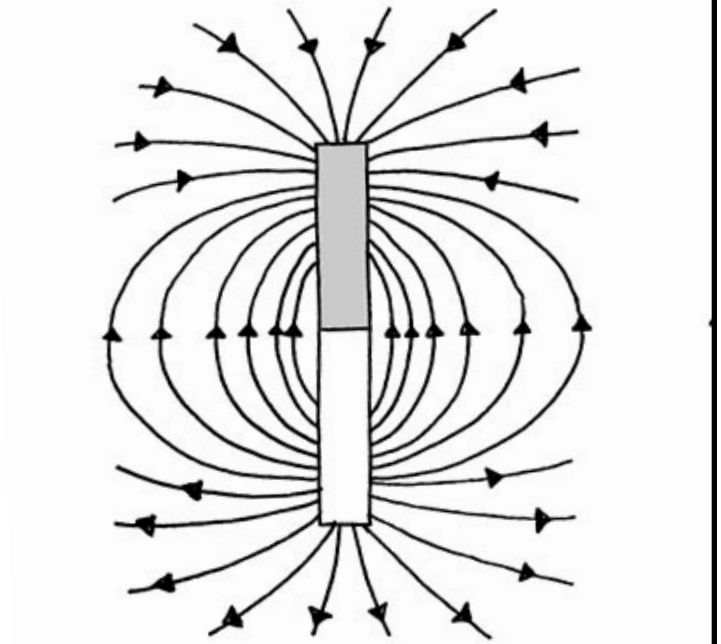
Gather different sizes and shapes of magnets. Place one magnet at the end of this ruler. Place the other magnet a few inches away. Slide the magnet toward the other magnet at the end of the ruler. Record what happens in a journal.



Magnetic Fields

A magnet has forces that push and pull. The forces surround the magnet with a magnetic field. Where is the force of the magnetic field the strongest? It is strongest at the north and the south pole of the magnet.

Magnetic Field of a Magnet

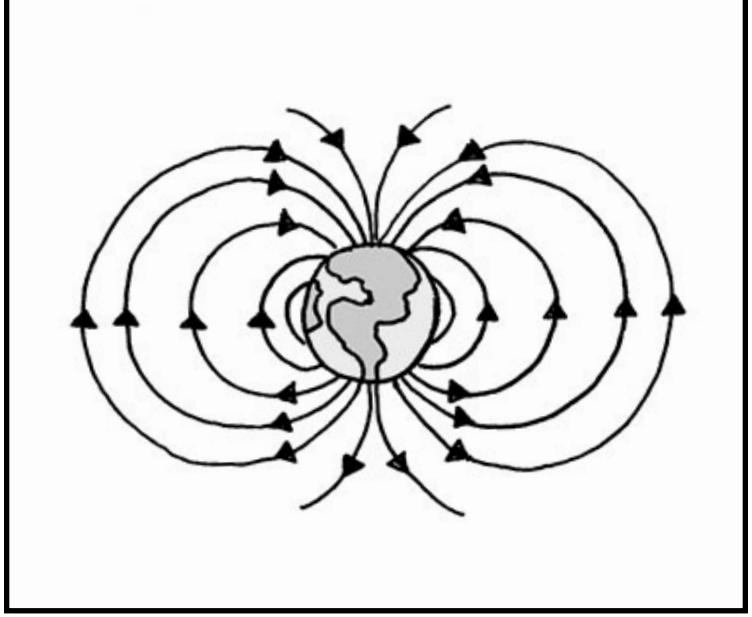


Where is the magnetic field the strongest?

Earth Is a Magnet

Earth is a giant magnet. It also has a magnetic field around it. Like a magnet, the Earth has a north pole and a south pole. The Earth's magnetic field is strongest at the north and south magnetic poles.

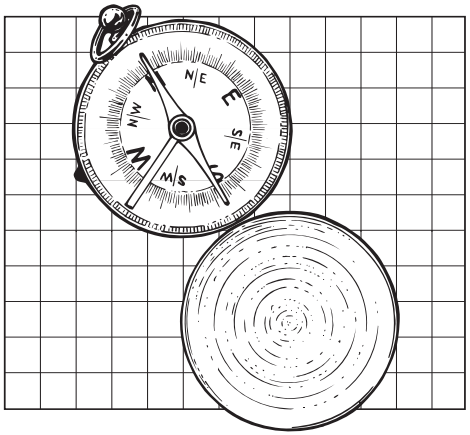
Magnetic Field of Earth



How a Compass Works

A compass is a simple **device** that can keep people from getting lost. A compass has a magnet called the needle. No matter which way you turn the compass, one end of the needle always point towards the north. The other end always points toward the south.

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



device: something made or invented for a special use

Try It Yourself!

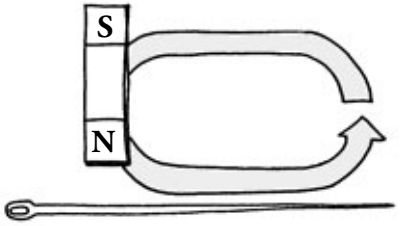
You can make your own compass. To create one, you will need the following:

Materials

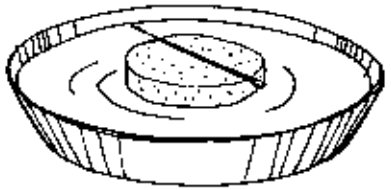
- craft needle
- cork or sponge
- magnet
- bowl filled with water

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.

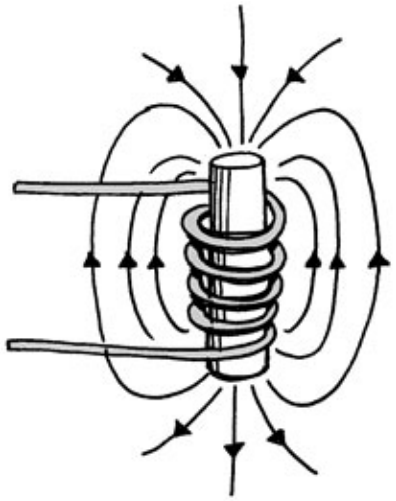


3. In which direction does the needle on your compass point?

Electricity Creates Magnetic Fields

When an electric current flows through a wire, the wire has its own weak magnetic field. This magnetic field can be made stronger if the wire is coiled around an iron bar. This creates a **temporary** magnet called an electromagnet.

The electromagnet only has a magnetic field when the electricity flows. If the current is switched off, the electromagnet loses its magnetic field. It is no longer a magnet.



Electricity flows through the electromagnet. It then has a magnetic field.

temporary: lasting only for a short time

Hans Christian Oersted

Hans Christian Oersted was a teacher in Denmark. One day in 1819, he set up two **demonstrations**. First, he was going to show how an electric current heats a wire. Then he was going to show magnetism using a compass.

While Oersted was showing how electricity heats a wire, he looked at the compass. He noticed that when the electric current was switched on, the nearby compass needle moved.

He discovered that an electric current flowing through a wire could move the needle of a compass. His discovery showed the connection between electricity and magnetism.

demonstration: showing how something works

Try It Yourself!

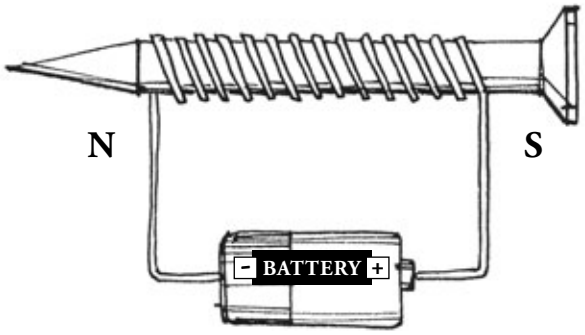
You can make your own electromagnet.

Materials

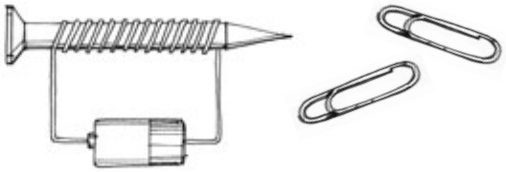
- copper wire with insulation
- 8d iron nail
- D battery
- tape
- small metal items such as paper clips, and staples
- compass

Procedure

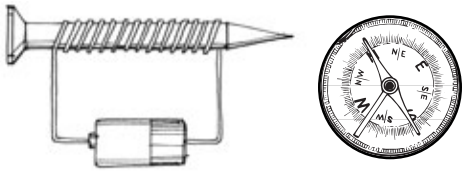
1. Ask an adult to strip the insulation off both ends of the copper wire.
2. Carefully wrap, or coil, the copper wire around the nail ten or more times.
3. Attach one end of the wire to the negative (–) side of the battery with tape. Attach the other end to the positive side (+).



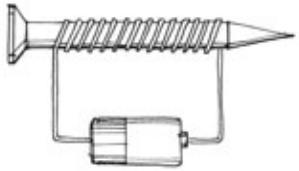
4. Place the nail close to the small metal objects. Record what happens.



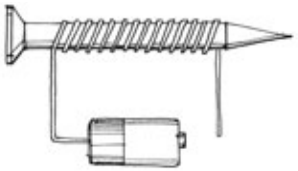
5. Place the compass close to the nail. Move the compass around the nail. Record your findings.



6. Reverse the wires on the battery. Repeat step 3. Record your findings.



7. Disconnect one wire from the battery and repeat steps 3 and 4. Record your findings.



CHAPTER 2

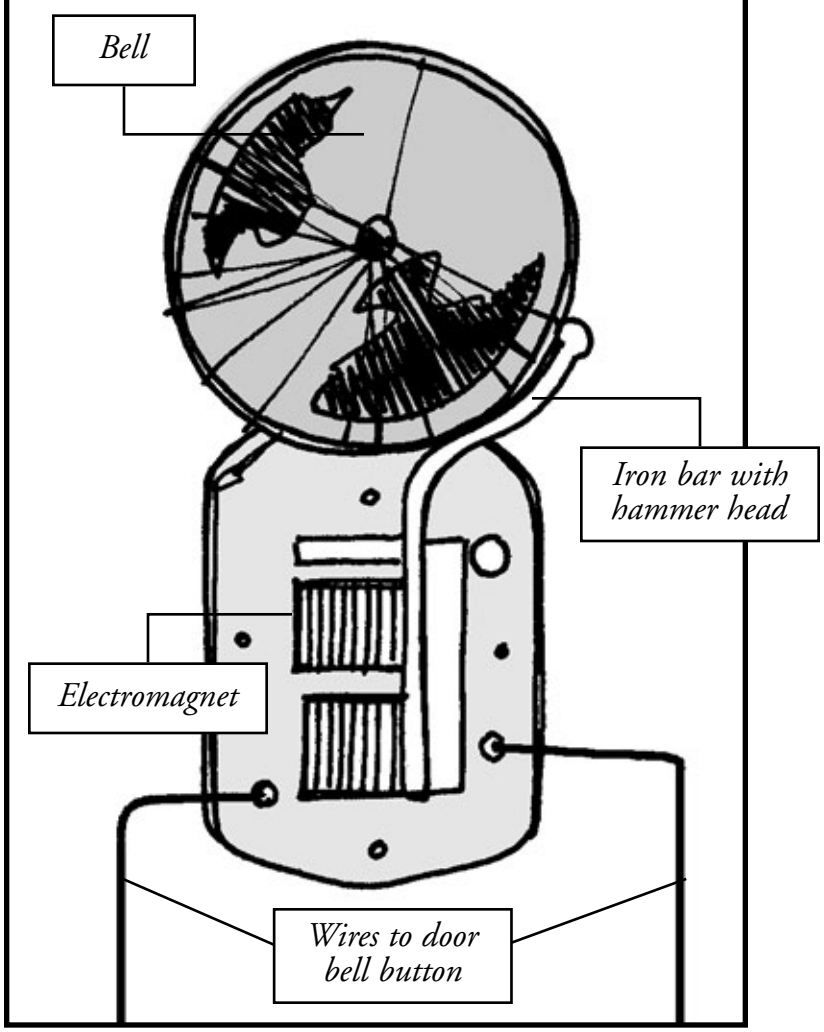
Electromagnets in Use

Electromagnets Are All Around Us

Electromagnets are all around us. The bell on a classroom wall can use an electromagnet. Look at the picture to see how it works.

First, someone pushes a button connected to the bell. This sends an electric current to the electromagnet in the bell. Now the electromagnet has a magnetic field. An iron bar with a hammer head is attracted to the magnetic field. This causes the hammer head to strike the bell.

Diagram of a Classroom Bell

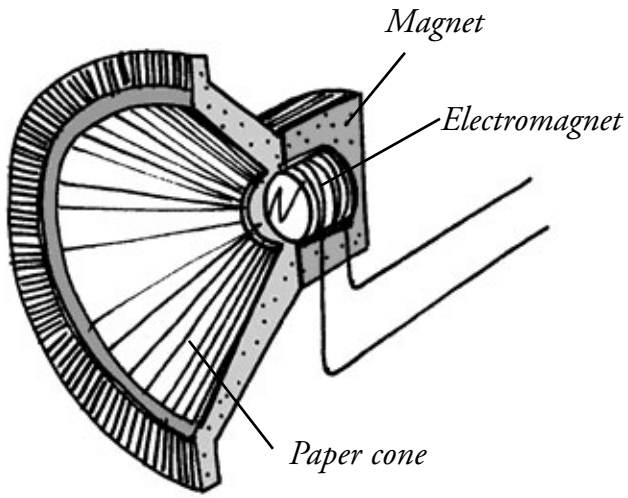


Brainstorm a list of things you use or have seen that have an electromagnet.

The speaker in your classroom is also an electromagnet. Look at the picture below. The speaker has a paper cone, a magnet, and an electromagnet.

Magnetic forces between the electromagnet and the magnet push or pull on the paper cone. The movement of the cone forms sound waves.

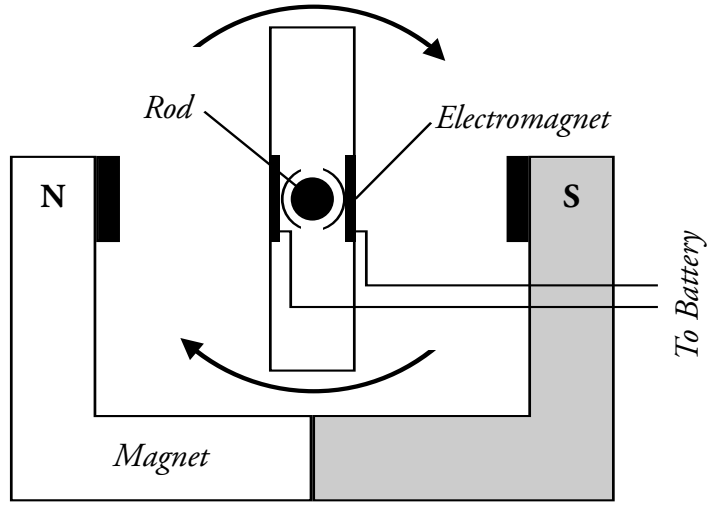
Diagram of a Speaker



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

A motor uses an electromagnet. The electromagnet is surrounded by a magnet. The electromagnet is connected to a rod. The rod allows the electromagnet to spin. When an electric current passes through, the magnetic force causes the electromagnet to spin.

Diagram of an Electric Motor



Try It Yourself!

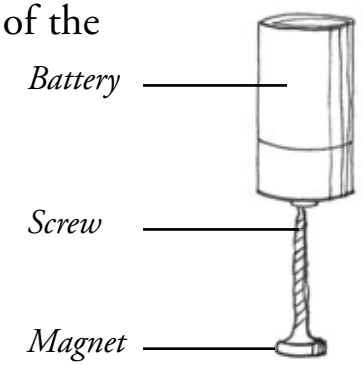
You can make your own electric motor.

Materials

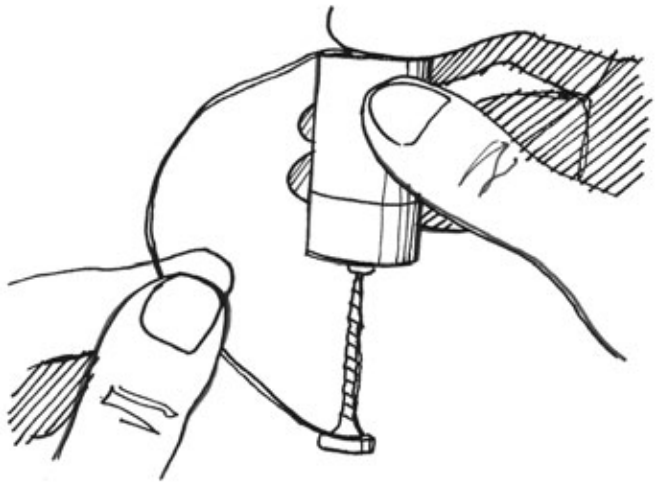
- safety glasses
- 6 inches of copper wire
- 1.5 V battery
- small neodymium disk magnet
- iron screw with flat head such as a drywall screw

Procedure

1. Have an adult 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 findings and explain what you observed.

Glossary

attract—to make something come closer

demonstration—showing how something works

repel—to make something move 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

Index

compass, 10, 13

doorbell, 16

electric motor, 19

electrical charges, 4–5

magnetic fields, 8–9, 12

Oersted, Hans Christian, 13

speaker, 18

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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.

Synonyms and Antonyms

Words that mean the same, such as *tiny* and *small*, are synonyms. Words that mean the opposite, such as *tiny* and *large*, are antonyms.

For example, a synonym for *push* is *shove*. *Push* and *shove* have the same meaning. An antonym for *push* is *pull*. *Push* and *pull* have opposite meanings.

Write the correct words from the box on the lines. You will use some of the words twice.

attract	negative	opposite	strongest
temporary	discovered	nearby	

1. A synonym for *found* _____

2. An antonym for *same* _____

3. An antonym for *weakest* _____

4. A synonym for *come closer* _____

TRY THE SKILL

5. A synonym for *the other end* _____

6. An antonym for *repel* _____

7. A synonym for *close* _____

8. An antonym for *positive* _____

Find more words in the book that have synonyms and antonyms. Write them on the lines below.

_____

_____

_____

_____

_____

_____

_____

Sequential Order

Sequential order is the order in which things happen. Understanding sequential order can help you understand and remember what you read. You can retell the sequential order. To do this, use words such as, *first, then, next,* and *finally.*

Read this passage from *Electromagnetic Energy.*

Tie strings to two balloons. Rub each balloon on your hair. Both balloons get a negative charge. Then hold them close together by the strings. The balloons move apart. They repel each other because both charges are negative.

What are the steps in this investigation? A graphic organizer can help you identify the steps.

Step 1	Tie strings to two balloons.
Step 2	Rub each balloon against your hair.
Step 3	Hold the balloons close together.

TRY THE SKILL

Read this passage from *Electromagnetic Energy.* How does a bell with an electromagnet work? Retell in sequential order. Use the graphic organizer to help.

First, someone pushes a button connected to the bell. This sends an electric current to the electromagnet in the bell. Now the electromagnet has a magnetic field. An iron bar with a hammer head is attracted to the magnetic field. This causes the hammer head to strike the bell.

Step 1	
Step 2	
Step 3	
Step 4	

Identify a Purpose

As you choose something to read, you usually have a purpose in mind, such as these:

- **to gain or understand information**
- **to learn how to do something**
- **to gather information in order to form an opinion**
- **to be entertained**

For example, you read this book to gain information about electromagnetic energy. You also learned how to perform several experiments—another purposes for reading.

As you look through books, magazines, and articles, think about your purpose for reading. Choose reading material that matches your purpose.

Read the description of each selection. Then identify its main purpose.

1. This selection tells why magnets attract and repel each other.

Ⓐ to inform
Ⓑ to tell how to do something
Ⓒ to persuade
Ⓓ to entertain

TRY THE SKILL

2. This selection tells how to build an electromagnet.

Ⓐ to inform
Ⓑ to tell how to do something
Ⓒ to persuade
Ⓓ to entertain

3. This selection explains the benefits of using electric powered cars.

Ⓐ to inform
Ⓑ to tell how to do something
Ⓒ to persuade
Ⓓ to entertain

4. This selection tells about early scientists who investigated magnetism.

Ⓐ to inform
Ⓑ to tell how to do something
Ⓒ to persuade
Ⓓ to entertain

Distinguish Fact from Opinion

TRY THE SKILL

A fact can be proved. For example, a scientists can say that an electromagnet only has a magnetic field when the electricity flows through it..

An opinion is what someone believes. For example, a person might say electromagnets waste energy However, other people might disagree with this opinion.

Being able to tell facts from opinions makes you a better reader. Opinion sentences often have words such as *better, worse, should, difficult, toughest*, and *easy*. Here are more examples:

Fact

Hans Christian Oersted was a teacher in Denmark.

Opinion

Hans Christian Oersted made the most important discovery about magnetic fields.

Mark each statement below *F* for fact or *O* for opinion.

1. Everything in the word is made up of atoms. ____
2. The experiment testing the strength of two magnets was fun. ____
3. Objects with a negative charge repel other objects with a negative charge. ____
4. You should never leave on a trip without a compass. ____
5. Earth is a giant magnet. ____
6. Hans Christian Oersted should have known what caused the compass needle to move. ____
7. A speaker uses an electromagnet to send sound waves. ____
8. Opposite charges attract. Similar charges repel. ____

On the back of this page, write one fact and one opinion about electromagnetic energy.

Answer Key

Synonyms and Antonyms

1. discovered
2. opposite
3. strongest
4. attract
5. opposite
6. attract
7. nearby
8. negative

Sequential Order

Step 1: Someone pushes a button
Step 2: An electric current is sent to the electromagnet
Step 3: An iron bar with a hammer head is attracted to the magnetic field.
Step 4: The hammer head strikes the bell.

Identify a Purpose

1. A
2. B
3. C
4. A

Distinguish Fact from Opinion

1. F
2. O
3. F
4. O
5. F
6. O
7. O
8. F