Physical Science

Electricity and Magnetism

On Level

Electromagnetic Energy

LOOK INSIDE FOR:

- Core Curriculum Covered
- Student Book
- Assessments and Reading Activities

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Electromagnetic Energy

What are the properties of electricity and magnetism?

CORE CURRICULUM STATEMENTS

Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

Objects have properties that can be observed, described, and/or measured: length, width, volume, size, shape, mass or weight, temperature, texture, flexibility, reflectiveness of light.

The material(s) an object is made up of determine some specific properties of the object (sink/float, conductivity, magnetism).

Properties can be observed or measured with tools such as hand lenses, metric rulers, thermometers, balances, magnets, circuit testers, and graduated cylinders.

Objects and/or materials can be sorted or classified according to their properties.

Energy exists in many forms, and when these forms change energy is conserved.

Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.

Interactions with forms of energy can be either helpful or harmful.

Energy and matter interact through forces that result in changes in motion.

Magnetism is a force that may attract or repel certain materials.

The forces of gravity and magnetism can affect objects through gases, liquids, and solids.

The force of magnetism on objects decreases as distance increases.

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Electricity and Magnetism

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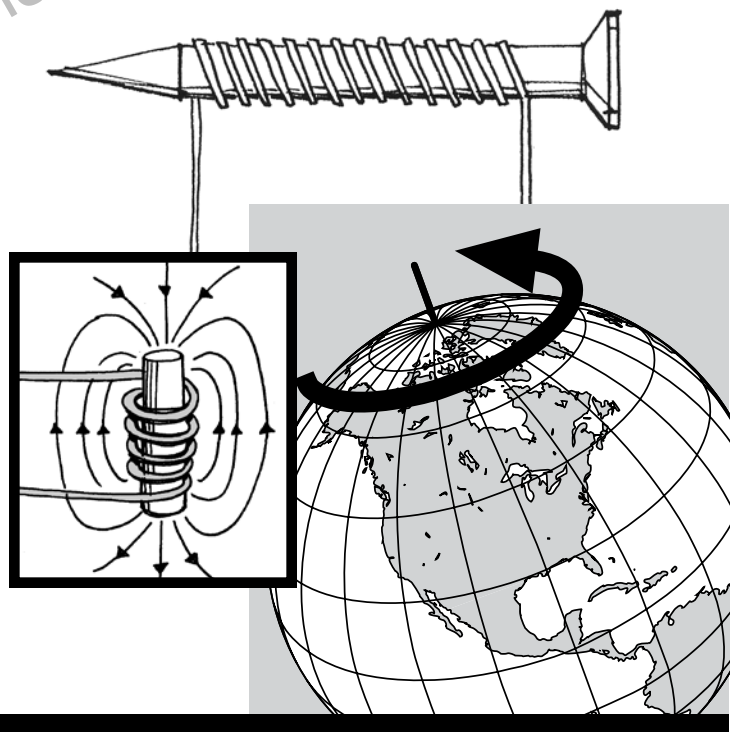
by Ken Sibila



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Curriculum materials for **your** content standards

Table of Contents

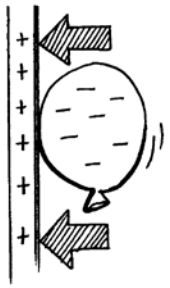
INTRODUCTION

Electrical Charges

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

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

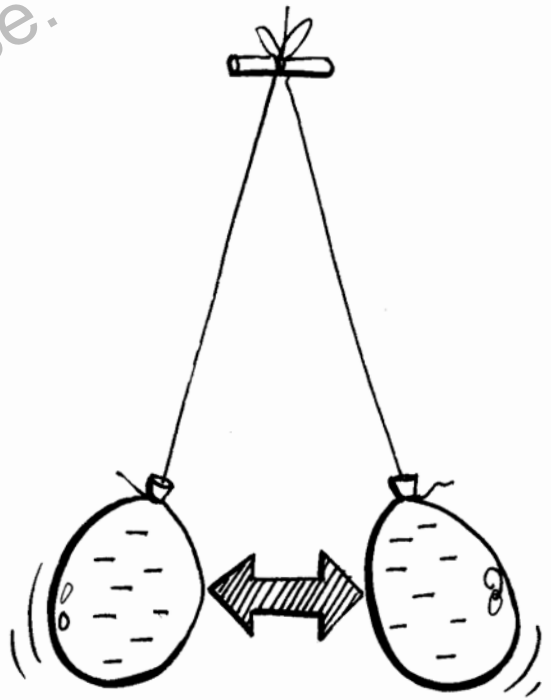
When you rubbed the balloon against your hair, the balloon picked up extra negative charges. The negatively-charged balloon **repels** other negative particles in the wall. This leaves positively charged particles near the surface of the wall. The balloon is attracted to those positive particles and 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. Likes repel!

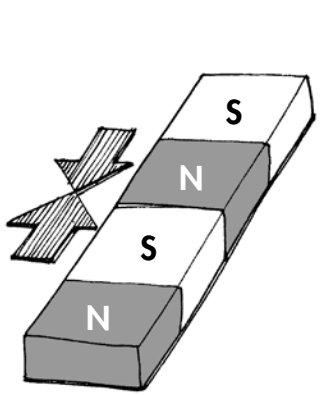


CHAPTER 1

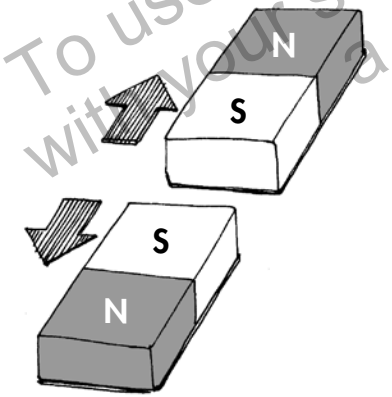
What Are Magnets?

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).

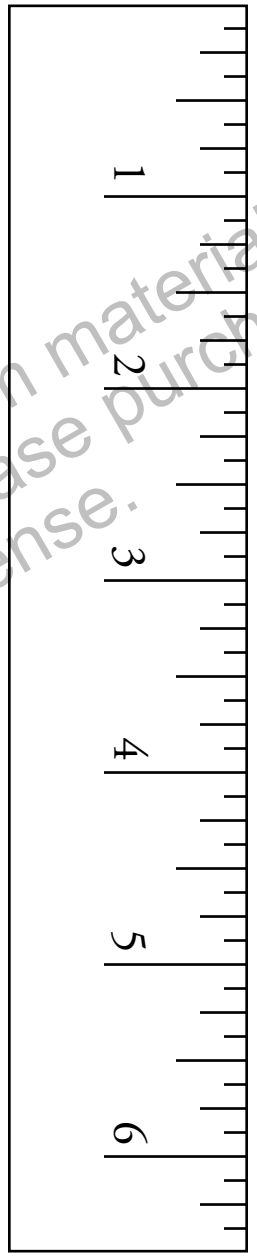
If you put opposite poles of two magnets close together, they will pull each other together. If you put similar poles close together, they will repel each other.



Opposite poles attract each other.

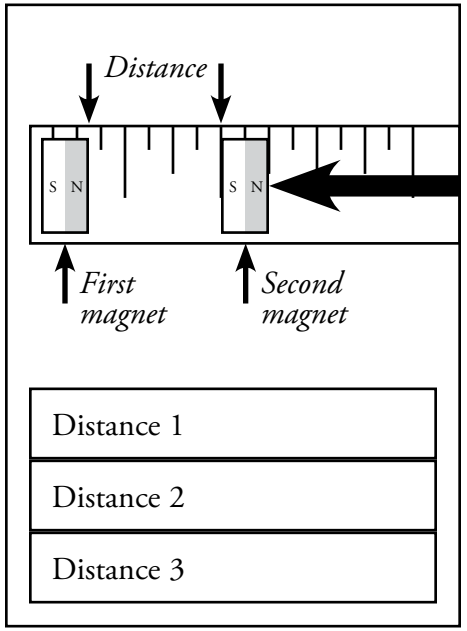


Like poles repel each other.



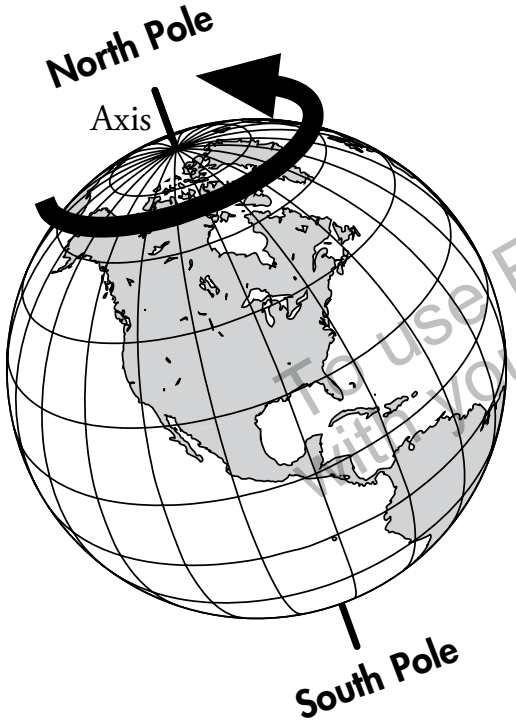
Try It Yourself!

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.



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.

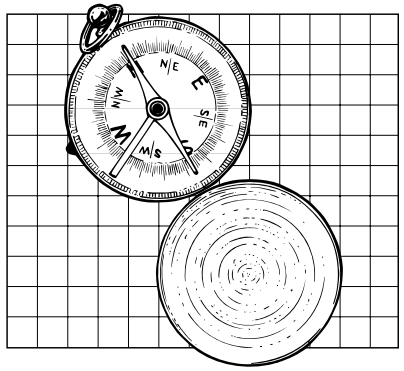


molten: melted by heat
axis: a real or imaginary line about which something turns

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!

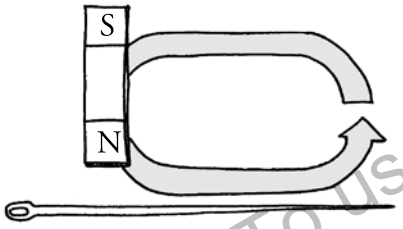
You can make your own compass. To create one, you will need the following:

Materials

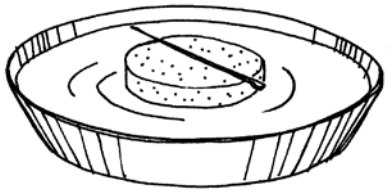
- craft needle
- cork or sponge
- magnet
- bowl filled with water

Procedure

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

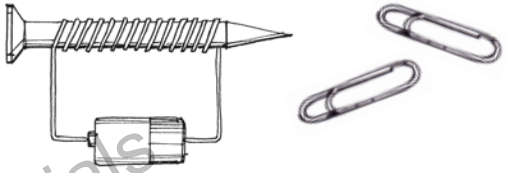


2. Place the cork or sponge in the bowl. Rest the needle on top.

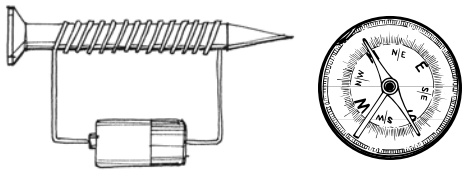


3. Observe what happens and record your observations in a journal.

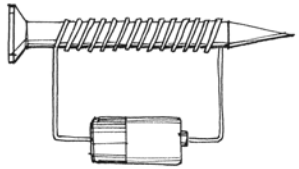
4. Place the nail close to the small metal objects. Record what happens.



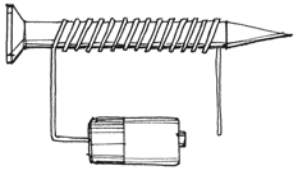
5. Place the compass close to the nail. Move the compass around the nail. Record your findings.



6. Reverse the wires on the battery. Repeat steps 3, 4 and 5. Record your findings.



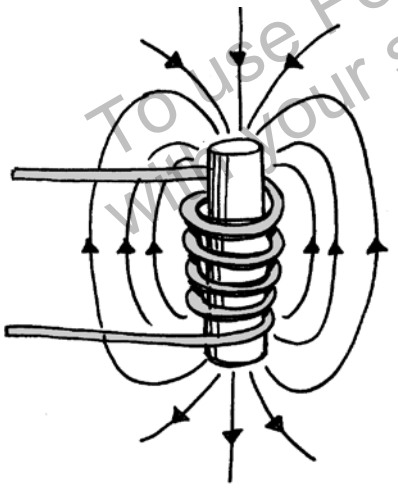
7. Disconnect one wire from the battery and repeat steps 4 and 5. Record your findings.



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!

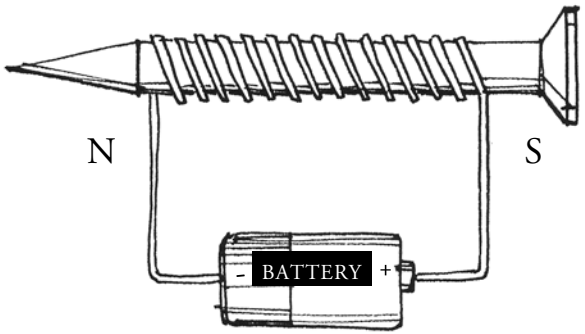
You can make your own electromagnet.

Materials

- copper wire with insulation
- 8d iron nail
- D battery
- tape
- small metal items such as paper clips, 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 (+).



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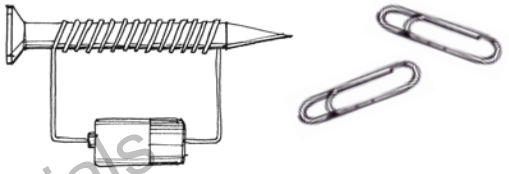

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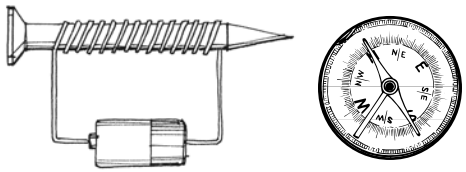

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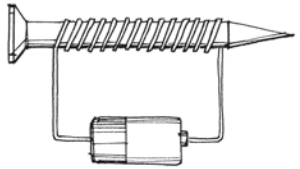

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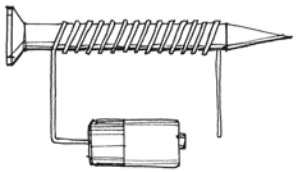


CHAPTER 3

Electromagnets in Use

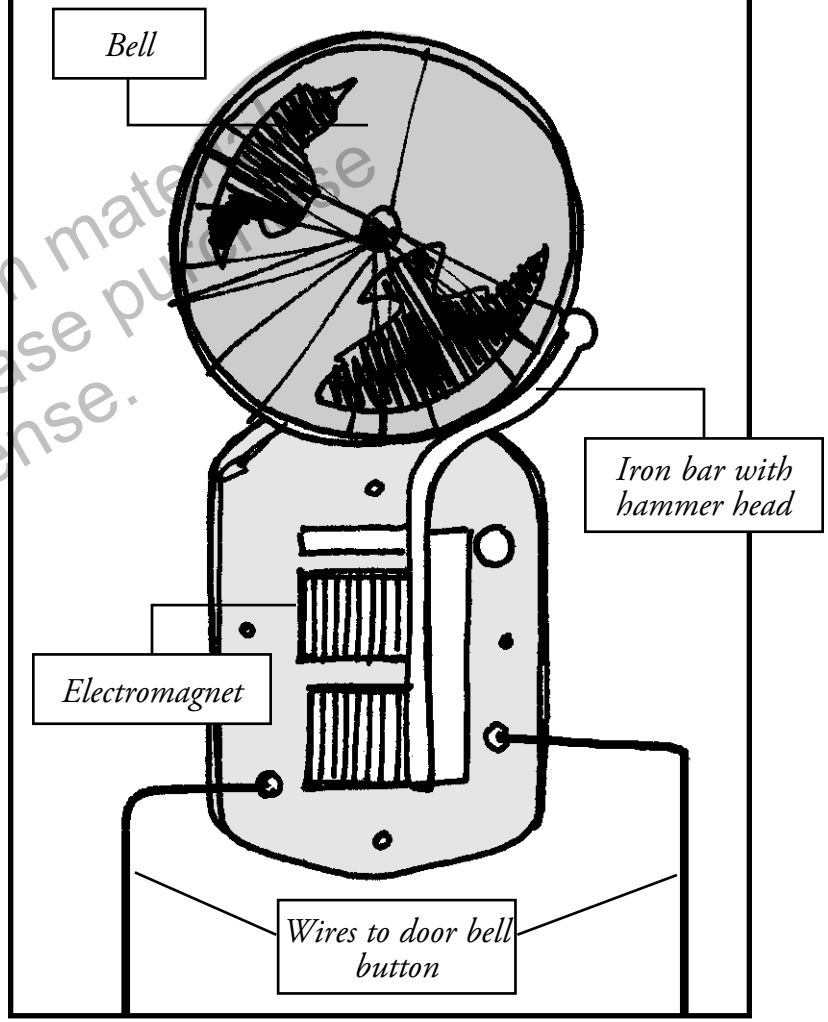
Electromagnets Are All Around Us

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.

Diagram of a Classroom Bell

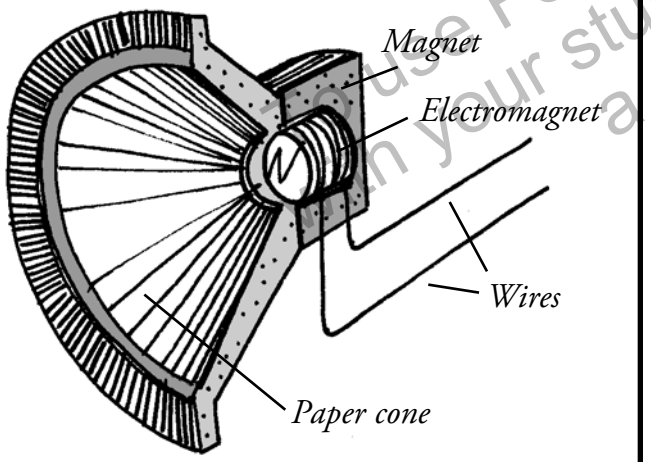


Brainstorm a list of things you use or have seen that have an electromagnet.

The speaker in your classroom is 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.

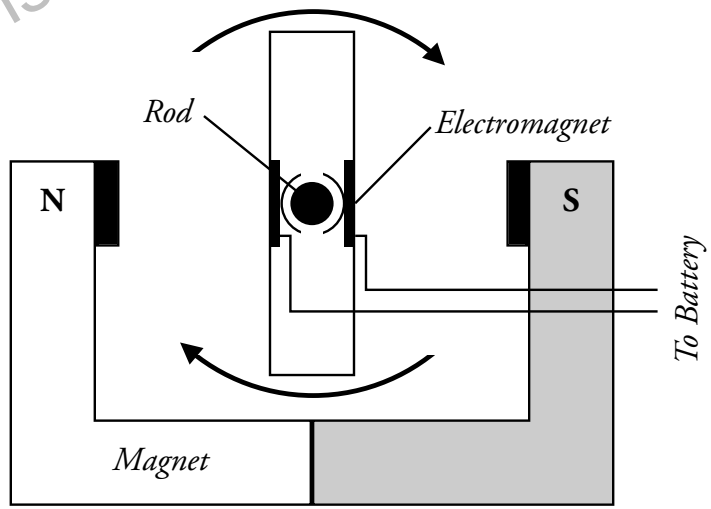
Diagram of a Speaker



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.

Diagram of an Electric Motor



Try It Yourself!

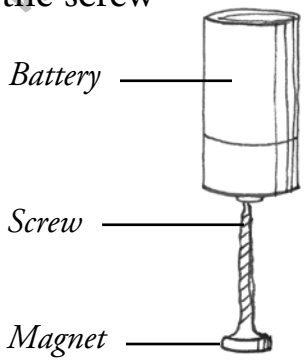
You can make your own electric motor.

Materials

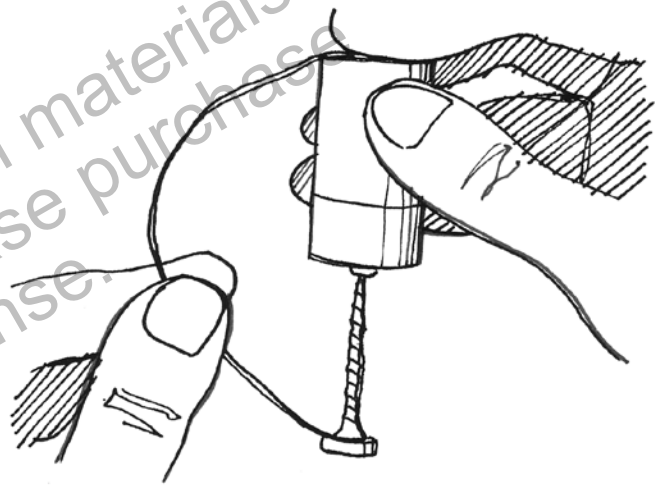
- safety glasses
- 6 inches of copper wire
- 1.5 V battery
- small neodymium disk magnet
- iron screw with flat head such as a drywall screw

Procedure

1. 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

Be sure you and 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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Assessments

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Print pages 20–22 of this PDF for the reading activities.

Electromagnetic Energy

Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

1. What force causes two magnets to repel each other?

Ⓐ friction

Ⓑ gravity

Ⓒ electricity

Ⓓ magnetism

2. A magnet and a metal paper clip will have the strongest magnetic attraction when the distance between them is

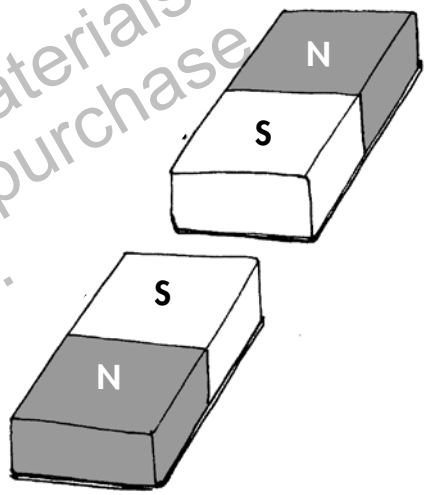
Ⓐ one-quarter inch

Ⓑ one-half inch

Ⓒ one inch

Ⓓ two inches

3. A student places two magnets close to each other. Explain what will happen to the magnets.



Electromagnetic Energy

Check Understanding

Write your answer on the lines provided.

4. A student asks, "Does the distance you wrap a wire around an electromagnet affect the strength of the magnetic force?" The student hypothesizes that if you wrap the wire closer together around the nail, the force will be greater. Describe how the student can set up an investigation of his hypothesis.

_____

_____

_____

_____

_____

Describe how the student can collect data to support his hypothesis.

_____

_____

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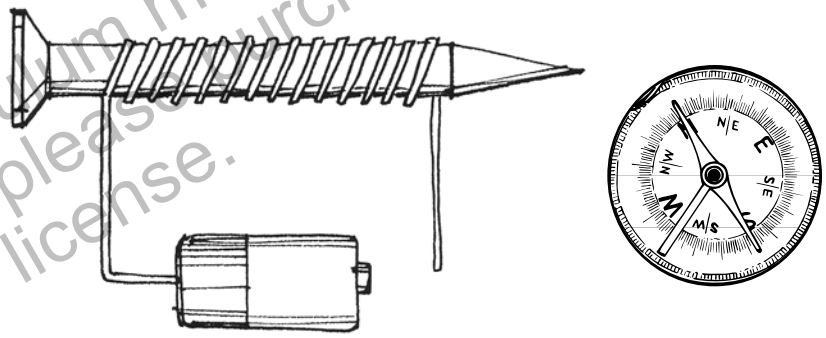
5. A student creates an electromagnet by using an iron nail, copper wire, and a battery shown in the diagram below. What effect will the electromagnet have on the compass resting nearby.



_____

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_____

Electromagnetic Energy

Assessment Scoring Guidelines

1. Answer D is correct.

2. Answer A is correct.

3. The magnets will repel to each other because the ends of the magnet closest to each other are the same poles.

4. The student should explain a setup that includes and electromagnet with wires coiled far apart and another with wires coiled tightly together. The student would then test both electromagnets to see how many metal items, such as paper clips, each electromagnet can move or pick up.

The student should explain how to create a table to record the results of the experiment.

5. The electromagnet will have no effect because the wire is disconnected from the battery. There is no electricity flowing through the electromagnet.

Physical Science

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On Level

English-language Arts Activities

Electromagnetic Energy

Print pages 24–28 of this PDF for the reading activities.

Words with Multiple Meanings

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.

TRY THE SKILL

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

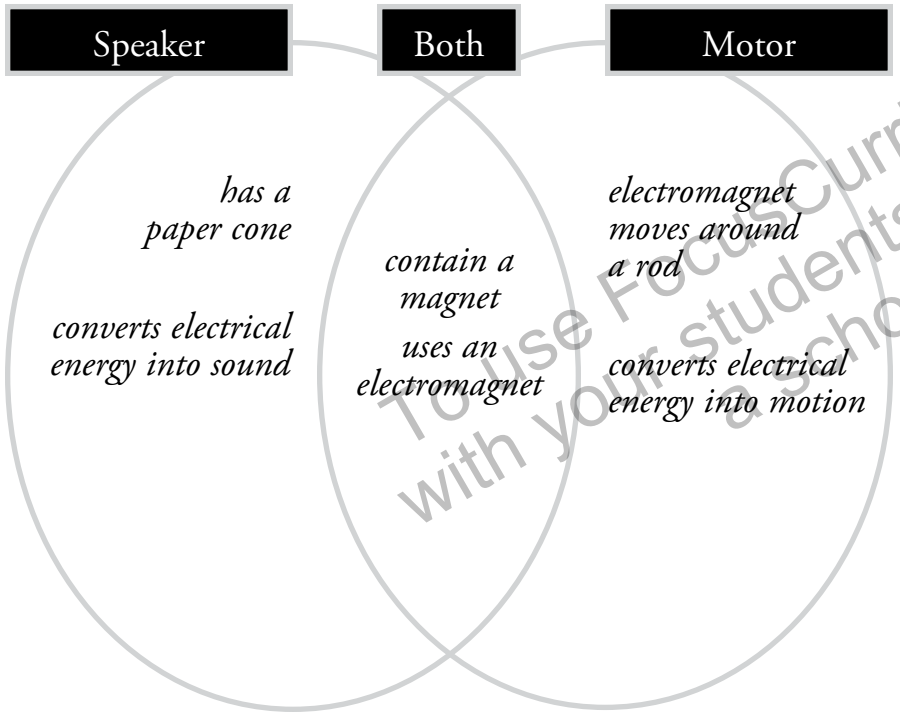
4. _____ the needle on top of the cork.

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

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

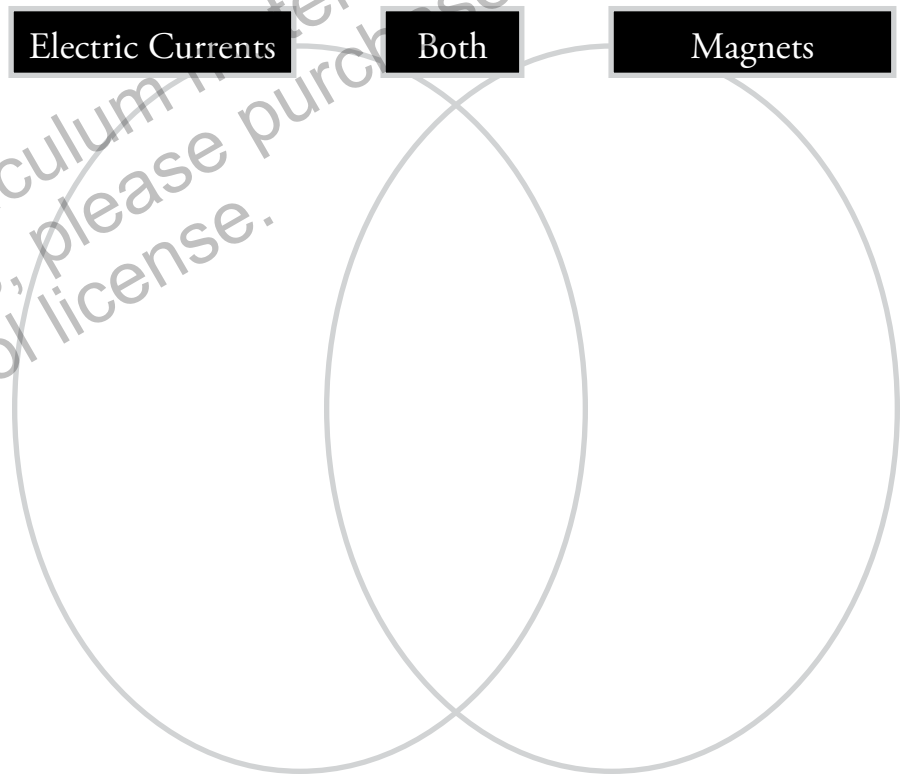
Compare and Contrast

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.



TRY THE SKILL

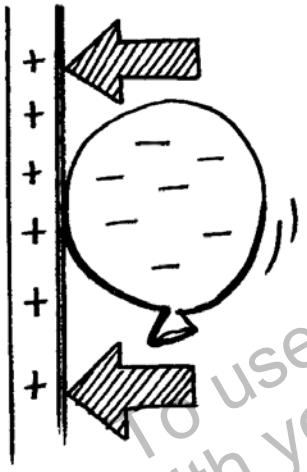
Use this Venn diagram to compare electric currents and magnets.



Make a Prediction

TRY THE SKILL

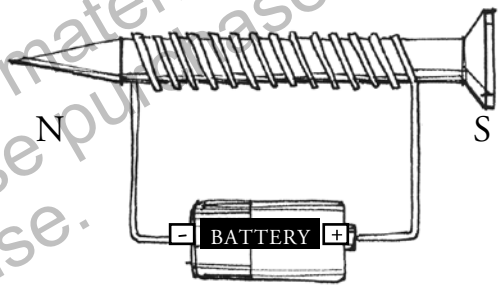
Graphics can give you information quickly and help you understand how something occurs or works. Look at the graphic showing the wall and the balloon and make a prediction.



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