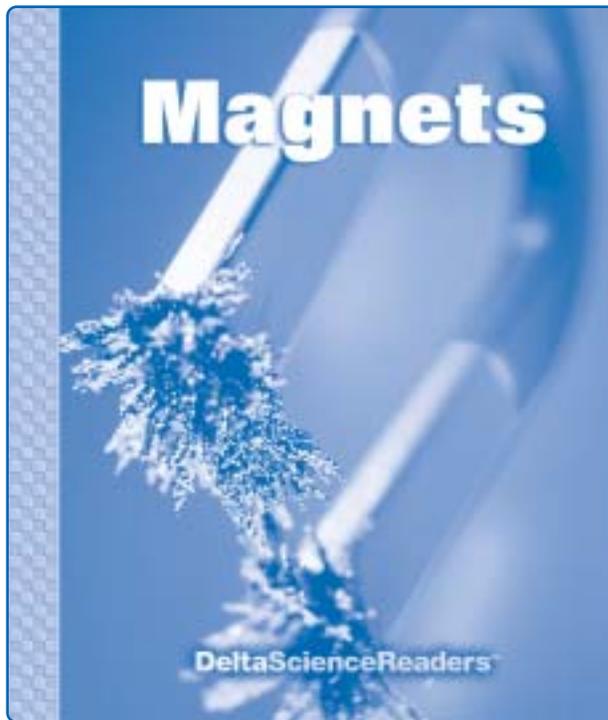


Magnets



Delta Science Readers are nonfiction student books that provide science background and support the experiences of hands-on activities. Every **Delta Science Reader** has three main sections: *Think About . . .*, *People in Science*, and *Did You Know?*

Be sure to preview the reader Overview Chart on page 4, the reader itself, and the teaching suggestions on the following pages. This information will help you determine how to plan your schedule for reader selections and activity sessions.

Reading for information is a key literacy skill. Use the following ideas as appropriate for your teaching style and the needs of your students. The After Reading section includes an assessment and writing links.

OVERVIEW

In the Delta Science Reader *Magnets*, students read about magnets and magnetic fields. They learn how magnets are made, how magnets can create electricity, what magnets are used for, and how Earth is like a magnet. They also read about Michael Faraday, the famous nineteenth-century scientist who invented the electric motor and the electric generator, both of which use magnets. Finally, students learn about applications of magnets in magnetic resonance imaging (MRI) and maglev trains.

Students will

- ▶ discover facts about magnets and magnetism
- ▶ learn about the relationship between Earth's magnetic field and how a compass works
- ▶ read about electromagnets and generators
- ▶ discover the many uses of magnets
- ▶ examine nonfiction text elements such as table of contents, headings, and glossary
- ▶ interpret photographs and diagrams to answer questions
- ▶ complete a KWL chart

READING IN THE CONTENT AREA SKILLS

- Draw conclusions from facts about magnets
- Recognize cause-effect relationships related to magnets and magnetism
- Determine the main ideas and supporting details in text sections
- Compare Earth with a magnet
- Describe the steps in the process by which a generator produces electricity
- Demonstrate critical thinking
- Interpret graphic devices
- Summarize and paraphrase

NONFICTION TEXT ELEMENTS

Magnets includes a table of contents, headings, photographs, illustrations, captions, boldfaced terms, labels, diagrams, and a glossary.

CONTENT VOCABULARY

The following terms are introduced in context and defined in the glossary: *attract, compass, electric motor, electromagnet, field lines, force, friction, generator, lodestone, magnet, magnetic, magnetic field, magnetic north pole, magnetic poles, magnetic south pole, magnetism, magnetite, metal, nonmagnetic, north-seeking (N) pole, permanent magnet, repel, south-seeking (S) pole, temporary magnet.*

BEFORE READING

Build Background

Access students' prior knowledge of magnets by displaying and discussing the cover. Ask, *What is this object?* (a magnet) *What does a magnet do?* (It attracts metal objects.) *What do you know about how a magnet works?* (Accept reasonable responses.)

Read the title aloud, and invite students to share what they know about the topic from

their personal experiences and hands-on explorations in science. To stimulate discussion, ask questions such as these: *What kinds of objects are attracted to a magnet? What uses do magnets have? What things can you think of that you use every day that have magnets in them?*

Begin a group KWL chart by recording facts students know about magnets in the K column and questions students have about magnets in the W column. You may want students to copy the KWL chart so they can maintain their own charts as they read.

K What I Know	W What I Want to Know	L What I Learned	+ What I Want to Explore Further

Preview the Book

Explain that when students preview nonfiction, they should look at the title, the table of contents, headings, boldfaced words, photographs, illustrations, charts, graphics, and captions.

Then preview the book with students. Call attention to the various nonfiction text elements and explain how they can help students understand and organize what they read. Ask questions such as these: *How do the headings help you predict what you will read about? What do you see in this picture? How do you think it will help you understand the text?* Explain that the words in boldface type are important words related to magnets. Point out that these words are defined in the glossary. Choose one word and have students find its definition in the glossary.

Preview the Vocabulary

You may wish to preview some of the vocabulary words before reading, rather than

waiting to introduce them in the context of the book. Possibilities include creating a word wall, vocabulary cards, sentence strips, or a concept web.

For example, after helping students define the words, have them find pairs of words or terms that are antonyms, words with opposite meanings. Examples in the glossary include *attract-repel*, *magnetic-nonmagnetic*, and *permanent magnet-temporary magnet*. Then ask students to find a pair of synonyms, words with the same or similar meanings, such as *lodestone-magnetite*.

Set a Purpose

Discuss with students what they might expect to find out from the book, based on their preview. Encourage them to use the questions on the KWL chart to set an overall purpose for reading.

GUIDE THE READING

Preview the book yourself to determine the amount of guidance you will need to give for each section. Depending on your schedule and the needs of your class, you may wish to consider the following options:

- **Whole Group Reading** Read the book aloud with a group or the whole class. Encourage students to ask questions and make comments. Pause as necessary to clarify and assess understanding.
- **Shared Reading** Have students work in pairs or small groups to read the book together. Ask students to pause after each text section. Clarify as needed and discuss any questions that arise or have been answered.
- **Independent Reading** Some students may be ready to read independently. Have them rejoin the class for discussion of the book. Check understanding by asking students to explain in their own words what they have read.

Tips for Reading

- If you spread out the reading over several days, begin each session by reviewing the previous day's reading and previewing what will be read in the upcoming session.
- Begin each text section by reading or having a volunteer read aloud the heading. Have students examine any illustrations or graphics and read accompanying captions and labels. Discuss what students expect to learn, based on the heading, illustrations, and captions.
- Help students locate context clues to the meanings of words in boldface type. Remind them that these words are defined in the glossary. Provide help with words that may be difficult to pronounce.
- As appropriate, model reading strategies students may find helpful for nonfiction: adjust reading rate, ask questions, paraphrase, reread, visualize.

Think About . . . (pages 2–12)

Pages 2, 3 *What Is a Magnet?*

- Direct students' attention to the photograph at the top of page 2 and have them read the caption. Ask students to point to each type of magnet as you read the names of the shapes. Ask, *What conclusion can you draw from this information?* (Magnets can be just about any shape.) Elicit that we cannot tell whether an object is a magnet just by looking at it.
- Have students read page 2 through the end of the first complete paragraph on page 3. Check comprehension by asking, *What is a magnet?* (an object that pulls, or attracts, certain materials to it) *What do we call the force of a magnet?* (magnetism) *What are magnets made of?* (Most contain iron, nickel, or cobalt.) *What is the name for materials that are attracted to a magnet?* (magnetic) *What do we call materials that are not attracted to a magnet?* (nonmagnetic)

- Explore causes and effects by asking, *What is the effect of placing a magnet near an object made of iron or steel?* (The object is attracted to the magnet.) *What causes this?* (Magnetism pulls magnetic objects to the magnet.) *What will happen if you place a magnet near a piece of plastic or silver?* (nothing) *Why not?* (Plastic and silver are nonmagnetic; magnetism does not affect them.) *What conclusion can you draw about metals and magnets?* (All materials that are attracted to magnets are metals, but not all metals are attracted to magnets.)
- Have students finish reading page 3. Ask students to summarize the information on magnetic poles. (A magnet has two magnetic poles, places where the magnetism is strongest. The north-seeking pole always points north, and the south-seeking pole always points south.) Ask, *What makes this feature of magnets useful?* (Students may mention that magnets are used in compasses to help people locate directions.)
- Ask, *What is the main idea—the most important idea—expressed in the last paragraph?* (Unlike magnetic poles attract; like poles repel.) As appropriate, tell students that this is called the Law of Magnetic Attraction. Then have students look at the photograph at the top of the page, read the caption, and answer the questions. (You would place the magnets so that like poles are facing each other. The cars will push away from each other.)

Pages 4, 5 *What Is a Magnetic Field?*

- Before reading page 4, have students study the photograph at the top of the page and read the caption. Invite volunteers to describe what they see. Ask students what they think the iron filings show. Then have them read page 4 to find out about magnetic fields.
- Assess comprehension by having students paraphrase the information about magnetic fields. (A magnetic field is the

space around a magnet where the magnet's force works. The magnetic field spreads out, so a magnet's force can act at a distance. The strength of the force gets weaker with distance from the magnet. The force can act through solids, liquids, and gases.) Point out that a magnet can move an object without actually touching the object.

- Ask, *How can you “see” a magnetic field if it is invisible?* (You can see its effect. Iron filings line up along the field lines and show where the magnetic field is.)
- Have students read page 5 to discover how magnetic field lines show that unlike poles attract and like poles repel. Ask, *What happens to the field lines when unlike poles of two magnets come together?* (They connect.) *What effect does this have?* (The magnets pull together.) *What happens to the field lines when like poles of two magnets come together?* (The field lines do not connect.) *What effect does this have?* (The magnets push each other away.)

Pages 6, 7 *How Are Magnets Made? and How Is Earth Like a Magnet?*

- Have students read the text about how magnets are made on page 6 and look at the accompanying diagram. Ask, *How can you make a magnet?* (Place an iron or steel object in a magnetic field.) *What effect does this have?* (It causes groups of particles in the object to line up with their north poles pointing in the same direction.) *Why are some magnets only temporary, while others are permanent?* (In some metals, the groups of particles do not stay lined up, so the magnetism lasts for only a short time. In other metals, the groups of particles stay lined up, so the magnetism is permanent.) *What actions can cause a magnet to lose its magnetism?* (heating, hammering, or dropping it) *What result do these actions have?* (They make the groups of particles fall out of line.)

- Before having students read page 7, ask them to study the diagram at the top of the page. Ask, *What do the lines around the picture of Earth look like?* (the field lines around a magnet) Then have students read to find out how Earth is like a magnet.
- Have students compare Earth with a magnet. Ask, *How is Earth like a magnet?* (It has magnetic north and south poles. It has field lines like the field lines of a magnet.) *What shape of magnet is Earth most like?* (Earth looks like a ball, but in terms of magnetism, it is most like a bar magnet.)
- Before discussing the possible cause of Earth’s magnetism, you may wish to explain that Earth is made up of layers: the rocky outer crust, a mantle of rock so hot it can flow, a rotating outer core of melted metals, and a solid inner core. You might also review that an electric current is the flow of electrical charges through a substance. Ask, *What do scientists think causes Earth’s magnetism?* (electric currents in the swirling liquid part of the core)
- Ask, *What is the most interesting or surprising fact you learned about Earth?* (Students may mention the fact that Earth’s geographic North and South Poles and its magnetic north and south poles are not in the same places.)
- If necessary, provide help with the pronunciation of *alnico* (AL-nih-ko).

Further Facts

- Earth’s magnetic field is not exactly the same shape as that of a bar magnet. It is blown out of shape by the solar wind—the stream of electrically charged particles that is emitted by the sun. On the side of Earth facing the sun, Earth’s magnetic field—called the magnetosphere—is compressed toward Earth. On the side facing away from the sun, the magnetosphere forms a long tail like that of a comet, blown away from

Earth by the solar wind. These same electrically charged particles cause the colorful and dramatic *aurora borealis* (northern lights) and *aurora australis* (southern lights).

- William Gilbert (1544–1603), physician to Queen Elizabeth I of England, first proposed the idea (around 1600) that Earth is a giant magnet with its magnetic poles some distance away from its geographic poles.
- A compass is useless at Earth’s magnetic poles because there the field lines point straight up and down.
- Geophysicists discovered that in the past, Earth’s magnetic field has reversed itself. In some cases reversals happened in just a few thousand years or less—very quickly on the geological time scale. In recent geologic time, reversals have occurred about every 200,000 years. The last reversal was some 780,000 years ago. Scientists also know that the field has been weakening for the past 2,000 years. They do not know, however, whether this is the beginning of another reversal.

Pages 8, 9 *What Is a Compass?*

- Before students read, write the word *compass* on the board. Encourage volunteers to share what they know about compasses and how they work. Then have students read “What Is a Compass?” Check comprehension by asking, *What is a compass?* (an instrument that is used to find north) *How does a compass work?* (A compass has a magnetic needle that turns around on a pin. The north-seeking pole of the needle always points to Earth’s magnetic north pole.)
- Ask, *Why was the compass such an important tool for sailors such as Christopher Columbus?* (Far from shore there are no landmarks to guide sailors. Sailors could use the stars to find north only on clear nights. With a compass, sailors could check their direction at any

time on the open ocean.) *What surprising fact did Columbus learn on his voyage?* (The compass needle did not always point exactly north.) *What was the reason for this?* (The needle pointed to the magnetic north pole, not the geographic North Pole.)

- If necessary, provide help with the pronunciation of *magnetite* (MAG-nuh-tite).

Pages 10, 11 *What Is an Electromagnet?* and *How Can a Magnet Make Electricity?*

- Have students read the text about electromagnets on page 10 and look at the photograph and caption at the top of the page. Assess comprehension by having students summarize how an electromagnet works. (An electric current flows through a wire coil. This creates a magnetic field around the coil. The coil becomes a magnet. When an iron rod or nail is placed in the coil, the magnetic force gets stronger. This makes an electromagnet.)
- Ask, *What details support the main idea that an electromagnet is extremely useful?* (An electromagnet can be turned on and off; it can be very strong; it has many different uses.)
- Direct students' attention to the photograph at the bottom of the page. Ask students to predict what will happen when the electromagnet is turned off. (The metal will fall off the magnet and drop.) Ask, *How can an electromagnet be used to sort scrap metal?* (It will pick up only metal that is magnetic, such as iron and steel. It will not pick up nonmagnetic metals, such as aluminum and copper.)
- Direct attention to the diagram on page 11 and explain that it shows how a machine called a generator produces electricity. Ask students to follow the steps as you read each numbered label. Then have them read the text.
- Ask students to describe the sequence of steps that enable a generator to produce electricity. (Mechanical energy causes a

wire loop to spin between magnets. This causes an electric current to form in the loop. Electricity travels from the loop to metal rings. The rings spin against brushes. The electricity travels to the brushes and from the brushes to wires. The wires carry the electricity to where it will be used.)

To make electricity, either the magnets or the wire coil must move. Moving the magnets around the coil creates a current in the wire. So does spinning the coil between the magnets.

- If necessary, provide help with the pronunciation of *electromagnet* (ih-lek-tro-MAG-net).

Page 12 *What Uses Do Magnets Have?*

- Before reading, have students look at the photographs at the top of the page and read the caption. Ask, *How do you think magnets are used in a computer? How do you think they are used in the other things shown?* (Accept reasonable responses.)
- Have students read page 12 to discover the answers to the questions about the devices pictured. Then ask the questions again: *How are magnets used in a computer?* (Magnetic materials are used to store information on the hard drive.) *How are magnets used in a cassette tape?* (Magnetic material records and stores music.) *How are magnets used in a hair dryer?* (An electric motor runs the fan inside the hair dryer.) *How are magnets used in a toaster?* (An electromagnet holds the toast tray down; turning off the magnet lets the toast tray pop up.)
- Ask, *What are probably the most important uses magnets have?* (in electric generators and electric motors) *What details support this main idea?* (Without generators to make electricity, we would not have electric lights, television, telephones, or anything else that runs on electricity. Electric motors run many things we use every day.)

- Read aloud the question at the end of the page: *How many times a day do you use magnets?* Invite students to share their answers to the question.

People in Science (page 13)

Michael Faraday

- Before reading, ask students whether they have heard of Michael Faraday. Encourage volunteers to share any information they have about Faraday and his work. If necessary, explain that Michael Faraday made important discoveries about magnetism and electricity.
- After students read the text on page 13, ask, *What obstacles did Michael Faraday have to overcome before he could become a scientist?* (His family was poor, and he had very little education.) You may wish to share with students that Michael was just 14 when he went to work in the book shop. Encourage students to discuss what personal qualities may have helped Michael to overcome his childhood background and succeed. (Students may mention intelligence, drive to learn, and interest in science.)
- Check understanding by asking, *What important contributions did Faraday make?* (He invented the electric motor and made the first electric generator.)

Further Facts

- The article on electricity that fascinated Faraday appeared in the third edition of the *Encyclopedia Britannica*. It inspired him to make a crude generator using old bottles and lumber.
- The famous chemist under whom Faraday studied was Sir Humphry Davy (1778–1829). Davy discovered several chemical elements (including sodium and potassium) and compounds and also invented the miner’s safety lamp. It was said that Davy’s greatest discovery was Faraday.

- As a chemist, Faraday produced the first known compounds of carbon and chlorine (1820) and isolated and described benzene (1825). In addition, his investigations of steel alloys laid the foundation for scientific metallurgy.
- The discoveries on which Faraday based his work in electromagnetism were made by Hans Christian Oersted (1777–1851), a Danish physicist and chemist, and André-Marie Ampère, a French physicist who founded and named the science of electrodynamics, now known as electromagnetism. It was Oersted who, in 1820, discovered that the flow of an electric current through a wire produced a magnetic field around the wire.

Did You Know? (pages 14, 15)

Page 14 About MRIs

- Direct students’ attention to the MRI images and the photograph of a patient being placed in an MRI machine. Explain that an MRI is a tool that uses magnets to let doctors see inside the human body. Then have students read page 14.
- Check understanding by asking, *What makes an MRI a better tool than an X-ray?* (An MRI shows more details than an X-ray picture.) *What makes an MRI machine work?* (an electromagnet)
- As appropriate, share with students how an MRI machine functions. When an iron object is placed in a magnetic field, tiny particles in the object line up so that their north poles all face in the same direction. The same thing happens to tiny particles inside the human body when it is placed in a magnetic field. An MRI machine is essentially a tube that runs through a giant magnet. The patient is placed in the tube. The magnetic field runs straight through the center of the tube, passing through the patient. The machine captures images that are revealed by the alignment of the body’s atoms.

Further Facts

- The first MRI performed on a human being took place on July 3, 1977. It took almost five hours to produce one image. MRIs today can take as little as 20 minutes.
- The magnets used in MRI scanners are so powerful that they have sucked oxygen tanks, IV poles, heart monitors, and patient stretchers—anything containing magnetic material—into the tube. Patients and technicians are carefully screened for metal objects before entering the scan room.

Page 15 *About Maglev Trains*

- Before students read, ask them whether they have ever heard of a train that runs without touching the ground. Then have them read page 15 to find out about maglev trains.
- After reading, ask, *What force lets a maglev train float in the air?* (magnetism) Refer students to the photographs of the two types of maglev trains. Ask, *How does the train on the left use magnetic repulsion?* (There are electromagnets under the train and on the guideway. The like poles of the magnets are facing each other. When the electromagnets are turned on, they repel each other. This pushes the train up off the guideway.) Direct attention to the train on the right and ask, *How does this train use magnetic attraction?* (The guideway has iron in it. The train has wings that wrap around the guideway. When electromagnets in the bottom of the wings are turned on, they are attracted to the iron in the guideway. This lifts the train up.)
- Ask, *What lets a maglev train go faster than a train that runs on tracks?* (Because the maglev train does not touch the guideway, there is no track friction to slow it down.)

AFTER READING

Summarize

Complete the KWL chart you began with students before reading by asking them to share the answers to their questions. Call on volunteers to retell each text section. Then have students use the information in the KWL chart to write brief summary statements.

Discuss with students how using the KWL strategy helped them understand and appreciate the book. Encourage them to share any other reading strategies that helped them understand what they read. Direct attention to the fourth column in the chart and ask: *What questions do you still have about magnets? What would you like to explore further?* Record students' responses. Then ask, *Where do you think you might be able to find this information?* (Students might mention an encyclopedia, science books, and the Internet.) Encourage students to conduct further research.

Review/Assess

Use the questions that follow as the basis for a discussion of the book or for a written or oral assessment.

1. What is a magnet and how does it work? (A magnet is an object that attracts certain materials to it. A force called magnetism pulls objects toward the magnet.)
2. Why is a magnet able to push or pull an object without actually touching the object? (A magnet has a force field that spreads out around the magnet. This lets the magnet act on objects at a distance. The magnetic field can pass through solids, liquids, and gases.)
3. How are magnets made? (A magnet can be made by placing an iron or steel object in a magnetic field. This causes particles in the object to line up.) What makes some magnets permanent while others are only temporary? (In permanent magnets, the

particles stay lined up when the magnetic field is removed. The particles in temporary magnets do not stay lined up.)

4. What is an electromagnet, and what makes it useful? (An electromagnet is a magnet made by wrapping wire around an iron nail or rod and sending an electric current through the wire. An electromagnet is useful because it can be turned on and off and because it can be very strong.)

Writing Links/Critical Thinking

Present the following as writing assignments.

1. Describe Earth's magnetic field and tell how it is related to a compass. (Earth acts like a giant magnet. It has a magnetic north pole and a magnetic south pole. A compass has a magnetic needle that turns freely. The north-seeking pole of the magnet in the compass always points toward Earth's magnetic north pole.)
2. Earth's gravity affects how magnets work. In order to lift an object, a magnet has to be strong enough to overcome the pull of gravity. How do you think magnets would work in space away from Earth's gravity? (In space, magnets would not be affected by either Earth's gravitational pull or Earth's magnetic field. They would float freely and would be affected only by the magnetic force of the magnets themselves. Magnets would be able to lift greater mass because they would not have to overcome gravity.)

Science Journals: You may wish to have students keep the writing activities related to the Delta Science Reader in their science journals.

References and Resources

For trade book suggestions and Internet sites, see the References and Resources section of this teacher's guide.