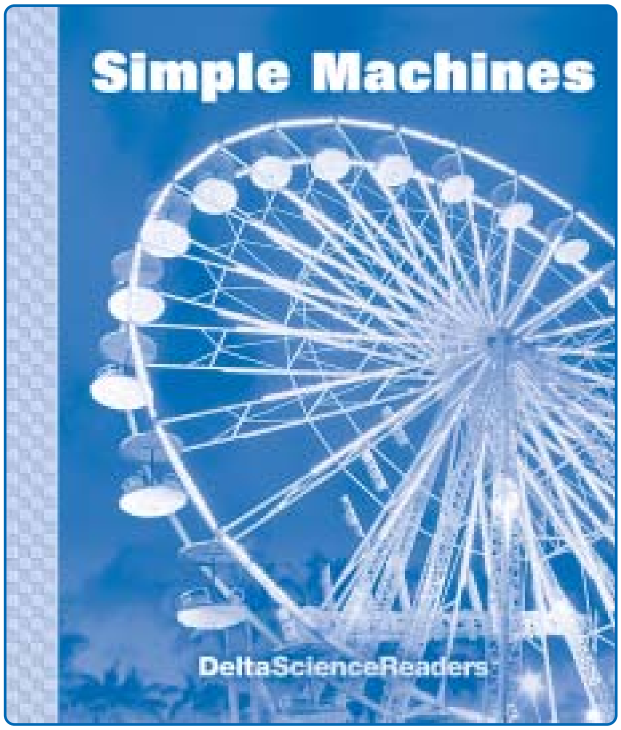
Delta Science Reader

Simple Machines



***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

The Delta Science Reader *Simple Machines* introduces students to the world of simple machines and the energy that makes them work. Students explore the six simple machines—the inclined plane, the lever, the wheel and axle, the pulley, the wedge, and the screw—and read about the difference between simple and compound machines. The book also presents biographical sketches of two key scientists in this field—Archimedes, an ancient Greek mathematician, and Lillian Gilbreth, a twentieth-century inventor. Students also investigate the levers in the human body and find out how a roller coaster works.

Students will

- discover the forces that make things move and stop moving
- understand how work and energy are related and learn the formula for calculating work
- identify the six simple machines and how they work
- examine nonfiction text elements such as table of contents, headings, lists, and glossary
- extend their reading by writing about the ways that simple machines affect their lives
- interpret photographs and diagrams to answer questions
- complete a KWL chart

READING IN THE CONTENT AREA SKILLS

- Compare and contrast a variety of simple machines
- Recognize cause-and-effect relationships by exploring the transfer of energy
- Think critically about why and how simple machines affect daily life
- Preview, make predictions, and set a purpose for reading
- Skim and scan text
- Adjust reading rate when text content is more challenging
- Draw conclusions
- Interpret graphic devices
- Summarize and restate information

NONFICTION TEXT ELEMENTS

Simple Machines includes a table of contents, headings, photographs, diagrams, captions, boldfaced terms, and a glossary.

CONTENT VOCABULARY

The following terms are introduced in context and defined in the glossary: *compound machine, distance, efficiency, effort, energy, force, friction, fulcrum, gravity, inclined plane, inertia, joule, kinetic energy, lever, machine, motion, newton, potential energy, pulley, resistance, screw, simple machine, speed, wedge, wheel and axle, work.*

BEFORE READING

Build Background

Access students' prior knowledge of simple machines by displaying the cover, reading the title, and inviting students to share what they know about the topic from their personal experiences and hands-on science explorations. Point out that if they have ever pulled a wagon, pushed a shopping cart, turned a doorknob, or even used a spatula, they have used a simple machine.

To stimulate discussion, ask questions such as these: *How would the use of items, such as a wagon, shopping cart, doorknob, or spatula make a task easier?* Encourage students to talk about other tools that they use that make their daily tasks easier. Explain that they are about to learn about simple machines—the foundation of tools that make work easier.

Begin a KWL chart by recording any facts or ideas that students have about simple machines in the K column. Ask students to 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

Have students take a few minutes to skim the pages of *Simple Machines*. Explain that skimming is a way of looking over or previewing what they will read. As they skim, they should read the title, table of contents, headings, and boldfaced words and examine the photographs and diagrams.

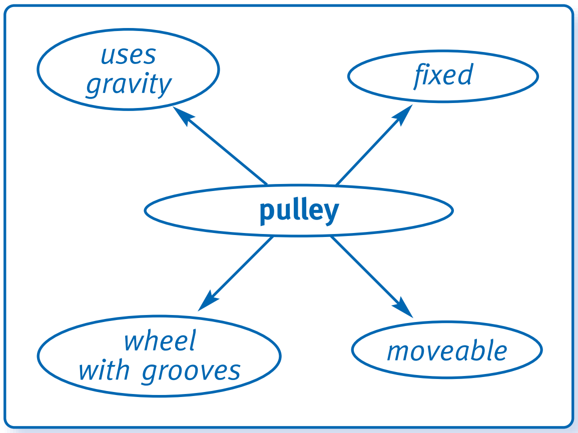
Call attention to the various nonfiction text elements and explain how they can help students understand and organize what they read. Point out that the table of contents lists all the headings in the book and their page numbers. Ask, *How do the headings help you know what you will* *learn about?* Point to some of the illustrations and ask questions such as *What does this picture show you? How do you think it will help you understand the text?* Explain that the words in boldface type are important words related to simple machines. Point out that these words are defined in the glossary. Choose one word and have students find its definition in the glossary.

After the preview, ask, *What questions do you have about machines, work, and energy that you hope this book will answer?* Have students write these questions in their KWL charts. Remind them that they will be completing their charts after they finish their reading.

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, let students work in small groups to develop webs for each of the simple machines based on points made in the Build Background discussion and in the preview. Here is an example.



▲ *A concept web for* ***pulley.***

Set a Purpose

Discuss with students what they might expect to find out when they read the book, based on their preview. Encourage them to use the questions in their KWL charts 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 form pairs or small groups and read the book together. Pause students after each text section to clarify as needed and to discuss any questions that arise or have been answered. New questions can be added to the KWL chart.
- **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. Discuss what students expect to learn, based on the heading. Have students examine any illustrations or graphics and read accompanying captions or labels.

- 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 2–11)

Pages 2, 3 *What Makes Things Move?* and *How Are Work and Energy Related?*

- Have students look at the photographs and captions on pages 2 and 3. Ask, *What do these two photographs illustrate?* (Someone is applying force to make the wagon and cart move.)
- Before students begin reading this section, ask them to look for the main ideas as they read. When they have finished, ask, *What are the main ideas on page 2?* (Force is the action that causes an object to move faster, slower, change direction, or stop; gravity and friction are forces; speed is how fast something is moving.)
- Point out the boldfaced word **newton.** Ask, *Why do you think the measure of force is called a* ***newton?*** (It is named after Isaac Newton.) Ask, *Why do you think is it named after Sir Isaac Newton?* (Newton observed that a moving object will keep moving or stay still unless a force acts on it. He experimented with force and movement.) Remind students that many scientific terms are named after scientists.
- Encourage students to speculate about what they read. Ask, *What might happen if friction didn't exist?* (Objects would keep moving and never stop.) Have them consider the consequences of living in a world without friction.
- Have students look at the boldfaced terms. If necessary, provide help with the pronunciation of *inertia* (in-UR-shuh) and *joule* (jool).
- As students read page 3, remind them to find the main ideas. Ask, *What are the two main ideas on this page?* (Work is done only when something moves. There are two types of energy: kinetic and potential.)
- After students have read about kinetic and potential energy, have them compare and contrast these two types of energy. Ask, *What do kinetic and potential energy have in common?* (They are both forms of energy; they both have the same amount of energy; energy can change from one type to the other.) *How are these two types of energy different?* (Kinetic energy is energy that is in motion. Potential energy is energy that is stored.)
- Assess students' understanding of the text by asking them to apply their learning to their own experiences. For example, you might ask, *What are some examples of inertia in your own life?* (Accept all reasonable answers, such as a runner overrunning a base in baseball or softball, or a sled having to be pushed to start sliding.)

Page 4 *What are Simple Machines?* and *Inclined Plane*

- Before students begin reading, encourage them to organize the information they read by creating a Simple Machines chart with three columns: *Name of Machine, Description,* and *Example*. They can fill in the chart as they read about each simple machine.
- As students read the body text, pause and assess their understanding by having them recall the key points of each paragraph. For the first paragraph on page 4, ask, *What is the definition of a machine?* (A machine is any tool that makes it easier to do work.) For the second paragraph, ask, *What is an inclined plane?* (a flat surface with one

end higher than the other) *Why do people use inclined planes?* (to move heavy objects with less force) *What is the efficiency of a machine?* (It is a way to compare the work you get out of a machine with the energy you put into it.)

- Discuss the relationship between force and distance in using an inclined plane. Be sure students understand that the longer and more gradual the ramp, the less force is required to move a load along it. This is sometimes called a "tradeoff."

- Draw students' attention to the boldfaced word **efficiency.** Ask them to speculate about what they think the word might mean. Then have them read the definition in the book and in the glossary and compare their own predictions with the glossary definition.

- Work together to fill in the first entry, *inclined plane,* in the Simple Machines chart.

Pages 5, 6 *Lever*

- Ask students to read the body text on page 5 and then to describe how a lever works.

- Have students look at the picture of the screwdriver and the paint can on page 5. Ask, *How is the screwdriver a lever?* (The screwdriver is a lever because it pivots on the edge of the paint can. You need to push down on the handle to make the lid of the can pop up.)

- Use the photographs to explore cause and effect. Explain that simple machines and the energy it takes to move them are examples of cause and effect. Invite a volunteer to point out the cause and effect in the picture on page 5. (The effect is that the can lid opens easily. What causes the lid to open easily is the effort applied to the lever, or screwdriver.)

- Be sure that students understand the concept of resistance and resistance arm length. If students are having difficulty with this concept, remind them to adjust their reading rate by reading more complicated parts more slowly. Then have them restate the idea in their own words. The closer the resistance or load is to the fulcrum, the less effort is needed to move it.

- Page 6 is a continuation of the section on levers. Based on the captions, what do students think they will find out about on this page? (about second- and third-class levers)

- Before they continue reading about levers, draw students' attention to the photographs. Ask them to examine the photographs and draw conclusions about what they see. Ask, *What makes these two tools—the wheelbarrow and the broom—alike? What makes them different?* Then ask, *Based on these photographs and on what you know about first-class levers, what do you think second-class and third-class levers might be?* Encourage students to speculate. If necessary, explain that the difference is in the position of the fulcrum, effort, and resistance.

- Have students add *lever* to their Simple Machines chart.

Page 7 *Wheel and Axle*

- Have students look at the photographs on page 7 and read the caption. Explain that these are examples of the third simple machine: the wheel and axle. Ask, *Based on what you now know about simple machines, how is the wheel and axle similar to or different from the lever?* (It requires force to make it work; the wheel and axle move in circles.)

- Encourage students to think of other examples of the wheel and axle such as a ceiling fan, pencil sharpener, or door knob.

- Have students look at the vocabulary phrase **wheel and axle.** Let them know that *axle* is a word many people misspell. Encourage them to practice spelling this word.

- As they read, be sure students understand the concepts behind the movement of the wheel and axle. Ask, *What makes up a wheel and axle?* (a large wheel fixed to a smaller wheel or shaft) Ask, *Which of the two pieces of the wheel and axle is the resistance wheel?* (the axle, or smaller of the two wheels)

- When students have finished reading, have them list three main facts that they learned about the wheel and axle. Have them add these facts to the KWL chart.

- Remind students to add *wheel and axle* to their Simple Machines chart.

Pages 8, 9 *Pulley, Wedge,* and *Screw*

- Before they read pages 8 and 9, have a volunteer read the headings. Invite students to share what they know about these three simple machines and how they work.

- Have students look at the photographs of the boy with the two pulley setups. Ask them to talk about any pulleys they have observed in everyday life.

- Ask, *In what way does the pulley make the job easier?* (It changes the direction of a force, making it easier to lift or lower objects.)

- Add *pulley* to the Simple Machines chart.

- Students may think of the boldfaced words **wedge** and **screw** as specific objects. Explain that in this scientific context the two words have a broader meaning. Have students compare their understanding of the words to the definitions in the text and in the glossary.

- Check students' understanding of the wedge and screw as simple machines. Ask, *In what way does a wedge make work easier?* (When force is applied to the wide end of the wedge, the narrow end changes the direction of the force and splits the object apart.)

- Ask, *In what way are an inclined plane and a wedge the same?* (A wedge is a type of inclined plane. It has one or two sloping sides like an inclined plane.) *How are they different?* (A wedge has to move to do its work but an inclined plane does not.)

- Invite students to speculate about why a sharper edge or point makes the job of cutting easier. (They may suggest that the more narrow or sharp the wedge, the easier it is to cut through something.)

- Have students look at the photograph of the chisel and the piece of wood. Ask them if they have ever chiseled something. Then ask, *What would happen if there were no wedge on the end of the chisel?* (The chisel could not cut the wood very well; the carving would be rough or crude; it would take much longer to carve the object.)

- Point out that one way to remember the function of a wedge is to look for the word within a word—*edge*. This will remind them that a wedge has a sharp edge and is used to cut through something.

- Have students read the section about the screw. The screw, like the wedge, is related to the inclined plane. Ask a volunteer to explain how. (A screw is an inclined plane wrapped around a shaft.)

- Be sure students understand the use of a screw as a tool. Ask, *For what is a screw used?* (to hold things tightly together)

- Direct students to the photograph of the screw. Ask, *How is force applied to a screw?* (The top is turned by a screwdriver. The screw changes the direction of the force when it goes down into wood.)

- Have students read the caption under the picture of the screw. Ask, *Why do you think that the closer the threads are on the screw, the less force you need to apply?* (Because the closer the threads are, the longer and less steep the inclined plane.) Remind students of the tradeoff between force and distance.

- Students can complete their Simple Machines charts by adding *wedge* and *screw.*

Pages 10, 11 *What Are Compound Machines?*

- Before students read, ask them to think about words they know that are called compound words. Ask, *What is a compound word?* (a word that is made up of two smaller words, such as *homework, backpack,* or *sweatshirt*) Then help students draw a conclusion about the definition of **compound machine.** Ask, *Since you know that a compound word is made up of two smaller words, what do you think a compound machine is?* (a machine made up of two or more simple machines)

- Before students read, have them look at the photograph of the bicycle. Let them know that they will be reading about the way in which bikes are compound machines. Ask them to identify as many simple machines as they can without looking at the captions around the photograph. Then as they read, have students check their lists with the list of bicycle parts.

- Be sure that students understand each of the boldfaced words and can accurately identify the bicycle parts that correspond to them.

- The list contains many facts about bicycles that students probably don't know. Be sure they include these facts in their KWL charts.

- Have students look at the photograph of the combine on page 11. Challenge them to identify all six of the simple machines it contains. Here are some possible answers:

- *Inclined plane*—The conveyor belt that moves grain up to the threshing cylinder is an inclined plane.

- *Lever*—The combustion engine that runs the combine contains levers, and the windshield wipers are levers.

- *Wheel and axle*—The tractor wheels and the cutting reel on the front of the combine are wheels and axles.

- *Pulley*—The grain elevator uses pulleys to lift pans of processed grain up to the storage tank.

- *Wedge*—The teeth on the cutter bar are wedges.

- *Screw*—Machines called augers, similar to the Archimedes screw, pull the cut wheat into the harvester and pump it out of the tank.

People in Science (pages 12–13)

Page 12 *Archimedes*

- Before reading pages 12 and 13, point out that many scientific discoveries are based on simple machines. Explain that they will read about an ancient Greek mathematician, Archimedes, and the way his work with simple machines continues to influence modern science. They will also read about Lillian Gilbreth, a woman known as the mother of modern management, who used her scientific knowledge to make the lives of workers—and her family—more efficient.

- Before they begin reading, have students skim the article and look for any unfamiliar words. Work together to find context clues to the meanings of such words as *irrigating* and *wastewater plant.* (Irrigating is a way of getting water to crops, and a wastewater plant is a way of treating and cleaning dirty water.)

- Direct students' attention to Archimedes' statement, "Give me a place to stand and a lever long enough, and I will move the Earth." Students will understand that Archimedes may have been exaggerating, but that he was stating a principle about simple machines. Have them apply what they have read about levers to visualize the statement. Ask, *Why did Archimedes suggest that he needed a **long** lever to move the earth?* (The closer the load or the resistance is to the fulcrum, the more work the lever does. So the longer the distance between Archimedes and the fulcrum, the less amount of work it would take to lift something very heavy.)

- Ask, *Besides the lever, what other simple machine does the text about Archimedes mention?* (the screw) *What is the Archimedes screw?* (It is a machine that brings water from a lower level to a higher level using a screw inside a cylinder.)

- Extend students' learning by asking, *Why was the use of the screw so important to the machine?* (Students may respond that there would be no way to bring the water up if the chambers inside the cylinder were straight—the water would just flow back down.)

- Before students read the final paragraph on page 12, turn their attention to the illustration of the Archimedes screw. Ask them to speculate about how the screw would be powered to bring up water and debris. Ask, *What force do you think might be used to move the Archimedes screw?* (They may suggest animals or a group of strong people.) *How do you think the Archimedes screw might be powered today?* (Students may suggest solar power, electricity, gas, wind power.) Then have them read the final paragraph to see if they were correct or if they had some ideas not mentioned in the text.

Further Facts

Archimedes (287–212 B.C.E.)

- Invented the compound pulley.
- While experimenting with buoyancy, discovered the law of hydrostatics, which states that the buoyant force exerted on an immersed object equals the weight of the liquid it displaces.
- Invented the catapult as warfare weapon.
- The Archimedes screw, which he invented in the third century B.C.E., has been used ever since its invention to irrigate and drain land.
- Generally considered the greatest mathematician of ancient times.
- Performed many geometric proofs, discovering how to find areas and volumes of many shapes and solids.
- Legend has it that Archimedes died at age 75 when he was absorbed in figuring a mathematical proof in the sand. When a Roman soldier came by, Archimedes allegedly said, "Do not disturb my diagrams." The Roman soldier was offended and killed him.

Page 13 *Lillian Gilbreth*

- Have students look at the portrait of Lillian Gilbreth on page 13. Explain that she was a woman of "firsts" and is known as the mother of modern management. Ask them to keep that phrase in mind as they read to see why she might have been given that title.

- Be sure students understand the key events in Dr. Gilbreth's life that led to her success. Ask, *What happened in 1924 that drastically changed Dr. Gilbreth's life?* (Her husband died leaving her with twelve children.) *What did Lillian do after her husband died?* (She continued the work she and her husband had been doing and she kept running their company.) *What are some* *things that Dr. Gilbreth did that contributed to work efficiency?* (She invented things like the step-on trash can and the electric food mixer. She also designed an efficient kitchen that was later used to train physically challenged people.)

- Ask students to look a little deeper into Dr. Gilbreth's life. *Besides her inventions, what made Dr. Gilbreth such an unusual inventor?* (In those days there weren't many female inventors; in those days, not as many women worked who had children, especially twelve children; she continued to work into her 80s; she was the first woman to become a member of the National Academy of Engineering.)

- After students have read about the two inventors on pages 12 and 13, tell them about the expression, "Necessity is the mother of invention." Ask them to speculate about what that expression means. (Encourage them to think about why inventors invent things. They may suggest that people invent things to fill a need.) Ask, *What necessity inspired Archimedes to create the Archimedes screw?* (the need to move water from lower levels to higher ones to irrigate land) *What necessity inspired Dr. Gilbreth?* (the need to have workers work more efficiently; the need to run her busy household efficiently)

- Urge students to think about an invention that would meet a need in their own lives. Encourage them to be creative and imaginative.

Further Facts

Lillian Gilbreth (1878–1972)

- In 1900, received her B.A. in literature from the University of California at Berkeley and was the first woman ever to speak at the commencement.
- In 1902, received a master's degree in literature also from the University of California.
- In 1915, when the mother of four children, received a doctorate from Brown University.
- Became the first female professor in the engineering school at Purdue University in 1935.
- In 1944 was dubbed a "genius in the art of living," by the *California Monthly*.
- Won the Hoover Medal of the American Society of Civil Engineers in 1966.
- Retired from professional work in her 80s.

Did You Know? (pages 14–15)

Pages 14, 15 *Your Body Has Levers* and *How a Roller Coaster Works*

- Before they read the text on page 14, have students look at the title. Invite a volunteer to say what she or he thinks the text will be about. (the ways levers are used in the body to help you move) Ask, *What parts of your body might act as levers?* (Accept all reasonable answers.) Remind students that a lever is a straight, rigid object, so the *whole* arm or *whole* leg could not be a lever because each bends at a joint in the middle.

- Before students read about the levers in the body, have them first recall the differences between first-, second-, and third-class levers. Ask, *What characterizes a first-class lever?* (With a first-class lever, the effort and resistance move in opposite directions. The fulcrum is located between the effort and the resistance.) *What characterizes a second-class lever?* (With a second-class lever, the fulcrum is closer to the resistance producing greater strength.) *What characterizes a third-class lever?* (With a third-class lever, the effort is between the fulcrum and the resistance.)

- Have students skim the text looking for vocabulary words that they have learned in *Simple Machines*. Ask them to review each of the terms they find and to define them without help from the glossary. If they have difficulty, remind them to look for context clues, or how the words are used in sentences, as hints.

- Ask for volunteers to demonstrate each of the three examples in the text so students can both see and experience what they have read.

- After students have read the body text, draw their attention to the diagrams at the bottom of page 14. Have volunteers describe the ways in which each body part is a first-, second-, or third-class lever.

- If you have audiovisual equipment, you may wish to have students view a video of a roller coaster ride. As they watch, encourage students to talk about their own experiences with roller coasters. Then ask why they think a page about roller coasters would be in a book about simple machines.

- Before students read page 15, have them look at the picture and read the caption. Ask, *What makes a roller coaster different from many other moving machines?* (It doesn't have an engine.) *What keeps the roller coaster moving?* (gravity, kinetic energy, and inertia)

- Be sure students understand the science concepts in the article. Ask, *What types of simple machines are found in a roller coaster?* (inclined planes and pulleys) *What types of energy does a roller coaster use?* (kinetic and potential) *What pulls the roller coaster cars down the hills?* (gravity) *What makes the roller coaster climb back up a hill?* (kinetic energy) *What else keeps it moving?* (inertia) *What causes a roller coaster to stop?* (friction)

- Ask students to think about how friction affects roller coasters. Ask, *What would happen if there were no friction in the roller coaster machine?* (The coaster would just keep going and never stop.)

- After the reading and if you have time, encourage students who have ridden a roller coaster to describe their experiences of kinetic and potential energy moments in the ride. Which did they prefer: the actual movement—kinetic—or the anticipation of the movement—potential?

AFTER READING

Summarize

Complete the KWL chart you began with students before reading by asking them to share their answers to the questions they asked in the W category. Call on volunteers to retell each of the sections in the text. Then have students use the information in the 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 with their reading, such as finding the main idea, drawing conclusions, comparing and contrasting, predicting, and classifying.

Direct students' attention to the fourth column in the chart and ask, *What questions do you still have about simple machines? What would you like to explore further?* Record students' responses. Then ask, *Where might you be able to get this information?* (Students might mention an encyclopedia, science books, and the Internet.) Encourage interested students to do research on the history of the bicycle.

You may also want to make available a book called *The New Way Things Work* by David Macaulay (Houghton Mifflin: 1998). This best-selling book contains information about the way all kinds of machines work in everyday life, from the toaster to the computer.

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 are the six simple machines and what do they have in common? (The six machines are the inclined plane, the lever, the wheel and axle, the pulley, the wedge, and the screw. They are all machines that help people do work by moving things faster, farther, or easier. A simple machine is usually powered by the energy of a person or animal.)

2. How do simple machines work? (All simple machines work because a force or effort is applied to them. The machine increases the amount of force or changes the direction of the force to move a load or overcome resistance.)

3. How are energy and work related? (Work is done when force is applied to an object and the object moves. Energy is the ability to do work. Energy can be kinetic or potential.)

4. What two natural forces affect the motion of objects? (gravity, which pulls objects toward the Earth, and friction, which slows objects that rub together)

Writing Links/Critical Thinking

Present the following as writing assignments.

1. Think about your morning routine—you get up, get dressed, brush your teeth, eat, put on your backpack or bookbag, walk or are driven to school, sit in your seat. Now think about what your routine would be like without the forces of gravity, inertia, or friction. How would your day be different? (Nothing would stay in place, the water in the sink would spill all over the place and it would never stop, the bus would not stop for you, and so on.)

2. All six of the simple machines are essential to human and natural functions. Which one do you think is the most important? Why? (Accept any simple machine as an answer, but be sure that students support their choice with specific reasons.)

Science Journals: You may wish to have students keep the writing activities related to the 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.