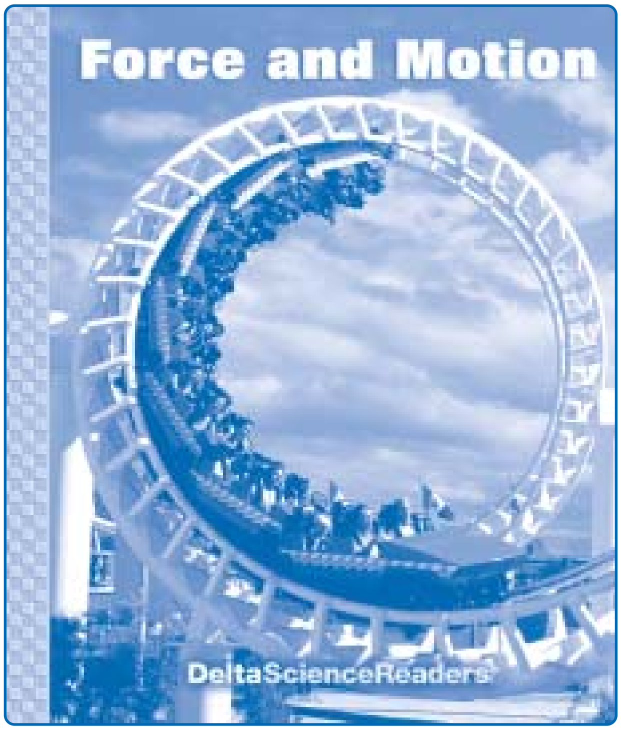
Force and Motion



***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 link.

OVERVIEW

In the Delta Science Reader *Force and Motion,* students read about about the relationship between force, motion, and work. They discover how the six simple machines—lever, wheel and axle, pulley, inclined plane, wedge, and screw—help people do work by moving objects easier, faster, or farther. They also read about people in science—bicycle inventors—and how they created ways to make the bicycle an increasingly more complex (and safe) machine. Finally, students read about how the waterwheel works and how friction affects motion.

Students will

- discover facts about force, motion, and friction
- identify the six simple machines and how they work
- discuss the function of a table of contents, headings, and a glossary
- interpret photographs and diagrams to answer questions
- complete a KWL chart
- organize information in a variety of ways

READING IN THE CONTENT AREA SKILLS

- Compare and contrast a variety of simple machines
- Classify information by understanding the difference between first-, second-, and third-class levers
- Recognize cause-and-effect relationships having to do with how simple machines work
- Demonstrate critical thinking
- Interpret graphic devices
- Summarize

NONFICTION TEXT ELEMENTS

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

CONTENT VOCABULARY

The following terms are introduced in context and defined in the glossary: *direction, distance, effort, energy, force, friction, fulcrum, gravity, inclined plane, lever, load, lubricant, machine, motion, newton, pivot, position, pulley, screw, simple machine, speed, spring scale, wedge, weight, wheel and axle, work.*

BEFORE READING

Build Background

Access students' prior knowledge of force and motion by displaying and discussing the cover. Ask, *Have you ever been on a roller coaster? What is it like? How do you think it climbs up to the top of a curve like this? How does it get down?* (Students may be surprised to learn that a roller coaster has no engine. A machine called a pulley pulls the roller coaster to the top of the first hill. Gravity pulls it down. It uses the energy it has gathered during the ride down to climb to the top of the second, smaller hill or to complete the next spiral, and so on.) 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 are some objects that move, or have motion? How do they move? Do they move fast or slow? Do they move long or short distances? What do you think force is? What is a task that takes a lot of force? What is a task that takes only a little force?*

Begin a class KWL chart by recording facts students know about force and motion in the K column. You may wish to copy the KWL chart and 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

Take a few minutes to have students look through the book. Explain the steps involved in previewing nonfiction: think about the title, read the table of contents, read the headings, read boldfaced words, and examine any photographs, illustrations, charts, and graphics.

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 main 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 photographs 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 force and motion. Remind students that these words are defined in the glossary. Choose one word and have students find its definition in the glossary.

Following the preview, ask: *What questions do you have about force and motion that you would like this book to answer?* Record students' responses in the second column of the KWL chart. Explain that they will complete the chart after they finish 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, many of the words can be categorized according to whether they have to do with force or motion. Develop a two-column chart like the one that follows:

Force	Motion
effort	distance
energy	pivot
gravity	speed

Set a Purpose

Discuss with students what they might expect to find out from the book, based on their preview. Encourage them to use their individual questions 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. Students can record new questions in their lists.

- **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 and 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 Is a Force?* and *What Is Motion?*

- Have students read the first paragraph and look at the photograph and caption on the right of page 2. Ask, *What is the girl in the picture doing?* (pushing a wheelbarrow) *What is another word for the push that she's giving the wheelbarrow?* (a force) *What if the wheelbarrow was big instead of small and was filled with big, heavy stones? Do you think the girl would be able to move it?* (no) *Why not?* (She wouldn't be strong enough. She wouldn't be able to push hard enough.)

- Point out that most of the activities we do every day involve moving things. Ask students for examples. (writing their names, brushing their teeth, lifting a backpack, drinking a glass of milk) For each suggestion, have them name the objects being moved. Then have them compare the amount of force needed to move the different objects.

- Have students read the second paragraph and look at the photograph and caption on the left of the page. Ask, *What is the name of the force that's pulling on the apple in the picture?* (gravity) *What if a bunch of bananas was hanging from the spring scale? Compared with the apple, would the scale show that more or less force was needed to lift the bananas?* (more) *Why?* (The bananas would weigh more.)

- Tell students that the newton, the unit used to measure force, is named for Sir Isaac Newton, an English scientist of the 1600s who did many experiments involving motion.

- Have students read the last paragraph on page 2. Discuss with students how they apply friction in their daily lives, such as when they brush their teeth or use an eraser.

- Have students read the body text on page 3 and look at the photograph and captions. Ask them to summarize the main ideas. (Motion happens when something changes its position. Distance is a measure of how far something moves. Speed is a measure of how fast something moves.) Demonstrate motion, distance, and speed by walking across the room at different paces. As you walk back, change the direction in which you are walking. Ask, *What made me able to change the direction I was walking in?* (the force you applied with your body and legs)

Pages 4, 5 *Energy and Work* and *What Are Simple Machines?*

- Before students read, write the word *work* on the board. Ask, *What are some of the kinds of work you do every day?* (Students may suggest homework, picking up their toys, setting the table, and so on.) Then explain that, in science, *work* has a special meaning. Have them read page 4 to find out what that meaning is.

- Provide some books and have a student carry out the experiment with the books described on page 4.

- Then ask several students to line up facing a wall. (Be sure the wall is permanent and strong, rather than a partition.) At your signal, have them push on the wall as hard as they can while you count to ten. Ask, *What happened when the students pushed on the wall?* (nothing; the wall didn't move) *Why not? Didn't the students use any energy?* (Yes, but it wasn't enough to move the wall.) *Did the students who pushed against the wall do any work?* (No, because the wall didn't move.) Encourage students to speculate on machines, such as a bulldozer, that would be able to apply enough force to move the wall.

- Test students' understanding by opening a book and looking at a page. Say: *I'm reading a book. Am I doing work?* (no) Then turn the page and say, *I'm turning a page. Am I doing work?* (yes) Have them summarize why the second activity was work. (You made something move by the use of force.)

- Have students read page 5 to find out about simple machines. Ask, *Is a bicycle a machine?* (yes) *Is a vacuum cleaner a machine?* (yes) *Is a television set a machine?* (no) *Why not?* (It doesn't help people do work.) Then discuss why a bicycle and a vacuum cleaner are not simple machines. (They have many moving parts.)

- After students look at the photograph and read the caption, point out individual tools that are pictured and ask what work each one helps people do.

Pages 6, 7 *Lever* and *Wheel and Axle*

- Have students read the body text on page 6. Also have them look at the diagrams and labels. Ask, *In the diagram of the girl moving the rock, what do you notice about the distance the effort moves and the distance the load moves?* (The distance the effort moves is greater.) *Do you think the girl could lift the rock without using the lever?* (Maybe, but it would be much harder.)

- Then have them look at the points labeled fulcrum in the diagrams of the first-, second-, and third-class levers. Point out that sometimes the fulcrum is not part of the lever being used but is instead part of the person using the lever. As an example, explain that when a person uses a lever called a shovel, the wrist closest to the load-bearing part is the fulcrum.

- Offer some examples of other levers, and discuss which class they belong to—for example, a seesaw (first-class), a bottle opener (second-class), the lower arm (third-class).

- Have students read page 7 and look at the diagram and photographs. Ask, *How does the diagram of the wheel and axle help you understand how a wheel and axle works?* (It shows exactly what the text is talking about.) *In the diagram, what does distance refer to?* (the circumference, or distance around the outside, of the wheel and the axle)

- Encourage students to speculate about what would happen to the force applied to an axle if the difference in size between the wheel and the axle were bigger than that shown in the diagram. (The axle would move with even greater force.)

Pages 8, 9 *Pulley* and *Inclined Plane*

- Have students read the text about pulleys on page 8. Then have them look at the photographs and caption. Assess understanding by having them summarize the differences between a fixed and movable pulley. (A fixed pulley doesn't move. A movable pulley does move. A fixed pulley changes the direction of a force but not its amount. A movable pulley changes the amount of force but not its direction.)

- Have students who have used a fixed pulley to raise a flag, for example, to describe the action. (pulling down on a rope lifts up the flag) Ask, *Why is it helpful to be able to pull down in order to lift something?* (It's easier to pull down than to lift or push up. Sometimes you can't get higher than the object you want to lift.) *Why do you think it is easier to pull down than to lift?* (A person's weight and the force of gravity help her or him pull down.) Remind students, however, that a fixed pulley such as that used to raise a flag does not change the amount of force needed.

- Have students read the text about the inclined plane on page 9. Then have them look at the photograph and caption. Ask: *How is the ramp making the man's work easier?* (Without the ramp, the man would have to take a big step straight up while carrying a heavy load. That would be hard.)

- Explain that the inclined plane may be the oldest kind of simple machine. Tell students that the Egyptians used inclined planes to move the huge, heavy stones they used to build the pyramids.

- Encourage students to think of inclined planes or ramps that are useful in everyday life. (They might suggest a wheelchair ramp or a skateboarding ramp.)

Pages 10, 11 *Wedge* and *Screw*

- Have students read the body text about the wedge on page 10. Then have them look at the photograph and caption. Assess understanding by asking, *What are wedges usually used for?* (to push objects apart or to split an object) *How does a wedge change the force a person applies?* (It changes the direction of the force.)

- Ask a volunteer to describe a wedge. (It is thick at one end and has a thin edge at the other.) Point out that *wedge* contains the word *edge*. This may help students remember how a wedge looks and works.

- Remind students that the sides of a wedge are inclined planes. Ask, *How is a wedge different from an inclined plane?* (It needs to move to do its job.)

- Ask students whether they think the edge of a wedge should be sharp or dull. (They may decide that a wedge with a sharp edge would be more useful than one with a dull edge because it would cut through something more easily.)

- Have students read the text about screws on page 11. Then have them look at the illustrations and caption. Ask, *What is a screw used for?* (to hold things tightly together)

- Ask students who have watched screws being used to describe the process. (The sharp tip of a screw is put into an object. A screwdriver is put into a groove at the top of the screw and turned. Each turn drives the screw deeper into the object.) Ask, *How is this different from using a nail?* (You have to pound down hard on a nail. You have to turn the top of a screw sideways or around. It's easier to turn a screw than to pound a nail.)

- Remind students that a screw is a kind of inclined plane. Ask, *Would a screw that has many threads that are close together be harder or easier to insert than one that has fewer threads that are farther apart?* (easier) *Why?* (The sharp edges of the threads do the work.) Point out that the more threads the screw has, the more gradual is the slope of the inclined plane wrapped around it.

People in Science (pages 12–13)

Bicycle Inventors

- Before they read, ask students to raise their hands if they ride a bicycle. Ask volunteers to describe the experience. Encourage them to give details about making a bike go faster or slower, putting on the brakes, and shifting gears. Then have them read pages 12 and 13 to find out about some early bicycles.

- Encourage students to discuss what makes a bicycle a machine. (It helps people do work—the work of walking or of getting from one place to another.)

- Inform students that on some early bikes the pedals didn't turn in a circle. Instead they were attached to cranks and were pushed up and down.

- Encourage students to speculate about the difficulty of riding a high-wheel bicycle. Ask questions such as these: *How hard must it have been to get on?* (The rider would need help or would have to climb on something to reach the seat.) *What might happen if the cyclist hit a stone in the road or had to stop suddenly?* (The wheel would stop suddenly and the cyclist would pitch forward onto the road.)

- Remind students that women of the 1870s wore long skirts. Could they have ridden the high-wheel bicycle successfully?

- Ask students why they think the new bicycle of the 1880s was called a safety bicycle. (Probably because it was a lot safer to ride than the high-wheel bicycle. People didn't have as many accidents while riding it.)

Further Facts

Milestones in the History of the Bicycle

- 1817 Baron Von Drais discovers that a machine on two in-line wheels will stay upright even while being steered.

- 1842 Kirkpatrick Macmillan rides a bicycle from Dumfries to Glasgow, Scotland, and back—a distance of 140 miles.

- 1861 A coach builder named Pierre Michaux begins to manufacture a bicycle he calls a *velocipede*.

- 1869 Metal-spoked wheels, solid rubber tires, and a four-speed gear invented.

- 1870 The high-wheeler invented, also called the *penny-farthing* after two English coins, one large and one small.

- 1884 The safety bicycle invented.

- 1880s Pneumatic (air-filled) tires invented.

- 1970s The mountain bike invented.

Did You Know? (pages 14–15)

How Waterwheels Work and *About Friction*

- Have students read page 14 to find out about how waterwheels work. Then have them look at the photograph and answer the question in the caption. (wheel and axle)

- Have students refer to the glossary to review the definition of *energy* in the first paragraph. (the ability to do work)

- Ask students to name the force caused by the stones rubbing together and grinding grain into flour. (friction)

- Ask students if their kitchens have any other tools for grinding things into smaller pieces. (Students may suggest a mortar and pestle, pepper mill, or rolling pin.)

- Have students read page 15. Then have them look at the photograph and read the caption. Discuss other ways athletes reduce the friction caused by water or air passing over a surface, such as greasing their bodies before swimming, shaving their legs before biking, wearing smooth clothing that won't catch the wind or special helmets that slice through the air. Point out that some athletes may want to increase friction. For example, gymnasts may coat their hands with chalk to increase friction so that they don't slide off the bar.

- Tell students that the surfaces of all objects have tiny bumps and pits that result in friction. Explain that this means that eventually any object will slow down and stop. Lubricating an object smooths over the bumps and pits, reducing friction.

- Point out another effect of friction by having students rub their hands together and noting the sensation. (heat)

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 force and motion 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 are the six simple machines, and what do they have in common? (The six simple machines are the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw. They all help people do work.)

2. What is the only simple machine that does not move, and how does it help people do work? (The inclined plane is the only simple machine that does not move. It helps people do work because it lets them use less force to raise a load.)

3. What is the scientific definition of *work?* How is this definition different from the usual definition? Give an example of each kind of work. (In science, work is done only when a force acts on an object and the object moves a certain distance. For example, lifting a book is work. In the usual definition, *work* means the same as *job*. For example, a person's "work" or job might be to read books or think of new ideas or talk into a microphone. None of these is work according to the scientific definition.)

Writing Link/Critical Thinking

Present the following as a writing assignment.

All six of the simple machines are essential to daily life. Choose one that you find especially useful in your own life and write about it. How would your life be more difficult or less fun without it? (Accept all reasonable answers.)

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.