The Machines Behind Machines

A Closer Look at Simple Machines

The modern world is filled with machines great and small, from wind-up toys to cars to space exploration vehicles. Consequently, students are curious about how machines work. *Get to Know Simple Machines* Teacher Guide serves to fuel further exploration of the fundamentals of the mechanical world. By using this guide, you have an opportunity to tap into high student interest while exposing students to broader mechanical and technological issues.

Participation in these lessons will lead students to make global connections and understand higher-level concepts, such as technical design and mechanical engineering. Students will become aware of some of the issues involved in using tools, constructing simple machines, and cooperating to solve mechanical problems. They will realize that they can understand complex machines by first understanding the functions of simple machines.

The lesson plans in this guide are tailored for Grades 3 and 4 and address various subjects, such as science, language arts, and mathematics. Each lesson plan is designed to stand alone. As such, they do not need to be presented in sequential order. Helpful reproducible worksheets appear at the end of the guide. The book titles referenced in this guide include:

Get to Know Inclined Planes

Get to Know Levers

Get to Know Pulleys

Get to Know Screws

Get to Know Wedges

Get to Know Wheels and Axles

As students investigate the topics addressed in the guide and become more aware of the functions of simple machines, they will sharpen their critical thinking skills to work toward creative solutions to worldwide problems. We invite you to jump in and ask questions with your class as you have fun learning more about simple machines.

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National Standards Correlation

Lesson Plan Title	Correlation to National Standards
In the Kitchen	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information). **Science** Students should develop an understanding of properties of objects and materials. Students should develop an understanding of position and motion of objects.
Find the Pitch!	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes. **Mathematics** Students should build and draw geometric objects. **Science** Students should develop an understanding of position and motion of objects. Students should develop an understanding of abilities of technological design
Stop It!	**Language Arts** Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes. **Science** Students should develop an understanding of the properties of objects and materials. Students should develop an understanding of position and motion of objects.
Racing Levers	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes. **Science** Students should develop an understanding of position and motion of objects. Students should develop abilities of technological design.

Lesson Plan Title	Correlation to National Standards
Pulling Together	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes. **Science** Students should develop an understanding of position and motion of objects. Students should develop abilities of technological design.
Can You Pull It Off?	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes. **Science** Students should develop an understanding of properties of objects and materials. Students should develop an understanding of position and motion of objects. Students should develop abilities of technological design.
On a Roll	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information). **Mathematics** Students should build and draw geometric objects. **Science** Students should develop an understanding of position and motion of objects. Students should develop an understanding of abilities of technological design.
Water Makes the Wheel Go Round	**Language Arts** Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works. Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information). **Mathematics** Students should build and draw geometric objects. **Science** Students should develop an understanding of position and motion of objects. Students should develop an understanding of abilities of technological design.

For state specific educational standards, please visit www.crabtreebooks.com

Overview and Scope of Lesson Plan Activities

Lesson Plan Title	Subject Areas	Major Concepts
In the Kitchen	Language Arts Science	• wedges • tool design
Find the Pitch!	Language Arts Mathematics Science	• screws • measurement • tool design
Stop It!	Language Arts Science	• inclined planes • friction • motion
Racing Levers	Language Arts Science	• levers • technological design
Pulling Together	Language Arts Science	• pulleys • mechanical motion • technological design
Can You Pull It Off?	Language Arts Science	• pulleys • technological design • force and effort
On a Roll	Language Arts Mathematics Science	• wheels and axles • motion • technological design
Water Makes the Wheel Go Round	Language Arts Mathematics Science	• wheels and axles • mechanical motion • naturally-powered machinery

Pacing Chart and Vocabulary

One class period is approximately 40 minutes.

Lesson Plan Title	Pacing	Vocabulary	Assessment
In the Kitchen	1 class period	cut lift wedge	Check student reproducibles for comprehension of major concepts.
Find the Pitch!	1 class period	head pitch screw shaft threads tip	Monitor students for participation and check student reproducibles for comprehension of major concepts.
Stop It!	1–2 class periods	friction frictional force inclined plane	Monitor student participation in the activity and assess student reproducibles for comprehension of major concepts.
Racing Levers	1–2 class periods	design fulcrum lever	Monitor student participation and evaluate student reproducibles for understanding of major concepts.
Pulling Together	1 class period	force load pulley rope	Monitor student participation and evaluate student pulleys and reproducibles for understanding of major concepts.
Can You Pull It Off?	1–2 class periods	effort groove pull	Monitor student groups for participation, and evaluate student reproducibles for accuracy and comprehension of major concepts.
On a Roll	1–2 class periods	axle circle square stable wheel	Monitor student participation and evaluate student reproducibles for understanding of major concepts.
Water Makes the Wheel Go Round	2–3 class periods	energy natural rotate	Monitor students for participation and understanding of major concepts.

In the Kitchen

A Lesson on Wedges

Content

Students will learn about the usefulness of wedges by working with kitchen tools.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Science

Students should develop an understanding of properties of objects and materials.

Students should develop an understanding of position and motion of objects.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Linguistic
- Visual-Spatial

Prerequisites

Have students read the book *Get to Know Wedges* before starting the lesson.

Materials

- *Get to Know Wedges* books
- small tub of sand
- chalkboard and chalk or whiteboard and markers
- various wedge-shaped kitchen implements (pizza cutter, rubber scraper, spatula, spoon, fork, butter knife, zester, grater, etc.)
- note cards
- lemon (optional)
- block of cheese (optional)
- modeling clay
- student copies of the *In the Kitchen* reproducible

Instructional Procedure

Anticipatory Set

Before class, fill a small tub with sand and set it up at the front of the classroom. Make your hand into a fist and hold it up for the class to see. Ask students to describe the shape your fist makes. (round; a circle) Start "digging" in the sand using your fist. Then flatten your hand at an angle so it resembles a shovel. Tell students that now your hand has a *wedge* shape. Dig in the sand using your flattened hand as a shovel. Then ask students to describe the difference between how the sand moved when you used your fist and when you used your "wedge-shaped" hand. (It was easier to move sand when your hand was a wedge; more sand was moved at once using a wedge.) Tell students that even though you used the same amount of force for both your fist and your "wedge" hand, the wedge shape helped you get more done more easily. Explain that the wedge shape helps tools to move under or between things, and when you use force behind the wedge shapes, this gets the job done.

Class Discussion

Write the word *wedge* in the middle of an oval on the board. Have students name different tools that are wedges, referring to their *Get to Know Wedges* books for help. Write student responses in a web around the "wedge" oval. Then have students list actions or tasks that wedge-shaped objects can do. (*cut*, *lift*, stop, etc.) Fill in the web with the different functions of wedges as students name them. Then ask students how the wedge shape of these tools helps them accomplish these tasks. (Sample answers: The wedge shape of a door stop helps it to fit between the door and the floor and stop the movement of the door. The wedge shape of a spatula helps it slide under food to lift it.)

Objectives

The student will be able to…

- analyze the advantages and disadvantages of different tools for different tasks
- learn about and use various wedge-shaped kitchen tools

Activity

Before class, set up several stations around the room with 3–4 kitchen implements at each station. Write the name of each tool on a note card, and place the note card next to the appropriate tool. If you brought a zester and grater, set up these tools, as well as the lemon and block of cheese, at a station that you will monitor throughout the class period. When class begins, distribute copies of the *In the Kitchen* reproducible and a piece of clay to each student. Instruct students to model different types of simple foods out of their clay. (Examples may include pancakes, hot dogs, hamburgers, carrots, apples, etc.)

After students finish making their clay food, divide them into small groups and assign each group a station at which to start. Explain to them that the kitchen is one place in particular where we use a lot of wedges in our everyday lives. Guide students to safely use the various wedge-shaped tools to manipulate their clay food. For example, have them use a spatula to lift and flip their pancake, a pizza cutter to slice their pizza, etc. If you brought a zester and grater, help students zest a part of the lemon and grate some cheese (or demonstrate for them) and observe how these tools cut into the foods by inserting small, sharp wedges into their surfaces. Monitor students to ensure they are using the tools safely and correctly.

Have students record on the reproducible the name of each tool, a description of the tool, whether it's a single or double wedge, and the tool's purpose. Students should refer to pages 12 and 16 of *Get to Know Wedges* for help. Have students experiment with using different tools for the same job, such as trying to cut a clay hot dog first with a spoon, then with a knife. Instruct students to record their observations on the student reproducible. Once students have experimented with all the tools at one station, have groups rotate stations.

Accommodations and Extensions

Demonstrate the use of each tool in front of the class, and have students complete their reproducibles as you show them how each tool is used.

As an extension, have students create their own design for a wedge-shaped kitchen tool. Have them draw the tool and write a few sentences about the tool's purpose and how it works.

Closure

As a class, discuss each kitchen tool. Have student volunteers describe each tool and its purpose. Then ask them how the wedge shape of each tool helps accomplish its purpose. Ask students to describe why some tools are better than others at accomplishing certain tasks.

Assessment

Check student reproducibles for comprehension of major concepts.

Find the Pitch!

A Lesson on Screws

Content

Students will learn about screws by manipulating bolts, nuts, and screws. They will also learn how to measure screw length, pitch, and thread count.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and non-fiction, classic and contemporary works.

Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Mathematics

Students should build and draw geometric objects.

Science

Students should develop an understanding of position and motion of objects.

Students should develop an understanding of abilities of technological design

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Interpersonal
- Linguistic
- Logical-Mathematical
- Visual-Spatial

Prerequisites

Have students read the book *Get to Know Screws* before starting the lesson. Review with students the different parts of a screw: the *head*, the *threads*, the *shaft*, and the *tip*.

Materials

- *Get to Know Screws* books
- screws, nuts, and bolts (at least 1 or 2 per student)
- chalkboard and chalk or whiteboard and markers
- rulers (1 per pair)
- several screwdrivers (should fit the screws)
- tape
- small strips of paper
- several different lengths of self-threading screws (2 different lengths per pair)
- small ball of clay (1 per pair)
- student copies of the *Find the Pitch!* reproducible

Instructional Procedure

Anticipatory Set

Spread out the screws, nuts, and bolts on a table and have students take turns trying to screw the nuts on different bolts and screws. Point out that nuts are threaded on the inside, and bolts and screws are threaded on the outside, which makes them fit together. Make sure they notice that the nuts don't fit on every bolt. When they manage to screw a nut onto a bolt, have them try to pull the two apart. Explain that the threads on nuts, bolts, and screws helps them fit together, gives them a strong connection, and allows them to fasten objects.

Class Discussion

Write the word *pitch* on the board. Have students look at page 24 in their *Get to Know Screws* book as a reference to define *pitch*. (the space between the threads of a screw or bolt) Draw two pictures of screws on the board, complete with evenly-spaced threads. One picture should have widely-spaced threads, the other closely-spaced threads. Ask students to explain the difference between small pitch and large pitch. (A screw with threads that are close together has small pitch; a screw with threads that are far apart has large pitch.) Then ask which picture on the board has large pitch and which has small pitch. (the closer the threads, the smaller the pitch) Explain to students that pitch is measured by the number of threads in one inch.

Objectives

The student will be able to…

- measure the length and pitch of a screw
- analyze the differences between driving a screw manually and with a screwdriver
- work in pairs to record measurements and analyses

Then ask students to refer to their books to find out how many turns it will take to drive a screw into an object (It's the same as the number of threads on the screw.)

Have students think back to the screws, nuts, and bolts they manipulated in the Anticipatory Set. Ask: *Why did the nuts fit on some bolts but not others?* (The threads of some bolts weren't the same as the thread of the nuts.) Explain to students that nuts only fit on bolts that have the same pitch.

Activity

Part I: Making Measurements

Tape a small strip of paper to one side of each of the screwdrivers' handles. Distribute the *Find the Pitch!* reproducible. Then divide the students into pairs and give each pair a ruler, 2 screws of different lengths, and a ball of clay. Instruct students to first measure the length of each screw, followed by the pitch. Remind them that the pitch is the number of threads in a single inch, expressed as a simple fraction (8 threads in one inch would be a pitch of 1/8). Instruct students to record these measurements on the reproducible. Then have students determine how many full turns it would take to completely screw in each screw. Remind them that they should count the total number of threads on each screw, as each thread represents one complete turn. Have them record their measurements on the reproducible.

Part II: Driving Screws

Distribute the screwdrivers to half of the pairs. Guide them to use the screwdriver to drive their first screw into the ball of clay. While one student uses the screwdriver, have the other student keep track of the number of times the screwdriver turns by counting each complete revolution of the strip of paper on the screwdriver handle. When the screw has been driven in, have the counter confirm their count with the prediction they recorded on the reproducible. Then have partners switch jobs and repeat the process for their second screw.

Meanwhile, have the other half of the pairs drive their screws into their clay using just their hands, with one partner turning the screw and the other recording the number of turns it takes. Have them confirm their count with their prediction. Make sure students switch jobs and repeat the process for their second screw.

When all students have completed their first task, instruct the pairs with screwdrivers to give the screwdrivers to another pair of students and complete the second task. Have them carefully unscrew the screws from the clay and repeat the process using either their hands or the screwdriver (whichever they have not yet done). Then have them complete the bottom of the reproducible.

Accommodations and Extensions

Have each pair of students experiment with only one screw. Then have each pair team up with a second pair to discuss their results so they can see how different lengths and pitches affect the number of turns needed.

As an extension, have students use their books to write a few sentences about how force is used to make screws work.

Closure

Ask students to describe their results. Have students describe the differences they felt between using their fingers and using the screwdrivers to drive the screws into their clay, including time it took, effort it took, etc. Then discuss how the length and pitch of the screws affected the experiments. Ask students to explain why different lengths of screws might be needed for different tasks.

Assessment

Monitor students for participation and check student reproducibles for comprehension of major concepts.

Stop It!

A Lesson on Frictional Force

Content

Students will learn about frictional force by observing how different objects move across different surfaces on an inclined plane.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

Science

Students should develop an understanding of the properties of objects and materials.

Students should develop an understanding of position and motion of objects.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Linguistic
- Visual-Spatial

Prerequisites

Students should read the book *Get to Know Inclined Planes* before starting the lesson. Have students review pages 7–9 to make sure they are familiar with the concept of friction.

Materials

- *Get to Know Inclined Planes* books
- chalkboard and chalk or whiteboard and markers
- a box or stack of books
- a small piece of cardboard
- three or four marbles
- student copies of the *Stop It!* reproducible
- tape
- 4 small objects of various materials (rubber ball, toy soldier, wooden block, etc.)
- 4 surface materials (aluminum foil, plastic wrap, sandpaper, gravel or sand, etc.)
- cooking spray (optional)
- pencils

Instructional Procedure

Anticipatory Set

Write the term *frictional force* on the board and explain that it is the force of an object rubbing against another object. Explain that some materials are better than others at slowing or stopping things. Walk around the classroom and point to different surfaces, such as a desk, the floor, a curtain, and a carpet. Ask students to think about what would happen if they rolled a small object across each surface. Ask them how well they think each surface would slow or stop the rolling object. Then have student volunteers roll a marble across each of these surfaces. Encourage students to find other surfaces in the room to test frictional force.

Class Discussion

Ask students to think about the materials across which they just rolled marbles. Ask: *What is usually better at stopping things: a rough material or a smooth material?* (rough) Then ask students to explain how a sliding object would be affected by the surfaces of a playground slide and a concrete ramp. (It would move easily down a slide because it is smooth and slippery. It would not move well down a concrete ramp because it is very rough.)

Have students discuss different types of frictional materials they've seen outside the classroom. Remind the class that

Objectives

The student will be able to…

- analyze the effects of friction
- record observations about friction and movement based on various materials
- work in a small group to perform an experiment

frictional force depends on two materials: the material that the object is made of, and the material that the sliding surface is made of. It is the interaction of these different materials as they touch each other that determines whether the moving object will slow, stop, or move faster.

Activity

Distribute copies of the *Stop It!* reproducible to each student. Set the box or stack of books on a table or the floor. Lean the cardboard on the stack of books to form a ramp, preferably at a 45° angle. Divide students into four groups. Assign each group an object, and tell the groups that they will be responsible for observing how well their object slides on each of the four surfaces.

Before the groups slide their objects, have them describe the texture of their object. Ask them what their object is made of and whether it's rough or smooth. Then have them touch the cardboard and describe its texture. Have them record their observations on the reproducible.

Have the groups take turns sliding their object down the cardboard ramp, instructing them not to push the object but simply let it slide on its own. Have them note on their reproducible how their object slid down the cardboard (quickly, slowly, went partway then stopped, etc.). Once each group has tested their object on the cardboard, tape the aluminum foil to the cardboard. After students have touched and described the texture of the foil, have the groups repeat the sliding process, noting how their object slides down the foil. If you brought the optional cooking spray, spray the foil and have the groups repeat the process, noting the results on their reproducible.

When the students are done with the foil, apply one of the other surface materials to the cardboard, using tape to affix it if necessary (for loose materials, such as gravel or sand, adjust the angle of the ramp to prevent the material from sliding off the cardboard). Have students repeat the process for each material. When the groups are finished, have each group discuss how much each material slowed their object.

Accommodations and Extensions

Perform the experiment as a class, testing only two different objects on the 4 different surface materials. Have student volunteers come to the front of the classroom to slide each object, then discuss the results and fill out the reproducibles as a class.

As an extension, have the students adjust the angle of the ramp to see how it affects the movement of their given object. Have them make a second chart on the back of their reproducible to record their observations.

Closure

Have students discuss the results of the experiment. Ask students how each material affected their object, and have them compare and contrast the ways each of the objects was affected. Then explain to students that frictional force is an important issue for people who work or interact with inclined planes. Have students use their books to find instances in which friction is important. (Examples: The worker on page 6 needs a dolly that won't easily slide down a ramp, so there must be some friction between the rubber tires and the metal ramp. The bicyclist on page 7 needs some friction to keep her rubber tires from slipping down the hill, but not so much friction that her bicycle won't move.)

Assessment

Monitor student participation in the activity and assess student reproducibles for comprehension of major concepts.

Racing Levers

A Lesson on Levers

Content

Students will learn about levers by designing and building their own levers.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Science

Students should develop an understanding of position and motion of objects.

Students should develop abilities of technological design.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Linguistic
- Logical-Mathematical
- Visual-Spatial

Prerequisites

Have students read the book *Get to Know Levers* before starting the lesson.

Materials

- *Get to Know Levers* books
- a few examples of various types of levers (nutcracker, tennis racket, tongs, bottle opener, etc.)
- chalkboard and chalk or whiteboard and markers
- masking tape
- large marshmallows (1 per team)
- pieces of cardboard (about 1.5" x 4") (1 per team)
- squares of construction paper (about 2" x 2") (1 per team)
- markers (1 per team)
- pencils (1 per team)
- craft sticks (3 per team)
- student copies of the *Racing Levers* reproducible

Instructional Procedure

Anticipatory Set

Bring some different types of *levers* to class (examples: a nutcracker, a tennis racket, a soda can, tongs, a hammer, a bottle opener). Have students review the three classes of levers using their *Get to Know Levers* books. Keep the levers hidden behind your desk, and hold up one lever at a time. Instruct students to quickly raise their hands when you hold up a lever they can identify. Call on the first student to raise his or her hand, and have the student name the object and the class of lever it belongs to. If the student correctly identifies the lever and its class, move on to the next lever. Continue until you've gone through all the levers.

Class Discussion

Have students name the three parts of a lever. (effort, load, *fulcrum*) Write the answers on the board and ask students to describe what each part of a lever does. (Effort is the energy that goes into operating the lever; load is the object being moved or worked on; fulcrum is the point at which a lever turns.) Write "First-Class Lever" on the board. Ask students to explain how the three parts of a lever are arranged in a first-class lever. Write the parts in the correct order on the board. (effort, fulcrum, load) Repeat this for second-class levers (effort, load, fulcrum) and third-class levers. (load, effort, fulcrum) Then have students refer to their books to provide some common examples of each type of lever.

Objectives

The student will be able to…

- identify classes of levers and their characteristics
- design and build a lever

Activity

Part I: Getting Ready to Race

Divide students into teams of six, then divide each team into three pairs. Assign each pair a number: 1, 2, or 3, to designate which class of lever they will design. Have the pairs turn to page 12, 16, or 20 in their *Get to Know Levers* books to review the characteristics of their class of lever.

Explain to students that they must move a marshmallow from one end of the classroom to the other using only levers. Spread the teams out around the classroom so that each has an equal distance to work with. Mark each team's starting point and finish line with masking tape, and divide the path of each relay into three equal sections.

Part II: Building a Lever

Tell students that they are going to *design* and build their own levers. To each first-class lever pair, give a piece of cardboard and a marker. Tell them they must figure out a way to use the pieces to make a catapult-like device. To each second-class lever pair, give two craft sticks, a pencil, and some tape to create a tongs-like device. To each third-class lever pair, give one craft stick, some tape, and a square piece of construction paper to create a paddle (like a tennis racket). Tell students that they must use all of their components when building their lever to move the marshmallow. The first pair will move the marshmallow from their starting point to the second pair's starting point. The second pair must take the marshmallow to the third pair, who will take the marshmallow to the finish line.

Allow the teams time to design their levers. When they have completed their lever designs, have the teams of six take turns running their relay. When the races are over, distribute the *Racing Levers* reproducible for students to complete.

Accommodations and Extensions

After assigning each pair a lever class, have all the 1s work together, the 2s work together, and the 3s work together to design their levers. When pairs have finished building their levers, have them return to their teams to complete their relay.

As an extension, have students think about the ideal lever for moving their marshmallow. Tell them to come up with a design for a lever using any household materials they would like, and have them build and test their new lever designs.

Closure

Have the pairs take turns describing their relays, including how they decided to design their levers and the difficulties of moving the marshmallow with their class of lever. Have them discuss what action their class of lever is best suited to perform. Then have students discuss why certain levers are better suited for different tasks.

Assessment

Monitor student participation and evaluate student reproducibles for understanding of major concepts.

Pulling Together

A Lesson on Pulleys

Content

Students will learn about pulleys by constructing a basic pulley system.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Science

Students should develop an understanding of position and motion of objects.

Students should develop abilities of technological design.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Linguistic
- Logical-Mathematical
- Visual-Spatial

Objectives

The student will be able to…

- analyze how the different parts of a pulley system work together
- work in small groups to construct a pulley system

Prerequisites

Have students read the book *Get to Know Pulleys* before starting the lesson.

Materials

- *Get to Know Pulleys* books
- blinds or curtains (if available in classroom)
- chalkboard and chalk or whiteboard and markers
- scissors
- craft sticks (1 per group)
- markers (2 per group)
- blocks of Styrofoam (1 per group)
- large, wide-banded rubber bands (1 per group)
- toilet paper tubes or paper towel tubes (2 per group)
- student copies of the *Pulling Together* reproducible

Instructional Procedure

Anticipatory Set

Use a set of blinds or curtains in the classroom to demonstrate a real-life *pulley*. Pull the cord to show how the blinds rise. Ask students to describe what happened to the cord. (It got longer when you raised the blinds.) Then lower the blinds and have students describe what happened to the cord. (It got shorter.) Explain that the cord moves this way because when you pull the blinds up, the cord is released from the pulley mechanism, and when you let the blinds down, the cord is drawn into the pulley mechanism. Have students take turns operating the blinds on their own, making sure they notice how the cord is pulled into the blinds mechanism when the blinds are lowered. If blinds are not available, draw a set of blinds on the board, and draw arrows to show how pulling the cord raises the blinds. Have students mime a pulling motion with their hands and arms.

Class Discussion

Ask students to refer to their *Get to Know Pulleys* books to name the parts of a pulley. (a wheel and a rope or chain to go around the wheel) Pull the cord on the blinds again. Have students point to and describe the parts of the pulley that make the blinds work. (The cord is the rope. The wheel is inside the blinds mechanism.) If they have difficulty figuring out where the wheel is, have them take turns looking up at the blinds mechanism to see the pulley wheel. Remind students that in order for a pulley to work, *force* must be applied. Ask students to explain what the force is when you operate this pulley. (The force is the act of pulling on the cord.) Then have students explain what the *load* is in this pulley. (The load is the actual slats of the blinds themselves.)

Activity

Divide the students into small groups. Give each group a piece of Styrofoam, two markers, two cardboard tubes, and a rubber band. Instruct them to slide a cardboard tube down around each marker. Have them wrap the rubber band around the two tubes. Then instruct them to hold the markers far enough apart so that the rubber band is taut enough not to slip. Once students have stretched it to this distance, have them poke the two markers into the Styrofoam so that they are standing straight up with the rubber band stretched taut between them. Then instruct students to make a handle by taping a craft stick vertically along the top of one of the cardboard tubes. Have them try out their pulley system by using the handle to rotate the tube.

Distribute the *Pulling Together* reproducible and have students diagram and label their pulley design, using their books for reference.

Accommodations and Extensions

Demonstrate how to make the pulley system in front of the class before students begin building their own. Walk students through each step, discussing what each part is and how it works.

As an extension, have students look through their *Get to Know Pulleys* books to find an example of a real-life pulley that is similar to the ones they made. (for example, a bicycle chain or car engine), and have them write a few sentences about how that pulley (or system of pulleys) works.

Closure

Have students describe their pulleys, including the names of the parts. Ask students to describe how the parts worked together to make the pulley move. Then ask students whether their pulleys were fixed or moveable (fixed), and have them explain how they knew.

Assessment

Monitor student participation and evaluate student pulleys and reproducibles for understanding of major concepts.

Can You Pull It Off?

A Lesson on Moving Objects with Pulleys

Content

Students will learn about the function and purpose of pulleys by making a simple ski lift.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Science

Students should develop an understanding of properties of objects and materials.

Students should develop an understanding of position and motion of objects.

Students should develop abilities of technological design.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Linguistic
- Logical-Mathematical
- Visual-Spatial

Prerequisites

Have students read the book *Get to Know Pulleys* before starting the lesson.

Materials

- *Get to Know Pulleys* books
- chalkboard and chalk or whiteboard and markers
- student copies of the *Can You Pull It Off?* reproducible
- empty thread spools with hollow centers (2 per group)
- pencils (2 per group)
- loops of string (several feet long) (1 per group)
- small objects of various weights, such as a matchbox, a plastic bag, toy car, etc. (4 per group)
- tape

Instructional Procedure

Anticipatory Set

Have students look at the photo on page 28 of their *Get to Know Pulleys* books. Ask them to name the parts of a pulley they see in the ski lift. Then ask them to demonstrate with their arms and hands which way they would need to *pull* the cable (shown in the background) to move the ski lift to the left. Then ask them which way they would need to pull the cable to move the ski lift to the right.

Class Discussion

Draw a flagpole on the board. Then ask students to direct you in drawing a pulley system to raise the flag. Guide them by asking these questions: *What do I need to make a pulley?* (a wheel with a *groove*, a rope) *If I need to pull a rope to raise the flag, where should the wheel go?* (at the top of the flagpole) *Where should the rope go?* (It should loop around the wheel. The two ends of the rope should meet at the bottom of the pole.) Then ask students which side of the rope you should pull on to raise the flag and which side to lower the flag. Ask students how the pulley system would be affected if, instead of raising a flag, you were raising a bucket of water. (You would need to pull harder on the rope since a bucket of water weighs more than a flag.) Explain that when you use a pulley system, the heavier the object is, the more force is needed to lift it.

Objectives

The student will be able to…

- operate a simple pulley system
- create a miniature ski lift
- observe a relationship between weight and the effort required to move weight

Activity

Distribute the *Can You Pull It Off?* reproducibles. Divide students into groups of three and give each group two spools, two pencils, four small objects of various weights, a loop of string, and tape. Tell students that they are in charge of transporting the small objects from the bottom to the top of a "mountain" (a table or desk). They must accomplish this task by making a ski lift out of a pulley system.

Explain to students the steps for making their pulley system. Have two students in each group each put one pencil through the middle of a spool and hold onto the pencil. Have them loop the string around the two spools and then back away from each other until the loop of string is taut. Tell one of the students to sit on the floor so that the pulley is angled. The other holder should hold her spool at the top of the table or desk.

Have another student tape one object to the bottom string of the loop, close to floor. The student should pull on the top side of the string loop to move the object toward the top of the desk. As he pulls on the loop, have the student describe to his group how much *effort* is required—or how easy or difficult it is—to move the object. Have students record their observations of the movement on their reproducibles. When the object has reached the top of the desk, have the student remove the object. Have groups repeat the process for the other objects, and make sure group members rotate between holding the spools and pulling the strings.

Accommodations and Extensions

Perform the pulley experiment as a class, having student volunteers come to the front of the room to hold the pulleys and move the objects. Complete the reproducibles together as you go.

As an extension, have students experiment with different lengths of string to see how far they can extend the ski lift pulley system. Then have them discuss how adding length affected the way their pulleys worked.

Closure

Review the results of the pulley experiments as a class. Have students describe the connection between the weight of the object and the amount of effort required to move it with the pulley. Then guide students as they discuss the amount of effort that various real-world objects would require in a pulley system. (For example, a ski lift would require more effort than a bucket in a well; an elevator would require more effort than a curtain.)

Assessment

Monitor student groups for participation, and evaluate student reproducibles for accuracy and comprehension of major concepts.

On a Roll

A Lesson on Wheels and Axles

Content

Students will learn about wheels and axles by building simple wheel-axle sets. They will also learn how the shape and size of a wheel and the combination of wheels on an axle affect movement.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and non-fiction, classic and contemporary works.

Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Mathematics

Students should build and draw geometric objects.

Science

Students should develop an understanding of position and motion of objects.

Students should develop an understanding of abilities of technological design

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Interpersonal
- Linguistic
- Logical-Mathematical
- Visual-Spatial

Prerequisites

Have students read the book *Get to Know Wheels and Axles* before starting the lesson. Review with students the definitions of *axle* and *wheel*.

Materials

- *Get to Know Wheels and Axles* books
- various small square objects (erasers, plastic or wooden blocks, small boxes)
- various small round objects (rolls of tape, coins, buttons)
- chalkboard and chalk or whiteboard and markers
- scissors (1 per pair)
- pieces of cardboard (1 per pair)
- straws (1 per pair)
- various circular items (lids, jars, cans, etc.) of different sizes for students to trace (2 per pair)
- student copies of the *On a Roll* reproducible

Instructional Procedure

Anticipatory Set

Hand out a *square* object to each student. Instruct students to take turns rolling the square object across the floor. Encourage them to try different ways of releasing the object to make it move in different ways. Then collect the square objects, and hand out a circular object to each student. As with the square objects, have students take turns rolling their object across the floor. Have students discuss the differences in how the *circle* and square objects moved across the floor. Ask: *Which object was easy to move a long distance?* (the circular object) *Why does a circular object move farther and with a smoother motion than a square object?* (the circle shape causes it to roll) Then have students discuss how easy it was to control where their circular objects traveled. (The round objects were harder to control than the square objects because they rolled freely in random directions.)

Class Discussion

Explain to students that as they just observed, round objects are much easier to move over longer distances than square objects. This is why *wheels* have a round shape. Then remind students that even though their round objects moved more easily, they were also more difficult to control. Roll a coin across a table or the floor. Ask: *What happens to the coin when it slows down?* (It falls over.) Draw a wheel on the board. Explain that, by itself, a wheel has nothing to stop it from falling over. Draw another

Objectives

The student will be able to…

- understand the importance of wheel shape
- analyze how different-sized wheels move
- work in pairs to build simple wheel-axle sets

wheel on the board and join the two with an *axle*. Explain that when two wheels are joined by an axle, the wheels become *stable*, that is, they don't fall over. Ask: *Now that two wheels are joined by an axle, how will the wheels move?* (in a straighter, more controlled path) Explain that by combining the round shape of the wheels with the strength and stability of the axle, you can move almost anything much more easily.

Activity

Distribute the *On a Roll* reproducible. Divide students into pairs, and give each pair a piece of cardboard, a pair of scissors, a straw, and two circle-shaped items. Instruct students to trace the circular items on their cardboard and then cut them out to make two pairs of wheels — one small, and one large. Then have students make two pairs of wheels that are not perfectly circular by drawing an irregular shape, cutting it out, and then tracing it to make a matching wheel. Help students use pencils or scissors to carefully poke a hole in the center of each wheel, then have them mount one pair of wheels on their straw axle. Have them experiment with rolling their wheel-axle constructions around the room. Have students sketch their wheel-axle construction on the reproducible, then write a sentence or two to describe how it moves. (Does it go in a straight line? Does it veer to the side? etc.) Then have them try a different pair of wheels and record the results. Encourage students to try combinations of different shapes and sizes on the same axle to see how differences in wheel size affect movement.

Accommodations and Extensions

Provide pre-made pairs of wheels for students and have them experiment with the pre-made sets of wheels on their axles. Then discuss their observations as a class.

As an extension, have student pairs combine their wheel and axle sets to make a vehicle to move a load. Provide cardboard and tape for students to create a surface to carry the load, and then have them move small classroom objects using their creations. Have students refer to pages 14–15 of their books for ideas.

Closure

Ask students to share their observations with the class. Have them discuss how their different wheel sets moved. Encourage them to talk about the differences in movement between sets of well-formed wheels and imperfectly formed wheels, as well as how combinations of different-sized wheels affected the movement. Ask students how this information might be useful in the real world. (For example, wheel-axle sets must be carefully made to make sure that vehicles move efficiently.)

Assessment

Monitor student participation and evaluate student reproducibles for understanding of major concepts.

Water Makes the Wheel Go Round

A Lesson on Moving Wheels

Content

Students will learn how applying effort makes wheels and axles move by making a simple water wheel.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Mathematics

Students should build and draw geometric objects.

Science

Students should develop an understanding of position and motion of objects.

Students should develop an understanding of abilities of technological design

Multiple Intelligences

The following intelligences will be activated throughout the lesson:

- Bodily-Kinesthetic
- Linguistic
- Logical-Mathematical
- Visual-Spatial

Prerequisites

Have students read the book *Get to Know Wheels and Axles* before starting the lesson.

Materials

- *Get to Know Wheels and Axles* books
- chalkboard and chalk or whiteboard and markers
- student copies of the *Water Makes the Wheel Go Round* reproducible
- cardboard (2 pieces per pair)
- pencils (1 per pair)
- scissors
- glue
- pencils
- plastic tubs (1 per pair)
- plastic blocks
- large cups of water (1 per pair)

Instructional Procedure

Anticipatory Set

Write the word *rotate* on the board and ask students for its definition. (to spin around something) Instruct students to make fists and hold them close to their chests so that their arms are horizontal in front of them and the flat part of their fists are pointing toward each other. Then have them rotate one fist around the other. Point out that this is the same motion used by a wheel when it rotates around an axle.

Classroom Discussion

Explain to students that in order for a wheel to rotate around an axle, it needs *energy* and effort. Have students turn to pages 10 and 11 in their *Get to Know Wheels and Axles* books. Ask: *Where does the energy come from to turn these wheels?* (It comes from the person moving the wheels.) Then have students turn to page 13 and discuss where the energy comes from to move the semi-truck. (It comes from an engine.) Finally, have them turn to page 28 and discuss the source of the energy that operates a bicycle. (It comes from the person who moves the pedals.) Explain to students that the energy to operate a wheel can also come from a *natural* source, like wind or water. Ask students to explain how they think water might be used to create energy to turn a wheel.

Objectives

The student will be able to…

- analyze the effort and energy required to make a wheel move
- work in small groups to make a water wheel

Activity

Note: It may be helpful for you to bring in a finished water wheel to show students before they begin the activity.

Part I: Building the Wheels

Distribute the *Water Makes the Wheel Go Round* reproducibles to each student. Then divide students into pairs, and give each pair two pieces of cardboard. Have students cut out the templates from the reproducible and trace them onto the cardboard to make eight flaps and two circles. Instruct the pairs to cut out their shapes and to carefully use scissors to poke a hole through the center of each circle.

Instruct students to glue the cardboard flaps on their edges to one of the circles, like the spokes of a bicycle wheel (the flaps should be perpendicular to the plane of the circle). When they are done, instruct them to glue the other circle on top of the flaps. These wheels should be allowed to dry for several hours.

Part II: Rotating the Wheels

Distribute a small plastic tub and some blocks to each pair. Have students use the blocks to build a stand for the water wheels. The stand should be a stack of blocks with a groove-shaped structure at the top (two blocks standing on end, about a centimeter apart from each other), which will hold the axle in place. The stand should be tall enough to keep the wheel from touching the ground.

Once their water wheels have set, have students poke a pencil through the holes in wheel to create an axle. Then have them set their wheel on their stand so that the axle (the pencil) rests in the grooves. Encourage them to spin the wheel with their hands to make sure that it moves correctly. If the wheel doesn't move, they may need to adjust their stands or widen the hole in the cardboard.

Give each pair a large cup of water. Tell students to pour water over the flaps of their water wheel to demonstrate how water causes a wheel to rotate on an axle.

Accommodations and Extensions

Have the elements of the wheel pre-cut for students to use, so they simply must glue the wheels together. Then build a stand for students to use and have pairs take turns coming to the front of the classroom to set their wheels in the stands and pour water over their wheels.

As an extension, have students draw a picture of their water wheels and label the wheel and the axle.

Closure

Have students discuss their water wheel experiments. Ask them to describe how the wheel moved and what caused it to move. (The force of the water pushed the spokes, making the wheel rotate on its pencil axle.) Then have students give examples of other natural forces that can move objects. (wind, gravity, etc.) Write their responses on the board. Ask them for examples of human-made wheels that depend on natural forces to work. (windmills, pinwheels, etc.) Remind students that even though it seems simple, the wheel is one of the most important mechanical inventions in human history and that without the wheel, many of today's machines would never have been invented.

Assessment

Monitor students for participation and understanding of major concepts.

Name ______________________ Date ____________

In the Kitchen

Directions: Write the name of each kitchen tool and describe what it looks like. Decide whether it is a single or double wedge. Then write what the tool does and how the wedge shape helps the tool do that task.

Kitchen Tool	Single or Double Wedge?	What Does It Do?	How Does the Wedge Help?

Name ______________________ Date ______________

Find the Pitch!

Directions: Draw a picture of each screw. Then record your measurements and answer the questions at the bottom of the chart.

	Draw It	Length	Pitch	How Many Turns *Will* it Take?	How Many Turns *Did* it Take?	Describe It
Screw #1: Screwdriver						
Screw # 1: Hands						
Screw #2: Screwdriver						
Screw #2: Hands						

How did it feel to use the screwdriver to drive in your screws?

____

____

How did it feel to use your hands?

____

____

How was it different? Which was easier?

____

____

____

Name ______________________ Date ______________

Stop It!

Directions: Write the name of each object or surface, and use 1 or 2 words to describe its texture on the lines under its number. Then describe how each object slides on each surface.

	Surface 1 ________ ________ ________	Surface 2 ________ ________ ________	Surface 3 ________ ________ ________	Surface 4 ________ ________ ________
Object 1 ________ ________ ________				
Object 2 ________ ________ ________				
Object 3 ________ ________ ________				
Object 4 ________ ________ ________				

Name ______________________ Date ______________

Racing Levers

Directions: Draw a picture of your racing lever. Then title it with its lever class and label the load, the effort, and the fulcrum.

____

Name ______________________________ Date ________________

Pulling Together

Directions: Draw a picture of your pulley. Label each part of the pulley in your drawing. Look back at page 5 of *Get to Know Pulleys* for help. Then draw arrows to show which way the different parts move.

Name ______________________ Date ______________

Can You Pull It Off?

Directions: Watch each object as it moves along the pulley. Then answer the questions about each object.

Object 1

What is the object? ______________________ Is it light or heavy? ______________

What did the pulley string look like while the object was moving?

____

How hard did the pulley worker have to pull on the string to move the object?

____

Object 2

What is the object? ______________________ Is it light or heavy? ______________

What did the pulley string look like while the object was moving?

____

How hard did the pulley worker have to pull on the string to move the object?

____

Object 3

What is the object? ______________________ Is it light or heavy? ______________

What did the pulley string look like while the object was moving?

____

How hard did the pulley worker have to pull on the string to move the object?

____

Object 4

What is the object? ______________________ Is it light or heavy? ______________

What did the pulley string look like while the object was moving?

____

How hard did the pulley worker have to pull on the string to move the object?

____

Name ______________________ Date ______________

On a Roll

Directions: Draw each wheel-axle set you built. Then describe how it moved.

Drawing	How Did It Move?

Name ______________________________ **Date** ________________

Water Makes the Wheel Go Round

✂ **Directions:** Cut out the circle and rectangle. Use the circle to trace 2 wheels onto your cardboard. Use the rectangle to trace 8 wheel flaps onto your cardboard.