Simple Machines

Mainstream Grade 3 Science
By: Daisy Torres
Summer 2003
Unit: Simple Machines

Grade: 3rd

Class: Mainstream Science Class with Integrated ELLs

You might be particularly interested in how this teacher:

- How the teacher uses gestures while talking (11).
- How the teacher varies the lab reports for the different ELL levels (20-21).
- How the teacher made text comprehensible by creating a T-list on Work and Energy (38).
- How the teacher checks for understanding and negotiates meaning with the students (37).
Introduction
Title: “Simple Machines and their importance to our world”

Grade: Grade 3 Science Unit

Target Group: Mainstream class with integrated ELL learners.

Source of written materials: Book Title: Merrill Science Grade 3
Authors: Dr. Jay Hackett, Dr. Richard Moyer, and Dr. Donald Adams
Publisher: Merrill Publishing Company
Columbus, OH 43216

Internet Sources: www.mikids.com/SMachines
www.grc.nasa.gov
www.sirinet.net

Source of lessons: Merrill Science Teacher Handbook grade 3
Internet worksheets

Overview:

Lesson #1: An introduction to force:
Students will learn what is needed to move objects and the amount of force needed to move an object depends on the object’s mass.

Lesson #2: Gravity and Friction:
Students will learn there is a pulling force between objects, friction slows moving objects, and physical properties affect friction.

Lesson #3: Work and Energy:
Students will learn work is done when a force moves an object, energy is used when work is done, and there are different sources of energy.
Lesson #4: An Introduction to Simple Machines:
Students will learn why simple machines are used, and why a lever is a simple machine.

Lesson #5: More Simple Machines:
Students will learn a wedge and a wheel and axle, inclined plane, a screw, and a pulley are also simple machines. Students will be able to identify the six simple machines.

Culminating Activity: Field trip to the Durham Fair to see real simple machines and discuss their importance.

Create your own simple machine with at home materials and present an oral report on your project.

Unit Goals:
I want my students to know the need of simple machines in our world, why force is needed to move objects, and the names and functions of the 6 simple machines.
<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Language</th>
<th>Content</th>
<th>Learning Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve student’s academic language.</td>
<td>Know how to locate a main idea and important details.</td>
<td>Know the need of simple machines in connection to the world around us. Know why force is needed to move objects. Names and functions of the 6 simple machines.</td>
<td>Mnemonic devices to memorize the 6 types of simple machines.</td>
</tr>
<tr>
<td></td>
<td>Know to link prior knowledge to new reading.</td>
<td>Make predictions within a text.</td>
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</tr>
<tr>
<td>Skills</td>
<td>Conduct a force experiment and write observations in written form.</td>
<td>Estimate amounts of force within an experiment.</td>
<td>Use of visuals (steps to conduct an experiment).</td>
</tr>
<tr>
<td></td>
<td>Orally name examples of work and the importance of when work is done.</td>
<td>Justify, decide, and discuss when work is done and why it is important.</td>
<td>Roles of students in small group work (ex. recorder, time keeper, etc.)</td>
</tr>
<tr>
<td></td>
<td>Orally discuss the 6 types of simple machines in small groups.</td>
<td>Decide and discuss the importance of simple machines.</td>
<td>Use of the COPS strategy (capitalization, overall appearance, punctuation, spelling) during writing.</td>
</tr>
<tr>
<td></td>
<td>Write a paragraph about why simple machines are important</td>
<td>Define the lever, give an example, and summarize their importance to our world.</td>
<td>Role of a presenter when presenting a project (ex. eye contact, tone of voice, etc.)</td>
</tr>
<tr>
<td></td>
<td>Match the picture of a simple machine to its correct title.</td>
<td>Identify the 6 simple machines and match them to their correct label.</td>
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<td></td>
<td>Construct individual simple machines using at home materials and use oral skills to present project.</td>
<td>Construct individual simple machines and conduct an oral report.</td>
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<td></td>
<td>Orally discuss what gravity and friction are.</td>
<td>Define gravity and friction.</td>
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<tr>
<td>Brainstorm many different machines as teacher records on chalkboard. Discuss. Observe different examples of simple machines in pictures.</td>
<td>Recognize the need and purpose of simple machines.</td>
<td>Make connections to self, other texts, or the world.</td>
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<tr>
<td>Orally identify load and fulcrum on a lever system.</td>
<td>Identify the load, fulcrum, and force of a lever system.</td>
<td>Apply critical listening skills.</td>
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</tr>
<tr>
<td>Read passage and discuss use of incline planes within the school.</td>
<td>Infer how much incline planes make work easier.</td>
<td>Access and apply prior knowledge and experience to help in understanding of new material.</td>
<td></td>
</tr>
<tr>
<td>Orally discuss.</td>
<td>Compare and summarize the similarities and differences among an inclined plane, a wedge, and a screw.</td>
<td>Use context clues to aid in understanding. Highlight words to be clarified.</td>
<td></td>
</tr>
<tr>
<td>In small groups, list examples of how pulleys are used. Discuss.</td>
<td>Give examples of how pulleys are used.</td>
<td>Use of questioning strategy for aid in comprehension skills.</td>
<td></td>
</tr>
<tr>
<td>Orally discuss the various types of machines seen at the Durham Fair and complete worksheet.</td>
<td>Locate the various simple machines at the Durham Fair</td>
<td>Use of a glossary and index for clarification of unknown words.</td>
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<tr>
<td>In groups, students will brainstorm names of machines through use of pictures.</td>
<td>Recognize the six simple machines</td>
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<tr>
<td>Students will write all of the words they can think of related to the word machine after</td>
<td>Brainstorm words related to machine</td>
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<tr>
<td>See a picture.</td>
<td>In pairs, students will read passage and write any words or phrases that need to be clarified.</td>
<td>Read passages about simple machines.</td>
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<tr>
<td>Using the text as reference, students will fill in missing information.</td>
<td>Complete a T chart.</td>
<td>Identify important information from the text.</td>
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<td>Students will use highlighter tape to highlight important information from the text.</td>
<td>Complete an Information Gap Task.</td>
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<tr>
<td>Students will pair up to fill in missing information about the six simple machines.</td>
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</table>

**Attitudes/Awareness**

| Awareness of the need of simple machines in connection to the world around us. Appreciate how simple machines help make work easier. |

| Simple Machines Grade 3 Science Unit |

**Goals and Objectives**

By: Daisy Torres

FLA 518
Lesson 1
Unit: Simple Machines
Grade 3 Science Unit

Lesson 1 objectives:

All students should learn:
  - A force is a push or pull.
  - People use force everyday.
  - Machines use force when they do work.
  - Many objects move when pushed.
  - Many objects move when pulled.

Most students should learn:
  - Lifting is a type of force.
  - A grader is one type of machine that uses force.
  - The force needed to move an object depends on the object’s mass.

Some students should learn:
  - Equal sized objects may have different amounts of mass.

Students will:
  - Explain what force is
  - Decide what is needed to move an object
  - Experiment and discuss the amount of force needed to move an object
<table>
<thead>
<tr>
<th>Function</th>
<th>Situation</th>
<th>Formula</th>
<th>Grammar Structure</th>
<th>Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain</td>
<td>what force is.</td>
<td>Force is ___. A push or pull is ___. Some types of force are ___. A road grader uses ______.</td>
<td>Present tense</td>
<td>Force</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Objects move when ______. If I lift something, this is one way to ______.</td>
<td>Present tense Conditional tense (If I...)</td>
<td>Mass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More force is needed to ______.</td>
<td>Present tense</td>
<td>Object</td>
</tr>
<tr>
<td>Decide</td>
<td>what is needed to move an object</td>
<td></td>
<td></td>
<td>Push</td>
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<td></td>
<td></td>
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<td></td>
<td>Pull</td>
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<tr>
<td>Experiment and orally</td>
<td>The amount of force needed to move an object</td>
<td></td>
<td></td>
<td>Lift</td>
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<tr>
<td>discuss</td>
<td></td>
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<td></td>
<td>Grader</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Work</td>
</tr>
</tbody>
</table>
Modified Lesson plan # 1

Forces and work

Initiation:
Students will be introduced to the word *machine* on the board (or overhead). For ELL’s (English Language Learners), this word may be difficult. Teacher should display a magazine or drawn picture of a machine so students can understand what this word means. Students will be given a word splash (see handout color coded blue) and asked to think of all the words or short phrases they can think of related to the word *machine*. Students will be prompted to think of what a machine does and how it works. Teacher will give students 5 minutes in pairs of two to complete as many spaces as they can. At the sound of the 5 minute timer, teacher will ask pairs of students to share possible word associations and teacher will record on board. Teacher will look for possible answers of: wheels, motor, movement, metal, driver, work, etc (answers may vary). Teacher will link answers to the focus of the day:

“All over the next 2 weeks, we will be learning about simple machines (teacher points to words already written on the board and reads in a slow paced speech). Today we will be reading and discussing force and work (also written on the board). We will discuss when work is done, why it is important, and what is needed to move objects using a science experiment.”

Materials:

Individual copies 1 roll of masking tape 1 ball of string
of science text

poster board or chart paper 5 trays to hold science experiment materials

markers 2 boxes of paperclips

1 for each student:
word splash worksheet crayon* small paper* large rubber band
milk carton* scissors* cardboard strip

experiment worksheet
(*other objects may be substituted)

Time: 1 hour (30 minutes for initiation and reading and 30 minutes for experiment and closure)

Procedure:

Students will open their Science books to page 118 (OL). Teacher will ask students to observe picture of a road grader. Teacher will explain that a road grader is a type of machine that uses force. The teacher will use the following slow paced speech:
Please look at the picture on page 118. A road grader is a machine that pushes dirt to make a new road. Point to the road grader now (teacher will hold up her book and point to the picture). A road grader is a machine that uses force. Force is a push or pull (teacher should demonstrate using gestures what a push may look like. An example may be pushing a chair away from the table. An example of a pull may be pulling the chair closer to you). (Teacher writes the word force on the board. Teacher repeats, “A pull or push is a force”, “A road grader uses force” while pointing to the word on the board.) The grader is using force to push the dirt.”

Next, teacher will model reading fluency by reading pages 118-121 (teacher will provide a simplified copy of text for ELL’s; please see handouts color coded pink). As teacher comes to important vocabulary words such as object and mass, discussion will take place in context of what is being read. Teacher will point student’s attention to the picture of two people carrying a stove on page 119. Teacher will ask students the following question:

“Describe what is happening in the picture of the two people carrying the stove.” (Possible answers may include: Objects move when there is force. They are pushing or pulling the stove to move it. If you lift something, that is one way to move an object.) For beginning ELL’s, teacher may ask one of the following questions:

“Point to the person pushing the stove.” “Point to the person pulling the stove.”

Teacher will continue reading to the end of page 121. Teacher will ask students the following question:

“What kinds of force do you use to move objects in the classroom?” (Possible answers may include: using a pencil to write-pushing the pencil down on the paper, pulling your chair out to sit down, pushing a pencil in a pencil sharpener, etc). For beginning ELL’s, a teacher may ask the following question:

“Is pulling your chair out when you sit down (teacher uses gestures and actually models pulling out a chair) using force?”

*Teacher will scaffold only when needed. As students answer questions, teacher will paraphrase and repeat what is being said indicating active listening is taking place. Examples may include: “So you are saying.....”, nodding, eye contact, etc.

At the conclusion of questioning, teacher will comment on the instructional conversation that just took place. For example, a teacher may say, “I really like the different ideas of ways we all use force within our classroom.” This is especially important not only to Ell’s but to all learners. The teacher is acknowledging student’s answers as valid and creating a safe, stimulating and non threatening environment for students to take risks.

Optional: Teacher may wish to give students a 5 minute “stretch” time to use the bathroom, move around, etc. 1 hour is a long time for 3rd graders to sit for an extended period of time.

The Science Experiment: (OL)

Please note: This experiment can be a lot of preparation. It would be very helpful to have 4 or 5 parents, volunteers, and/or paraprofessionals help each group with this experiment.
“Now we will estimate, or guess how much force is needed to make an object move. An object can be something as small as a pencil or as big as a chair (teacher shows a pencil and sits in a chair to demonstrate). For today’s experiment we will use 4 objects. We will use a milk carton (teacher holds it up), a crayon (teacher holds it up), a small piece of paper (teacher holds it up), and a pair of scissors (teacher holds it up). In small groups you will be making a Puller Pal (teacher holds up a picture of a finished Puller Pal). A Puller Pal will help us estimate or guess the amount of force needed to move the objects I just showed you. Let’s take a look at the steps you will be using to create your Puller Pal.”

Teacher should have steps listed on chart paper in large letters for all students to see. Teacher will point to each step on the chart as it is discussed. As each step is read, teacher will model how to follow that step and show each the students the result.

1. First, slip one end of the large rubber band into one end of the paperclip.
2. Attach the paperclip to one end of the cardboard strip and secure with masking tape.
3. Slip the free end of the rubber band into a second paper clip. (see attached sheet)

Teacher shows students completed Puller Pal. Teacher will tell students that they will be making their own Puller Pals in 5 cooperative groups. Each student will be assigned a role (previously explained, modeled, and practiced in class). The roles will be as follows:

<table>
<thead>
<tr>
<th>Title</th>
<th>Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Keeper</td>
<td>Keeps students adhered to specific time schedule during activity</td>
</tr>
<tr>
<td>Reporter</td>
<td>Reports results to the class</td>
</tr>
<tr>
<td>Materials Manager</td>
<td>Responsible for getting materials and clean up</td>
</tr>
<tr>
<td>Problem Solver</td>
<td>Responsible for ensuring students stay on task and “keep the peace”.</td>
</tr>
</tbody>
</table>

Teacher assigns students to groups according to their personal number (Teacher can break into groups in a different way- optional). Each student was given a number 1-20 at the beginning of the year. The teacher can call student numbers to form groups and assign roles.

Teacher will tell students they will be given 8 minutes to complete their Puller Pals. Teacher will ask all Materials Managers to get their materials tray and bring back to their group. Teacher will set timer for 8 minutes and instruct students to begin. At this time, each parent or volunteer can act as a facilitator in one of the 5 groups. Teacher will circulate the room.

At the conclusion of the 8 minutes, teacher will ask the reporter of each group to share how the activity went, if there were any problems, etc.
Teacher now explains that they will use their Puller Pals to find out how much force is needed to move an object. Teacher refers to steps (previously written out) on chart paper.

Speech:

"In your groups, each person will take a turn observing how much force an object has. In this experiment we will see how far the rubber band stretches (teacher should model what "stretches" mean. Teacher should take the rubber band and stretch it so students get an understanding of how a rubber band stretches) and we will mark it with a pencil. Let’s see how much force this milk carton has. Pay attention to how far the rubber band stretches. This will tell us how much force there is."

Teacher refers to steps on the chart and models each step with the Puller Pal:

1. First, make a pencil mark on the cardboard to show where the rubber band ends.
2. Hook an object to the Puller Pal.
3. Lift the object. Notice how far the rubber band stretches and mark with a pencil.

Teacher repeats procedure with a different object. Teacher will show the differences in force of each object. Teacher will ask the following question:

"Which object had the most force and why?"

For beginning ELL’s, a teacher should ask:

"Did the _____ (object) or the _______ (object) have more force?"

Teacher will then have a student repeat directions of science experiment to ensure understanding. Students will be experimenting with 4 different objects: a crayon, scissors, a small piece of paper, and a milk carton. Teacher will also refer students to the board. There will an experiment worksheet that each group will be responsible for answering as a group (see handouts color coded orange). Materials Manager will get paper and reporter will record. Students will be given 7 minutes to experiment.

At the conclusion of 7 minutes, teacher will compare findings of each group on an oversize chart paper or overhead transparency. The reporter will report back group findings of group worksheet. Teacher will write answers generated from the class on the overhead.

Closure:

Teacher will ask students the following question:

"Now that we have completed this science experiment, how did this help us understand the word force?" (Teacher points to the word force on the board, waits for responses and engages in a 2-3 minute instructional conversation encouraging students to develop higher level thinking skills in answering why questions).

Evaluation:

The teacher’s observations of cooperative group work and answers to questions serves as an evaluation of the lesson.
Descriptive Narrative

This science lesson prepared students to be actively engaged in a safe and stimulating environment while learning about force and work that will prepare them for a unit on simple machines.

In this lesson, many modifications were made with attention to English Language Learners (ELL’s). The content for this lesson was taken from a teacher Science handbook geared toward mainstream classrooms. However, this content, as is, would not be comprehensible to an ELL student. All learners need to be taught content successfully. The modifications allowed ELL students opportunities to engage in the lesson, answer questions, and work cooperatively with peers in a group setting.

Modifications included:

- Modified text
- Meaningful student centered activities (small group work conducting an experiment)
- Slow paced speech (explanation of expectations of experiment and discussion of pages read)
- Use of visuals (steps to experiment, group results)
- Focus on background knowledge (word splash)
- Create roles in the classroom for family members (invite parents to facilitate a group during the Science experiment)
- Holding high expectations of all learners by using high level questioning (teacher asks questions following experiment and during reading)
- Plenty of modeling (steps to experiment and how to make a Pulley Pal)
- Actively involve all learners (participation in group experiment)
- Checking for understanding (nodding, gestures, back channeling)
- Framing main ideas or concepts (write important words and phrases on board)
Lesson # 1

Words for the Word Wall

Force    Mass    Object

Push    Pull    Lift

Grader    Work
Chapter 7
Forces and Work

We use forces every day. Force is used to lift a bag of groceries or to walk from one place to another. Machines also use force when they do work. This machine is called a grader. It pushes soil to make a smooth surface for a new road. How else is it using force when it does work?
LESSON GOALS
In this lesson you will learn
• what is needed to move objects.
• the amount of force needed to move an object depends on the object's mass.

We can move objects in different ways. Many objects will move if you push them. Other objects move when you pull them. A push or pull is a force. The workers in Figure 7-1 are moving furniture. They are using forces. They are using pushes and pulls.

An object will move when you lift it. Lifting is a force. Do you use a push or a pull to lift a chair off the floor? Some objects can be lifted by using a small force. Other objects need greater forces in order to be lifted. The amount of force needed to lift or move an object depends on how much matter the object has.

A push or a pull is called force. Lifting is a kind of force. Force makes objects, or things, move. In order to move an object, it depends on how much it weighs or how heavy it is.
QUESTION How much pull does it take?

Materials

- cardboard strip 5
- large rubber band 5
- masking tape 1 roll
- string (30 cm) 1 ball
- paper clips 3
- small objects 15
- pencil and paper

What to do

1. Make a “Puller Pal” like the one shown.
2. Make a pencil mark on the cardboard to show where the rubber band ends.
3. Hook an object to your Puller Pal. Lift the object.
4. Make a pencil mark on the cardboard to show how far the rubber band stretches. Write the name of the object by the mark.
5. Repeat steps 3 and 4 with all the objects.

What did you learn?

1. Which object took the most force to lift? How do you know?
2. Which object took the least force?

Using what you learned

1. Predict the force needed to lift 3 of the objects at once. Test your prediction.
2. Pull each object across the table with the Puller Pal. Compare these forces with those needed to lift the objects.

ACTIVITY CLOSURE

Discuss and compare findings with estimates that students made in the Activity Introduction. Discuss the questions as a group. You may also wish to compare the Puller Pals using standard weights.
Imagine you and a friend are shopping in an antique store. You find two boxes like the ones in Figure 7-3. Both boxes are the same size. One box, however, is filled with old books. The other box is filled with postcards. The box of books takes more force to lift. This is because the box of books has more mass than the box of postcards.

More force is needed to lift an object with a large mass. Look at Figure 7-4. It would take more force to lift the bowling ball than the soccer ball. Which ball has more mass?

Lesson Summary

- Force is needed to move objects.
- The greater an object's mass, the more force that is needed to move the object.

Lesson Review

Review the lesson to answer these questions.
1. What is a force?
2. What type of objects need large forces in order to be moved?
Word Splash

Title ___________________________
Circle the picture that took the most force in your experiment.

- crayon
- milk carton
- paper
- scissors

***Early ELL's
Names of each person in group: ____________________________

A Science Experiment

Answer the following question BEFORE you experiment:

1. Make a prediction:
   Which object do you think will have the most force and why?
   ____________________________
   ____________________________
   ____________________________

Answer the following question AFTER you experiment:

2. Which object took the most force to lift and why?
   ____________________________
   ____________________________
   ____________________________

***Intermediate ELL’s
Lesson 2
Unit: Simple Machines
Grade 3 Science

Lesson 2 Objectives:

All students should learn:
- Gravity is a pulling force between objects.
- The pull of gravity is greatest when two objects are close together.
- Friction happens whenever one object moves over another.

Most students should learn:
- Gravity is the property of all matter.
- The amount of friction depends on the kind of surface that touch each other.
- Friction is the force that slows or stops an object in motion.

Some students should learn:
- The pulling force on an object becomes less as the two objects are closer together.
- There is more friction when an object touches a rough surface than when it moves over a smooth surface.
- An example of an object touching a smooth surface and a rough surface.

Students will:
- Define gravity and friction.
- Give examples of effects of gravity and friction.
- Conduct a science experiment on friction and record results.
<table>
<thead>
<tr>
<th><strong>Function</strong></th>
<th><strong>Situation</strong></th>
<th><strong>Formula</strong></th>
<th><strong>Grammatical Structure</strong></th>
<th><strong>Vocabulary</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Gravity and friction</td>
<td>Gravity is a _____</td>
<td>Present tense</td>
<td>pulling force</td>
</tr>
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<td></td>
<td></td>
<td>Friction is the _____ that _____</td>
<td>Present tense</td>
<td></td>
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<td>If _____ are close together, the pull of _____ is the greatest.</td>
<td>Conditional (If....)</td>
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<td></td>
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<td>One object will move over another when _____ happens.</td>
<td>Future</td>
<td>friction</td>
</tr>
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<td></td>
<td></td>
<td>Friction feels _____</td>
<td>Adjective clause</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Friction happened when</td>
<td>Descriptive clause</td>
<td>hot</td>
</tr>
<tr>
<td></td>
<td>How friction happens</td>
<td></td>
<td>Past tense</td>
<td>smooth</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>objects</td>
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<td>touched</td>
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</tbody>
</table>

- **Define** - Gravity and friction
- **Give examples** - Effects of gravity and friction
- **Conduct experiment** - How friction happens
Modified Lesson
Lesson #2

Initiation:
Teacher will show the students a ball and hold it up so all students can see. Teacher will ask the students to watch the ball at all times (teacher may point to her eyes). Speech:

"I want you to watch as I throw this ball up in the air. Think about what is happening. Think about what we learned about in our last Science lesson. We made Puller Pals to show something (teacher should show Puller Pal). What was the word we learned about? (Teacher will wait for responses. If students are having difficulty, teacher can write the first letter of the word force on the board f_____ . As students generate answers, the teacher may finish writing the word.) Who would like to come up here and show us what force looks like with this chair? (Student may demonstrate).

Now I will throw this ball again. There is a special kind of force that is making this ball fall. (Teacher writes the word gravity on the board and point to the word, repeats the word, and has the students repeat as well.) Gravity is a pulling force between an object (teacher writes this phrase on the board.) The object I used was a ball (hold the ball)." (OL) Teacher will now post objectives for the lesson on the board and read them to the class (see objectives and goals for lesson).

Materials:

Vocabulary on index cards for word wall
Science text
Chart paper
Worksheet Activity 7-2
Tray with the following materials for each group:
   2 hand lens
   3 marbles
   liquid soap
   experiment paper

Pencils
highlighter tape
pencils/markers
small ball

Time: About 1 hour

Procedure:
Students will open their books to page 122 (OL). Teacher will provide students with a highlighter tape and instruct students to highlight important words from the reading. These can be words the students don’t understand, find interesting, or think may be important to know. Teacher will tell students they will read pages 122-124 independently. At this time, the teacher can pair up an ELL with a native speaker to
complete this assignment. At the conclusion of the 10-12 minutes, teacher asks students to share some of the words they came up with. Teacher makes a list on the overhead or board making note of which words were often chosen (gravity, friction, motion, etc.) Teacher briefly discusses these words and may show pictures, draw pictures, or use gestures to make these concepts easier to understand. Teacher can ask ELL’s how you might say that particular word in their native language and writes it. Teacher puts these words on index cards to add to the existing word wall for students to use as reference. Now students can refer to these words in English and ELL’s can refer back to that word in their native language if needed. (Teacher should also include these English words as part of the student’s spelling program as well).

Teacher will tell students they will now conduct an experiment to demonstrate how you can make friction. (OL)
Teacher will pass out Activity 7-2 (color coded blue).
Teacher will go over materials needed and demonstrate procedure to students.
What to do: (These steps should be clearly labeled on chart paper or poster so students can refer back to when needed.)
1. Rub your hands together 20 times (students can assist the teacher in counting and they may also copy the teacher). Record what you see (teacher can write down observations generated from the students: Example: “My hands feel hot”.

Teacher asks students to complete steps 2-4 and record what they learned on chart paper in small groups. Teacher will pair up ELL’s with native speakers and assign each student a role from previous science experiment: Timekeeper, recorder, reporter, problem solver. Teacher gives students 8-10 min to experiment.

At the end of about 10 minutes, teacher asks reporter to report findings for class. Teacher tapes each group’s chart findings on board (can be turned into a What we Learned about Friction bulletin board later.)

Closure/Review:
Teacher asks students to explain how this experiment helped us learn about friction. Teacher asks someone to explain:
Friction is __________________. Friction happens when __________________.
Gravity is __________________. Gravity happens when __________________.

Assessment:
Answers to questions, vocabulary word discussion, and cooperative group work serves as an assessment to this lesson.
<table>
<thead>
<tr>
<th>Tell what your hands felt like after each step.</th>
<th>Why did your hands feel different each time you rubbed them together?</th>
<th>What caused the difference?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This chart should be copied onto chart paper for each group to record their findings.

Beginning ELL's could use the help of native language speakers and reliable students in their group to assist in completing this chart.
Descriptive Narrative lesson # 2

This science lesson prepared students to understand the concept of gravity and friction. In this lesson, students brainstormed ideas of friction and gravity and learned hands on what friction felt like through use of a science experiment. Through use of cooperative groups, students were able to process content information while being actively engaged.

Modifications included:

Small group work
Framing Main Idea
Developing vocabulary
Use of visuals
Plenty of modeling
Activating prior knowledge
Pacing teacher’s speech
Applying appropriate questioning strategies
Allowing real life meaningful activities
Allowing for students to plan and process
LESSON GOALS
In this lesson you will learn
• there is a pulling force between objects.
• friction slows moving objects.
• physical properties affect friction.

Earth pulls on objects. This pull brings you back to Earth when you jump into the air. The attraction or pulling force between objects is called gravity (GRA-vit ee). Gravity is a property of all matter. Gravity causes the grain in Figure 7–5 to fall. Gravity causes the rain to fall, too.

The pull of gravity is greatest when two objects are close together. The pulling force on each object gets less, however, as the two objects get farther apart. Think of the pulling force between two magnets. The pull is great just before the magnets touch. What happens to the pull on each magnet when the magnets get farther and farther apart?
The Sears Tower in Chicago rises 443 meters into the sky. Engineers dream of building super skyscrapers as much as four times that height, one and a half kilometers high. However, first, they must solve a problem. Every day, a super skyscraper must withstand wind as strong as 150 kilometers per hour.

How can tall buildings withstand wind? Braces on the sides of skyscrapers provide stiffness. Linking neighboring buildings with cables would help support the buildings.

Steel-reinforced concrete might also be used to make super skyscrapers strong, but flexible. This type of concrete is made by letting concrete harden around steel rods. It permits some bending or flexing. Skyscrapers must bend or flex with the wind. If the building is too rigid, it could crack.

Taller and taller buildings are likely to be built. The force of wind against them will be strong. Holding them steady against this force will be an increasing challenge.
Friction

Friction (FRIHK shun) is the force that slows down or stops objects in motion. Imagine that you are riding a bike on level ground. Think about what happens when you stop pedaling. Friction between the tires on your bike and the ground slows you.

Friction happens whenever one object moves over another. The amount of friction depends on the kind of surfaces that touch each other. There is more friction when an object moves over a rough surface than when it moves over a smooth surface. For example, you are able to ride a sled very fast down a hill covered with snow. You could not ride a sled as easily on a grassy hill. There is more friction because the grass is not as smooth as the snow.

Lesson Summary

• The attraction or pulling force between objects is called gravity.
• Friction causes moving objects to slow down or stop.
• Contact between rough objects causes more friction than contact between smooth objects.

Lesson Review

Review the lesson to answer these questions.
1. Why do rain drops fall toward Earth?
2. Why is it hard to ride a sled down a grassy hill?
Activity 7-2 Reducing Friction

QUESTION How can you make less friction?

Materials
hand lens       liquid soap
3 marbles       pencil and paper

What to do
1. Rub your hands together 20 times. Record what you feel.
2. Use the hand lens to look at your hands. Record what you see.
4. Put a little liquid soap in your hands. Repeat step 1.

What did you learn?
1. Tell about the surface of your hands after each step.
2. Why did your hands feel different each time you rubbed them together?
3. What caused the difference?

Using what you learned
1. How do marbles reduce friction?
2. How does soap reduce friction?
3. How could you make more friction? Why would you want to make more friction?
Lesson 3
Unit: Simple Machines
Grade 3 Science

Lesson 3 Objectives:

All students should learn:
  - Work is done when force moves an object.
  - Energy is used when work is done.
  - There are different sources of energy.

Most students should learn:
  - The amount of work on an object depends on the object being moved.
  - The more work you do, the more energy you use.
  - Food is one source of energy.

Some students should learn:
  - The amount of work done depends on both force and distance.
  - Forces in nature supply energy.
  - Most energy to run machines is supplied by fuel or electricity.

Students will:
  - Define work and energy.
  - Determine when work is done.
  - Locate and fill in a T-chart with information from the text.
<table>
<thead>
<tr>
<th>Function</th>
<th>Situation</th>
<th>Formula</th>
<th>Grammar structure</th>
<th>Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Work</td>
<td>Work is when ______. Work depends on both ______ and ______.</td>
<td>Verb clause</td>
<td>Force, Moves, Objects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy is ______. The more work you do, the more ______ you use.</td>
<td>Compound sentence</td>
<td>Force, Distance</td>
</tr>
<tr>
<td>Define</td>
<td>Energy</td>
<td>The two things you must do to find the amount of work done is find the</td>
<td>Verb to be</td>
<td>Ability, Work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>______ and ______. Energy supplies ______, ______, and ______.</td>
<td>Noun clause, Energy</td>
<td></td>
</tr>
<tr>
<td>Locate</td>
<td>information</td>
<td>Energy supplies ______, ______, and ______.</td>
<td>Verb, Numerals (sequence)</td>
<td>Fuel, Electricity, Gas</td>
</tr>
</tbody>
</table>
Modified Lesson #3

Work and Energy

Initiation:
Students will be instructed to open their science books to page 128 and observe the pictures (OL). Teacher will hold up her book and point to the dogs pushing the sleds. Teacher will ask students to think-pair share with the student next to them about what they think is happening in the picture. Teacher will give students 5 minutes.

At the conclusion, teacher will ask for volunteers to share their observations. Teacher will record on overhead. Discussion will take place. Teachers will refer to the framed objectives on the board for the lesson.

Materials:
- Overhead and blank transparencies
- Science text
- T chart (1 for each student)
- Pencils
- Pictures of food and work
- What I learned worksheet (1 for each student)
- Time: About 35-40 minutes

Procedure:
Teacher will pair up students to partner read the pages 126-128 in the text (OL) and complete the T-Chart (Please note: if this type of graphic organizer has not been used before then teacher will need to model how to use it to gather information). Teacher will explain that the T-chart has information from the text with blanks. The students need to work together to fill in the missing information using their text as reference. Teacher gives students 10 minutes to complete. At the end of the time allotted, teacher will review answers. Sample of teacher follow up questions to review material presented:

- "When is work done on an object?" (Teacher may show picture of people doing work).
- "How do people get energy?" (Teacher shows picture of food).

At this time, teacher should call for volunteers to demonstrate what work is by showing an example (moving a chair, picking up a pile of books) to make this concept more clear to the ELL. Teacher should show pictures of food and people working (see handout color coded blue) to demonstrate that food is the source of energy and that energy allows us to do work.

Teacher will give each student a What I Learned sheet (see handout: color coded orange). In pairs, students (teacher should pair an ELL with a reliable native speaker) can think about what they learned as a result of discussion, reading, and completing a T-chart.
Teacher will give students. This interaction with the ELL and a native speaker will help the ELL hear and see written and spoken English language. Students often work well in a pair or small group setting as opposed to a whole group setting when they emphasis is placed more on oral language skills.

Teacher should give students 5 minutes to complete. Discussion will take place at the end of the time. Teacher may take these sheets and use them for a What We Learned about Work and Energy bulletin display along with pictures of people working and the pictures of food needed for energy.

**Closure:** What we Learned about Work and Energy serves a closure to this lesson.

**Assessment:** Answers to questions, observations, small group work, and discussing what was learned serves as an assessment to this lesson.
Descriptive Narrative lesson # 3

This science lesson prepared students to understand the concept of work and energy and its relation to simple machines. In this lesson, students thought and discussed pictures of people at work using a think-pair-share. This motivation helped students to infer how work relates to simple machines. Students also used a T-chart to locate and fill in missing information. Group work allowed students to process and contextualize new information.

Modifications included:

Small group work
Framing Main Idea
Developing vocabulary
Use of visuals
Plenty of modeling
Activating prior knowledge
Pacing teacher’s speech
Instructional conversations
Use of graphic organizers
Applying appropriate questioning strategies
Allowing real life meaningful activities
Allowing for students to plan and process
### T-Chart

#### Work and Energy

<table>
<thead>
<tr>
<th>A. Work</th>
<th>B. Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. _______ moves an object.</td>
<td></td>
</tr>
<tr>
<td>2. You need two things to find the amount of work done on an object: Force and _______.</td>
<td></td>
</tr>
<tr>
<td>3. An _______ must be moved in in order for work is done.</td>
<td></td>
</tr>
<tr>
<td>1. The more work you do, the more _______ you use.</td>
<td></td>
</tr>
<tr>
<td>2. In order to do work, people need _______.</td>
<td></td>
</tr>
<tr>
<td>3. Once source of energy is _______.</td>
<td></td>
</tr>
<tr>
<td>4. Most of the energy to run machines is supplied by _______ or _______.</td>
<td></td>
</tr>
</tbody>
</table>
bananas
strawberries
carrots
corn
potato
tomato
Types of Work

- Illustration of people working in a construction site.
- Illustration of a person pushing a large object.
- Illustration of a person emptying a trash can.
- Illustration of a hand writing or signing something.
LESSON GOALS
In this lesson you will learn
- work is done when a force moves an object.
- energy is used when work is done.
- there are different sources of energy.

Forces cause objects to move. Scientists say that work is done when a force moves an object. Where is work being done in Figure 7-8? How do you know?

To find the amount of work done on an object you need to know two things. You must know how much force is needed to move the object. You must also know how far the object is moved. The amount of work done depends on both force and distance. More work is done if a wagon is pulled uphill ten meters than if it is pulled five meters up the same hill.

Look at Figure 7-9. The workers are stacking bricks. The bricks move. They move because the workers use a force. Which worker is doing more work? Why?
Remember that an object must be moved in order for work to be done on the object. You may push with all your might on a stalled car. However, if you do not move the car, you have not done work on the car. Likewise, imagine that you have picked up a pile of books. You do work when you lift the books. However, if you stand holding the books you have not done more work on the books. Why?

Each time a force moves an object, such as the wagon or bricks, work is done. When work is done, energy (EN ur jee) is used. Energy is the ability to do work. The more work you do, the more energy you use.

Figure 7-10. Work is only done on the books when they are moved.

Figure 7-11. Energy is used when work is done.
In order to do work, people need a source of energy. Food is important. It provides the energy people need to do work.

Machines also need a source of energy. Sometimes forces in nature supply this energy. Water flowing in a stream, for example, may turn a paddlewheel.

Most of the energy to run machines is supplied by fuel or electricity. Gasoline supplies the energy needed to run the engines of cars. Electricity runs machine such as computers.

**Lesson Summary**

- The amount of work done depends on both force and distance.
- The more work you do the more energy you use.
- Food and fuel are two sources of energy.

**Lesson Review**

*Review the lesson to answer these questions.*

1. When is work done on an object?
2. What is energy?
3. Name four different sources of energy.
A detective is a person who searches for information that is not easy to find. A detective must investigate or find out information. He or she must closely study facts already known, and ask questions to get all the information that is needed. A detective, while observing or asking questions, writes notes. These notes are important. They are the written record of what the detective has seen or heard.

A doctor is similar to a detective. The doctor observes or listens to a patient and records information. All information is then on hand when the doctor decides what is wrong with the health of the patient.

As a student, you should work in the same way as a detective or doctor. You should observe, study, ask questions, and take notes. When you get ready to review, the notes can help you remember what you have already read or observed.
Lesson 4
Goals and Objectives
Lesson # 4

Simple Machines Pt. 1

All students should learn:
- There are many kinds of machines.
- Why simple machines are important.
- A machine with few or no moving parts is called a simple machine.
- Simple machines make work easier.
- There are 6 types of simple machines.
- A lever is used to move objects.
- All levers have 3 parts.
- Not all levers are the same.

Most students should learn:
- Some machines having moving parts.
- Simple machines change the amount of force needed to do work.
- The 3 parts of a lever are the load, fulcrum, and force.
- The push or pull that moves the lever is the force.

Some students should learn:
- Some simple machines can change the direction of force.
- Levers can be used to change the direction of the force needed to lift an object.
- The closer the fulcrum is on the load, the less force needed to lift the load.

Students will:
- Discuss why simple machines are important.
- Define simple machines
- Identify the load, fulcrum, and force of a lever system
- Write a paragraph about why simple machines are important.
<table>
<thead>
<tr>
<th>Function</th>
<th>Situation</th>
<th>Formula</th>
<th>Grammar Structure</th>
<th>Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discuss</td>
<td>simple machines</td>
<td>The six simple machines are</td>
<td>Present Noun clause</td>
<td>Lever, Inclined plane, Wedge, Screw, Wheel and axle, Pulley</td>
</tr>
<tr>
<td></td>
<td></td>
<td>_______</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The first, second,... machine is</td>
<td>Ordinal (Numerals)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>_______</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Define</td>
<td>simple machines</td>
<td>A machine that has few or no moving parts is a</td>
<td>Intensifier Indefinite article</td>
<td>Simple machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>_______</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify</td>
<td>load, fulcrum, and force</td>
<td>This is the _______.</td>
<td>Pronoun Noun</td>
<td>Load, Fulcrum, Force</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is a _______.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>paragraph</td>
<td>A lever is one type of _______.</td>
<td>Verb to be Noun clause</td>
<td>Fork, Work, Easier, Example, Push, Pull, Less, People, Simple machine, Can opener, Spatula, Scissors, Hoe, Stapler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>_______ is one type of lever.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Modified Lesson # 4  
Simple Machines part 1

Initiation:
Teacher will hand out worksheet labeled Examples of Levers (see handout: color coded yellow). Students will cut out each picture and match it to the correct label and glue it on construction paper. Teacher should display a finished copy so students can see what it should look like. Students may work in pairs to complete this quick introduction to levers (teacher should pair up ELL’s with native speakers). Teacher gives students 10 minutes to work on this exercise. At the end of ten minutes, teacher will ask each pair of students to share what they discovered. Teacher should refer to her model when discussing each picture. Teacher explains to students the purpose of this exercise:

“Today we will learn about a simple machine called a lever. (Teacher holds up picture) A simple machine is a machine with few or no moving parts (teacher writes this sentence on the board or overhead and points to each word as sentence is repeated and students repeat.) A lever is one type of simple machine (teacher holds up picture).”

Teacher makes sure speech is slow and frames objectives for the day for students to see. Students should orally hear and see what the lesson objectives will be.

Materials:

Pictures of simple machines  science text
Picture of different types of levers  copied text for ELL’s
Index cards for word wall  writing frame
Formula for writing  pencils and erasers
Construction paper  glue sticks

Scissors

Procedure:  
Teacher will tell students to open their books to page 132 (OL). Teacher will instruct students to read page 132-133 silently (Please note: teacher may give students a copy of these text pages with only important information for the student to follow highlighted. Teacher may wish to give these students this copy the night before so they have had time to process. See worksheet). At the conclusion of 5 minutes, teacher will discuss important concepts and vocabulary. Teacher will put words on index card to add to the word wall. Teachers may ask following review questions: (OL)

“How many movable parts are on the apple peeler?”
“Why are simple machines important to have?”
For beginning Ell's:

"Point to the apple peeler."

"Is this a simple machine?"

Teacher repeats procedure for pages 134 and 135 and 136 and 137. It is important to break this section into parts so students have time to process the information, ask and answer questions, and not feel so overwhelmed.

At the conclusion of the reading, teacher will pass out writing frame (see handout color coded orange). Teacher will explain to students that they will tell why they think simple machines are important, pick a machine that has a lever (teacher will refer to pictures of levers with matching labels from initiation exercise) and describe how that makes work easier for people. Teacher will model how to use the writing frame to organize their thoughts. Beginning Ell's can refer to writing formula (color coded pink) to help with language skills. After students fill in, students may share what they wrote. This can be used as a "sloppy copy". Teacher may wish to edit them and write final copy paragraphs on the computer at the computer lab. Students may wish to surf the internet for a picture of their level and attach to their paragraph. Teacher can hang finished products.

Evaluation:

Answers to questions, discussion, and written paragraph serves as an evaluation of this lesson.
Descriptive Narrative lesson # 4

This science lesson introduced students to simple machines and their importance to our world. Students were introduced to one type of simple machine: the lever. Through use of many visuals, students were allowed to process what a lever was and what it looked like. To aid in comprehension of new material, students were encouraged to highlight important information or new information with a partner. Having ELL’s pair up with a native speaker is most beneficial to the ELL. Working in pairs allows this student to speak in a non formal setting and provides him or her to listen to appropriate language English. Students were allowed to process this information and apply it to writing their own paragraph.

Modifications included:

Pair work
Framing Main Idea
Developing vocabulary
Use of visuals
Plenty of modeling
Activating prior knowledge
Pacing teacher’s speech
Instructional conversations
Use of graphic organizer
Applying appropriate questioning strategies
Allowing real life meaningful activities
Allowing for students to plan and process
Simplifying text
Assigning appropriate tasks to varying levels
Examples of Levers

Can you name all the levers?

<table>
<thead>
<tr>
<th>scissors</th>
<th>hoe</th>
<th>crowbar</th>
<th>bat</th>
<th>clippers</th>
<th>stapler</th>
</tr>
</thead>
<tbody>
<tr>
<td>fork</td>
<td>screwdriver</td>
<td>spatula</td>
<td>teeter-totter</td>
<td>rake</td>
<td>can opener</td>
</tr>
</tbody>
</table>

ride the bus back to the Simple Machines page
Simple machines make work easier. For example, a ________ is one type of simple machine. 

Sample paragraph

Simple machines help make work easier. A lever is one type of simple machine. A can opener is one type of lever. A can opener helps a person open up a can. The force makes the object move around. Simple machines are important to have.
Formula for writing
Beginning Ell’s

Sample formula:

It has (0, 1) moving parts.

It is (red, blue, black, silver, orange, blue, another color: ________)

This machine lifts, cuts, carries, other ______ something to make work easier.

It has a fulcrum, load, and force.
There are many different kinds of machines. Some machines have few moving parts. Other machines have many moving parts. This machine was used to peel apples. The apple was placed on the spike and the blade moved around the apple to peel it. How many movable parts do you see on the machine?
LESSON GOALS
In this lesson you will learn
• why simple machines are important.
• a lever is a simple machine.
• not all levers are the same.

Imagine that you need to move a barrel but it is too heavy. A friend says to place one end of a long board under the barrel and rest the board on a log. Now, when you push down on the other end of the board the barrel moves. The board and log were used as a type of machine.

People can use many kinds of machines to do work. A machine with few or no moving parts is called a simple machine. Simple machines can be used to make work easier to do. They can change the amount of force needed to do work. Simple machines can also change the direction of the force. However, they do not decrease the amount of work that is done. Figure 8–1 shows the six kinds of simple machines.

Figure 8–1. The lever (a), inclined plane (b), wedge (c), screw (d), wheel and axle (e), and pulley (f) are six kinds of simple machines.
Lever

The man in Figure 8–2 is lifting an object. In Figure 8–2(b) he is using a lever. A lever is a simple machine that is used to move objects.

All levers have three parts. The object to be moved by the lever is called the load. The point where the lever rocks back and forth is called the fulcrum (FUL krum). The push or pull that moves the lever is the force. Find the load, fulcrum, and force in Figure 8–2(b).

Levers can be used to change the direction of the force needed to lift an object. Think about a seesaw. When you push down on one end, the person on the other end goes up.

Figure 8–2. Moving an object by hand (a) takes more force than using a lever (b).
Figure 8-3. The force needed to lift a load depends on the position of the fulcrum.

Levers can also be used to change the amount of force. Think about the seesaw again. The girl in Figure 8–3(a) wants to play on the seesaw with her older sister. She cannot lift her older sister if the fulcrum is in the middle. If the fulcrum is moved closer to her sister, as in Figure 8–3(b), she is able to lift her sister. Look at Figure 8–3(c). Her younger brother wants to ride on the seesaw. She is now the heavier one. Therefore, she must move the fulcrum closer to herself. The amount of force needed to lift a load depends on where the fulcrum is. The closer the fulcrum is to the load, the less force needed to lift the load.
Not all levers are the same. Some levers do not have the fulcrum between the force and the load. The nutcracker is a lever with the fulcrum at one end. The force is applied at the other end. The load is in the middle.

Figure 8-5 shows a person doing work. This machine is a lever, too. Find the fulcrum of the lever. Find the force and the load. Why do we call this machine a lever?

**Lesson Summary**

- Simple machines can be used to change the amount of force needed to do work or to change the direction of a force.
- A lever is a simple machine that is used to move objects.
- The position of the fulcrum is not the same on all levers.

**Lesson Review**

*Review the lesson to answer these questions.*

1. What is a simple machine?
2. What are the three parts of a lever?
3. What does a lever do?
Simple Machines

Simple machines make work easier for us by allowing us to push or pull over increased distances.

There are SIX simple machines:

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Pulley</strong> - how it works</td>
<td>![Pulley Image]</td>
<td>Pulleys</td>
</tr>
<tr>
<td>A pulley is a simple machine that uses grooved wheels and a rope to raise, lower or move a load.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. Lever</strong></td>
<td>![Lever Image]</td>
<td>Levers</td>
</tr>
<tr>
<td>A lever is a stiff bar that rests on a support called a fulcrum which lifts or moves loads.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3. Wedge</strong></td>
<td>![Wedge Image]</td>
<td>Wedges</td>
</tr>
<tr>
<td>A wedge is an object with at least one slanting side ending in a sharp edge, which cuts material apart.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4. Wheel &amp; Axle</strong></td>
<td>![Wheel &amp; Axle Image]</td>
<td>Wheels</td>
</tr>
<tr>
<td>A wheel with a rod, called an axle, through its center lifts or moves loads.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5. Inclined Plane</strong></td>
<td>![Inclined Plane Image]</td>
<td>Inclined Planes</td>
</tr>
<tr>
<td>An inclined plane is a slanting surface connecting a lower level to a higher level.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

http://www.mikids.com/Smachines.htm
6. Screw

A screw is an inclined plane wrapped around a pole which holds things together or lifts materials.

Printable Activity Sheet

Interactive Online Activities

Inventor's Toolbox

Simple Machines

Simple Machines, Work, Force & Energy

Simple Machines ~ Society of Women Engineers

Simple Machine Quiz - online and interactive

ride the bus back to the main page

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http://www.mikids.com/Smachines.htm

7/15/2003
Lesson 5
Lesson 5 objectives:

All students will learn:
- An inclined plane moves objects higher or lower
- A wedge is made of two inclined planes
- A screw is an inclined plane wrapped around a post.
- A wheel and axle is a wheel that turns a post, or an axle.
- A pulley is a wheel on a post with a rope around it.

Most students will learn:
- A ramp is an example of an inclined plane.
- A knife is an example of a wedge.
- Work is done when a wedge presses against two objects.
- The force needed to turn a screw is less than that needed to pound a nail of equal size.
- Wheel and axles are seen on bikes, trains, cars, and trucks.
- A fixed pulley can be used to raise a flag on a flagpole.

Some students will learn:
- The longer the distance moved on an inclined plane, the less force needed.
- A wedge is sometimes used to raise objects a short distance.
- A wedge can push objects apart.
- A pulley may be fixed or movable.
- Pulleys decrease the force needed to move an object.

Students will:
- Define inclined plane, wedge, screw, wheel and axle, and pulley
- Infer how simple machines make work easier
- Complete an Gap Information task on the 6 simple machines
<table>
<thead>
<tr>
<th>Function</th>
<th>Situation</th>
<th>Formula</th>
<th>Grammar Structure</th>
<th>Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Inclined plane, wedge, screw, wheel and axle, and pulley</td>
<td>A _____ is _____</td>
<td>Verb to be Present</td>
<td>Objects, Higher, Lower, Place, Inclined plane, Wrapped around post, wheel, turns, post, changes, direction, force</td>
</tr>
<tr>
<td>Infer</td>
<td>Incline planes make work easier</td>
<td>An inclined plane makes _____</td>
<td>Plural</td>
<td>work, easier</td>
</tr>
<tr>
<td>Complete</td>
<td>Gap Information Task</td>
<td>A lever helps us _____</td>
<td>Present</td>
<td>lift, move down, across side, slide, ramp, nail</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An example of a lever is _____</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Modified Lesson # 5
Simple Machines part 2

Initiation:
Teacher will post objectives on the board. Teacher will explain that yesterday they learned about one type of simple machine: the lever. Teacher will explain that today they will learn about the remaining 5 simple machines. Teacher will review objectives and then introduce pictures of the 6 simple machines. Teacher should start with one simple machine, write the name on the board, and show the picture. Then teacher should have students repeat the word. Teacher should continue with remainder of pictures.

Materials:

Pictures of simple machines
Science text
Highlighter tape

Gap Information Task
pencils
overhead and transparencies

Time: About 1 hour

Procedure:
Students will pair up (ELL’s should be paired with native speakers) and open their text to page 138 (OL). Together students will partner read pages 138-141. Teacher will explain to students that they will be responsible for highlighting important words or concepts from the reading. These can be words not understood or interesting to them. Teacher will give students 10 minutes to complete. Teacher will discuss with the students what was found. Teacher should make sure students understand words that were important by modeling, using gestures, and using students as volunteers to demonstrate a concept. Teacher should write vocabulary on index cards to place on the word wall. Teacher should repeat procedure for pages 142-145. Discussion should take place with material presented after 10 minutes is up. Teacher should ask review questions to students such as (OL):
“What is a pulley?”
“Who can give me an example of a wedge?”

For beginning ELL’s:
Sample questions may include:
“Point to the wheel and axle.”
“Is this an inclined plane?”

After reading, students will engage in an Information Gap Task. This task requires that 2 students work together to find information. They will need to ask and answer questions
in order to find their missing information (See handouts color coded yellow.) This is especially useful to ELL’s because it forces them to speak in a non threatening environment. Caution: Pair capable native language students with ELL’s. Teacher can give students 8-10 minutes to complete while teacher circulate the room and observes the conversation and interaction that is taking place.

Closure:

At the end of ten minutes, teacher should review answers on overhead and discuss the experience that took place.

Assessment:

Answers to questions, group work and discussion serves as an assessment to this lesson.
Descriptive Narrative lesson # 5

This science lesson introduced students to the remaining simple machines and their importance to our world. Through use of many visuals, students were allowed to process what the various simple machines were and what they looked like. Children were also exposed to another opportunity to process this information through use of an Information Gap Activity that allowed students to pair and use oral and written language to gather missing information while at the same time learning new information.

To aid in comprehension of new material, students were encouraged to highlight important information or new information with a partner. Having ELL’s pair up with a native speaker is most beneficial to the ELL. Working in pairs allows this student to speak in a non formal setting and provides him or her to listen to appropriate language English. Students were allowed to process this information and apply it to writing their own paragraph.

Modifications included:

Pair work with Information Gap Task
Framing Main Idea
Developing vocabulary
Use of visuals
Plenty of modeling
Activating prior knowledge
Pacing teacher’s speech
Instructional conversations
Use of graphic organizer
Applying appropriate questioning strategies
Allowing real life meaningful activities
Allowing for students to plan and process
Simplifying text
Please note: Realia is very important to show ELL’s when discussing examples of simple machines.

**Information Gap Task**

<table>
<thead>
<tr>
<th>Simple Machines</th>
<th>What it is</th>
<th>How it helps us work</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lever</td>
<td></td>
<td></td>
<td>Shovel, nutcracker, sesaw</td>
</tr>
<tr>
<td>Inclined Plane</td>
<td>A machine that moves objects up and down.</td>
<td>Things move up and down</td>
<td>Slide, stairs, Ramp</td>
</tr>
<tr>
<td>Wheel and Axle</td>
<td></td>
<td>Lifts or moves loads</td>
<td></td>
</tr>
<tr>
<td>Screw</td>
<td>An inclined plane wrapped around a post.</td>
<td>Holds things together</td>
<td>Screw, drill, bolt</td>
</tr>
<tr>
<td>Pulley</td>
<td>A wheel on a post with a wheel around it.</td>
<td>Moves things up, down, or across</td>
<td>Flagpole, curtain rod, mini blind</td>
</tr>
<tr>
<td>Wedge</td>
<td></td>
<td>Cuts or spreads an object apart</td>
<td>Knife, nail, pin</td>
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<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lever</td>
<td>A machine with 3 parts used to move an object.</td>
<td>Shovel, nutcracker, see saw</td>
<td></td>
</tr>
<tr>
<td>Inclined Plane</td>
<td></td>
<td></td>
<td>Slide, stairs, Ramp</td>
</tr>
<tr>
<td>Wheel and Axle</td>
<td>A wheel with a post called and axle that move together.</td>
<td>Lifts or moves loads</td>
<td>Car, wagon, bike</td>
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Please note: Realia is very important to show ELL’s when discussing examples of simple machines.

### Information Gap Task

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<td>Knife, nail, pin</td>
</tr>
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</table>

***Answers***
LESSON GOALS
In this lesson you will learn
• an inclined plane is a simple machine used to move objects.
• a wedge has two important uses.
• a screw is a type of inclined plane.

An inclined plane is a simple machine used to move objects to a higher or lower place. A ramp and a path going up a hill are examples of inclined planes. In Figure 8–6 both children want to go to the top of the hill. The girl on the steeper path goes a shorter distance. She uses more force to get to the top. The boy goes a longer distance. He uses less force to get to the top. The longer the distance moved on an inclined plane, the less force needed.
Activity 8–2  Inclined Planes

QUESTION  How do inclined planes make work easier?

Materials
4 books  8 marbles
"Puller Pal"  ramp (board)
milk carton  pencil and paper

What to do
1. Pile 4 books on top of each other.
2. Put 8 marbles into the milk carton.
3. Lift the milk carton with the Puller Pal until the bottom of the carton is even with the top book.
4. Mark how far the rubber band stretches.
5. Set up the ramp, milk carton, and Puller Pal as shown.
6. Pull the carton up the ramp. Mark how far the rubber band stretches.

What did you learn?
1. Which way took more force to move the carton?
2. Which way took a longer distance?

Using what you learned
1. Find out what happens to the force needed if the ramp is made higher.
2. Why are roads built around mountains instead of straight up the sides?

Optional
A wedge (WEJ) is a simple machine made of two inclined planes. Knife blades, chisels, pins, and the blade of a hatchet or axe are all examples of wedges. Work is done when the wedge presses against two objects. Sometimes a wedge is used to raise objects a short distance. A heavy object such as a stove might be raised over a crack in a floor by using a wedge. Other times a wedge is used to push objects apart. Logs are split by using axes and hatchets. The blade of the hatchet or axe is forced into the log. It pushes the pieces of log apart. How can you use each wedge shown in Figure 8-7?
The force needed to raise an object with an inclined plane depends on the distance moved. A longer distance is covered when an inclined plane is wrapped around a post. This can be shown by cutting an inclined plane out of paper. When this paper is wrapped around a cardboard tube the resulting object is a screw. A screw is an inclined plane wrapped around a post. Each time the screw makes a complete turn it moves a load a certain distance along the screw. This distance depends on the amount of space between each overlap of the inclined plane on the post. Screws, drill bits, and other objects commonly found in the home make use of the screw. The force needed to turn a screw is less than that needed to pound a nail of equal size. A longer distance is covered when you turn a screw. Therefore, less force is needed.

**Lesson Summary**

- An inclined plane is a simple machine used to move objects to higher or lower places.
- A wedge is a simple machine used to raise objects or to push them apart.
- A screw is an inclined plane wrapped around a post.

**Lesson Review**

*Review the lesson to answer these questions.*

1. Name three examples of inclined planes.
2. Why is less force needed to turn a screw than to pound a nail of equal size?
LESSON GOALS
In this lesson you will learn
• a wheel and axle is a simple machine.
• a pulley is a simple machine with two different uses.

Look at Figure 8–9. Which door would you want to try to turn open? Why? The doorknob is a wheel and axle. A wheel and axle is a simple machine with a wheel that turns a post. The post is called an axle. Wheels and axles are commonly seen on cars, trains, trucks, and bicycles. The crank on some fruit presses, which crush fruit, is also a wheel and axle.

Compare the sizes of the wheels and axles in Figure 8–10. The distance around the wheel is greater than the distance around the axle. Therefore, less force is needed to turn the wheel than to turn the axle.
A **pulley** is a simple machine that changes the direction or amount of a force. A pulley is a wheel on a post with a rope around the wheel. A pulley may be fixed or movable. One fixed pulley is shown in Figure 8-11. It can make work easier to do by changing the direction of a force. This type of pulley is used to raise a flag on a flagpole. You pull down on the rope. As you pull down, the flag moves up the pole.

A movable pulley is shown in Figure 8-12. It is helpful in a different way. Using it can decrease the force needed to lift a load. The force can be reduced by one-half if one movable pulley is used to lift the load.

---

**Figure 8-11.** One fixed pulley can be used to change the direction of a force.

**Figure 8-12.** A movable pulley reduces the force needed to lift a load.

**Figure 8-13.** A fixed pulley can be used to raise a flag on a flagpole.
Two or more pulleys joined together may also be used to decrease the force needed to lift a load. Each part of the rope that is wrapped around the pulleys supports a part of the load. Look at Figure 8-14. The pulleys are being used to lift a heavy object. A person would not be able to lift it without the pulleys. The pulleys decrease the force needed to lift the object.

**Lesson Summary**

- A wheel and axle is a simple machine with a wheel that turns a post.
- A pulley is a simple machine that changes the direction or amount of force.

**Lesson Review**

*Review the lesson to answer these questions.*

1. Why is it easier to open a door with the doorknob than with the doorknob axle?
2. What is the advantage of using several pulleys?
Examples of Wedges

Can you name all the wedges?

<table>
<thead>
<tr>
<th>floor nail</th>
<th>back wedge</th>
<th>pins</th>
<th>iron wedge</th>
</tr>
</thead>
<tbody>
<tr>
<td>paint can opener</td>
<td>chisels</td>
<td>car tire</td>
<td>wedge</td>
</tr>
</tbody>
</table>

ride the bus back to the Simple Machines page

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http://www.mikids.com/SMachinesWedges.htm
Examples of Inclined Planes

Can you name all the inclined planes?

<table>
<thead>
<tr>
<th>roller coaster</th>
<th>dump truck</th>
<th>unloading ramp</th>
<th>hill</th>
</tr>
</thead>
<tbody>
<tr>
<td>parking ramp</td>
<td>car ramps</td>
<td>ladders</td>
<td>stairs</td>
</tr>
</tbody>
</table>

ride the bus back to the Simple Machines page

http://www.mikids.com/SMachinesInclinedPlanes.htm
A pulley is a wheel that turns around an axle.

Compound pulley:

1. A Pulley is a Grooved Wheel that turns around an Axle (Fulcrum), and a rope or a chain is used in the grove to lift heavy objects.

http://www.sirinet.net/~jgjohnso/simple.html
The wheel and axle is a wheel connected to a rigid pole. A handle can be a section of a wheel.

Modern use of wheel and axle

1. The Wheel and Axle was first used around 3000 B.C. and is one of the most important inventions in

http://www.sirinet.net/~jgjohnso/simple.html

7/15/2003
1. The Screw is another form of an Inclined Plane.

2. The Screw is an Inclined Plane Wrapped in a spiral around a Cylinder Post.

3. A Screw has two (2) parts:
   
   A. The Body – Cylinder Post
   
   B. The Thread – Inclined Plane wrapped around the cylinder.

4. When thinking about a Screw think about anything that has Threads.

5. If you look closely at the Screw, you'll see that the threads form a tiny “RAMP” that runs around the Screw from the tip to near the top.

6. The Pitch of a Screw is the Distance between two consecutive threads.

7. One function of the Screw is to Fasten Things – the Standard Screw or Nuts & Blots.

8. Drill Bits are a Screw used to make holes.

9. A Jackscrew is used to Lift heavy objects. Car Jack.

10. Airplane Propellers, Helicopter Blades, and Fan Blades are Screws that screw through the air.

11. Propellers on Boats Screw through the water.

12. Most every machine built requires the use of some form of Screw to Fasten it together.

13. Imagine you are driving a Screw into a Board. As you turn the Screw, the Threads seem to “PULL” the Screw into the wood. The Wood seems to “SLIDE” up the Inclined Plane. Actually, the Plane Slides through the wood.

THE WHEEL AND AXLE

http://www.sirinet.net/~jgjohnso/simple.html
12. What do you call the Force of Gravity on your Mass? WEIGH! Remember?

13. Two important factors dealing with force are: Mass and Distance, The Earth hold you because its mass is so large compared to yours, but you do not feel the gravity pull of your neighbor sitting next to you!

14. Force in the SI is measured in Newton and is part of the equation for Work! \( W = F \times d \).

THE LEVER

1. One of the earliest and simplest of machines, a large stick would work as a lever to move huge rocks.

2. The Lever is essentially a Rigid Bar that is free to turn about a Fixed Point called the Fulcrum.

3. Every Lever has three (3) parts:
   
   A. **Resistance Force or Load**, What you are trying to move or lift.
   
   B. **Effort Force** - The Work done on the Lever.
   
   C. **Fulcrum** – A fixed pivot point.

4. Levers are divided into Three Classes depending on the position of the Effort, Resistance, and Fulcrum. **FREE**.
2) There is usually a loss in Force, but a gain in Speed and Distance.

3) Samples of Third Class Levers – Broom, Shovel, Fishing Pole, Baseball Bat, and Tongs.

**INCLINED PLANE**

1. An INCLINE PLANE is a Sloping Surface used to lift heavy loads with relative little Effort. The Incline Plane does not MOVE.

2. A surface that is raised at one end.

3. An Inclined Plane provides for NOT Less Work but Less Effort. The trade off is Greater Distance to Travel.

4. Allows you to lift a weigh you normally couldn't lift to a Higher Level, Sample Barrows.

5. Increase the elevation of heavy objects without having to lift the object directly.

6. LIFTING A BARROW OR ROLLING A BARROW UP AN INCLINED PLANE

   A. LIFTING - The Force needed is equal to the weigh of the barrel multiplied by the height of the platform. 100 lb barrow up 5 m, force equals 100 lb x 5 m = 500 N.

   ![Diagram of inclined plane](http://www.sirinet.net/~jgjohnso/simple.html)
B. ROLLING – The Force equals weigh of barrel multiplied by the height of the platform, divided by the distance of the Inclined Plane 10 m, Force equals 100 lb x 5 m / 10m = 50 N.

7. Samples of Inclined Planes – Simple Ramp, Escalator, Stairs, Ship Plank, and Ladder.

**THE WEDGE**

1. A Wedge is a form of the Inclined Plane which is used to increase Force. With a Wedge, the material (log) remains in place while the Wedge moves through it.

2. A Wedge can be one sloping surface, a Single Incline Plane, like a doorstop. Or two sloping surfaces, a Double Incline Plane, like the Wedge used to split wood for the fireplace.

3. Wedges can be forced between two things to hold them tightly together, like nails or a doorstop.

4. When sharpened the Wedge becomes either a knife or an ax blade. The tip of a Screwdriver (other than Philips) is a simple Wedge.

5. Wedges can be used to split, cut or fasten.


**THE SCREW**

http://www.sirinet.net/~jgjohnso/simple.html
# Simple Machines in the Library

<table>
<thead>
<tr>
<th>Simple Machines</th>
<th>Find and Record</th>
<th>Find and Record</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHEELS</strong></td>
<td>at least 2 different types of wheels.</td>
<td>one wedge.</td>
</tr>
<tr>
<td><strong>LEVERS</strong></td>
<td>at least 2 different types of levers.</td>
<td>one example of a lever.</td>
</tr>
<tr>
<td><strong>INCLINED PLANE</strong></td>
<td>one example of an inclined plane.</td>
<td>one type of screw.</td>
</tr>
<tr>
<td><strong>GEARS</strong></td>
<td>one example of gears.</td>
<td>Which is YOUR favorite Simple Machine?</td>
</tr>
</tbody>
</table>

**Printable sheet**

Ride the bus back to the Simple Machines page

http://www.mikids.com/Smachines1.htm
End of the Unit Optional Activities:

At the end of these 5 lessons, an at home project may be sent home with students. Students can create their own simple machines with any materials from home. Students can get really creative with recycled materials and old unwanted materials. Teacher may wish to give students 2-3 weeks to complete and students may bring in their finished products. A short report can be written and typed up about their project, what materials they used, and how this simple machine is useful. The report and simple machine can be displayed for all to see.

Every Fall, the Durham Fair is held and this is a great field trip to take. This a nice place to see real simple machines up close and personal. Enclosed is a worksheet (color coded orange) that students may use to record the simple machines they found. Discussion can take place upon arrival at school (if there is time) or the next day about their observations.
Checklists
FLA 518: TAT Sheltered ELL Strategies Checklist

Write the PAGE NUMBERS and any other identifying features to identify those parts of your lessons that employ the following strategies.

<table>
<thead>
<tr>
<th>I. Contextualize Lesson</th>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
<th>Lesson 4</th>
<th>Lesson 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.1.a Visuals (Realia, Manipulatives, Gestures)</td>
<td>19,20</td>
<td>25,26</td>
<td>31,46</td>
<td>30,58</td>
<td>75-82</td>
</tr>
<tr>
<td>I.1.b Model (Instructions, Processes)</td>
<td>10,11</td>
<td>25,26</td>
<td>35,36</td>
<td>48,49</td>
<td>63,64</td>
</tr>
<tr>
<td>I. 2. Activate Background Knowledge</td>
<td>10,11</td>
<td>25,26</td>
<td>35,36</td>
<td>48,49</td>
<td>63,64</td>
</tr>
<tr>
<td>II. Make Text Comprehensible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II.1. Graphic Organizers</td>
<td>19,20</td>
<td>38</td>
<td>51,52</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>II.2. Develop Vocabulary</td>
<td>10,11</td>
<td>25,26</td>
<td>35,36</td>
<td>48,49</td>
<td>63,64</td>
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<tr>
<td>II. 3. Simplify Written Text</td>
<td>15</td>
<td></td>
<td>48,49</td>
<td></td>
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<tr>
<td>III. Make Talk Comprehensible</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>III.1. Graphic Organizers; Listening Guides (checklists, etc.)</td>
<td>19</td>
<td>25,26</td>
<td>35,46</td>
<td>51,52,58</td>
<td>63</td>
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<td>63,64</td>
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Original Lessons
Chapter 7
Forces and Work

Time Allotment: Allow four 30-minute science periods to complete this chapter.

Introduction

TEACHING TIPS
Using the Photograph
Inform students that the force in the grader is the result of burning fuel. The hot gases from the burning fuel push the parts of the engine. The turning engine parts cause the wheels to turn. Then the grader can push the dirt.

Research
Have interested students find how an internal combustion engine converts chemical energy in the fuel to mechanical energy.

Classroom Management
The Individual Student Assessment master on page 103 of the Teacher Resource Book provides an organized method for recording individual student progress.

Readiness Master
Have students complete the Readiness master on page 101 of the Teacher Resource Book.

CHAPTER BACKGROUND
- The force with which Earth attracts an object depends on the object's mass. Therefore, the force needed to lift an object depends on its mass. The greater the mass, the greater the force of attraction, and therefore the greater the force needed to overcome that attraction.
- Whenever a force is applied to move an object across the surface of another object, a force of friction opposes the applied force. In order for motion to occur, the applied force must be large enough to overcome the force of friction. Lubricants and smooth surfaces are used to reduce friction.
- Energy is the ability to do work. Therefore, energy is the ability to exert a force to move

LESSON PLAN

LESSON OPTIONS

STUDENT ASSESSMENT

Chapter 7

1. Accept all reasonable answers. Students should realize that it

Chapter 7
uses force when its wheels push against the ground.

We use forces every day. Force is used to lift a bag of groceries or to walk from one place to another. Machines also use force when they do work. This machine is called a grader. It pushes soil to make a smooth surface for a new road. How else is it using force when it does work?
Lesson 7: Force

Lesson Objectives
Students should be able to
1. define force.
2. estimate the relative amounts of force required to move various objects.
3. explain that the force needed to move an object depends on the object's mass.

Lesson Vocabulary
force

2 Developing the Lesson

MOTIVATION
Reenact the motions shown in the photographs on this page. Initiate a discussion on motion. Emphasize that without a push or a pull there can be no motion.

TEACHING TIPS
- Explain and demonstrate the definition of force as any push or pull.
- Have students lift both heavy and light objects. Ask them to characterize the objects as being light or heavy and compare the force needed to move the objects. Be sure each uses the word "force" correctly in the comparison.

REINFORCEMENT
Review the major ideas of this unit by discussing forces in the classroom. Ask, what kind of forces do you use to move objects in the classroom?

CURRICULUM INTEGRATION
Health: Safety
Discuss the safe way to move or lift objects. Tell students to always bend their legs so that the leg muscles can assist the more fragile back muscles when lifting an object. Improper lifting is the main cause of back injury. A major source of chronic pain suffered by people. Students should make safety posters showing the correct methods of lifting.

LESSON BACKGROUND
- Any push or pull is a force. While force is required to move an object, a force does not always produce motion. Only an unbalanced force on an object produces motion. An unbalanced force on an object is one that is greater than the force that opposes motion. When a small child pushes on a large refrigerator, the force from the child may never exceed the force of friction from the floor on the refrigerator. Consequently, the refrigerator does not move.
- In this chapter, the word move refers to starting an object in motion, i.e., accelerating the object, or moving an object against the force of friction. A force is not needed to keep an object at constant velocity (coasting) in a frictionless, gravity-free environment such as empty space. Students are not likely to have had this experience.

ENGE

Three pennies on a smooth surface.

B

C

Students to move penny C to a between A and B without moving or touching penny A. After students must solve this puzzle, demonstrate by using a finger to press down B slide penny C toward B. Release it hits the edge of B. The Penny will be transmitted through which will scoot to the left. Penny C be easily placed between pennies A
Gravity and Friction

Preparing the Lesson

Lesson Objectives
Students should be able to
1. define gravity.
2. give examples of effects of gravity.
3. define friction.
4. give examples of effects of friction.

Lesson Vocabulary
gravity  friction

2 Developing the Lesson

MOTIVATION
Have one student throw a ball straight up in the air. Release a roller skate at the top of a ramp made from a board and some books. Pour some water from a pitcher into a glass. Tell students that the same force acted on the objects. Have students suggest what that force might be.

TEACHING TIPS
- Students may wonder why the gravitational attraction between all objects does not seem evident. Explain that at least one of the objects must be very large, such as Earth, before the attraction is very large. However, the attraction is there, even between small objects.
- If students carried out Activity 7-1, ask them to explain, using the word gravity, what the Puller Pal measured. It measured the force of gravity between Earth and the object.

LESSON BACKGROUND
- Gravity is a property of all matter that causes it to attract all other matter. The amount of attraction between two objects depends on the masses of both objects and the distance between them. It is important to remember that gravity is a mutual attraction. A person exerts a force on Earth equal to the force Earth exerts on the person. However, because Earth is much more massive, we do not see the effects of this force on Earth. For example, Earth is not "pushed away" when we jump from its surface.
- Friction is the force that resists motion when two objects in contact. Friction results from the nature of the surfaces as well as the force pressing them together. Friction causes objects in motion to slow down and eventually stop. Friction also causes heat and the wearing away of the surfaces in contact.

LESSON GOALS
In this lesson you will learn
- there is a pulling force between objects.
- friction slows moving objects.
- physical properties affect friction.

Earth pulls on objects. This pull brings you back to Earth when you jump into the air. The attraction or pulling force between objects is called gravity (GRAV u thee).
Gravity is a property of all matter. Gravity causes the rain to fall, too.
The pull of gravity is greatest when two objects are close together. The pulling force on each object gets less, however, as the two objects get farther apart. Think of the pulling force between two magnets. The pull is great just before the magnets touch. What happens to the pull on each magnet when the magnets get farther apart?

1. The pull on each magnet becomes less.

ENRICHMENT
Students may be interested in finding out how, if gravity causes rain to fall, the rain got into the sky in the first place.

CHALLENGE
Have students investigate a simple pendulum. One can be made by attaching a heavy object, such as a bolt, to one end of a heavy string. Tie, and then tape, the other end of the string to a ruler. Lay the ruler on a surface that is more than one meter high and hold in place with several heavy books so that the pendulum can swing freely. Ask students how to start the pendulum and to describe what force causes it to work. Using a stopwatch, time ten free swings; divide by ten to determine the time used for one swing. Allow students to measure and adjust the string's length to get a swing one second long (about one meter). Ask students to describe what happens as the string's length is increased or decreased. Have them begin the pendulum's swing at different heights to discover what effect this has. Study the effect of changing the mass of the object while keeping the length the same. Have students predict the result first.

CURRICULUM INTEGRATION
Language Arts: Creative Writing
Have half of the students write a story about a school without gravity. Have the other students write about a school where the gravity is ten times the gravity of Earth.
Super Skyscrapers

Steel-reinforced concrete might also be used to make super skyscrapers strong, but flexible. This type of concrete is made by letting concrete harden around steel rods. It permits some bending or flexing. Skyscrapers must bend or flex with the wind. If the building is too rigid, it could crack.

Taller and taller buildings are likely to be built. The force of wind against them will be strong. Holding them steady against this force will be an increasing challenge.

Teaching Suggestions

► Explain that very tall buildings are constructed in cities because land is limited.
► Tell students that steel has made it possible to build very tall buildings. Show a photograph of a skyscraper under construction. These buildings are more flexible than buildings made only of brick and concrete.
► A very tall skyscraper is built to move or sway toward the top.
► Ask students who have been to the top of a very tall building to describe their experience.

Feature Vocabulary

super skyscraper

FEATURE BACKGROUND

► The World Trade Center and the Sears Tower sway three to four feet, a movement that is unnoticed by the occupants.
► At roof line, the World Trade Center is 411 m and the Empire State Building is 381 m.
Lesson 7.3

Pages 126–129

Work and Energy

1 Preparing the Lesson

Lesson Objectives
Students should be able to
1. operationally define work.
2. determine when work is done.
3. define energy.

Lesson Vocabulary
work energy

2 Developing the Lesson

MOTIVATION
If your school has seesaws, take your class outside after they have read the first paragraph of the lesson. Have groups of students demonstrate how to use the equipment. Remind them of safety. Ask students to note and remember instances in which they see work being done. When you return to the classroom, list and discuss these instances.

TEACHING TIPS
Problem Solving: Ask students to think of ways the workers in Figure 7–9 could be doing different amounts of work while stacking bricks the same height. Students should first review the discussion of work carefully. They should conclude that more work will be done if one worker’s bricks are heavier (require more force to lift).

LESSON BACKGROUND
- In a scientific sense, work is done only when a force causes an object to move. A person pulling on a rope tied to a tree does no work on the tree unless the tree is moved.
- The amount of work done is determined by both the force exerted and the distance the object is moved in the direction of the force. If you carry a stack of books across a room you may exert a large upward force to support the books. However, besides the distance moved, the work done depends only upon the small horizontal force needed to push the books forward through the air as you carry them. When you raise the books, the work done then depends on the upward force needed to lift the books.

LESSON GOALS
In this lesson you will learn
- work is done when a force moves an object.
- energy is used when work is done.
- there are different sources of energy.

 Forces cause objects to move. Scientists say that work is done when a force moves an object. Where is work being done in Figure 7–8? How do you know?

To find the amount of work done or object you need to know two things. You must know how much force is needed to move the object. You must also know how far the object is moved. More work is done if a wagon pulled uphill ten meters than if it is pulled five meters up the same hill.

Look at Figure 7–9. The workers are stacking bricks. The bricks move. They move because the workers use a force. Which worker is doing more work?

REINFORCEMENT
Have students conduct a survey of work done at home and the force needed to do the work. Students should also note the motion caused by the force.

HELPFUL HINTS
See Curriculum Integration on page T117c.

ENRICHMENT
Have students attach one small object to a Puller Pal. Lift the object ten centimeters off the table and measure the amount of force used. Attach a second object and lift it five centimeters off the table. Record the used. Ask the students which time more work was done. Students should answer that both objects moved the same distance but more work was done when more force was
Figure 7-10. Work is only done on the books when they are moved.

1. More work is not being done on the books because the books are not being moved.

Figure 7-11. Energy is used when work is done.

TEACHING TIPS

- Be sure students understand why no work is done in Figure 7-10. Ask students for other examples of situations in which forces are exerted but no work is done.
- Review and reinforce the relationship among force, work, and movement. Have students first push against an object they cannot move and then lift a small object. Ask them in which case more work was done. Have them lift an object a distance and then lift it a greater distance. Again ask them to compare the work done. Last, have students lift a light object and a heavy object the same distance and compare the work done.
- Paraphrase the definition of energy. If energy is the ability to do work, it is, therefore, the ability to move something by using a force. Have students look at each of the Figures in this chapter and try to find examples that illustrate energy. Ask them to explain their choices. In each case they should show how an object is being moved using a force. Guide them to use the words force, move, distance, and energy in their explanations.

- Challenge master, TRB-109
- Language Arts master, TRB-110
- Curriculum Integration, TRB-111

CHALLENGE

Name ____________________________

CHAPTER 7

THE FORCE OF WATER

Materials: plastic 2-liter bottle, water, nail, mixing tape, pencil, and paper

What to do:
1. Remove the label from the bottle.
2. Have your teacher use the nail to punch 2 holes in the bottle. One hole should be 10 cm from the bottom of the bottle. The other hole should be 20 cm from the bottom of the bottle. The holes should be in a straight line.
3. Place a strip of masking tape over the holes.
4. Fill the bottle with water.
5. Place the bottle in a sink.
6. Gently remove the tape. Watch the stream of water.

What did you learn?
1. What stream of water shoots better out of the bottle?
2. Why do you think this stream shoots out farther?

LANGUAGE ARTS

Chapter 7

Name ____________

OBSERVING AND RECORDING

A

B

A push or pull is a force. A force is needed to move objects. Work is done when a force moves an object.

1. Look at picture A. Is the boy doing work on the bricks?
2. Look at picture B. Is the boy doing work in this picture?

Explain why or why not.

CURRICULUM INTEGRATION

Chapter 7

Name ____________

LEARNING ABOUT ENERGY

Decode the messages below. Above each blank is a pair of numbers. The first number matches a number along the left side of the grid. The second number matches a number along the top of the grid. Below your fingers along the row and down the column until you meet. For example, the pair 23 matches the letter I. Put the letters you find in the blanks to decode the messages.


A B C D E F
2 1 3 4 5 6
G H I J K L
M N O P Q R
S T U V W X
Y Z

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Teacher Resource Book Page 110
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Forces and Work 127
Chapter 8

Simple and Compound Machines

There are many different kinds of machines. Some machines have few moving parts. Other machines have many moving parts. This machine was used to peel apples. The apple was placed on the spike and the blade moved around the apple to peel it. How many movable parts do you see on the machine?

There are many different kinds of machines. Some machines have few moving parts. Other machines have many moving parts. This machine was used to peel apples. The apple was placed on the spike and the blade moved around the apple to peel it. How many movable parts do you see on the machine?
On GOALS

This lesson you will learn:

1. Simple machines are important.
2. All levers are the same.

Imagine that you need to move a barrel that is too heavy. A friend says to place one end of a long board under the barrel and rest the board on a log. Now, when you down on the other end of the board, the barrel moves. The board and log were as a type of machine.

People can use many kinds of machines to do work with few or no moving parts called a simple machine. Simple machines can be used to make work easier. They can change the amount of force needed to do work. Simple machines can change the direction of the force. However, they do not decrease the amount of work that is done. Figure 8-1 shows the kinds of simple machines.

Machines cannot reduce the total amount of work that is done. When a lever reduces the force needed to lift an object, the force must be exerted over a longer distance.

Lesson Objectives

- Students should be able to:
  1. recognize the need and purpose of simple machines.
  2. define simple machines.
  3. identify the load, fulcrum, and force of a lever system.
  4. infer the effect of changing the position of a lever's fulcrum.

Lesson Vocabulary

- Simple machine
- Load
- Lever
- Fulcrum

MOTIVATION

Have students brainstorm to list as many different machines as they can. List the machines on the chalkboard and have students tell what work is done by each machine. Point out to students that objects do not have to be complex to be classified as a machine. Many simple tools and other objects are also machines.

TEACHING TIPS

- Have students name each simple machine in Figure 8-1.
- Emphasize here and throughout the chapter that machines do not reduce the amount of work.
- Teaching Master, TRB-124

REINFORCEMENT

Refer to Figure 8-1. Ask students how they could use each simple machine in the drawing. The wheel and axle could be used to steer a truck or automobile. The wedge acts as a doorstop by exerting an upward force on the door. The pulley set (block and tackle) could be used to pull or lift heavy objects. The lever might be used to lift the rock. The ramp is used to move objects to a higher or lower level. The screw is used as a jack to lift the corner of a house.

HELPFUL HINTS

See Mainstreaming on page T131c.

LESSON BACKGROUND

- A machine is any device that helps us do work. Some machines increase the applied force. Sometimes machines are used only to change the direction of the applied force. Thus we can lift an object more conveniently by using a downward push or pull. Another use of a machine is to increase the speed or range of movement.
- Machines never decrease the amount of work that must be done, but rather make it easier by spreading it over a longer distance or time, or by making it more convenient in some way.
- The fulcrum, load, and applied force of levers may be in any arrangement. If the distance from the fulcrum to the force is greater than the distance from the fulcrum to the load, the lever increases applied force.
Activity Process Skills: Observing/Measuring

Levers

How much push does it take?

Materials
- 3 pencils
- 15 small ball of clay
- 1 box
- masking tape
- 1 roll
- 5-8 metal washers
- 25-40 metric ruler
- 5 pencil and paper

What to do
1. Tape the pencils together as shown. Put them under the middle of the ruler.
2. Put the clay at one end of the ruler.
3. Add washers one at a time to the other end of the ruler until the ball of clay is lifted.
4. Record how many washers it took to lift the ball of clay.

What did you learn?
1. What simple machine did you make?
2. What was the force?
3. What was the load?
4. How many washers lifted the load?

Using what you learned
1. What happens to the force needed if you move the pencils? How can you find out?
2. Where do you put the pencils to use the smallest force? The largest force?

ACTIVITY CLOSURE
Discuss the questions. Relate the activity to everyday levers with which students may be familiar—seesaws, pry bars, bottle openers, shovels, and so on.

ACTIVITY LESSON PLAN

Levers

Objectives
- Be able to construct and demonstrate a simple lever.
- Understand how the placement of the fulcrum affects the force needed to lift a load.

Preparation
- Wooden rulers work well as levers. Plastic rulers tend to bend too much to be effective. Alternatively, use wooden lattice purchased at local lumber stores. Large washers may be purchased in bulk at hardware stores.
- You may want to have one student prepare clay prior to the activity.

Introduction
- Complete the apparatus for student use. Compare the activity to a playground extension: Allow 30 minutes to complete.

ACTIVITY WORKSHEET
- Name ________
- Activity: Lever
- Question: How much push does it take?
- Observations and Data:
  1. What simple machine did you make?
  2. What was the force?
  3. What was the load?
  4. How many washers lifted the load?

What did you learn?
1. What simple machine did you make?
2. What was the force?
3. What was the load?
4. How many washers lifted the load?

Using what you learned
1. What happens to the force needed if you move the pencils? How can you find out?
2. Where do you put the pencils to use the smallest force? The largest force?

Teacher Resource Book Page 121
Lever

The man in Figure 8-2 is lifting an object. In Figure 8-2(b) he is using a lever. A lever is a simple machine that is used to move objects.

All levers have three parts. The object to be moved by the lever is called the **load**. The point where the lever rocks back and forth is called the **fulcrum** (FUL krum). The push or pull that moves the lever is the **force**. Find the load, fulcrum, and force in Figure 8-2(b).

Levers can be used to change the direction of the force needed to lift an object. Think about a seesaw. When you push down on one end, the person on the other end goes up.

![Image of a man lifting an object using a lever]

**Figure 8-2.** Moving an object by hand (a) takes more force than using a lever (b).

1. Load is large log, fulcrum is small log, force is force applied by the man.

**CHECKING FOR UNDERSTANDING**

Construct a simple lever as in Activity 8-1. Demonstrate its use in lifting an object. Name the parts of the lever and have students name each part of the lever and the whole. If students have trouble completing the assignment, go to the Reteaching Alternative.

**Reteaching Alternative**

Discuss with students any situation in which they have used a lever. If students cannot name the parts of a lever, display a bottle of closed caps and ask students to use the tool as a lever.

**HELPFUL HINTS**

See Gifted on page T131c.
TEACHING TIPS

- If possible, use a playground seesaw that has provision for altering the position of the fulcrum to demonstrate Figure 8-3. Let students predict how changing the position affects the force needed. Remind students to be careful when moving the fulcrum. Fingers or hands may be easily pinched.

- **Problem Solving:** Construct a simple lever like those used in Activity 8-1 (or larger if possible). Arrange it so that a Puller Pal may be hooked to one end to provide a downward force. The Puller Pal will be used upside down. Use a load large enough to cause the Puller Pal to stretch when the fulcrum is in the center of the lever. Tape the load in place. Display this setup to students and ask them to predict, on the basis of what they have learned, how the reading on the Puller Pal will change as the fulcrum is moved toward and away from the load. Proceed to vary the fulcrum's position so students can see if their predictions were correct. If possible, set up a station where students can try this experiment for themselves. An advantage of this approach is that students can actually feel the force increase and decrease as the fulcrum is moved back and forth.

- Problem Solving master, TRB-125
- Language Arts master, TRB-127

Figure 8-3. The force needed to lift a load depends on the position of the fulcrum.

Levers can also be used to change the amount of force. Think about the seesaw again. The girl in Figure 8-3(a) wants to play on the seesaw with her older sister. She cannot lift her older sister if the fulcrum is in the middle. If the fulcrum is moved closer to her sister, as in Figure 8-3(b), she is able to lift her sister. Look at Figure 8-3(c). Her younger brother wants to ride on the seesaw. She is now the heavier one. Therefore, she must move the fulcrum closer to herself. The amount of force needed to lift a load depends on where the fulcrum is. The closer the fulcrum is to the load, the less force needed to lift the load.

LESSON OPTIONS

**ENRICHMENT**

Make a bulletin board showing many kinds of levers. You may want to label them: First Class Levers, Second Class Levers, and Third Class Levers. Have students identify the fulcrum, load, and force on each lever.

**CHALLENGE**

Have interested students investigate how the distance the lever must be moved varies with the force required to move a given load.

**CURRICULUM INTEGRATION**

Health: Skeletal System

Have students research and report on and why the arm and leg of a human are considered to be levers.
The three parts of a lever

1. Fulcrum of lever is part of luggage cart just above wheels.
2. Force is applied by woman. Load is luggage.
3. Machine is a lever because it changes direction and amount of force needed to lift the load.

Summary

Machines can be used to change the direction of force needed to do work or change the direction of a force. A simple machine is one that is used to change the direction of force. The position of the fulcrum is not the same for all levers.

Review

Lesson to answer these questions:
1. Are the three parts of a lever? Does a lever do?

3 Evaluating the Lesson

Have students find references in the lesson that support their answers to the Lesson Review questions.

Lesson Review Answers

1. A simple machine is a machine with few or no moving parts.
2. Force, load, and fulcrum
3. Changes the direction or amount of force

Teaching Tips

- Point out that the load, force, and fulcrum are not in the same position on all levers. Have students point to the force, load, and fulcrum in Figures 8-4 and 8-5. Ask them to explain how these levers are different from those described earlier in the lesson.
- If most students are familiar with wheelbarrows and how they are used, ask them to draw a wheelbarrow and label the load, force, and fulcrum.
- Another kind of lever has the fulcrum at one end and the load at the other. The effort force is exerted between the two. An ordinary household broom is an example of this type of lever. You may want to demonstrate a broom and challenge students to identify the fulcrum, force, and load and to tell what is gained by using this type of lever. A short, slow movement of the force (the hand) produces a long, faster motion of the load (the friction of the broom against the floor).
Lesson 8.2

Inclined Plane, Wedge, and Screw

1 Preparing the Lesson

Lesson Objectives
Students should be able to
1. define inclined plane.
2. infer how inclined planes make work easier.
3. compare the similarities and differences among inclined planes, wedges, and screws.

Lesson Vocabulary
inclined plane screw wedge

2 Developing the Lesson

MOTIVATION
Display various examples of inclined planes, wedges, and screws. Have the students choose two examples and draw pictures showing how each can be used.

TEACHING TIPS
- Explain the definition of inclined plane. Have students list where they have seen or used inclined planes. Discuss how each inclined plane makes work easier.
- Avoid using stairs as an example of an inclined plane. They are an inclined plane only when being used as a ramp, such as when a large piece of furniture is being moved. A wheelchair ramp is a better example of an inclined plane.

LESSON GOALS
In this lesson you will learn
- an inclined plane is a simple machine used to move objects.
- a wedge has two important uses.
- a screw is a type of inclined plane.

Assuming that the boy and girl have the same mass, they do the same amount of work.

Figure 8-6. More force is needed on the steeper path.

An inclined plane is a simple machine used to move objects to a higher or lower place. A ramp and a path going up a hill are examples of inclined planes. In Figure 8-6 both children want to go to the top of the hill. The girl on the steeper path uses more force to get to the top. The boy goes a longer distance and uses less force to get to the top. The longer the distance moved on an inclined plane, the less force needed.

CURRICULUM INTEGRATION
Math: Measuring
Have students carefully measure the steepness of steps and stairs in your school or at home. For those who are skilled at arithmetic, the steepness is usually expressed in terms of the rise divided by the run or slope.

Lesson #5
More Simple Machines
A **wedge** (WEJ) is a simple machine made of two inclined planes. Knife blades, chisels, pins, and the blade of a hatchet or axe are all examples of wedges. Work is done when the wedge presses against two objects.

Sometimes a wedge is used to raise objects a short distance. A heavy object such as a stove might be raised over a crack in a floor by using a wedge. Other times a wedge is used to push objects apart. Logs are split by using axes and hatchets. The-blade of the hatchet or axe is forced into the log. It pushes the pieces of log apart. How can you use each wedge shown in Figure 8-7?

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**ENRICHMENT**

Ask students to discover which holds better, a nail or a screw. They can do this with a heavy piece of corrugated cardboard, a nail, and a screw. Turn the screw through the cardboard. Push the nail through the cardboard. Allow the head of each to extend about 5 mm. Leave a small gap between two desks, and ask one student to hold the cardboard in place so that the ends of the nail and screw are in the gap. Have another student try to pull out first the screw and then the nail. Have the student compare the amount of force needed to remove the nail with that of the screw.

**CHALLENGE**

Have students explain why less force is needed to peel an apple or potato with a sharp knife than with a dull one.
needed to raise an object with plane depends on the distance. The farther distance is covered when plane is wrapped around a post. It can be done by cutting an inclined plane. When this paper is rolled around a cardboard tube the object is a screw. A screw is an inclined plane wrapped around a post. Each turn makes a complete turn it does a certain distance along the distance depends on the amount when each overlap of the thread on the post. Screws, drill bits, bolts are commonly found in the use of the screw. The force needed to turn a screw is less than that needed to turn a nail of equal size. A longer distance is covered when you turn a screw around a post, less force is needed.

Summary

A plane is a simple machine used to raise objects to higher or lower places. Inclined plane is a simple machine used to raise objects to push them apart.

TEACHING TIPS

- If possible, exhibit devices that use screws. Possibilities include an automobile screw jack, vise, food grinder, drill bits, as well as ordinary screws and bolts.
- CAUTION: Do not allow students to operate food grinder or any other device that could cause injury. Keep crank-operated devices on hand to use as examples of the wheel and axle.
- Compare a screw to a wedge and an inclined plane. Turning a screw causes a load to move the length of the screw by moving gradually along its slope. With a screw jack, the load is the car. In a food grinder, the load is the force of the food against the end plate.
- Have students wrap a string along the threads of a large screw or bolt, then unwind the string to see how far the load must travel in order to move the length of the bolt or screw.

3 Evaluating the Lesson

Have students find references in the lesson that support their answers to the Lesson Review questions.

LESSON REVIEW ANSWERS

1. Answers may include a loading ramp, a path on a hill, a wheelchair ramp, and a playground slide.
2. A longer distance is covered when you turn the screw than when you pound the nail.

Figure 8-8. A screw is an inclined plane wrapped around a post.

ARTS: Reading


Lesson #5

Continue with other Simple Machines

Intro to Compound Machines
Lesson Objectives
Students should be able to
1. define wheel and axle.
2. infer the relationship between the size of the wheel and magnitude of the force.
3. define pulley.
4. give examples of how pulleys are used.

Lesson Vocabulary
wheel and axle pulley

2 Developing the Lesson

MOTIVATION
Have students examine Figure 8–9 and tell why they think the knob is useful and how it qualifies as a simple machine.

TEACHING TIPS
- Many students may not know that a doorknob is a wheel and axle. Turning the latch with the knob requires less force than turning only the smaller axle.
- Use Figure 8–10 to emphasize that the distance around the wheel is far greater than the distance around the axle. A small force applied at the edge of the large wheel can move a large load at the smaller axle.
- Not all wheels are examples of a wheel and axle. They qualify only if a force is applied to the wheel in order to turn the axle or vice versa.

LESSON BACKGROUND
- The wheel and axle is actually a lever that can turn continuously. Normally, the applied force acts along the edge of the wheel and the load is at the edge of the axle. Thus, the force is applied at a greater distance from the fulcrum than the load. Therefore, the force applied to the wheel results in a larger force at the axle.
- A winch is an example of a wheel and axle. A long crank (the wheel) is turned through a long distance in order to wind up a rope or cable on the much smaller axle. The winch is not presented because it would be unfamiliar to many students at this level.
- Pulleys are also variations of the lever but are not wheels and axles. A single fixed pulley serves as an excellent example of changing the direction of a force.

REINFORCEMENT
Have students make a list of as many devices as they can that use wheel and axles. Compare the size of the wheels of each.

ENRICHMENT
Some students may be interested in how cranks qualify as wheel and axle. A winch is a wheel and axle. A wheel and axle is a simple machine with a wheel turns a post. The post is called an axle. Wheels and axles are commonly seen in cars, trains, trucks, and bicycles. The on some fruit presses, which crush fruit also a wheel and axle. Compare the sizes of the wheels in Figure 8–10. The distance around wheel is greater than the distance are the axle. Therefore, less force is needed to turn the wheel than to turn the axle. 2. Because the doorknob turns the narrow
pulley

A pulley is a simple machine that changes direction or amount of a force. A pulley is a wheel on a post with a rope around the wheel. A pulley may be fixed or movable. A fixed pulley is shown in Figure 8-11. It can make work easier to do by changing the direction of a force. This type of pulley is used to raise a flag on a flagpole. You pull down on the rope. As you pull down, the flag moves up the pole.

A movable pulley is shown in Figure 8-12. It is helpful in a different way. Using it can decrease the force needed to lift a load. The force can be reduced by one-half if one movable pulley is used to lift the load.

Figure 8-11. One fixed pulley can be used to change the direction of a force.

Figure 8-12. A movable pulley reduces the force needed to lift a load.

Figure 8-13. A fixed pulley can be used to raise a flag on a flagpole.
more pulleys joined together may be used to decrease the force needed to lift a heavy object. Each part of the rope that is round the pulleys supports a part of the weight being used to lift a heavy object. You would not be able to lift it without them. The pulleys decrease the force needed to lift the object.

Summary

A wheel and axle is a simple machine with a wheel that turns a post.

A lever is a simple machine that changes the speed or amount of force.

Lesson Review

Use the lesson to answer these questions.

1. Does it easier to open a door with the doorknob than with the doorknob axle? Why?

2. What is the advantage of using several pulleys?

3 Evaluating the Lesson

Have students find references in the lesson that support their answers to the Lesson Review questions.

Lesson Review Answers

1. Less force is needed to turn the wheel than to turn the axle.

2. Using several pulleys decreases the amount of force needed to move a load.

Lesson Options

Enrichment

Take a walk around the neighborhood. Have the class list any places they see pulleys. Some possibilities may include flagpoles, tow trucks, construction cranes, and scaffolding for window washing or construction.

Challenge

Students may want to investigate how using two or more pulleys together can decrease the force needed to lift an object. They may want to rig a set of pulleys as shown in Figure 8-14.