Introduction
Title: Simple Machines

Grade: 6

Target Group: Sheltered Instruction


Goals: I want my student to know how to build and test simple machines.
I want my students to know how to use the scientific method when testing simple machines.
I want my students to know how to write a conclusion based on the results of testing simple machines.
I want my students to know how to use content specialized vocabulary when discussing and writing about simple machines.
Lesson 1
**SIMPLE MACHINES: Lesson One: Content and Language Objectives and Performance Indicator Goals**

**By:** Kristine Anderson  
**Grade:** 6  
**Class:** Science

<table>
<thead>
<tr>
<th>Content Objectives:</th>
<th>Language Objectives:</th>
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<tbody>
<tr>
<td>1. Students will find the amount of force (newtons) needed to lift at least four classroom items by lifting each item 0.7 of a meter with a spring scale in order to learn the relationship between force and work.</td>
<td>1a. In groups of four, students will discuss the questions about which items required the most/least force/work to demonstrate understanding of the relationship between force and work.</td>
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<td>2. Students will calculate the amount of work (joules) needed to lift at least four classroom objects by multiplying the number of newtons by 0.7.</td>
<td>1b. Individually, students will write complete sentences to answer the questions about which items required the most/least force/work to demonstrate understanding of the relationship between force and work.</td>
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<td>2. In groups of four, students will read and complete a table in writing using numbers.</td>
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<table>
<thead>
<tr>
<th>Domain/Topic</th>
<th>Fluent/Bridging Level 5</th>
<th>Expanding Fluency Level 4</th>
<th>Speech Emerging Level 3</th>
<th>Early Production Level 2</th>
<th>Preproduction Level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading and Writing</td>
<td></td>
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</tr>
<tr>
<td>Complete a table</td>
<td>In small groups, students will read, take turns leading a discussion, and complete a table with correct data as to how many newtons were required to lift a minimum of four classroom objects and calculate the amount of work.</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how many newtons were required to lift four classroom objects and use a calculator to calculate (if they don’t know how to do the calculations by hand) the amount of work using sentence starters to aid in their discussion.</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how many newtons were required to lift four classroom objects and use a calculator to calculate (if they don’t know how to do the calculations by hand) the amount of work using sentence starters and definitions with illustrations of the content vocabulary words to aid in their discussion.</td>
<td>In small groups, students will lift a book, pencil box, spiral notebook, and paperback novel and after listening to phrases, select the correct phrase out of a phrase bank telling the amount of newtons required.</td>
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<tr>
<td>Speaking and Listening</td>
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</tr>
<tr>
<td>Force and Work</td>
<td>In small groups, students will take turns leading a discussion about which classroom objects required the most/least force and work to lift.</td>
<td>In small groups, students will discuss which classroom objects required the most/least force and work to lift.</td>
<td>In small groups, students will discuss which classroom objects required the most/least force and work to lift using provided sentences to aide their discussion.</td>
<td>In small groups, students will discuss which objects required the most/least force and work to lift using sentences to aide their discussion and illustrations of specialized vocabulary, as well as, least and most.</td>
<td>In small groups, the students point to or name using a word bank with pictures the classroom objects that required the most/least force and work to lift.</td>
</tr>
<tr>
<td>Writing</td>
<td>The students independently will write complete sentences using the question to begin their answer and indicate which objects required the most/least force and work to lift.</td>
<td>The students will work as a group to rewrite questions to begin answers before finishing sentences independently indicating which objects required the most/least force and work to lift.</td>
<td>The students will independently complete sentences with sentences starters provided indicating which objects required the most/least force and work to lift.</td>
<td>The students will independently complete sentences with using sentence frames to indicate which objects required the most/least force and work to lift.</td>
<td>The student will match labeled illustrations with diagrams to indicate which objects required the most/least force and work to lift.</td>
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<tr>
<td>Function</td>
<td>Situation</td>
<td>Expression</td>
<td>Words/Phrases</td>
<td>Grammar</td>
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<tr>
<td>Predict</td>
<td>Students predict whether it will take more or less force to lift a brick than a math text book.</td>
<td>It will take _____ force to lift a _____ brick than a _____.</td>
<td>More less brick science notebook brick science notebook</td>
<td></td>
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<tr>
<td>Explain</td>
<td>How much force and work does it take to lift a classroom object?</td>
<td>To lift a _____ it takes _____ newtons took</td>
<td>book binder brick spiral notebook stapler hole puncher chart paper</td>
<td>noun</td>
<td></td>
</tr>
<tr>
<td>Explain</td>
<td>How do you find the amount of work it takes to lift a classroom object?</td>
<td>To find the amount of work (joules), multiply force times distance. It took the _____ _____ to lift a ____.</td>
<td>book binder brick spiral notebook stapler</td>
<td>adjective</td>
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</tr>
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<td></td>
<td>Which classroom object took the most/least force/work to lift?</td>
<td></td>
<td>force newtons work joules</td>
<td>noun</td>
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<td></td>
<td>book</td>
<td>noun</td>
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<tr>
<td>Explain</td>
<td><strong>What unit measures force?</strong></td>
<td>_____</td>
<td>newtons joules</td>
<td>noun</td>
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<td></td>
<td>What unit measures work?</td>
<td>measure _____</td>
<td>force joules</td>
<td>noun</td>
<td></td>
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<tr>
<td>Draw conclusions</td>
<td><strong>What is the relationship between force and work?</strong></td>
<td>The more _____ it takes</td>
<td>force newtons</td>
<td>noun</td>
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<td></td>
<td></td>
<td>to lift a(n) _____</td>
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<td>noun</td>
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<td></td>
<td>the more _____ it takes</td>
<td>work joules</td>
<td>noun</td>
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<tr>
<td>Draw conclusions</td>
<td><strong>What is the relationship between force and work?</strong></td>
<td>The less _____ it takes</td>
<td>force newtons</td>
<td>noun</td>
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<td></td>
<td></td>
<td>to lift an object,</td>
<td>book binder brick spiral notebook stapler hole puncher chart paper</td>
<td>noun</td>
<td></td>
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Simple Machines: Lesson 1
Page 4

Unit: Simple Machines
Lesson 1: Doing Work
By: Kristine Anderson
Grade: 6
Time: 60 Minutes

Materials for each pair: meterstick, spring scale, string, brick, various classroom objects

Materials for class: chart paper, markers, chart with spring scale scale, vocabulary words with picture for word wall (page 11).

Vocabulary: force, joule, newton, work (See page 11 for pictorial representations)

Classroom Organization: For this lesson, students will work in pairs and small groups. The pair is the person they are sitting next to and the small group is the two pairs sitting in the same group.

KEY:

Comic San Serif: from Original Lesson
Arial: new information to meet language needs of students
Bookman: Sheltered Strategy

5 minutes

Introduce the objective: We will investigate the relationship between force and work.

(I.B. Develop vocabulary, I.E. Create opportunities to negotiate meaning, IV.B. Practice instructional conversation) Write What is force? on chart paper. Ask students to stand up behind their chairs. Tell students to slide the chair under their desk. Turn and talk with group Ask: What force was used to move the chair? Ask students to move the chair out from underneath the desk. Turn and talk with group Ask: What force was used to move the chair out? Repeat, if needed until the students come up with push and pull. Quick whole class answering of questions.

(I.B. Develop vocabulary, VI.B. Model language for oral and written production) Answer What is force? on chart paper. Write Force is the push or pull of an object on the chart paper. Have students read out loud together: Force is the push or pull of an object.

(I.E. Create opportunities to negotiate meaning) Ask students to push in their chair making lots of noise. Turn and talk with group Ask: What did you do to make the noise? Expected answer: Push harder.
Ask students to pull out their chair quietly. Turn and talk with group Ask: **What did you do to move your chair quietly?** *Expected answer: Pull gently.* Quick whole class answering of questions.

**5 minutes**

(I.B. Develop vocabulary, VI.B. Model language for oral and written production) Add **newton** to the chart paper. Explain that force can be measured in newtons. Write: **A newton is the international unit of force.** Force is measured in newtons.

Newton measure how much or how little force is needed to push or pull an object. You used more force (write **MORE force** on the board), therefore, more newtons, when you made a lot of noise pushing in your chair. You used less force (write **LESS force** on the board), therefore less newtons, when you quietly pulled out your chair. Have student read out loud together: **Force is measured in newtons.**

(I.E. Create opportunities to negotiate meaning) Ask students to stand in front of a wall and apply force to the wall, push against it. Ask: **What’s the different between pushing the wall and pushing the chair?** *Expected answer: The wall did not move; the chair did.***

(I.B. Develop vocabulary, I.C Use extensive visuals, VI.B. Model language for oral and written production) Write **work** on the chart paper. Explain: **Work happened when pushing the chair because the chair moved a distance.** Work did not happen when pushing the wall because the wall did not move. *(Additionally, for Level 1 and 2’s see page 13 for a pictorial representation.)* **Work only occurs when an object moves a distance as a result of force.** If an object does not move, no matter how great the force is applied to it, no work is done. Write: **Work is accomplished when an object moves as a result of force put upon it.** On the chart paper. *(Additionally, for Level 1 and 2’s see page 12 for a pictorial representation.)* Have student read out loud together: **Work is accomplished when an object moves as a result of force put upon it.**

**5 minutes**

(I.B. Develop vocabulary) Write **joule** on the chart paper. Add: **Joule is the unit of measurement for work.** 1 joule of work = 1 newton of force to move an object 1 meter. **Work = force x distance or \( W = f \times d \).**

(III.E. Check for Understanding) Ask questions for choral answers: What is force? How is force measured? What is work? How is work measured?

(I.A. Build and activate background knowledge) Turn and talk ask: What tools are used for measuring? Quick whole class discussion: rulers, thermometers, cups, etc. Show the students a variety of measuring tools.
5 minutes

(I.B. Develop vocabulary, I.C. Use extensive realia) Pass out spring scales to pairs of students. Write: **Spring scales are used to measure force in newtons** on chart paper. (Additionally, post the sentence on page 15 with the key words highlighted for Level 1 and 2s.) Point out the newton scale on the left side of the spring scale. Introduce and show the indicator (the yellow line that moves when force is applied to the hook). Have student gently pull on hook to make the indicator move. Make sure that ALL students understand what the indicator is.

(I.D. Model) Model: Holding spring scale by ring on the top and using the indicator to read the scale. If the indicator is not exactly at 0 newtons, it must be “zeroed out” by turning the nut on the top to the left or the right. Have each student in the pair practice zeroing out the spring scale.

(I.C. Use extensive visuals, I.E. Create opportunities to negotiate meaning) Using a premade chart (A sample is on page 15. All spring scales are different and many have a different scale. Make a chart that shows the scale on the spring scales being used.) with the newton scale from the spring scale, explain and model reading the spring scale. The little lines between the numbers represent 0.2. Point to different places on the chart and ask the students how many newtons it represents. Have each pair hook their spiral science notebook to the spring scale and read the number of newtons.

5 minutes

(I.B. Develop vocabulary, I.C. Use extensive realia, I.E. Create opportunities to negotiate meaning) Pass out the meter sticks. Write **meter sticks measure distance** on the chart paper. **Students will lift each object the same distance.** Explain that we are going to lift object 0.7 of a meter. 0.7 meter is equal to 70 centimeters. Have students find the 70 centimeters mark on the meter stick.

(I.D. Model) Model: Place meter stick perpendicular to the floor with the 0 on the floor. Have a student put the science notebook on the floor next to the meter stick and then lift it to the 70 centimeter mark and then reading the spring scale.

(I.E. Create opportunities to negotiate meaning) Have pairs practice pulling their science notebooks 0.7 of a meter and noting the amount of force require to lift the object.

5 minutes

(V.A. Vary question techniques, II.V. Modify written text) Distribute Activity Sheet 1 (pages 8-10. Page 8 is for level 4 and 5. Page 9 is for level 3. Page 10 is for level 1 and 2). Review the table and column titles. **Have students write 0.7 in the distance column in each row.** Explain that each object they pull, they will have to pull 0.7 meters. On the board, model writing science notebook in the object column. Write 2.2 newtons in the force column. We will calculate the work later.
(I.E. Create opportunities to negotiate meaning) Have each student begin the first row.

(VI.C. Use group/pair work to elicit student talk, IV.B Practice instructional conversations) In the second row, write brick. Show the students a brick. Have students talk to their partner. Will more or less force be needed to pull the brick than the science notebook? Why or why not? (See functional language chart on page 2 and handout on page 17 for accommodations for levels 1-3).

(I.E. Create opportunities to negotiate meaning) Pass out a brick (with string tied around it) to each group. Have pairs pull the brick and record the number of newtons on Activity Sheet 1. (If students are ready, set them off to finish the activity. If not, model using another common object or two.)

5 minutes

(VI.C. Use group/pair work to elicit student talk, IV.B. Practice instructionalall conversations, I.C. Use extensive pictures) Brainstorm a list of classroom objects the students can use. Math text book, writing notebook, reading notebook, chart paper, stapler, masking tape, novel, etc. Put examples of each item on the ledge of the board and label the item above it. (Note: Students at Level 1 will use the Activity Sheet with the pictures of classroom objects to use.)

(I.D Model) Model how to use a loop of string to pull a text book without injuring the book. Pass out loops of string to each pair.

10 minutes

(IIIA. Pace teachers speech, VI.A. Challenge students to produce extended academic talk) Explain: Each pair will select a minimum of four additional classroom items and record the item and the amount of newtons it takes to pull the object a distance of 0.7 meters. If you use items from the ledge, please only take one and return it as soon as you are done. (See the Performance Indicator chart for specific modifications.)

VI.C. Students as researchers) Allow students to complete the activity. Walk around and monitor student behavior and help students as needed. Challenge students to use academic talk.

Students return to their seats and all materials are collected.

5 minutes

(IIIE. Check for understanding) Ask: How is work calculated? (Point to the chart paper, if needed.) Expected answer: Multiply the force times distance.

(I.D. Model) Model: Multiply 2.2 x 0.7 for the science notebook. While doing the work on the board, review each step. Remind student where to put the decimal point in the product. Model a second time using the brick. Have students tell the teacher what to do. (Give calculator support if students need).
(VI.C. Use pair work to elicit student talk) Students work with their partner and calculate the amount of work in joules required to pull an object. If necessary, students can check their calculations using calculators.

10 minutes

(VI.C. Use pair work to elicit student talk) With your partner, discuss: Which object required the most force to lift? Which object required the least force to lift? Which object required the most work to lift? Which object required the least work to lift?

(IV.A. Use teacher question and response strategies, VI.B. Model language for oral and written production) Review the answers to those questions as a whole class. Model and practice answering questions in complete sentences.

Students write answers to the questions in complete sentences.

(III.C. Use of word walls) Afterwards: make sure chart remains available each during for the rest of the Simple Machines Unit. Add key vocabulary words to illustrated science word wall.
### DOING WORK

<table>
<thead>
<tr>
<th>Object tested</th>
<th>Force (newtons)</th>
<th>distance (meters)</th>
<th>Work (joules)</th>
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</table>

1. Which object required the most force to lift?

2. Which object required the least force to lift?

3. Which object required the most work to lift?

4. Which object required the least work to lift?
**DOING WORK**

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1. Which object required the most force to lift?

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2. Which object required the least force to lift?

______________________________ required the least force to lift.

3. Which object required the most work to lift?

______________________________ required the most work to lift.

4. Which object required the least work to lift?

______________________________ required the least work to lift.
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<th>distance (meters)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>science notebook</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>brick</td>
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<td></td>
<td></td>
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<tr>
<td>text book</td>
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<td></td>
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<tr>
<td>pencil box</td>
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<td></td>
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<tr>
<td>novel</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>masking tape</td>
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</tbody>
</table>

1. Which object required the most force to lift?

   _______________ required the most force to lift.

2. Which object required the least force to lift?

   _______________ required the least force to lift.

3. Which object required the most work to lift?

   _______________ required the most work to lift.

4. Which object required the least work to lift?

   _______________ required the least work to lift.
VOCABULARY

force

newton

work

joules

spring scale
The chair moved a distance.
The wall did not move.
newtons
are used to
measure force
Spring scales
Hanger

Pointer

Scale calibrated in Newton

Spring pulled down by object

Object
<table>
<thead>
<tr>
<th>It will take _____</th>
<th>More less</th>
</tr>
</thead>
<tbody>
<tr>
<td>force to lift a _____</td>
<td>brick science notebook</td>
</tr>
<tr>
<td>than a _____.</td>
<td>brick science notebook</td>
</tr>
</tbody>
</table>

more +
less -

brick
science notebook
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Narrative

Sheltered Instruction:

Instead of having one student push and pull out a chair and push on the wall, I will have all students participate. This is using realia in order for the students to understand force. Additionally, I will show students a variety of measuring tools, so they understand that using a spring scale is one type of measuring tool.

I also amplified the main concepts. Each concept is reviewed more than once: modeled, written on chart paper, read by students, and applied by students. Finally, students answer questions to show understanding.

Instead of writing vocabulary and definitions on the board as in the original lesson, I will do all the writing on chart paper. That chart will remain available to all students for the entire unit.

Activity Sheet 1 has been modified for three different language levels. Students at level 4 and 5 will do the original work sheet. Students at levels 2 and 3 will use the work sheet with sentences starter and students at level one will use the worksheet with pictures and model sentences.

Adjusting discourse:

I slowed down the pace of the lesson, so I can talk more slowly and review the ideas more than once. Instead of just telling the students, I will model and explain step-by-step each idea they are to learn.

Enhancing interaction:

I added several turn and talks that will last for thirty seconds to a minute in an effort to get the students to use the content vocabulary. Students will work with a partner instead of a small group for the activity so they can have more time to talk and use the materials. I made an illustrated vocabulary list with the most important words from the unit. I wrote sentence frames on Activity Sheet 1 that can be used during group discussion. I put words and pictures on Activity Sheet 1 for preproduction language learners.
Lesson 2
# SIMPLE MACHINES: Lesson Two: Content and Language Objectives and Performance Indicator Goals

**By:** Kristine Anderson  
**Grade:** 6  
**Class:** Science

## Content Objectives:
1. Students will discover that levers can be used to decrease the effort needed to do a certain amount of work.
2. Students will construct a lever.
3. Students will investigate the mechanical advantage of a lever by experimenting with the positions of the fulcrum, load, and effort.

## Language Objectives:
1a. In groups of four, students will discuss the number of paper clips (effort) it takes to lift a hex nut (load) and how the position of the fulcrum creates mechanical advantage.
1b. Individually, students will write complete sentences to draw a conclusion about the position of the fulcrum.
2. In groups of four, students will read and complete a table in writing using numbers.

## Domain/Topic

<table>
<thead>
<tr>
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<tr>
<td><strong>Reading and Writing</strong></td>
<td>In small groups, students will read, take turns leading a discussion, and complete a table with correct data as to how many paper clips (effort) were required to lift a hex nut (load).</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how many paper clips (effort) were required to lift a hex nut (load).</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how many paper clips (effort) were required to lift a hex nut (load) using sentence starters to aid in their discussion.</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how many paper clips (effort) were required to lift a hex nut (load) using sentence starters and definitions with illustrations of content vocabulary words to aid in their discussion.</td>
<td>In small groups, students will complete a table with correct data as to how many paper clips (load) were required to lift a hex nut (effort) and after listening to phrases, select the correct phrase out of a phrase bank telling the amount of paper clips required.</td>
</tr>
<tr>
<td><strong>Complete a table</strong></td>
<td>In small groups, students will discuss how the distance between the fulcrum and the load is connected with the amount of effort needed (mechanical advantage).</td>
<td>In small groups, students will discuss how the distance between the fulcrum and the load is connected with the amount of effort needed (mechanical advantage).</td>
<td>In small groups, students will discuss how the distance between the fulcrum and the load is connected with the amount of effort needed (mechanical advantage) using provided sentences to aide their discussion.</td>
<td>In small groups, students will discuss how the distance between the fulcrum and the load is connected with the amount of effort needed (mechanical advantage) using sentences to aide their discussion and illustrations of specialized vocabulary.</td>
<td>In small groups, the students point to the pictures that show the fulcrum position that requires the most effort to lift the load and the fulcrum position that requires the least amount of effort to lift the load (mechanical advantage).</td>
</tr>
<tr>
<td><strong>Speaking and Listening</strong></td>
<td>The students independently will write complete sentences using the question to begin their answer and indicate the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will work as a group to rewrite questions to begin answers before finishing the sentences independently indicating the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will independently complete sentences with sentence starters provided indicating the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will independently complete sentences using sentence frames to indicate the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The student will match labeled illustrations to show the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
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<td><strong>Force and Work</strong></td>
<td>The students independently will write complete sentences using the question to begin their answer and indicate the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will work as a group to rewrite questions to begin answers before finishing the sentences independently indicating the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will independently complete sentences with sentence starters provided indicating the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will independently complete sentences using sentence frames to indicate the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The student will match labeled illustrations to show the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td>The students will work as a group to rewrite questions to begin answers before finishing the sentences independently indicating the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The students will work as a group to rewrite questions to begin answers before finishing the sentences independently indicating the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
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<td>The student will match labeled illustrations to show the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
</tr>
<tr>
<td><strong>Force and work</strong></td>
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<td>The students will independently complete sentences using sentence frames to indicate the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
<td>The student will match labeled illustrations to show the relationship between the position of the fulcrum and the amount of effort needed to lift the load (mechanical advantage).</td>
</tr>
<tr>
<td>Function</td>
<td>Situation</td>
<td>Expression</td>
<td>Words/Phrases</td>
<td>Grammar</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Infer</td>
<td>What are machines?</td>
<td>Machines are ____</td>
<td>mechanical devices</td>
<td>Noun</td>
<td></td>
</tr>
<tr>
<td>Infer</td>
<td>What purpose do they serve</td>
<td>Machines serve the purpose of ____</td>
<td>permitting people to do work more easily</td>
<td>verb</td>
<td></td>
</tr>
<tr>
<td>Infer</td>
<td>How many different types of machines can you name?</td>
<td>One type of machine is a ____</td>
<td>cars, computers, tractor, television, cell phone, stove, refrigerator, air conditioner</td>
<td>noun</td>
<td></td>
</tr>
<tr>
<td>Infer</td>
<td>Some different kinds of machines are ____</td>
<td>____ provides the energy to operate ____</td>
<td>gasoline, electricity, battery, cars, computers, tractor, television, cell phone, stove, refrigerator, air conditioner</td>
<td>noun</td>
<td></td>
</tr>
<tr>
<td>Explain</td>
<td>What was the load in the experiment?</td>
<td>The load in the experiment is the ____</td>
<td>hex nut</td>
<td>noun</td>
<td></td>
</tr>
<tr>
<td>Explain</td>
<td>What was the force or effort?</td>
<td>The force or effort was the ____</td>
<td>paper clips</td>
<td>noun</td>
<td></td>
</tr>
<tr>
<td>Predict</td>
<td>How can you lift these two hex nuts with just one hex nut?</td>
<td>I can lift these two hex nuts with just one hex nut by ____</td>
<td>moving the fulcrum towards the load.</td>
<td>Verb phrase</td>
<td></td>
</tr>
<tr>
<td>Explain</td>
<td>In which direction did you move the fulcrum in order to lift the two-hex-nut load?</td>
<td>I moved the fulcrum ____ in order to lift the two-hex-nut load with a ____</td>
<td>towards the load</td>
<td>Verb phrase</td>
<td></td>
</tr>
<tr>
<td>Explain</td>
<td>How far did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?</td>
<td>I moved the fulcrum _____ in order to lift the two-hex-nut load with a one-hex-nut effort.</td>
<td>one hole two holes three holes four holes</td>
<td>Adjective/noun</td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>Draw conclusions</td>
<td>What can you conclude about the distance between the fulcrum and the load and the amount of effort necessary to move the load</td>
<td>I can conclude that the _____ distance between the fulcrum and the load, _____ amount of effort is necessary to move the load.</td>
<td>less more less more</td>
<td>adjective</td>
<td></td>
</tr>
</tbody>
</table>
Simple Machines: Lesson 2
Page 4

Unit: Simple Machines
Lesson 2: Levers
By: Kristine Anderson
Grade: 6
Time: 60 Minutes

Materials for each pair: 2-2 oz. plastic cups, 1 fulcrum, 3 hex nuts, 60 paper clips, 1 pegboard beam

Materials for class: chart paper, markers, vocabulary words with picture for word wall (page 11).

Vocabulary: arm, effort, fulcrum, lever, load, machine, mechanical advantage, simple machine (See page 11 for pictorial representations)

Classroom Organization: For this lesson, students will work in pairs and small groups. The pair is the person they are sitting next to and the small group is the two pairs sitting in the same group. The groups should be mixed language level groups.

KEY:

Comic Sans Serif: from Original Lesson
Arial: new information to meet language needs of students
Bookman: Sheltered Strategy

20 minutes

Introduce the objective: We will investigate the mechanical advantage of a lever by experimenting with the position of the fulcrum, load, and effort.

(I.B. Develop vocabulary, VI.C. Use group work to elicit student talk, VI.B. Model language for oral and written production) Write What are machines? What purpose do they serve? on chart paper. Students turn and talk with group A few students share their thoughts with the whole. Tell students and write on chart paper: Machines are mechanical devices that often permit people to do work more easily. Students chorally read the definition of machines.

I.B. Develop vocabulary, VI.C. VI.B. Model language for oral and written production) Write mechanical advantage on chart paper. Tell and write: Because machines usually perform work with less effort, they are said to provide mechanical advantage. Students chorally read the definition of machines.
(VI.C. Use group work to elicit student talk, I.A. Build and activate background knowledge, I.C. Use extensive visuals, V.A. Vary question techniques) Ask students and write on a new chart: **How many different types of machines can you name?** Students turn and talk with their group and then share out to the whole group. Write some student responses on chart paper. (Level 1 and/or 2 students can get the machines handout on page 15 to gain understanding of different types of machines. They can also draw examples of machines in their science notebooks.)

(VI.C. Use group work to elicit student talk, I.A. Build and activate background knowledge, I.C. Use extensive visuals, V.A. Vary question techniques) Ask students and write on chart: **What provides energy to operate the machines listed?** Quick student share out with the whole group (sample answers: electricity, diesel fuel or gasoline). (Level 1 and/or 2 students can get the energy handout on page 16 to gain understanding of different types of machines.)

**10 minutes**

(I.B. Develop vocabulary, I.C. Use extensive visuals) Unveil the prepared chart (sample on page 13) **Simple Machines.** Tell students that a **simple machine** requires only the **force (effort)** of a human or animal to perform work. There are six types of **simple machines:** the **lever,** the **wheel and axle,** the **inclined plane,** the **pulley,** the **wedge,** and the **screw.** Place a star next to **lever.**

(I.B. Develop vocabulary) **Tell that levers are simple machines that transmit, and sometimes magnify, or increase force.** All levers consist of four components: an **arm** (a beam or bar), a **fulcrum** (the pivot point), a **load** (the object to be moved), and an **effort** (the force needed to move the load.)

(I.B. Develop vocabulary, I.C. Use extensive visuals) Hold up the pegboard and say: **arm.** Have the students repeat the word. Hold up the fulcrum and say: **fulcrum.** Have the students repeat the word. Hold up the hex nuts and say: **load.** Have the students repeat the word. Hold up the paper clips and say: **force.** Have the students repeat the word. Hold up the four components of levers in random order and have the students call out their names. Quickly review the prepared chart with this information (page 12).

(I.A. Activate background knowledge, I.B. Develop vocabulary, I.C. Use extensive visuals) Show picture of see saw (page 14). Tell: **one of the simplest examples of a lever is the playground seesaw:** the **fulcrum** is located at the center of the board (arm), while the children seated at either end take turns being the **effort** and the **load.** Point to the parts on the picture and have students name the fulcrum, arm, load, and effort.
**20 minutes**

Tell: In this activity, you will construct a lever system and experiment with the position of the load, effort, and fulcrum.

(I.D. Model) Model constructing a lever system. Tape one cup to each end of the arm. Place the arm on the fulcrum. Show how to balance the arm and mark the center point.

(II.B. Modify written text) Distribute a copy of Levers Activity Sheet (Level 4 and 5 on page 7, Level 3 on pages 8-9, and Levels 1 and 2 on page 10) to each student, and two plastic cups, a fulcrum, three hex nuts, sixty paper clips, a pegboard bean, and two pieces of tape to each pair.

(I.D. Model) Model and instruct the pairs to tape a plastic cup to each end of the beam, center the pegboard on the beam, and mark the center of their pegboard beam with a pencil.

(VI.C. Students as researchers, VI.A. Challenge students to produce extended academic talk) For the activity, students work with a partner. They are to work together while doing the experiment and completing the activity sheet. It might be best for Level 1 students to work with two other students that have higher language levels. Have students place one hex nut into one of the cups. Tell them to drop paper clips (effort) into the other cup, one by one, and to count the number of clips it takes to lift the hex nut (load) end of the beam. Have students record this number in the chart on the Levers Activity Sheet. Students are to repeat the experiment several more times, moving the fulcrum first one hole, then two, and then three holes closer to the hex nut (load). Finally, tell students to repeat the experiment by moving the fulcrum one hole (from center) toward the paper clips (effort). Remind students to record their observations on the activity sheet. Walk around and check on groups. With individual groups, checking for understanding and challenging them to produce extended academic talk.

(III.E. Check for understanding, IV. Use teacher question and response strategies) Ask, What was the load in this experiment? What was the arm? (The hex nut was the load. The pegboard beam was the arm.) What was the force, or effort? (The paper clips.) Have students answer chorally. Level 1 and 2 students can also hold up the actual materials to show understanding or refer to the functional language chart.

**10 minutes**

Have the students remove the paper clips from the effort cup and add a second hex nut to the load cup. Ask, how can you lift these two hex nuts with just one hex
nut? (By placing the single hex nut in the effort cut and moving the fulcrum toward the two-hex-nut load cup.)

(I.E. Create opportunities to negotiate meaning) Have the students use the effort of one hex nut to lift a two-hex-nut load and record the position of the fulcrum on their activity sheet.

(II.B. Modify written text) Have the students answer questions 2-4 on their activity sheets.

(IV.A. Use teacher question and response strategies, III.E. Check for understanding, VI.B. Model language for oral and written production) When the students have finished, ask, What effect did moving the fulcrum closer to the load have? What effect did moving the fulcrum farther from the load have? Expected answers: Moving the fulcrum closer to the load makes the load easier to lift (less effort or force). Moving the fulcrum away from the load makes the load harder to lift (more effort or force). Use the functional language chart to support level 1 and 2 learners. Explain that in a lever system, the closer the fulcrum is to the load (and the farther away it is from the effort), the less force or effort will be required to move the load. This is mechanical advantage. Write on chart: **Mechanical advantage is when less work is required to lift a load.** Have students read this chorally.

(III.C. Use of word walls) Afterwards: make sure chart remains available each during for the rest of the Simple Machines Unit. Add key vocabulary words to illustrated science word wall.
LEVERS

Complete the chart below.

<table>
<thead>
<tr>
<th>Position of fulcrum</th>
<th>Number of paper clips needed to lift one hex nut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center</td>
<td></td>
</tr>
<tr>
<td>1 hole toward the load</td>
<td></td>
</tr>
<tr>
<td>2 holes toward the load</td>
<td></td>
</tr>
<tr>
<td>3 holes toward the load</td>
<td></td>
</tr>
<tr>
<td>1 hole (from center) toward effort</td>
<td></td>
</tr>
</tbody>
</table>

1. In which direction did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?

2. How far did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?

3. What can you conclude about the distance between the fulcrum and the load and the amount of effort necessary to move the load?
LEVERS

Complete the chart below.

<table>
<thead>
<tr>
<th>Position of fulcrum</th>
<th>Number of paper clips needed to lift 1 hex nut</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Center" /></td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="1 hole toward the load" /></td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="2 holes toward the load" /></td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="3 holes toward the load" /></td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="1 hole (from center) toward effort" /></td>
<td></td>
</tr>
</tbody>
</table>

1. In which direction did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?
   
   To lift a two-hex-nut load with a one-hex-nut effort, I moved the load __________

2. How far did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?
   
   To lift a two-hex-nut load with a one-hex-nut effort, I moved the fulcrum __________
3. What can you conclude about the distance between the fulcrum and the load and the amount of effort necessary to move the load?

The greater the distance between the fulcrum and the load, the

The smaller the distance between the fulcrum and the load, the
**LEVERS**

<table>
<thead>
<tr>
<th>Position of fulcrum</th>
<th>Number of paper clips needed to lift 1 hex nut</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="center.png" alt="Image" /> Center</td>
<td><img src="center.png" alt="Image" /> 0</td>
</tr>
<tr>
<td><img src="1hole.png" alt="Image" /> 1 hole toward the load</td>
<td><img src="1hole.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="2holes.png" alt="Image" /> 2 holes toward the load</td>
<td><img src="2holes.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="3holes.png" alt="Image" /> 3 holes toward the load</td>
<td><img src="3holes.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="effort.png" alt="Image" /> 1 hole (from center) toward effort</td>
<td><img src="effort.png" alt="Image" /></td>
</tr>
</tbody>
</table>

1. In which direction did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?

To lift a two-hex-nut load with a one-hex-nut effort, I moved the fulcrum toward the **load or effort**.

2. How far did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort?

To lift a two-hex-nut load with a one-hex-nut effort, I moved the fulcrum _____ holes toward the **load or effort**.

3. What can you conclude about the distance between the fulcrum and the load and the amount of effort necessary to move the load?
VOCABULARY

Paper clip

Hex nut

lever

effort

Load

mechanical advantage
Simple Machines

Pulley

Lever

Wheel and Axle

Inclined Plane

Screw

Wedge
computer

stove

car

cell phone

refrigerator

air conditioner
Simple Machines: Lesson 2
Page 17

Narrative

**Sheltered Instruction:**

Instead of quickly explaining making levers and using them to complete the activity, I will show each part, name it, and have the students say the name. Additionally, I will model creating a lever and moving the fulcrum, rather than just explaining it. Preproduction language learners will be given pictures of machines and energy to be able to participate in that part of the lesson.

**Adjusting discourse:**

I slowed down the pace of the lesson, so I can talk slowly and review the ideas more than once. Instead of just telling the students, I will model and explain step-by-step each idea they are to learn. Additionally, students will have sentence starters or frames to help them participate in small group and class discussions.

**Enhancing interaction:**

I added several turn and talks that will last for thirty seconds to a minute in an effort to get the students to use the content vocabulary. Students will work with a partner instead of a small group for the activity so they can have more time to talk and use the materials. I made an illustrated vocabulary list with the most important words from the unit. I wrote sentence starters and frames on the Activity Sheet that can be used during group discussion. I put words and pictures on the Activity Sheet for preproduction language learners.
Lesson 3
### SIMPLE MACHINES: Lesson three: Content and Language Objectives and Performance Indicator Goals

**By:** Kristine Anderson  
**Grade:** 6  
**Class:** Science

<table>
<thead>
<tr>
<th>Content Objectives:</th>
<th>Language Objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students will examine friction and how it affects the amount of force needed to move an object a certain distance.</td>
<td>1a. In groups of four, students will discuss predictions as to which surface will require the least amount of force and why.</td>
</tr>
<tr>
<td>2. Students will observe the effects of friction and the variable that increase and decrease friction.</td>
<td>1b. Individually, students will write a complete sentence explaining which surface requires the least amount of work and why.</td>
</tr>
<tr>
<td>3. Students will discover one method of decreasing friction.</td>
<td>2 In groups of four, students will read and complete a table in writing using numbers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Domain/Topic</th>
<th>Fluent/Bridging Level 5</th>
<th>Expanding Fluency Level 4</th>
<th>Speech Emerging Level 3</th>
<th>Early Production Level 2</th>
<th>Preproduction Level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reading and Writing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete a table</td>
<td>In small groups, students will read, take turns leading a discussion, and complete a table with correct data as to how much force and work is required to move a ½ brick.</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how much force and work is required to move a ½ brick.</td>
<td>In small groups, students will read, discuss, and complete a table with correct data as to how much force and work is required to move a ½ brick using sentence starters to aid in their discussion.</td>
<td>In small groups, students will complete a table with correct data as to how much force and work is required to move a ½ brick and after listening to phrases, select the correct phrase out of a phrase bank.</td>
<td></td>
</tr>
<tr>
<td><strong>Speaking and Listening</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force and Work</td>
<td>In small groups, students will take turns leading a discussion predicting on which surface the least amount of work will be required to move the ½ brick and why.</td>
<td>In small groups, students will discuss predictions about which surface the least amount of work will be required to move the ½ brick and why.</td>
<td>In small groups, students will discuss predictions about which surface the least amount of work will be required to move the ½ brick and why using provided sentences to aid their discussion.</td>
<td>In small groups, students will discuss predictions about which surface the least amount of work will be required to move the ½ brick and why using sentences to aid their discussion and illustrations of specialized vocabulary.</td>
<td></td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force and work</td>
<td>The students independently will write complete sentences using the question to begin their answer and answer the question stating the surface that required the most work to move the ½ brick and why.</td>
<td>The students will work as a group to rewrite questions to begin answers before finishing sentences independently stating the surface that required the most work to move the ½ brick and why.</td>
<td>The students will independently complete sentences with sentence starters provided stating the surface that required the most work to move the ½ brick and why.</td>
<td>The student will match labeled illustrations to show the surface that required the most work to move the ½ brick and why.</td>
<td></td>
</tr>
</tbody>
</table>
## SIMPLE MACHINES: Lesson One: Functional Language Chart

**By:** Kristine Anderson  
**Grade:** 6  
**Class:** Science

<table>
<thead>
<tr>
<th>Function</th>
<th>Situation</th>
<th>Expression</th>
<th>Words/Phrases</th>
<th>Grammar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infer</td>
<td>Students infer why they think it took effort to move the chair.</td>
<td>I had to use force to move the chair because ______</td>
<td>the chair has weight</td>
<td>sentence</td>
</tr>
<tr>
<td>Explain</td>
<td>Students are noticing the textures of the feet of their chairs and floor. They are also noticing signs of wear.</td>
<td>Wear is caused by ______.</td>
<td>pushing the chair in pulling the chair out</td>
<td>verb phrase</td>
</tr>
<tr>
<td>Explain</td>
<td>How do you find the amount of work it takes to move ½ brick?</td>
<td>To find the amount of work (joules), multiply force times distance.</td>
<td>one two three four five</td>
<td>adjective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It took the ______ joules to move the brick on the wooden board desktop carpet</td>
<td></td>
<td>noun</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predict</td>
<td>Student groups make predictions as to which surface will require the least amount of force.</td>
<td>I predict it will to take the least amount of force to pull the ½ brick on the ______ because the surface is ______</td>
<td>carpet floor desktop smooth bumpy rough</td>
<td>noun adjective</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain</td>
<td>After completing the activity the students answer questions explaining the results.</td>
<td>The surface that took the most work was the ______</td>
<td>carpet wooden board desktop</td>
<td>noun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More force was</td>
<td></td>
<td>noun</td>
</tr>
<tr>
<td><strong>Simple Machines: Lesson 3</strong></td>
<td><strong>Page 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>needed to move the brick across the carpet because it's _____</strong></td>
<td><strong>bumpy rough not smooth</strong></td>
<td><strong>noun</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The different between the board, desk, and carpet was the ____ of the surface.</strong></td>
<td><strong>smoothness roughness bumpiness</strong></td>
<td><strong>adjective</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The brick moved the easiest on the ____ because the _____.</strong></td>
<td><strong>desktop carpet floor</strong></td>
<td><strong>noun</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>surface is _____.</strong></td>
<td><strong>smooth not bumpy not rough</strong></td>
<td><strong>adjective</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The most friction happened on the _____.</strong></td>
<td><strong>desktop carpet floor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Draw conclusions</strong></td>
<td><strong>Develop a rule that explains the results of this experiment.</strong></td>
<td><strong>The ____ the surfaces that rub together</strong></td>
<td><strong>smoother bumpier rougher</strong></td>
<td><strong>adjective</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>The ____ friction there is.</strong></td>
<td><strong>less more joules</strong></td>
<td><strong>adjective</strong></td>
</tr>
<tr>
<td><strong>Infer</strong></td>
<td><strong>Infer other variables that might increase or decrease the amount of friction.</strong></td>
<td><strong>_____ might increase friction.</strong></td>
<td><strong>dry surfaces rubber sticky stuff</strong></td>
<td><strong>adjectives and nouns</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>_____ might decrease friction</strong></td>
<td><strong>ice water oil</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Explain</strong></td>
<td><strong>While rubbing two</strong></td>
<td><strong>I notice my fingers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infer</td>
<td>Infer other lubricants.</td>
<td>Another lubricant is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------------------------</td>
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<td>---</td>
</tr>
<tr>
<td><strong>fingers together.</strong></td>
<td>_____</td>
<td>get warm make noise</td>
<td>verb</td>
<td></td>
</tr>
<tr>
<td><strong>My fingers</strong></td>
<td>_____</td>
<td>get warm make noise</td>
<td>verb</td>
<td></td>
</tr>
<tr>
<td><strong>Because of</strong></td>
<td>_____</td>
<td>friction</td>
<td>noun</td>
<td></td>
</tr>
<tr>
<td><strong>With lubricant, my fingers don’t</strong></td>
<td>_____</td>
<td>get warm make noise</td>
<td>verb</td>
<td></td>
</tr>
<tr>
<td><strong>Because friction was</strong></td>
<td>_____</td>
<td>reduced lowered</td>
<td>adverb</td>
<td></td>
</tr>
<tr>
<td><strong>Infer</strong></td>
<td><strong>Infer other lubricants.</strong></td>
<td><strong>Another lubricant is</strong></td>
<td><strong>oil</strong></td>
<td><strong>noun</strong></td>
</tr>
</tbody>
</table>
Introduce the objective: We will investigate how surface affects the amount of force (effort) it takes to move a brick.

(1.E. Create opportunities to negotiate meaning, 1.A. Activate background knowledge) Remind students of the activity in lesson one. Force is the push or pull of an object. Have students stand behind their desks with their chairs pulled out. Tell them to push in their chairs, then pull them back out. Ask: Why did you have to use force to move your chair? Expected answer: Weight of the chair.

(1.E. Create opportunities to negotiate meaning) Have students observe, feel, and then describe the texture of both the floor and the feet their chairs. Have students look specifically for sign of wear. (Plan ahead with this, so you know where the “wear” is. On the chairs I use, the plastic parts to protect the floor are almost completely worn off leaving marks on the floor. If this is not the case, find another way
to demonstrate wear. The point is for students to understand that when two surfaces rub together, wear is created. “Wear” on the students’ shoes can be used. Ask: What caused the wear? Expected answer: pushing and pulling the chair across the floor.

(I.C. Use extensive realia) Explain: no matter how smooth a surface may feel, there are always rough spots—tiny bumps, craters, and sliver-like projections—on that surface. Use hand gestures to show smooth versus bumps (rough) and projections. Use realia. Select several classroom objects (for example: paper, crumpled paper, pegboards, transparency, etc.) Use the objects and have students say rough or smooth, as they are displayed. When the chair was pushed and pulled, the roughness on the surface of the floor rubbed against the roughness on the surface of the chair feet, making it somewhat difficult for the two objects to slide past each other. Push and pull the chair while explaining. Also use the vocabulary on page 12 to help level 1 and 2 students understand.

(I.B. Develop vocabulary, VI.B Model language for oral and written production) Write the word friction on chart paper. Write and explain: Friction is the resistance created by two surfaces rubbing together. Have students read this chorally.

(I.E. Create opportunities to negotiate meaning, IV.B. Use teacher question and response strategies) Model and then have students rub their hands together briskly until their palms become warm. Ask: Where did the heat come from? Expected answer: friction produced the heat. If students don’t say friction, refer them to the chart that was just created. As needed, refer level 1 and 2 students to the illustrated vocabulary to understand friction and heat. Explain that when two objects are rubbed together, the friction between the two surfaces produce heat.

5 minutes

Tell students that in this activity, they will investigate friction, its causes, and how to reduce it.

(II.B. Modify written text) Distribute a copy of Activity Sheet 3 (Levels 4 and 5 on page 8, level 3 on page 9, level 2 on page 10, and level 1 on page 11) to each student, and a wooden board, spring scale, piece of string, half brick, and meterstick to each team.
(I.D. Model) Model and have students use their metersticks to measure the length of their board. (Boards are 0.7 meters). Explain: Each time you move the brick, you will need to move it exactly 0.7 meters.

(I.D. Model, I.A. Activate background knowledge) Explain and model the activity. Remind students that they worked with spring scales in lesson one and that they must zero out their spring scale. Show them how to turn the nut on the top and make sure the indicator is on zero. Then, place the board flat on the floor. Tie one end of the string around the brick so that no string is under the brick and the other end around the spring scale. Place the brick at one end of the board. Pull the brick the entire length of the board. Explain and model keeping the spring scale perpendicular to the surface. Show the students incorrect ways to pull the spring scale and how its more life lifting the brick, rather than pulling it across the surface. Explain and model that to record the amount of newtons and distance on the activity sheet. Then calculate the amount of work done. Place the brick and meterstick on the carpet. Pull the brick 0.7 meters. Place the brick and meterstick on the desktop. Pull the brick 0.7 meters. Again, explain that the newtons and distance will be recorded on the activity sheet. (Do not tell the students the amount of newtons and work for moving the brick on the carpet and desktop.)

5 minutes

(VI.C. Use group work to elicit student talk) Students turn and talk to their partner making predictions as to which surface will require the least amount of effort to move the ½ brick. Remind students that predictions are not guesses. Students must have a reason. Have a few students share their predictions with the whole group. If necessary, remind students about friction.

20 minutes

(VI.C. Students as researchers, VI.A. Challenge students to produce extended academic talk) Student teams perform the activity, record the newtons and distance, and calculate the amount of work on the activity sheets. As needed, refer the students back to Lesson 1 and the vocabulary associated with that lesson. Again, if students don’t have the math skills to calculate the amount of work, allow them to use calculators (or if time allows, review multiplying decimals). While the students are working, walking around and work with student pairs to check understanding. Provide instruction as needed and challenge students to produce extended academic talk.

10 minutes

(III.A. Pace teachers speech, IV.A. Use teacher question and response strategies, III.E. Check for understanding, VI.D. Respond to students voice) This next part is a question answer session. Speak slowly and clearly. Emphasize content vocabulary. Give level 1-3 students the answer frames on page 15. Allow level
one student to point to the pictures on their activity sheet or vocabulary sheet to answer to actively participate and answer questions. Gently correct students' answers. After correct answers are given repeat them and have students chorally repeat them.

Ask: In which of these three setups did you do the most work? Expected answer: We did the most work when we used the most force—that is, when we moved the brick across the carpet.

Ask: Why do you think more force was needed to move the brick across the carpet than across the other surfaces? Expected answer: students may say that the brick seemed to stick to or get caught on the carpet.

Ask: What was the difference between the board, desktop, and carpet? Expected answer: the smoothness.

Ask: On which surface was the brick easiest to move? Expected answer: desktop.

Ask: Why do you think the brick moved easiest across the desktop? Expected answer: The surface of the desk was smoother than both the surface of the board and the carpet, so the desktop did not catch as much on the rough surface of the brick.

Ask: In which situation did the brick and the surface of the board display the most friction? Least friction? Expected answer: Most friction occurred when the brick moved over the carpet, and the least friction occurred when the brick moved over the desktop.

Ask: What rule can you state about friction and the surfaces of objects rubbing against one another? Expected answer: The smoother the surfaces that rub together, the less friction there will be.

Ask: What other variables might increase or decrease friction between two surfaces. Expected answer: wet and dry surfaces.

10 minutes

(I.E. Create opportunities to negotiate meaning) Have students rub their thumb and forefinger together and listen to the sound it makes. Explain that this sound is produced by friction between the surfaces of their two fingers. Ask: What else do you notice about your two fingers? Expected answer: Fingers become warm. That heat is produced by friction. Refer students to the friction chart, if needed.
Apply a dab of petroleum jelly on each student's forefinger. Have students rub their thumb and forefinger together again. Ask: What do you observe now? Expected answer: The sound has been reduced or eliminated and their fingers didn't get warm this time. Pass out paper towels for the students to wipe the petroleum jelly from their fingers.

(I.B. Develop vocabulary, VI.B. Model language for oral and written production) Write lubricant on the board. Explain and write: Lubricant is a substance that reduced friction between two moving parts. Have students chorally read this.


(VI.C. Use group work to elicit student talk) Ask: Can you name any other lubricants? Expected answers: oil, grease, slippery liquids, and semisolids. Have students turn and talk with their groups. Then have some students share out to the whole group.

(I.B. Develop vocabulary) Refer back to the charts. Have students chorally read the definitions of friction and lubricant.

(III.C. Use of word walls) Afterwards: make sure chart remains available each during for the rest of the Simple Machines Unit. Add key vocabulary words to illustrated science word wall.
**FRICTION**

**Work = force x distance**

1. Record your observations in the table below. For each surface test, calculate the amount of work performed.

<table>
<thead>
<tr>
<th>Surface Tested</th>
<th>Force (newtons)</th>
<th>Distance (meters)</th>
<th>Work (joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. On which surface was the most amount of work done by moving the brick? Why?
**FRICTION**

**Work** = force × distance

1. Record your observations in the table below. For each surface test, calculate the amount of work performed.

<table>
<thead>
<tr>
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<th>Distance (meters)</th>
<th>Work (joules)</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. On which surface was the most amount of work done by moving the brick? Why?

The most amount of work done by moving the brick was on the ____________, because ___________________________.
FRICION

Work = force x distance

1. Record your observations in the table below. For each surface test, calculate the amount of work performed.

<table>
<thead>
<tr>
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<th>Force (newtons)</th>
<th>Distance (meters)</th>
<th>Work (joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. On which surface was the most amount of work done by moving the brick? Why?

The most amount of work done by moving the brick was on the

because
FRICTION

Work = force $\times$ distance

1. Record your observations in the table below. For each surface test, calculate the amount of work performed.

<table>
<thead>
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<th>Force (newtons)</th>
<th>Distance (meters)</th>
<th>Work (joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. On which surface was the most amount of work done by moving the brick? Why?

   - desktop
   - carpet
   - board
VOCABULARY

friction
wooden board
carpet
desk
brick
heat

lubricant

rough

smooth
# Listening Guide

| The surface that took the most work was the ____ | carpet  
|                                                | wooden board  
|                                                | desktop  
| More force was needed to move the brick across the carpet because it's ____ | bumpy  
|                                                | rough  
|                                                | not smooth  
| The different between the board, desk, and carpet was the ____ of the surface. | smoothness  
|                                                | roughness  
|                                                | bumpiness  
| The brick moved the easiest on the ____ because the | desktop  
| surface is ____ | carpet  
|                                                | floor  
| The most friction happened on the ____ | desktop  
|                                                | carpet  
|                                                | floor |
Sheltered Instruction:

Instead of quickly reminding students to zero out the spring scales, I will review that vocabulary model how to do it. I will also model this entire activity; showing how to set up the activity and pull the brick on each surface. Realia is added so the students can understand smooth versus rough, if needed. Modeling and using realia take away the necessity of language and allow for level 1 and 2 learners to understand the activity. Additionally, for time sake, students that do not have the math skills to multiply decimals will be provided with calculators. Reteaching that math skill would add a great deal of new vocabulary pulling the lesson away from the science content. As new words are learned, they will be added to a picture word wall.

Adjusting discourse:

I slowed down the pace of the lesson, so I can talk slowly and review the ideas more than once. Instead of just telling the students, I will model and explain step-by-step each idea they are to learn. Additionally, students will have sentence starters or frames to help them participate in small group and class discussions.

Enhancing interaction:

I added several turn and talks that will last for thirty seconds to a minute in an effort to get the students to use the content vocabulary. Students will work with a partner instead of a small group for the activity so they can have more time to talk and use the materials. I made an illustrated vocabulary list with the most important words from the unit. I wrote sentence starters and frames on the Activity Sheet that can be used during group discussion. I put words and pictures on the Activity Sheet for preproduction language learners.
Checklists
# SHELTERED INSTRUCTION CHECKLIST

**By:** Kristine Anderson  
**Grade:** 6  
**Class:** Science

<table>
<thead>
<tr>
<th>SHELTERED STRATEGIES</th>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
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<tr>
<td>I. Contextualize Lesson</td>
<td></td>
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<tr>
<td>I.A. Build and activate background knowledge</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>I.B. Develop vocabulary</td>
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<td>4,5</td>
<td>6,9</td>
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<tr>
<td>I.C. Use extensive visuals, realia, manipulatives, &amp; gestures</td>
<td>5,6,7</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>I.D. Model</td>
<td>6,7</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>I.E. Create opportunities to negotiate meaning</td>
<td>4,5,6,7</td>
<td>7</td>
<td>5,6,8</td>
</tr>
<tr>
<td>II. Make text comprehensible</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>II.A. Intentional use of graphic organizers</td>
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<td></td>
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</tr>
<tr>
<td>II.B. Modify written text</td>
<td>6</td>
<td>6,7</td>
<td>6</td>
</tr>
<tr>
<td>II.C Amplify number of activities per text</td>
<td></td>
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<td></td>
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<tr>
<td>III. Make Talk Comprehensible</td>
<td></td>
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<tr>
<td>III.A Pace teacher’s speech</td>
<td>7</td>
<td>7</td>
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<tr>
<td>III.B Use of listening guides</td>
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<td>16</td>
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<tr>
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<td>7</td>
<td>8</td>
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<tr>
<td>III.D Frame main ideas</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>III.E Check for understanding</td>
<td>5,7</td>
<td>6,7</td>
<td>7</td>
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<tr>
<td>IV. Change traditional classroom talk</td>
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<tr>
<td>IV.A Use teacher question and response strategies</td>
<td>8</td>
<td>6,7</td>
<td>6</td>
</tr>
<tr>
<td>IV.B Practice instructional conversations</td>
<td>4,7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V. Engage at appropriate language proficiency levels</td>
<td></td>
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</tr>
<tr>
<td>V.A Vary question techniques based on student’s language proficiency level in conversations, activities, and assessments</td>
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<td>2,5</td>
<td>2,6,7</td>
</tr>
<tr>
<td>VI. Give students voice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI.A Challenge students to produce extended academic talk</td>
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<td>6</td>
<td>7</td>
</tr>
<tr>
<td>VI.B Model language for oral and written work to production</td>
<td>4,5,8</td>
<td>4,7</td>
<td>6,9</td>
</tr>
<tr>
<td>VI.C Use group/pair work to elicit student talk; student as researchers</td>
<td>7,8</td>
<td>4,5,6</td>
<td>7</td>
</tr>
<tr>
<td>VI.D Respond to student’s voice – writing and error correction</td>
<td></td>
<td></td>
<td>7</td>
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</tbody>
</table>
### Simple Machines

**GRAMMAR AND LANGUAGE FUNCTION CHECKLISTS**

By: Kristine Anderson  
Grade: 6  
Class: Science

<table>
<thead>
<tr>
<th>Grammar</th>
<th>Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nouns</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Verbs</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Adjectives</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Complete Sentences</td>
<td>1, 2, 3</td>
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</table>

<table>
<thead>
<tr>
<th>Language Function</th>
<th>Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predict</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Explain</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Draw conclusion</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Infer</td>
<td>2, 3</td>
</tr>
</tbody>
</table>
Original
Lessons
OBJECTIVES

Students begin their investigation of simple machines by studying the relationship between force and work.

The students

- measure the force required to move an object
- measure the distance the object was moved
- calculate how much work was done when the object was moved a measured distance

SCHEDULE

About 40 minutes

PREPARATION

1. Make a copy of Activity Sheet 1 for each student.
2. Cut a piece of string 2 m (about 6.6 ft) long for each team.
3. Have each student choose two or more objects to test during this activity. (Students will tie string around these objects and suspend them from a spring scale.) Appropriate objects include books, shoes, and so on.
4. Each team of four will need a spring scale, a piece of string, a meterstick, a pair of scissors, and a variety of objects to be tested.

BACKGROUND INFORMATION

Before an examination of simple machines can be conducted, students must understand the relationship between force and work.

A **force** is a push or pull on an object. The international unit of force is the **newton**, named after English scientist Sir Isaac Newton.

**Work** is accomplished when an object moves as a result of a force acting upon it. The **joule** is the unit of work. It is named for another English scientist, James Joule.

One joule of work is performed when a force of 1 newton moves an object a distance of 1 meter (about 3.3 ft). This relationship is expressed in the following equation:

\[
\text{Work} = \text{Force} \times \text{distance}
\]

In this activity, students measure the force required to lift various objects a premeasured distance, and then calculate the amount of work that was done.

VOCABULARY

- force
- joule
- newton
- work

MATERIALS

For each student

- 1 Activity Sheet 1

For each team of four

- 1 meterstick*
- objects to test (see Preparation)*
- 1 pair scissors*
- 1 spring scale

For the class

- 1 roll string

*provided by the teacher
**Activity Sheet 1**

**Doing Work**

\[ \text{Work} = \text{Force} \times \text{distance} \]

<table>
<thead>
<tr>
<th>Object tested</th>
<th>Force (newtons)</th>
<th>distance (meters)</th>
<th>Work (joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>small book</td>
<td>4</td>
<td>.7</td>
<td>2.8</td>
</tr>
<tr>
<td>roll of tape</td>
<td>1</td>
<td>.7</td>
<td>.7</td>
</tr>
<tr>
<td>scissors</td>
<td>1</td>
<td>.7</td>
<td>.7</td>
</tr>
<tr>
<td>big book</td>
<td>16</td>
<td>.7</td>
<td>11.2</td>
</tr>
</tbody>
</table>

Answers will vary. Sample answers from above example:

1. Which object required the most force to lift?
   - big book

2. Which object required the least force to lift?
   - roll of tape, scissors

3. Which object required the most work to lift?
   - big book

4. Which object required the least work to lift?
   - roll of tape, scissors

---

**Guiding the Activity**

1. Begin a discussion by asking, **What is force?**

   Have a student volunteer stand facing a wall and tell him or her to push against it. Explain that the student is exerting a force on the wall.

2. Have another student volunteer stand behind his or her desk with the chair pulled out. Direct the student to slide the chair under the desk. Ask, **What force was used to move the chair?**

   Ask, **What force would be used on the chair if you wanted to move it out from under the desk again?**

   Write the terms **force** and **newton** on the board. Explain that **force** is a push or pull on an object measured in units called newtons. A **newton** is the international unit of force.

---

**Additional Information**

A force is a push or pull on an object.

- a push
- a pull
**Guiding the Activity**

Ask, **What was the difference between pushing against the wall and pushing against the chair?**

Write the word *work* on the board. Point out that *work* was accomplished when the student pushed the chair because the force that was applied to the chair caused it to move over a distance. Work was not accomplished when the student pushed against the wall because the wall did not move.

Explain that work is only accomplished when an object moves as a result of a force acting upon it. If an object does not move, no matter how great the force applied to it, no work is done.

Write the term *joule* on the board. Explain that a *joule* is the unit of measurement for work. One joule of work equals 1 newton of force acting to move an object a distance of 1 m.

Distribute a spring scale, a piece of string, a pair of scissors, and a meterstick to each team of four.

Demonstrate how to use and read the spring scale and how to "zero" the scale if it fails to point to zero newtons with no load attached.

Tell the students to gather together the objects they have chosen to test.

**Additional Information**

The wall did not move; the chair did.

Remind students that 1 m equals approximately 3.3 ft.

The spring scale should be held vertically by the metallic loop, with the hook hanging down. Turn the nut on the spring scale so that the zero of the scale is next to the indicator.

The objects should be small and/or light enough to attach to the spring scale using the 2-m length of string. Tell students to make sure the objects they have selected do not exceed the weight limit of the spring scale. Some ideas include pencils, erasers, a stapler, a roll of tape, and books in a variety of sizes.
Guiding the Activity

Explain that they are going to lift a variety of objects with the spring scale, note the newtons of force required to lift each object (as indicated on the spring scale), measure the distance that each object is lifted, and then calculate the amount of work done (see Figure 1-1).

Distribute a copy of Activity Sheet 1 to each student.

Have each team use a meterstick to measure the distance from the floor to the desktop. Tell students to record the distance in the table on Activity Sheet 1.

Next, have each team choose an object, tie a piece of string around the object, attach the spring scale to the string, and use the scale to lift the object from the floor to the desktop. Tell students to record the spring-scale reading (using the newton side of the scale) on their activity sheets, and to repeat this procedure with the rest of their objects.

Additional Information

You may want to tell students that they will lift each object the same distance, and to go ahead and fill in the entire column labeled “distance (meters)” with this figure.

Remind students to raise the objects slowly and steadily so that an accurate force measurement can be read from the face of the scale.
### Guiding the Activity

<table>
<thead>
<tr>
<th>Step</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Write the equation $W = F \times d$ on the board. Explain that $W$ stands for work, $F$ for force, and $d$ for distance. Have students calculate the amount of work done for each object. To do this, have students multiply the force required to lift the object (newtons) by the distance the object moved (meters). When they have finished, tell them to answer questions 1–4 on the bottom of their activity sheets.</td>
</tr>
<tr>
<td>8</td>
<td>Discuss with the students which objects required the most force and the least force to lift. Then discuss which objects required the most work and the least work to lift.</td>
</tr>
<tr>
<td>9</td>
<td>In summary, ask students to define work.</td>
</tr>
</tbody>
</table>

### Additional Information

- Note that only $W$ and $F$ are written in uppercase.
- Remind students to record their results on their activity sheets.
- You may need to remind them that force is measured in newtons and work is measured in joules.
- Work is accomplished when a force that is exerted on an object causes that object to move over a distance.

### Reinforcement

Pose this question to students: How many joules of work will be required to move seventy-five books from the floor to a shelf 2 meters high, if each book requires a force of 2 newtons to lift? (Answer: $2 \text{ newtons} \times 2 \text{ meters} \times 75 \text{ books} = 300 \text{ joules}$.)

### Cleanup

Return the spring scales and pieces of string to the kit.

### Science Journals

Have students place their completed activity sheets in their science journals.
Science Extension

Make sure students understand that in science, work is done only when a force produces movement of an object. Ask students to suggest examples of forces operating without producing movement. They may suggest examples such as the force of Earth's gravity pulling downward on stationary objects, a person pulling or pushing against an object that is too heavy for the person to move, or balanced forces such as two people of equal weight and strength pushing against each other. Which factor in the equation \( W = F \times d \) is missing for each example? (distance) Ask students to suggest how each example could be changed so that work would result.

Science and Language Arts

Ask students to write down as many specific examples as they can of the use of the word work in any context, scientific or otherwise. (Examples might include "going to work," "Studying for a test is hard work," "working on a car," and so forth.) Give students about 10 minutes to brainstorm and complete their lists independently. Then have students share the examples they listed. As each example is offered, ask the class to determine whether it describes work in its scientific sense and to explain why or why not.

Science and Math

- Ask each student to create three math problems based on the equation \( W = F \times d \). Make sure each student also calculates the answers to the problems he or she created. Then let students take turns posing their problems for the rest of the class to solve. If students' answers to a problem do not agree, work through the problem with the class. Depending on students' abilities, problems could range from fairly simple calculations in which students solve for one unknown element—for example, 90 joules = ? newtons \( \times \) 5 meters—to more complex word problems such as the one given in the Reinforcement activity.

- Remind students that weight—the force of gravity—is measured in newtons. Have each student convert his or her weight from pounds to newtons by multiplying the weight in pounds by 4.448. Students also might enjoy using the following conversion table to calculate their weight in pounds and newtons on bodies other than Earth. (Note: Pluto is omitted from the table because its gravity is unknown.)

<table>
<thead>
<tr>
<th>Name of Body</th>
<th>Gravity (Earth = 1.00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.26</td>
</tr>
<tr>
<td>Venus</td>
<td>0.90</td>
</tr>
<tr>
<td>Mars</td>
<td>0.38</td>
</tr>
<tr>
<td>Jupiter</td>
<td>2.64</td>
</tr>
<tr>
<td>Saturn</td>
<td>1.13</td>
</tr>
<tr>
<td>Uranus</td>
<td>0.96</td>
</tr>
<tr>
<td>Neptune</td>
<td>1.00</td>
</tr>
<tr>
<td>Sun</td>
<td>28.00</td>
</tr>
<tr>
<td>Earth's moon</td>
<td>0.16</td>
</tr>
</tbody>
</table>

Science and Social Studies

Ask students to research and report on the work of Sir Isaac Newton (1642–1727) and James Joule (1818–1889). Students may already be familiar with Newton's laws of motion. Encourage students to include and explain these laws in their reports and to find out about Newton's other important achievements, including his discovery of the law of universal gravitation, his work in optics, and his design of the first practical reflecting telescope. Joule determined the relationship between heat energy and mechanical energy and discovered the first law of thermodynamics regarding conservation of energy. Ask students to explain how each man's work is related to the measurement units named in his honor.
Levers

OBJECTIVES

In this activity, students are introduced to the first of six types of simple machines: the lever. They discover that levers can be used to decrease the force needed to do a certain amount of work.

The students

- construct a lever
- investigate the mechanical advantage of a lever by experimenting with the position of the fulcrum, load, and effort

SCHEDULE

About 40 minutes

VOCABULARY

arm
effort
fulcrum
lever
load
machine
mechanical advantage
simple machine

MATERIALS

For each student

1 Activity Sheet 2

For each team of four

2 cups, plastic
1 fulcrum
3 hex nuts

60 paper clips
1 pegboard beam
1 pencil*

For the class

1 roll tape, masking

*provided by the teacher

PREPARATION

1 Make a copy of Activity Sheet 2 for each student.

2 Each team of four will need two plastic cups, one fulcrum, three hex nuts, sixty paper clips, one pegboard beam, and two pieces of masking tape about 4 in. long each.

BACKGROUND INFORMATION

Machines are mechanical devices that transfer, modify, or magnify force to help people do work. Machines can range in size and complexity from huge diesel-powered motors to simple machines that require only manual force from people or animals to perform work. Some machines allow us to do work while applying less force. This enhancement is known as mechanical advantage.

There are six types of simple machines: the lever, the wheel and axle, the inclined plane, the pulley, the wedge, and the screw. This activity examines the first of these: levers.

All levers consist of four components: an arm (a beam or bar), a fulcrum (the pivot point), a load (the object to be moved), and an effort (the force needed to move the load).
A good example of a lever is the common playground seesaw. On a seesaw, the fulcrum is located at the center of the board (arm), and the children seated at either end take turns being the effort and the load. The fulcrum does not have to be at the center of the arm, though. The position of the fulcrum, load, and effort can be manipulated to increase the mechanical advantage.

In this activity, students will discuss the four components of a lever and perform experiments to observe the benefits of using levers to perform work.

### Activity Sheet 2

#### Levers

1. Complete the chart below. Answers will vary. Sample answers:

<table>
<thead>
<tr>
<th>Position of fulcrum</th>
<th>Number of paper clips needed to lift one hex nut</th>
</tr>
</thead>
<tbody>
<tr>
<td>center</td>
<td>44</td>
</tr>
<tr>
<td>1 hole toward load</td>
<td>30</td>
</tr>
<tr>
<td>2 holes toward load</td>
<td>18</td>
</tr>
<tr>
<td>3 holes toward load</td>
<td>7</td>
</tr>
<tr>
<td>1 hole (from center) toward effort</td>
<td>57</td>
</tr>
</tbody>
</table>

2. In which direction did you move the fulcrum in order to lift the two-hex-nut load with a one-hex-nut effort? 
   toward the two-hex-nut load

3. How far did you have to move the fulcrum? 
   about 2.5 holes

4. What can you conclude about the distance between the fulcrum and the load and the amount of effort necessary to move the load?
   The greater the distance between the fulcrum and the load, the more effort that is required to move the load. Likewise, the smaller the distance, the less effort that is required.

### Guiding the Activity

1. Write the word *machine* on the board. Begin a discussion by asking, What are machines? What purpose do they serve?

   Tell students that machines are mechanical devices that often permit people to do work more easily.

   Write the term *mechanical advantage* on the board. Explain that because machines usually perform work with less effort, they are said to provide a mechanical advantage.

   Ask, How many different types of machines can you name?

   Ask, What provides the energy to operate each of the machines listed on the board?

### Additional Information

Accept all reasonable answers.

List students' responses on the board.

Some machines are powered by electricity, others are powered by diesel fuel or gasoline, and so on.
2 Write *Simple Machines* on the board. Tell the students that a **simple machine** requires only the force (effort) of a human or animal to perform work. There are six types of simple machines: the lever, the wheel and axle, the inclined plane, the pulley, the wedge, and the screw. List each of these on the board under the heading Simple Machines.

3 Circle the word *lever* on the board. Explain that **levers** are simple machines that transmit, and sometimes magnify, force. All levers consist of four components: an **arm** (a beam or bar), a **fulcrum** (the pivot point), a **load** (the object to be moved), and an **effort** (the force needed to move the load). Write these terms on the board and draw a line from each one to the term *lever*.

![ diagram of a lever ]

△ *Figure 2-1. The four components of a lever.*

Explain that one of the simplest examples of a lever is the playground seesaw. On a seesaw, the fulcrum is located at the center of the board (arm), while the children seated at either end take turns being the effort and the load (see Figure 2-1).

Tell students that in this activity, they will construct a lever system and experiment with the positioning of the load, effort, and fulcrum.

*One child provides the force (effort) to move the other child (the load).*
Distribute a copy of **Activity Sheet 2** to each student, and two plastic cups, a fulcrum, three hex nuts, sixty paper clips, a pegboard beam, and two pieces of tape to each team.

Instruct the teams to mark the center of their pegboard beam with a pencil and to tape a plastic cup to each end of the beam. Have them set up the lever system by centering the pegboard beam on top of the fulcrum (see Figure 2-2).

Have the students place one hex nut into one of the cups. Tell them to drop paper clips into the other cup, one by one, and to count the number of clips it takes to lift the hex-nut end of the beam. Have the students record this number in the chart on Activity Sheet 2.

The center of the pegboard beam can be determined by counting the holes. The cups should be equidistant from the ends of the pegboard.

Students should add enough paper clips to cause the "effort end" of the beam to touch the desktop.

![Figure 2-2. The lever system.](image)

Encourage the students to repeat the experiment several more times, moving the fulcrum first one hole, then two, and then three holes closer to the load. Finally, tell students to repeat the experiment by moving the fulcrum one hole (from center) toward the effort. Remind students to record their observations on the activity sheet.
Guiding the Activity

5. Ask, What was the load in this experiment? What was the arm?
What was the force, or effort?

6. Have the students remove the paper clips from the effort cup and add a second hex nut to the load cup. Ask, How can you lift these two hex nuts with just one hex nut?
Have the students use the effort of one hex nut to lift a two-hex-nut load and record the position of the fulcrum on their activity sheets.
Have students answer questions 2-4 on their activity sheets.

7. When students have finished, ask, What effect did moving the fulcrum closer to the load have?
What effect did moving the fulcrum farther from the load have?

Additional Information
The hex nut was the load. The pegboard beam was the arm.
The paper clips

By placing the single hex nut in the effort cup and moving the fulcrum toward the two-hex-nut load cup.

Less effort was needed to lift the load.
More effort was needed to lift the load.

Reinforcement
Ask students if they have ever seen someone use a jack to elevate a car and change a tire. Ask, Which part of the jack acted as the arm? The effort? Was the fulcrum closer to the car or to the person jacking up the car? Why? (Answer: The handle that was used to "pump" the jack was the arm, and the pumping motion was the effort. The fulcrum was closer to the car so that less force would be needed to lift it.)

Clean Up
Return the fulcrums, hex nuts, plastic cups, paper clips, pegboard beams, and roll of tape to the kit.

Science at Home
Have students examine the type of can opener that punches a triangle-shaped hole in a can. Ask them to describe the arm, fulcrum, load, and effort of this household lever.

Science Journals
Have students place their completed activity sheets in their science journals.
Connections

Science Challenge

Introduce and explain the three types (classes) of levers, using the diagrams shown below. Make sure students note the different positions of the fulcrum, load, and effort in the three types. As you explain each type, identify two or three examples, and ask students to offer additional examples.

First class
crowbar, shovel, claw hammer, used for prying

Second class
hinged door, wheelbarrow, pry-up bottle opener

Third class
fishing rod, baseball bat, broom

Science Extension

- Ask students to look at home and in the tool department of a hardware or gardening store to find and list examples of levers. Tell them to include tools that incorporate two levers—for example, scissors, pliers, and tweezers. If students have done the Science Challenge connection, also have them list the levers by class. In a follow-up discussion, have students share the examples they found. Ask volunteers to draw examples on the board and label the positions of the fulcrum, effort, and load.

- Have students recall the equation for calculating work: \( W = F \times d \). Explain that simple machines make doing work easier (requiring less effort) by either magnifying the force used to move an object or increasing the distance the object is moved. Ask students to describe examples of magnified force or increased distance produced by various levers.

Science and the Arts

As a continuing project throughout this module, students can create a bulletin board display of various examples of simple machines, beginning with levers in this activity. Encourage students to use creative methods of representing the machines, including three-dimensional models as well as pictures they have cut from magazines or drawn.

Science and Health

Encourage students to identify examples of levers in the human skeletal system. To lift an object with the hand, for example, a muscle in the upper arm pulls upward on a bone in the lower arm, with the elbow joint as the fulcrum. If possible, borrow a life-size model of a human skeleton so students can observe such levers directly.

Science and Math

- Have students calculate the amount of effort needed to balance an object with a lever, using the following formula: \( E \times d = L \times d \) (effort times its distance from fulcrum equals load times its distance from fulcrum). Work through one or two sample problems with the class—for example, how much effort is required to balance an object that weighs 5 newtons and is 10 cm from the fulcrum if the effort is applied 20 cm from the fulcrum? \( (E \times 20 = 5 \times 10; E \times 20 = 50; E = 2.5 \text{ newtons}) \) Provide additional problems for the class to solve.

- Explain that the mechanical advantage of a lever can be calculated by dividing the length of the effort arm by the length of the load arm. In the sample problem above, for example, the mechanical advantage would be \( 20/10 \), or 2—a force of half the weight of the load is needed to lift the load using the lever.
OBJECTIVES

Students examine friction and how it affects the amount of force needed to move an object a certain distance.

The students

> observe the effects of friction
> examine variables that increase and decrease friction
> discover one method of reducing friction

SCHEDULE

About 40 minutes

VOCABULARY

friction
lubricant

MATERIALS

For each student
1 Activity Sheet 3

For each team of four
1 brick, half†
1 meterstick*
1 spring scale
1 piece string (from Activity 1)
1 wooden board†

For the class
paper towels*
1 tube petroleum jelly
8 shts sandpaper

1 pair scissors*
1 roll tape, masking
8 shts waxed paper

*provided by the teacher
†in separate box

PREPARATION

1 Make a copy of Activity Sheet 3 for each student.

2 Cut each sheet of sandpaper into strips approximately 8 cm (about 3 in.) wide and 25 cm (about 10 in.) long. Cut each sheet of waxed paper in half.

3 Each team of four will need a brick half, a spring scale, a meterstick, a 1-m piece of string, three strips of sandpaper, two pieces of waxed paper, a wooden board, a few long strips of masking tape, a dab of petroleum jelly, and some paper towels.

BACKGROUND INFORMATION

The number-one enemy of any machine is friction. Friction is a force that resists motion whenever the surfaces of two objects rub against each other.

Regardless of how it may feel, no surface is perfectly smooth. All surfaces contain imperfections—tiny bumps, craters, and sliverlike “projections.” When two surfaces are rubbed against each other, the roughness of one surface catches on the roughness of the other surface, resulting in friction. Lubricants are substances that reduce friction between solid surfaces by smoothing over the bumps, craters, and projections on these surfaces.

In this activity, students pull a heavy object over surfaces that produce varying degrees of friction, then observe one method of reducing friction.
**Activity Sheet 3**

**Friction**

Work = Force × distance

1. Record your observations in the table below. For each surface tested, calculate the amount of work performed.

<table>
<thead>
<tr>
<th>Surface tested</th>
<th>Force (newtons)</th>
<th>distance (meters)</th>
<th>Work (joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>wooden board</td>
<td>6</td>
<td>0.6</td>
<td>3.6</td>
</tr>
<tr>
<td>sandpaper</td>
<td>9</td>
<td>0.6</td>
<td>5.4</td>
</tr>
<tr>
<td>waxed paper</td>
<td>3</td>
<td>0.6</td>
<td>1.8</td>
</tr>
</tbody>
</table>

2. On which surface was the most amount of work done by moving the brick? Why?
   The sandpaper; the friction was the greatest.

---

**Guiding the Activity**

1. Begin by instructing the students to stand behind their desks with their chairs pulled out. Tell them to push their chairs in, then pull them back out again. Ask, **Why did you have to use force to move your chair?**

   Have the students observe, feel, and then describe the texture of both the floor and the feet of their chairs. Have them pay particular attention for signs of wear.

   Ask, **What caused the wear?**

   Explain that no matter how smooth a surface may feel, there are always rough spots—tiny bumps, craters, and sliverlike "projections"—on that surface. When the chair was pushed and pulled, the roughness on the surface of the floor rubbed against the roughness on the surface of the chair feet, making it somewhat difficult for the two objects to slide past each other.

---

**Additional Information**

Answers will probably involve the weight of the chair.

The students will probably say that dragging the chairs across the floor caused the wear.
**Guiding the Activity**

Write the word *friction* on the board. Explain that *friction* is the resistance created by two surfaces rubbing together.

2. Have the students rub their hands together briskly until their palms become warm. Then ask, *Where did the heat come from?* Explain that when two objects are rubbed together, the friction between the two surfaces produces heat. Tell students that in this activity, they will investigate friction, its causes, and how to reduce it.

3. Distribute a copy of *Activity Sheet 3* to each student, and a wooden board, a spring scale, a piece of string, half of a brick, a meterstick, three sandpaper strips, two pieces of waxed paper, and a few long strips of masking tape to each team. Have students use their metersticks to measure the length of the wooden board.

4. Instruct the students to place the board flat on the floor or desktop. Tell them to tie one end of the string around the brick and the other end to the spring scale, and place the brick at one end of the board (see Figure 3-1). Have one student hold the board still while another uses the spring scale to pull the brick the entire length of the board.

![Figure 3-1. The setup.](image-url)

**Additional Information**

*Students may suggest that friction produced the heat.*

*Each board is 0.6 m (60 cm) long.*

*Students should tie the string around the brick so that no string is under the brick as it is pulled.*
Have the students record on their activity sheets the force required to move the brick and the distance the brick was moved. Then have them calculate the amount of work done.

Next, instruct the students to place their sandpaper strips end to end and tape them to the board. Tell them to use the spring scale to pull the brick across the sandpaper the entire length of the board. Remind them to record their results on Activity Sheet 3.

Finally, instruct the students to remove the sandpaper, place the pieces of waxed paper end to end, and tape them to the board. Tell them to repeat the procedure, dragging the brick the length of the board. Remind them to record their results on the activity sheet.

After everyone has finished experimenting, recording, and calculating their results, ask, In which of the three setups did you do the most work?

Ask, Why do you think more force was needed to move the brick across the sandpaper than across the other surfaces?

Ask, What was different about the board in each setup?

Ask, In which setup was the brick easiest to move?

You may need to remind them of the equation $W = F \times d$.

The students should realize that, because the distance was the same for each trial, they did the most work when they used the most force—that is, when they moved the brick across the sandpaper.

The students might point out that the surface of the brick seemed to stick to, or get caught on, the surface of the sandpaper.

The smoothness of the surface of the board when the brick was moved across the waxed paper.
### Guiding the Activity

**Ask, Why do you think the brick moved most easily across the waxed paper?**

**Ask, In which situation did the brick and the surface of the board display the most friction? The least friction?**

**Ask, What rule can you state about friction and the surfaces of objects rubbing against one another?**

**Ask, What other variables might increase or decrease friction between two surfaces?**

Tell students to rub their thumb and forefinger together and listen to the sound it makes. Tell them that this sound is produced by the friction between the surfaces of their two fingers. Ask, **What else do you notice about your two fingers?**

**Walk around the room and apply a dab of petroleum jelly to each student’s forefinger. Tell the students to rub their thumb and forefinger together again. Ask, What do you observe now?**

**Write the word lubricant on the board. Explain that a lubricant is a substance that reduces friction between two moving parts.**

**Ask, Is petroleum jelly a lubricant? Can you name any other lubricants?**

Distribute paper towels for the students to wipe the petroleum jelly from their fingers.

### Additional Information

If the students do not mention it, point out that the surface of the waxed paper was smoother than both the surface of the plain board and the surface of the sandpaper, and so did not catch as much on the rough surface of the brick.

The students should note that the most friction occurred when the brick was moved over sandpaper, and the least friction occurred when the brick was moved over waxed paper.

The smoother the surfaces that rub together, the less friction there will be.

If the students do not mention it, prompt them to think about wet and dry surfaces.

Students may notice that their fingertips have become warm. Remind them that heat is produced by friction.

Students will notice that the sound has been reduced or eliminated, and that their fingertips did not become as warm this time.

Yes, petroleum jelly is a lubricant. Oil, grease, and other slippery liquids or semisolids are also used as lubricants.
REINFORCEMENT
Have students describe what would happen if, as they walked, there were no friction between their shoes and the sidewalk. How does snow or ice affect friction?

SCIENCE JOURNALS
Have students place their completed activity sheets in their science journals.

CLEANUP
Have the students discard the waxed paper and the paper towels and return the wooden boards and spring scales to the kit. They should leave the strings tied to the bricks for use in Activity 4. Save the sandpaper strips for use in Activity 5.
Connections

Science Extension

Have students use the following procedure to determine whether increasing the mass of an object affects its speed down a slope. Tie one end of a length of smooth thread to a doorknob, and tie the other end to a heavy object. Position the object on the floor so the thread is stretched taut. Unbend a paper clip to form an S-hook, hang it at the top of the slope, and put a metal washer on the hook. Time how many seconds it takes for the washer to reach the bottom of the slope. Repeat the procedure adding one washer at a time. Students will discover that increasing the object’s mass increases its speed because the opposing force of friction is in effect “overwhelmed” by the increased force of the more massive object descending the string.

Obtain an ice cube and a blunt knife. Tell students that you will try to cut through the cube, first by simply pressing down on the knife and then by sawing back and forth with it. Which method is more successful, and why? (Sawing, because the friction of the knife against the cube creates heat that melts the ice.)

Science and Math

Have students create a bar graph of their results from the activity sheet investigation with the horizontal axis labeled Types of Surfaces and the vertical axis labeled Work (in joules).

Have students create a bar graph of their results from the first Science Extension connection, with the horizontal axis labeled Number of Washers and the vertical axis labeled Time (in seconds). Students also could determine the mass of one washer and create a line graph with the horizontal axis labeled Mass (in newtons). Students can then extrapolate the speeds of masses they could not test, such as masses equal to 1-in. and 2-in. washers.

Science, Technology, and Society

Students might enjoy reading about attempts throughout history to design and build perpetual motion machines. Have students explain why such machines are impossible.

Encourage students to research and report on hovercraft and hydrofoils—methods of transportation whose operation relies on reducing friction between the vehicle and a surface.

As appropriate, encourage supervised use of the Internet for research projects related to simple machines. A list of related websites is provided in the References and Resources section.

Science and the Arts

Ask a student, parent, or teacher who plays a bowed instrument to demonstrate it to the class. Explain that the sound production depends on friction between the bow and the strings and that the musician applies rosin to the bow to maximize friction.

Science and Language Arts

Ask students what everyday life would be like without friction. Commonplace activities such as walking and writing would be impossible. Suggest that they write poems, short stories, or skits about life in a frictionless world.

DELTA SCIENCE MODULES Simple Machines 31
How Are Work and Energy Related?

Suppose you push a shopping cart a certain distance through a store. Then, suppose a friend pushes on a wall with all his strength, but the wall does not move. Who is doing work? Scientists say that work is done only when a force makes something move. So pushing the grocery cart is work because the cart moves. Pushing on the wall is not work because the wall does not move.

To calculate work, you need to know how much force was applied to an object and the distance the object moved (Work = Force x distance). Work is measured in joules.

When scientists talk about energy, they are talking about the ability to do work. Anything that does work uses energy.

Things that are moving, such as a runner, have energy of motion—or kinetic energy. The faster something moves, the more kinetic energy it has.

If you are on a swing moving forward and up, you have kinetic energy. But when you reach the highest point in your swing, you stop for an instant. For that instant, you have no kinetic energy. All your energy is potential energy, which is stored energy. Your potential energy came from your kinetic energy. As you start to swing back down, your potential energy is changed back to kinetic energy. As you swing, you always have the same amount of energy. It just changes back and forth between kinetic and potential energy.
What Makes Things Move?

If you look around, you’ll see all kinds of moving things—from cars and trains to leaves on trees. But what makes some things move while other things stand still? A force is needed to make an object move. A force is a push or a pull. A force is also needed to make a moving object slow down, change direction, or stop moving. If you drop a ball, it falls to the ground. Gravity, the force that pulls objects toward the center of Earth, is acting on the ball. The unit used to measure force is called the newton.

About 300 years ago Sir Isaac Newton wrote that a moving object will keep moving unless a force acts on it. A ball rolling on a rug will slow down and stop because of friction. Friction is a force caused by one object rubbing against another. Friction between the ball and the rug slows and stops the ball.

Newton discovered that a still object will remain still unless a force acts on it. A ball sitting on a level floor will not start to move unless you push it. The tendency of an object to stay in motion or to stay still is called inertia.

Some objects move faster than others. The speed of an object tells how fast it is moving. Speed is usually described in terms of how far the object moves each second, minute, or hour.

A force can be a push or a pull. To make a wagon move, you can pull it or you can push it from behind.
**Lever**

*Levers* are machines that do work by turning around a fixed point. The point at which the bar of a lever pivots, or turns, is called the **fulcrum**. The force you apply to a lever is called the **effort**. The distance from the fulcrum to the effort is called the effort arm length. The **resistance** is the force exerted by the load you are trying to move. The distance from the fulcrum to the resistance is the resistance arm length. The closer the resistance is to the fulcrum, the less effort is needed to move the resistance.

Levers can be divided into three classes. They depend on the positions of the fulcrum, effort, and resistance. In first-class levers the fulcrum is located between the effort and the resistance. The effort and resistance move in opposite directions. Seesaws, scissors, and pliers are first-class levers.

*Pliers and scissors are double first-class levers. Effort is applied in two places.*