Anglophone School District - North

Grade 5 Science - Unit Lesson Guide

Forces and Simple Machines

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The Aim of Science Education - Scientific Literacy
The aim of science education in the Atlantic Provinces is to develop scientific literacy.

Scientific Literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

The Three Processes of Scientific Literacy
An individual can be considered Scientifically Literate when he/she is familiar with, and able to engage in, three processes: Inquiry, problem solving, and decision making.

Inquiry
Scientific inquiry involves posing questions and developing explanation for phenomena. While there is a general agreement that there is no such sing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving
The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making
The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important to their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Science Assessment Overview

Science is a hybrid term that houses different disciplines such as: Physics, Chemistry, Biology, Environmental Studies, Engineering, Math, etc. Given this broad spectrum, it is not realistic that we can paint science assessment with a single brush in terms of probes that work for every science activity. However, regardless of school subject, let alone science, the frequency of assessment should be unbalanced with formative assessment occupying 80% of practise and summative with the remaining 20%.

80% Formative - 20% Summative

Formative Assessment
Formative assessment is a range of formal and informal assessment procedures employed by teachers during their learning process in order to modify teaching and learning activities to improve student attainment. It typically involves qualitative feedback (rather than scores) for both students and teacher that focuses on the detail of content and performance. Feedback is the central function of formative assessment. It typically involves a focus on the detailed content of what is being learnt.

Science Formative Assessment falls into 2 distinct categories, and they are divided about how feedback is given. Please be aware that an activity could be informal or formal, it is the purpose of the task that determines purpose.

Informal Formative
Informal Formative Science Assessment acts as a monitoring probe and is distinct because it is not graded.

Formal Formative
Formal Formative Science Assessment provides specific feedback to students, the teachers corresponds via anecdotal feedback, rubrics, and written responses to offer progress to student attainment.

Summative Assessment
Summative assessment seeks to monitor educational outcomes, often for the purposes of external accountability. Usually occurring at the end of a learning unit and determines if the content being taught was retained.

Forces and Simple Machines

Focus and Context

The principal focus in this unit is problem solving. Students should have many opportunities for hands-on exploration to determine how various simple machines reduce effort. They should then be given open-ended challenges involving the reduction of effort in which they can use simple machines. singly or in combinations, to design solutions. Assessment should focus on the students' abilities to design creative solutions, not the one "right" answer. Inquiry also plays a role in this unit, especially in the beginning as students explore the effect of forces on motion.

There are various contexts through which this unit could be addressed. Relating the outcomes to simple machines at home (e.g., nails, screws, wrench, wheelbarrow) would make the unit relevant and useful. Another interesting context would be to relate the outcomes to the human body, and how biotechnology is developing machines to enhance or replace limbs. In both contexts, students can define problems to solve, and design solutions involving simple machines.

Unit Instructional Overview

Forces and their Effects	Friction	Simple Machines:An Introduction	Simple Machines - Levers	Simple Machines - Pulleys, Systems of Machines
Describing Force	Prior Knowledge	Using Simple Machines	Levers	Using Pulleys
Increasing and Decreasing Force	Access Prior Knowledge		Learning About Levers	Designing a Simple Machine
Measuring Force	1st Cycle - Activity – Sliding Blocks			
	2nd Cycle - Activity – Reducing friction			
	3rd Cycle - Activity – Rollers, wheels and axles			
	4th Cycle - Activity – Wheels			

* - EECD Grade 5 Inquiry package - available at
https://portal.nbed.nb.ca/tr/lr/k-8Science/Pages/default.aspx

Forces and Simple Machines - Curriculum Outcomes

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<tr><td colspan="2">Simple Machines: Pulleys, Systems of Machines</td><td colspan="2">303-20, 204-3 compare the force needed to lift a load using a single pulley system with that needed to lift it using a multiple pulley system, and predict the effect of adding another pulley on the load-lifting system</td><td colspan="2">204-7 design a system of machines to solve a task</td></tr>
<tr><td colspan="2">207-1, 206-6 communicate questions, ideas, and intentions; listen to others; and suggest improvements to the systems of machines designed by students in class</td><td colspan="2">107-8 describe examples of how simple machines have improved living conditions</td><td colspan="2">205-8, 105-5 identify examples of machines that have been used in the past and have developed over time, using information sources such as books, software packages, and the Internet</td></tr>
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Forces and Simple Machines
Strand - Forces and their Effects

General Curriculum Outcomes	Specific Curriculum Outcomes
303-12 investigate different kinds of forces used to move objects or hold them in place	303-12, 303-13 observe, investigate and describe how forces can act directly or from a distance to cause objects to move or remain in place
303-13 observe and describe how various forces, such as magnetic, mechanical, wind induced, and gravitational, can act directly or from a distance to cause objects to move	
104-7 demonstrate the importance to using the language of science and technology to communicate ideas, processes, and results	104-7 describe forces as contact or non-contact
303-14 demonstrate and describe the effect of increasing and decreasing the amount of force applied to an object	303-14 demonstrate and describe the effect of increasing and decreasing the amount of force applied to an object
205-4 select and use tools for measuring	205-4, 205-5 describe forces both qualitatively and quantitatively using their observations
205-5 make observations and collect information relevant to a given question or problem	
205-6 estimate measurement	205-6 estimate the force needed to lift or pull a given load in standard or nonstandard units

Describing Force

Outcomes:
303-12 investigate different kinds of forces used to move objects or hold them in place
303-13 observe and describe how various forces, such as magnetic, mechanical, wind induced, and gravitational, can act directly or from a distance to cause objects to move
104-7 describe forces as contact or non-contact

Lesson Activity Overview
Teachers can engage students in a KWL Activity about forces to begin this unit. The purpose of the KWL or a pre-unit assessment is to allow the teacher to determine students' conception about forces.

A force is a push or a pull

In this lesson opportunities should exist for students to **experience** several types of contact and non-contact forces. A great way for students explore the different types of forces it to create centers in the class. At each center a different learning experience is set up (i.e. wind from fan, magnetic, gravitational, mechanical, etc...) and students rotate through the centers. 303-12

At each center, students will be asked to describe each force as contact or non-contact. As well, students will be expected to describe what they have observed at each of the centers. 303-13, 104-7

Students should be able to identify the forces acting on objects as contact or non-contact. For example, if a student is lifting a paper clip in the air with a magnet, the non-contact forces of gravity and magnetism should be identified. A common misconception of students is if there is no motion, to presume there is no force. Teachers can explore students' conceptions of force by asking them to identify the forces acting on a book that is resting on a table. If they have difficulty conceptualizing the force of the table on the book, which is equal but opposite to the force of gravity pulling the book downwards, engage them in the following activity. Ask them to hold out their hands and then place book on their hands. They will feel the force of the book on their hands, and feel their hands straining to hold the book in this upward position. 104-7

Assessment: Informal Formative
Ensure students have experienced forces 303-12

Assessment: Formal Formative
Ensure that students were able to appropriately describe forces as either contact or non-contact 104-7

Ensure that students recorded observations from contact and non-contact forces 303-13

Describing Force

At each station, Identify the force as either contact or non-contact in the grey title box.
In that station's square, describe the force.

Station 1: ______________________	**Station 2:** ______________________

Station 3: ______________________	**Station 4:** ______________________

Increasing and Decreasing Force

Outcomes:
303-14 demonstrate and describe the effect of increasing and decreasing the amount of force applied to an object

Lesson Activity Overview
After students investigate the various types of forces, the next step is to have them to determine how they can increase or decrease the amount of force being exerted, and to observe what happens.
In most cases, changing the amount of force changes the speed at which an objects moves, but in some instances, however, it may have no effect on the motion of an object. For example, students may push on a wall, but the wall will not move.

Use the learning centers from the previous lesson. Have student go back and rotate through each station. The objective at each station is for students to design and describe a way to increase and/or decrease the amount or force applied at the station. 303-14

Assessment: Formal Formative
Ensure that students, at each station, have described the effect of increasing and/or decreasing the amount of force applied to the objects at each station 303-14

Increasing and Decreasing Force

At each station, Identify the force in the grey title box. In that station's square, describe how the amount of force applied can be increased and/or decreased.

Station 1: ________________________	**Station 2:** ________________________

Station 3: ________________________	**Station 4:** ________________________

Measuring Force

Outcomes:
205-4, 205-5 describe forces both qualitatively and quantitatively using their observations
205-6 estimate the force needed to lift or pull a given load on standard or nonstandard units

Lesson Activity Overview
Once students are comfortable with the concept of a force, and how to increase or decrease the amount of a force using terms such as "more" and "less", they can measure forces quantitatively using tools such as a spring scale or elastic bands.

•Students may be introduced to the Newton as the unit of force by illustrating how a spring scale shows the degree of force being applied. It is not important that students know the definition of a unit, but simply that it is a standard unit indicating the amount of force being applied. The greater the force, the greater the number of Newtons. Using spring scales, students can note the number of Newtons it takes to lift or pull various objects. Note, 1 kilogram is approximately equal to 10 Newtons)

<u>Using a Spring Scale</u>
Record the force used to lift an object (science book, pencil case, scissors, etc...), record the force in Newtons 205-4, 205-5

<u>Using a a student constructed Elastic Band instrument for measuring force</u>
Students may construct their own instruments for measuring force. For example, they might use elastic bands to measure how far they stretch, or SlinkiesTM to measure how far they stretch due the force of gravity as well as an applied force. Caution: possible injuries due to breakage of elastic bands. 205-4, 205-5

<u>Using a Pasco Force Sensor</u>
If available, students can use force sensors connected to computer interface equipment to measure and graph the force acting on an object as it is lifted in the air or pulled up a ramp. 205-4, 205-5

The above investigations can be followed by activities which involve estimating the force required to lift various objects or answering questions, such as:
• Does the angle of a ramp affect the amount of force required to pull/push an object up it?
• Does it take more force to open a door when pushing closer to the hinge or closer to the doorknob?
• Does it take more force to move an object faster?
Students could estimate the amount of force using standard (i.e., Newton) or nonstandard (e.g., the length an elastic band stretches, the amount the SlinkyTM

stretches) units. These activities help students appreciate the importance of accuracy, and working collaboratively with others during investigations. 205-6

Assessment:Informal Formative
Ensure that students have participated in a variety of explorations using devices that measure force 205-4

Assessment:Formal Formative
Ensure that students have recorded either the qualitative or quantitative results from the different possible explorations of force 205-5

Ensure that students have estimated the force required in the various scenarios 205-6

Forces and Simple Machines
Strand - Friction

General Curriculum Outcomes	Specific Curriculum Outcomes
204-1 propose questions to investigate and practical problems to solve	204-1, 204-5, 204-7 propose questions to investigate related to friction, identify variables to control when exploring the questions, and plan steps to determine factors that affect friction
204-5 identify and control major variables in their investigations	
204-7 plan steps to solve a practical problem and to carry out a fair test of a science-related idea	
303-15 investigate and compare the effect of friction on the movement of an object over a variety of surfaces	303-15 investigate and compare the effect of friction on the movement of objects over a variety of surfaces
303-16 demonstrate the use of rollers, wheels, and axles in moving objects	303-16 demonstrate the use of rollers, wheels, and axles in moving objects
106-4 describe instances in which scientific ideas and discoveries have led to new inventions and applications	106-4, 107-1 describe how understanding of the concept of friction has led to the development of products that reduce and enhance friction
107-1 describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs	

New Nouveau Brunswick
Be...in this place • Être...ici on le peut

Science Resource Package: Grade 5

Forces and Simple Machines: Friction

New Brunswick Department of Education

December 2010

Prior Knowledge:

Students are not required to know about friction, but may know:

- About making friction by rubbing hands together
- That friction makes heat
- It is often easier to move something on wheels
- Certain shapes move more easily than other shapes, e.g. wheels vs. ovals
- What a force is

Common Misconceptions:

- Friction is not useful.
- The amount of friction between objects cannot be changed.
- Wheels are independent (no axle or movable parts attached)

Did You Know?

The Teacher's Guide for the Grade 5 resource, "Putting it in Motion" (on page 43, 49) contains background information about friction.

Some other background information on friction can be found at:

http://www.howstuffworks.com/friction-info.htm

http://www.edu.pe.ca/southernkings/friction.htm

http://www.darvill.clara.net/enforcemot/friction.htm

http://www.learner.org/workshops/force/workshop3/highlights.html#3

Some supporting literature might include:

What is Friction? by Lisa Trumbauer.
From Wedges to Waterwheels by Michael Woods, Mary B. Woods
Experiments with Friction a True Book by Salvatore Tocci

Instructional Plan

Access Prior Knowledge

Activity

Use a "Think-Pair-Share" method for the following questions where students think about the answer themselves, then share their ideas with a partner, then share with the class.

Cross-curricular links:
ELA
1. Students will be expected to:
   a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
   c) Explain and support personal ideas and opinions
2. Students will be expected to:
   a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
   b) Use word choice and expression appropriate to the speaking occasion

3a. Students will be expected to:
Demonstrate an awareness of the needs, rights, and feelings of others by listening attentively and speaking in a manner appropriate to the situation

Ask students: *Imagine there is a toy car on the floor and you give it a push (don't hold on). What happens to the car? Imagine a there is a wooden block on the floor and you give it a push. What happens to the block?* You could actually do this rather than imagining it.

Why did the car and block go a distance and then stop? Why did they travel different distances before stopping?

How can the distance travelled by the block and the distance travelled by the car be changed?

On a piece of chart paper or on the smart board, create a list of their answers. Accept all answers as the characteristics of friction will be revisited throughout the following cycles.

✓ **Assessment:**
Note the concepts and misconceptions students are expressing. You will need to know these to plan effective questions for subsequent activities and discussions so that studer will examine and adjust their alternate conceptions.

Post student versions of curricular outcomes on chart paper (see page 24). Inform students that these outcomes will be addressed over the next portion of the unit. Point out to students which outcomes are being addressed in each activity.

🚲 1st Cycle

✪ Curriculum Outcomes

(Blue outcomes are in the French Immersion curriculum but not in the English compacted curriculum)

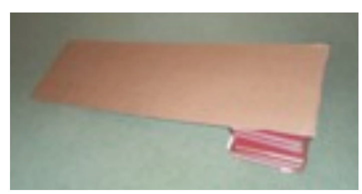
104-7 Demonstrate the importance of using the languages of science and technology to communicate ideas, processes, and results
204-3 State a prediction and a hypothesis based on an observed pattern of events
204-5 Identify and control major variables in their investigations
204-7 Plan steps to solve a practical problem and to carry out a fair test of a science-related idea
205-4 Select and use tools for measuring
205-5 Make observations and collect information relevant to a given question or problem
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations
303-15 Investigate and compare the effect of friction on the movement of an object over a variety of surfaces

✋ Activity – Sliding Blocks

Materials:

Wooden blocks of 2 different masses
Textbooks
Long pieces of cardboard (preferably shiny)
Materials to wrap around blocks and cover ramps such as aluminum foil, plastic garbage bags, bubble wrap, sandpaper, balloons, carpet, etc.
Double-sided tape and/or duct tape
Metre sticks and/or tape measures

Part 1 - Have students work in groups or do at the front of the class.



Construct a ramp using textbooks and the long pieces of cardboard. If doing as a demo, change some factors so that it is **not** a fair test. For example: start the block at different places on the ramp, sometimes give it a push, sometimes do not, or measure from different places on the block.

Test how far the wooden block will slide down the ramp. Do not give any further instructions (such as dimensions of the ramp, where to start the block on the ramp, whether to push the block or simply let it slide by itself, etc.).

Once students have done one trial, discuss the results from each group.

Ask the class: *How far did the block slide?*

Record the data on chart paper or smart board. Ask students why they didn't all get exactly the same results.

What are the things that might not have been done the same way?	What/how could we measure?
Possibilities include different ramp heights, some pushing blocks instead of just "releasing" them, different types of cardboard.	Possibilities include where they measure to and from – for example, the starting line for each group, did they use the leading edge of the block, the middle, or the back.

variables (left column) **observations** (right column)

Introduce the concept and importance of a **fair test**. To compare results between "researchers" (i.e. groups) they need to have done the test in the same way. Repeating experiments several times determines if a result happens consistently. Scientists talk about having many **trials**.

The word "**variable**" can be used (or introduced if the students are not familiar with it) to talk about creating a fair test. A fair test must have only one variable changing; the others should remain the same.

Tell students they are to test *how far blocks covered with different materials will slide*.

Have them identify:

What is the one thing we will change? (The materials covering the block.)

What needs to stay the same then? Refer back to chart created above. (For example: students should all use a ramp of the same size/height, place the block at the top of the ramp, simply allow the block to slide down the ramp without pushing it, then measure the distance from the "start line" on the ramp to the closest point on the block.)

How many trials do we need to determine if it happens consistently? At least three times.

Cross-curricular links:
ELA

1. Students will be expected to:
   a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
   c) Explain and support personal ideas and opinions
2. Students will be expected to:
   a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
   b) Use word choice and expression appropriate to the speaking occasion

3a. Students will be expected to:
Demonstrate an awareness of the needs, rights, and feelings of others by listening attentively and speaking in a manner appropriate to the situation

8. Students will be expected to:
   a) Use a range of strategies in writing and other ways of representing to
   - frame questions and answers to those questions
   - record and reflect on experiences and their responses to them
   b) Expand appropriate note-making strategies from a growing repertoire (e.g., outlines, charts, diagrams)

Students will test five different materials selected from those provided, and also test the bare wooden block.

Prior to experiments, students should rank their materials from 1 to 5 in order of which material they think will allow the block to go the farthest compared to just the uncovered wooden block.

The wooden block must be wrapped in each material, ensuring that the surface in contact with the ramp is completely covered by the material.

Students can use the student sheet *Sliding Blocks – Activity 1* found on page 25 to record results.

✓ **Assessment:**
During the student activity, make notes on outcomes (or parts of outcomes) you observe being addressed. Process skill outcomes are part of the curriculum and should be assessed. Using the observation chart or the checklist (see pages 29-33) on a clipboard may be helpful to you. Develop your own code for quick notes.

A suggested code:
√ observed and appropriate,
WD with difficulty,
A absent.

This chart may be used on multiple days, using a different coloured pen or pencil each day and putting the date in the corner. You may not have a symbol or note for every child every day. Some teachers like to focus on a group or two each time. However you choose to make note of your observations, you will always have a sense of who you need to take more notice of and who might need extra support. The information will also help you when it is reporting time.

Activity Part 2

Tell students they are going to conduct a similar experiment to what they have just done, but instead of covering the wooden block, they will cover the ramp with the 5 different materials they used in the first experiment. Have students predict what, if anything, they think will be different from the first activity.

Students can use the sheet *Sliding Blocks – Activity 2* provided on page 26 to record their results.

Reflection: Class Discussion

Remind your class about respectful discussion. The discussion tips on pages 21-22 may be helpful.

Part 1

In this part of the discussion, students may or may not use the word friction. They may talk about the smoothness or roughness of surfaces sliding against each other. Introduce the term friction, if it has not come up already, by using it to help them summarize their results, as opposed to defining it. They will define it more clearly in Part 2 of the discussion.

Ask students:

Which materials allowed the block to move the farthest distance?
Why do you think that happened? (Less friction).

Which materials allowed the block to move the least distance?
Why do you think that happened? (More friction)

Part 2

Ask students:

How did the results differ from the first set of experiments?
How were the results the same?

*What is friction? (*A force (push) against motion by the "bumps" (unevenness) of the surface of the object and surface it moves against).

- Even though it is not possible to see it with our eyes, have students draw a diagram to show what might actually be happening between the surfaces. Have students discuss these representations.

The animations, which can be found on the following sites, allow the surface on which a toy car travels to be changed and may be useful during the class discussion. http://www.bbc.co.uk/schools/scienceclips/ages/8_9/friction.shtml or http://www.sciencekids.co.nz/gamesactivities/friction.html

Cross-curricular links:
ELA

1. Students will be expected to:
   a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
   b) Ask and respond to questions to seek clarification or explanation of ideas and concepts
   c) Explain and support personal ideas and opinions
   d) Listen critically to others' ideas or opinions and points of view
2. Students will be expected to:
   a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
   b) Use word choice and expression appropriate to the speaking occasion
   c) Give and follow precise instructions and respond to questions and directions

3a. Students will be expected to:
Demonstrate an awareness of the needs, rights, and feelings of others by listening attentively and speaking in a manner appropriate to the situation

Application of Ideas

Ask:

When, in everyday life, is friction useful?

For example:

Allowing snakes to move http://teacher.scholastic.com/dirtrep/friction/snake.htm

Allowing the space shuttle to slow down http://teacher.scholastic.com/dirtrep/friction/shuttle.htm

Sanding icy roads in winter

Putting rosin on a violin bow

Cleats on baseball or soccer shoes

Brushing your teeth

When, in everyday life, is it useful not to have friction?

For example:

Skis on snow

Skates on ice

When sliding across carpet - "carpet burn"

The concepts in this cycle can be extended by using the Bill Nye video "Friction" from http://learning.aliant.net/. It shows many examples of where it is useful to have friction, and where it is useful to have only a little friction.

To access the video, type the title into the search box. Videos are available free of charge at this site. You will need to register, however registration is free. If you try to watch the video without logging in, you will be prompted to do so. Note that a table of contents opens beside the video so that you may select only certain sections for viewing if you wish. There is also the option to watch the video full screen.

ⓘ Teacher note: As a cross-curricular link to Language Arts, the origin of the word *friction* could be discussed. *Frict* comes from Latin and means rub together or chafe.

Revisit information on the chart from the Accessing Prior Knowledge activity (on page 4). Ask: *Is there anything that should be added to or revised? Is there other information we could add?*

Reflection: Journals

Why do you think a crazy carpet would go faster than a wooden sled on a hill?

What could you do to make the sled faster? Why do you think that would work?

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use a range of strategies in writing and other ways of representing to
- record, develop, and reflect on ideas, attitudes, and opinions
- record and reflect on experiences and their responses to them
c) Make deliberate language choices appropriate to purpose, audience, and form, to enhance meaning and achieve interesting effects in imaginative writing and other ways of representing

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Take note of which students can explain that friction is not always the same and why friction varies.

Possible extensions:

- Explore how much friction (traction) different kinds of shoes, sneakers, and winter boots have on one or more surfaces. See this site for some ideas:

  http://www.chabad.org/kids/whatif/default_cdo/aid/884568/jewish/Experiment.htm

- A song about friction: http://www.neok12.com/php/watch.php?v=zX66536e747d7a514265766b&t=Types-of-Forces

Sliding Blocks – Activity 1

1. Choose 5 materials to test.
2. Predict which will go farthest by ranking the materials from 1 to 5 with 1 being "will slide the farthest" and 5 being "will slide the least"

    1.

    2.

    3.

    4.

    5.

3. Wrap your block and slide it down the ramp.
4. Measure the distance and record it in the table below.
5. Repeat with the same material 2 more times.

	1st trial distance (cm)	2nd trial distance (cm)	3rd trial distance (cm)
Nothing			
Material 1			
Material 2			
Material 3			
Material 4			
Material 5			

Sliding Blocks - Activity 2

1. Use the same 5 materials used in Part 1.
2. Predict the distance the block will travel with each material.
3. Cover the ramp in the material and slide the uncovered wooden block down the ramp.
4. Measure the distance and record it in the table below.
5. Repeat with the same material 2 more times.

	Predict distance	1st trial distance (cm)	2nd trial distance (cm)	3rd trial distance (cm)
Nothing				
Material 1				
Material 2				
Material 3				
Material 4				
Material 5				

🚲 2nd Cycle

✪ Curriculum Outcomes

(Blue outcomes are in the French Immersion curriculum but not in the English compacted curriculum)

104-7 Demonstrate the importance of using the languages of science and technology to communicate ideas, processes, and results
106-4 Describe instances in which scientific ideas and discoveries have led to new inventions and applications
107-1 Describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs
107-8 Describe examples of technologies that have been developed to improve their living conditions
204-5 Identify and control major variables in their investigations
204-7 Plan steps to solve a practical problem and to carry out a fair test of a science-related idea
205-5 Make observations and collect information relevant to a given question or problem
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations

Have students rub their hands together. What do they notice? (Friction generates heat). Tell them that sometimes we don't want a lot of friction, especially between moving parts or objects. Can we change the amount of friction? How can we change it?

Activity – Reducing friction

Students will test the force necessary to move a container 30 cm. They will test a variety of materials to see how useful they are in reducing friction.

Materials:

- Styrofoam meat trays or plastic salad containers filled with about 500g of books, blocks or other objects
- Straws
- Pencils or crayons (round)
- Marbles
- Lubricants (liquid soap, WD 40, cooking oil, water, talcum powder)
- Pieces of felt and/or other items they would like to try
- String to wrap around the container and act as an attachment point for a spring scale
- Spring scales

ⓘ Teacher note: There may be less mess involved if identical trays are placed at stations, each station having one way of possibly reducing friction. Students will move to different stations to try different ways of reducing friction. Note that other variables will need to remain the same from station to station. One teacher has shared that plastic trays from a dollar-type store work well and can easily be cleaned and kept for another year.

Provide students with the loaded container. Tell them they need to move their containers 30 cm and that they will test different ways to decrease the friction. Brainstorm with the class the variables that need to be kept the same for all trials.

As a class, establish a procedure that will help ensure a fair test.

For example:

Where do we place the materials to test?
What observations will we make?
How will we know if friction is reduced? (Easier to move, less effort)
How can we measure this effort?

Introduce the spring scale as a useful tool. Explain how they work, how to read them, and how they will attach them to their containers. Students can choose 5 different potential ways of reducing friction for testing. Students can record their findings on the student sheet *Reducing Friction* found on page 27.

After students have tested 5 different materials, they will add or remove weight from their container and test 2 materials again to determine how that affected the force required to overcome the force of friction.

Cross-curricular links:
ELA
1. Students will be expected to:
   a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
   c) Explain and support personal ideas and opinions
2. Students will be expected to:
   a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
   b) Use word choice and expression appropriate to the speaking occasion

3a. Students will be expected to:
   Demonstrate an awareness of the needs, rights, and feelings of others by listening attentively and speaking in a manner appropriate to the situation

8. Students will be expected to:
   a) Use a range of strategies in writing and other ways of representing to
   - record and reflect on experiences and their responses to them
   b) Expand appropriate note-making strategies from a growing repertoire (e.g., outlines, charts, diagrams)

✓ **Assessment:**
On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Class Discussion

Remind your class about respectful discussion. The discussion tips on pages 21-22 may be helpful.

Make a class table showing results from all of the groups.

Discuss how similar the results were and why there were differences in what each group found with similar materials.

Differences may be due to the amount of weight in the container, how they laid out their chosen material on the surface, the amount of material they used (especially in the case of the liquid lubricants). Discuss how the reasons compare to the variables that were to be kept the same.

Ask students: *Why would we want to reduce the amount of friction?*
Answers may include: to make things move more easily, to prevent overheating, to stop things from getting scratched or stretched.

In everyday life, name some times when people change friction on purpose?
Answers may include things like: sanding icy roads, oiling squeaky hinges, wearing ice cleats on their winter boots, putting chains on truck or tractor tires, putting wax on dental floss, sharpening skates, sanding wood with sandpaper, pebbling ice at the curling rink, wearing a slider on one foot when curling, cleaning the ice surface at a rink, flooding the ice surface at a rink, putting studs in winter tires.

Examples of uses of friction (good and bad) can be found at http://www.school-for-champions.com/science/friction_uses.htm

Cross-curricular links:
ELA
1. Students will be expected to:
a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
b) Ask and respond to questions to seek clarification or explanation of ideas and concepts
c) Explain and support personal ideas and opinions
d) Listen critically to others' ideas or opinions and points of view
2. Students will be expected to:
a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
b) Use word choice and expression appropriate to the speaking occasion
3a. Students will be expected to:
Demonstrate an awareness of the needs, rights, and feelings of others by listening attentively and speaking in a manner appropriate to the situation

MATH
SP1: Differentiate between first-hand and second-hand data.

A hovercraft uses air to reduce friction. See the video at http://www.teachersdomain.org/asset/phy03_vid_zhovr/

Revisit information on the chart from the Accessing Prior Knowledge activity (on page 4). Ask: *Is there anything that should be added to or revised? Is there other information we could add?*

Reflection: Journaling

You have a large metal container that contains boxes of unwrapped glasses. The goal is to move it from one side of the room to another without breaking any glasses. It is too heavy to lift and carry across the room. What might you do to easily move the box across the room?

Or

Show students a picture of stone getting moved on rollers (e.g., building pyramids) like http://matthewpippin.com/images/E_Images/Education_LWW/BuildingPyramids6LWW.jpg
Have students explain how friction is getting reduced.

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use a range of strategies in writing and other ways of representing to
- record, develop, and reflect on ideas, attitudes, and opinions
- record and reflect on experiences and their responses to them
c) Make deliberate language choices appropriate to purpose, audience, and form, to enhance meaning and achieve interesting effects in imaginative writing and other ways of representing

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

When reading the journal entries, note whether students can discuss how to reduce friction.

Think like a scientist

Asking good questions is an important skill in science. Initially students will need support. Model the skill with the whole class and students will begin to have the confidence to contribute. After some practice, students will be able to generate questions successfully individually.

Cross-curricular links:
ELA
8a. Students will be expected to:
Use a range of strategies in writing and other ways of representing to
- frame questions and answers to those questions

Present students with a situation and ask them to generate questions that could be investigated scientifically. (These situations and questions do not have to be limited to those that can be done in a classroom.)

Situation:

Bowling lanes have been specially designed to allow balls to roll towards pins at the end of the lane. Different bowling alleys use different amounts and different types of oil on their lanes.

What is one question concerning bowling lanes that could be investigated scientifically?

For example:

Does the amount of oil affect the direction of the ball?
Does a bowling lane have to be oiled the same amount all the way to the pins?

Possible extensions:

- Explore friction on the playground slide. What sorts of fabrics allow you to slide well? Which do not?
- Build a hovercraft. http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collection/cub_/activities/cub_mechanics/cub_mechanics_lesson05_activity1.xml
- Students could research about joints of the human body and how friction is reduced between bones in joints. The following site would be helpful: http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collection/cub_/activities/cub_human/cub_human_lesson03_activity1.xml

Reducing Friction

1. With the weight in your container, move the container 30 cm while reading the spring scale to find the force used.
2. Choose 5 different materials.
3. Place 1 of the materials under the container then try to move the container 30 cm.
4. Record the amount of force necessary (read the spring scale).
5. Repeat using the other 4 materials.
6. Change the amount of weight in your container and test 2 samples again. Record the force necessary.

Material	Force measured (from spring scale)
Just the container on a bare surface	
Material 1	
Material 2	
Material 3	
Material 4	
Material 5	
Change the weight in the container	
Material 1 -	
Material 2 -	

🚲 3rd Cycle

✪ Curriculum Outcomes

(Blue outcomes are in the French Immersion curriculum but not in the English compacted curriculum)

104-7 Demonstrate the importance of using the languages of science and technology to communicate ideas, processes, and results
107-1 Describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs
204-5 Identify and control major variables in their investigations
204-7 Plan steps to solve a practical problem and to carry out a fair test of a science-related idea
205-4 Select and use tools for measuring
205-5 Make observations and collect information relevant to a given question or problem
205-6 Estimate measurements
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations
303-15 Investigate and compare the effect of friction on the movement of an object over a variety of surfaces
303-16 Demonstrate the use of rollers, wheels, and axles in moving objects

Ask students: *Why do we put wheels on objects?*
We are going to look at the effort needed to move across different surfaces using scooters.

Activity –Rollers, wheels and axles

Materials:

Scooter boards (from the gym; for image Google "scooter board")

Variety of surfaces (hard floor, sand, pea gravel, wood chips, snow, grass, etc.)

Measuring device (measuring tape, meter stick)

Stop watch

Table to record results

Pencil

Chalk or object to record starting and ending positions

Using a variety of surfaces, students will be able to estimate the differences in effort needed to push themselves and others across a selected surface in a given amount of time. Students should be given the opportunity to test at least 3 different surfaces. They will need a large surface area to complete each task. Choose which surfaces you would like your students to test.

This activity could be done as a set of work stations, in small groups or with partners. Students could move from one station to the next depending on the proximity of each surface. If this does not work you may need to move from surface to surface as a whole class.

Ask students to find a partner (or place them in pairs). Provide students with the *Rollers, Wheels, and Axles* sheet found on page 28 for recording results, scooter boards, measuring devices and stop watches.

Initially each student will use a scooter to begin at a set point on a surface.

For each surface the students will:

- Sit on the scooter and propel themselves across the surface for a specified time (30 seconds).
- Have students use chalk or some kind of object to indicate the place they are starting from and where they finished.
- Have students estimate the distance they moved.
- They will measure how far they were able to travel in 30 seconds.
- Each student will record their distances on their tables. (The units they use for measuring may vary depending on distance traveled.)

Each student in the pair should do one trial. The experiment should be repeated, but with their partner pushing them instead of the students propelling themselves.

✓ **Assessment:**
On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Class Discussion

Remind your class about respectful discussion. The discussion tips on pages 21-22 may be helpful.

Have students share the results from their trials and have students discuss.

- *What did you notice about the distance travelled and the type of surface?*
- *Why do you think it happened that way?*
- *Was it easier to move yourself or have your partner move you?*
- *Why do we put wheels on some things but not others?*
- *If we had our boxes of books that we tested last cycle, do you think it would be easier to move the boxes or the scooters over the same surfaces?*

Revisit information on the chart from the Accessing Prior Knowledge activity (on page 4). Ask: *Is there anything that should be added to or revised? Is there other information we could add?*

Cross-curricular links:
ELA
1. Students will be expected to:
   a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
   b) Ask and respond to questions to seek clarification or explanation of ideas and concepts
   c) Explain and support personal ideas and opinions
   d) Listen critically to others' ideas or opinions and points of view
2. Students will be expected to:
   a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
   b) Use word choice and expression appropriate to the speaking occasion

Reflection: Journaling

In modern times, most roads have a paved surface. Why would a vehicle use less gasoline driving on a paved road than going the same speed on a dirt road?

Cross-curricular links:
ELA
8. Students will be expected to:
   a) Use a range of strategies in writing and other ways of representing to
   - record, develop, and reflect on ideas, attitudes, and opinions
   - record and reflect on experiences and their responses to them
   c) Make deliberate language choices appropriate to purpose, audience, and form, to enhance meaning and achieve interesting effects in imaginative writing and other ways of representing

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Take note of whether students can explain that friction is different on the two types of surfaces. More friction requires more force (fuelled by the gas) to keep the car moving.

Possible Extensions:

- Research the history of the wheel. Prepare a skit or comic strip showing the evolution of the wheel.

- This website provides some background and current information about wheels and their introduction to society.

http://www.historyforkids.org/scienceforkids/physics/machines/wheel.htm

Rollers, Wheels and Axles

1. Choose a surface to test.
2. Sit on the scooter and have a partner use the stop watch to time you. You have 30 seconds to use your feet to move your scooter as far as you can.
3. After 30 seconds, estimate the distance moved.
4. Measure the actual distance moved.
5. Switch roles with your partner.
6. Next, repeat the procedure above, but have your partner push you instead.

Distance Traveled	Surface 1 ________		Surface 2 ________		Surface 3 ________		Surface 4 ________	
	Estimated distance	Actual distance	Estimated distance	Actual distance	Estimated distance	Actual distance	Estimated distance	Actual distance
________ (Name) (using feet)								
________ (Name) (using feet)								
________ (Name) (pushed by partner)								
________ (Name) (pushed by partner)								

🚲 4th Cycle

✪ Curriculum Outcomes

(Blue outcomes are in the French Immersion curriculum but not in the English compacted curriculum)

104-7 Demonstrate the importance of using the languages of science and technology to communicate ideas, processes, and results

106-4 Describe instances in which scientific ideas and discoveries have led to new inventions and applications

107-1 Describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs

107-8 Describe examples of technologies that have been developed to improve their living conditions

204-3 State a prediction and a hypothesis based on an observed pattern of events

204-5 Identify and control major variables in their investigations

204-7 Plan steps to solve a practical problem and to carry out a fair test of a science-related idea

205-4 Select and use tools for measuring

205-5 Make observations and collect information relevant to a given question or problem

207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations

303-16 Demonstrate the use of rollers, wheels, and axles in moving objects

By the end of this cycle, students will be able to define, explore and give examples of how different wheels will affect speed and distance. Students will also recognize wheel motion as friction.

✋ Activity – Wheels

Materials:

Small item from home with wheels

Ramp

Measuring tapes

Ask students to bring 1 item from home that has wheels (small enough to carry to school).

If possible, arrange students in groups where each student has a different kind of wheeled object (examples: Lego, Hot Wheels car, plastic truck, wooden train, Tech Decks, etc.).

Photos or sketches of each object will be helpful when it comes time to discuss results.

Ask students to create a ramp similar to the one made for the sliding blocks in the 1st cycle. The ramp should only have a slight incline so the objects roll an easy distance to measure.

Review the process of ensuring they are conducting a fair test (ramp at same height, car released not pushed, measuring from same start and finish point on ramp and on object, etc.).

Before testing, students should predict which object they think will travel the farthest, second farthest, and so on.

Students will let their wheeled objects roll down the ramp and measure the distance travelled by each.

Data should be recorded in a table of their own design.

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use a range of strategies in writing and other ways of representing to
- frame questions and answers to those questions
- record, develop, and reflect on ideas, attitudes, and opinions
b) Expand appropriate note-making strategies from a growing repertoire (e.g., outlines, charts, diagrams)

✓ **Assessment:**
On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Class Discussion

Remind your class about respectful discussion. The [discussion tips](#) on pages 21-22 may be helpful.

Have students share the results from their experiments.

If there are similar objects, such as multiple Tech Decks or Lego cars, compare the results found. *Are there differences? Why might that be?*

Ask: *Why don't all wheeled objects travel the same distance?* Lead students to ideas such as looking at the size of wheels, number of wheels, materials they are made from, and weight of the object.

Talk about how wheels are attached to something – an axle. Do any students know what strategies can be used to reduce friction in wheels? Students may have heard of bearings and be familiar with grease. For example, some students may have experience with vehicles like car wheels, farm equipment, skate boards, or know someone who periodically oils their sewing machine. *How are real vehicles able to stop where and when people want?* Many vehicles have disc brakes that use friction between the brake pad and the rotor to slow and stop the wheel. The type of road surface is also important as this simulation shows: www.fearofphysics.com/Friction/friction.html

Cross-curricular links:
ELA
1. Students will be expected to:
a) Contribute thoughts, ideas, and experiences to discussions, and ask questions to clarify their ideas and those of their peers
b) Ask and respond to questions to seek clarification or explanation of ideas and concepts
c) Explain and support personal ideas and opinions
d) Listen critically to others' ideas or opinions and points of view
2. Students will be expected to:
a) Contribute to and respond constructively in conversation, small-group and whole-group discussion, recognizing their roles and responsibilities as speakers and listeners
b) Use word choice and expression appropriate to the speaking occasion

Show students that all wheels are not on vehicles.
www.mikids.com/SMachinesWheels.htm

Revisit information on the chart from the Accessing Prior Knowledge activity (on page 4). Ask: *Is there anything that should be added to or revised? Is there other information we could add?*

Reflection: Journaling

Why does a big truck need a longer distance to stop than a car that is travelling at the same speed on the same road?

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use a range of strategies in writing and other ways of representing to
- record, develop, and reflect on ideas, attitudes, and opinions
- record and reflect on experiences and their responses to them
c) Make deliberate language choices appropriate to purpose, audience, and form, to enhance meaning and achieve interesting effects in imaginative writing and other ways of representing

✓ **Assessment:**
Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Take note of whether students can explain that the truck is heavier than the car so more friction is required to stop it.

Possible Extensions:

- Design and build a race car made of at least five fruits and vegetables. Additional materials such as toothpicks, skewers and a rubber band can be provided. Roll them down a ramp to see whose can go the farthest.

See other students race cars at http://pattonsblog.blogspot.com/2009/11/lunchbox-derby.html , http://www.gcms.k12.il.us/gcmsms/lunch_box_derby1.htm , or http://www.youtube.com/watch?v=QzBzWTWhefM

Compare a wheel without bearings to one with bearings.

Forces and Simple Machines
Strand - Simple Machines: An Introduction

General Curriculum Outcomes	Specific Curriculum Outcomes
205-2 select and use tools to manipulate materials and build models	205-2 use simple machines to reduce effort or increase the distance an object moves
303-17 compare the force needed to lift or move a load manually with the effort required to lift it using a simple machine	303-17 compare the force needed to lift or move a load manually with the effort required to lift it using a simple machine
206-9 identify new questions or problems that arise from learning new information	206-9 identify problems that consider the amount of effort needed to lift or move heavy objects, using the knowledge they gained through the study of forces

Using Simple Machines

Outcomes:
205-2 use simple machines to reduce effort or increase the distance an object moves
303-17 compare the force needed to lift or move a load manually with the effort required to lift it using a simple machine
206-9 identify problems that consider the amount of effort needed to lift or move heavy objects, using the knowledge they gained through the study of forces

Lesson Activity Overview
Simple machines can be used to reduce the effort required to move an object, or increase the amount of distance something moves.

Students could rotate through centres that highlight the use of simple machines such as scissors, a bottle opener, a can opener, an egg beater, tongs, a hammer, a clothes line pulley, pliers, screwdriver, or a monkey wrench. The centres should include common household or school devices that are simple machines, and provide opportunities for students to interact with and use the machines to learn more about them.
As students explore simple machines, emphasis should be given to developing the concepts of “load” and “effort”, and the distances over which these forces are applied. 205-2

*The **load** is the amount of force it would take to move an object without the aid of a simple machine, while the **effort** is the amount of force it takes with the aid of a simple machine*.

During experiments students can determine both load and effort using spring scales or instruments they have devised to measure force. This is achieved by measuring the force needed without the machine (load), and then measuring the force required to move the object with the effort applied to a machine. For example, students could measure the force needed to lift an object 0.5 m upwards in a straight direction, and then measure the force needed to slide the same object up a 2.0 m inclined plane to the same height. They should note that even though it was easier to slide the object up the ramp, they had to pull it for a longer distance. In cases in which a machine reduces the effort required to lift an object (force advantage), the effort force will always have to be applied over a larger distance (e.g., using low gear on a bicycle). In cases in which a machine increases the effort required to lift an object, the effort will have to be applied over a shorter distance, but the object will be lifted a greater distance (distance advantage) (e.g., using tongs). 303-17

Students should now have a good understanding about how much force it takes to move objects, and how much they can lift unaided. Until now students have been using spring scales or constructed force sensors to determine the force required to lift smaller objects or move things small distances. In classroom discussion, ask students how they would move something really heavy, or move something a long distance. For example, how can they lift a heavy box? Better yet, how could they lift it to the tenth floor of a building? Students will have seen heavy machinery, such as cranes and tractors, and may suggest using these to lift objects. They may also suggest pulleys or other simple machines of which they are aware. Students should be encouraged to bring in household machines such as wrenches, hammers, screwdrivers, or pictures or drawings of more complicated systems of machines to set up a classroom display. As the students explore simple machines, the more complicated pictures can be analysed to try to identify the simple machines that they are made from, and how the machines are connected. 206-9

Journal
Things that I would find very hard to lift or move by myself include...
Things I could use to help me move these objects are...206-9

Assessment: Informal Formative
Ensure that students have participated in centers in which they use various simple machines to move a weight 205-2

Assessment: Formal Formative
Ensure that students have compare the force needed to lift or move a load manually with the effort required to lift it using a simple machine 303-17

Ensure that students have answered the journal questions in which they compare lifting objects by themselves and things that make these tasks easier 206-9

Simple Machines Can Make My Life Easier

Take a copy of the table to the various centers around the room. Using a simple machine, determine if the force needed to move or lift the object is less than, equal to, or greater than the weight of the object. Record your findings on the table beside the appropriate activity center 205-2, 303-7

Activity Center	Simple Machine	Required Force
1 ______________________	No Machine	
2 ______________________	Pulley	
3 ______________________	Wheel and Axle	
4 ______________________	Ramp	
5 ______________________	Lever	

Compare your findings. Which simple machine required the least force to move the mass?

Which required the most?

Do you see any advantage to using a simple machine to move a mass?

Forces and Simple Machines
Strand - Simple Machines: Levers

General Curriculum Outcomes	Specific Curriculum Outcomes
303-18 differentiate between the position of the fulcrum, the load, and the effort when using a lever to accomplish a particular task	303-18 differentiate between the position of the fulcrum, the load, and the effort when using a lever to accomplish a particular task
303-19 design the most efficient lever to accomplish a given task	303-19 design the most efficient lever to accomplish a given task

Levers

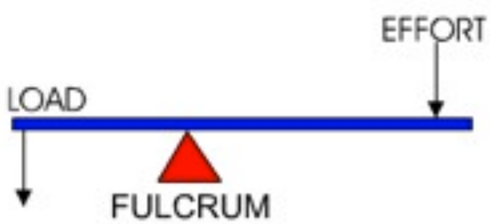
Outcomes:
303-18 differentiate between the position of the fulcrum, the load, and the effort when using a lever to accomplish a particular task
303-19 design the most efficient lever to accomplish a given task

Lesson Activity Overview
Students should be encouraged to investigate the advantages and disadvantages of changing the position of the fulcrum in a lever.

Students should become familiar with the common terms associated with levers (i.e., load, fulcrum, and effort).
The fulcrum *is the place where the rod pivots (or rotates).*
The load *is the scientific name for the weight.*
The effort *is quite simply the amount of effort used to push down on the rod in order to move the weight.*

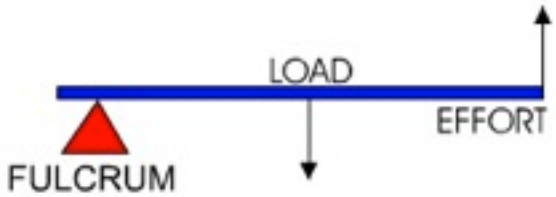
A variety of household levers (e.g., wrenches, nut crackers, wheelbarrows) can be displayed in the classroom. While students should not be required to memorize the characteristics of a first (e.g., teeter totter), second (e.g., wheel barrow), and third class lever (e.g., barbeque tongs), they should explore the differences that occur depending on the relative positions of the effort, load and fulcrum.

CLASS ONE



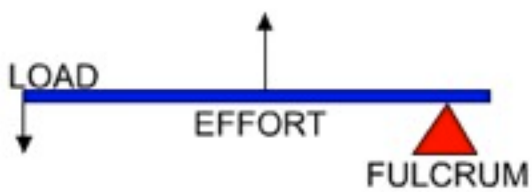
The workman uses a trolley to move the large packing case. The fulcrum is the wheel.

CLASS TWO



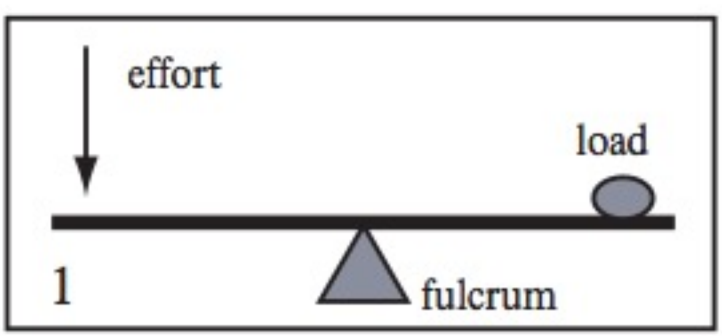
The gardener uses a wheel barrow to lift tools and garden waste. The load is in the centre of the barrow

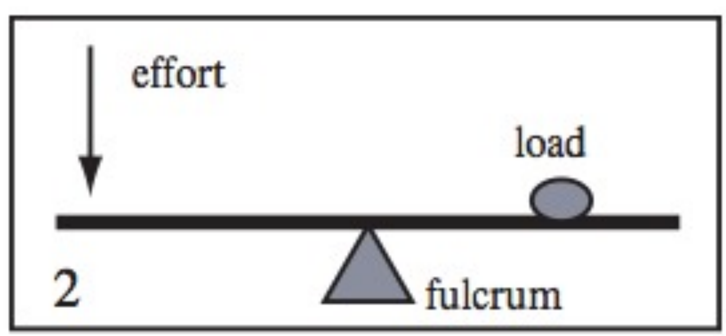
CLASS THREE



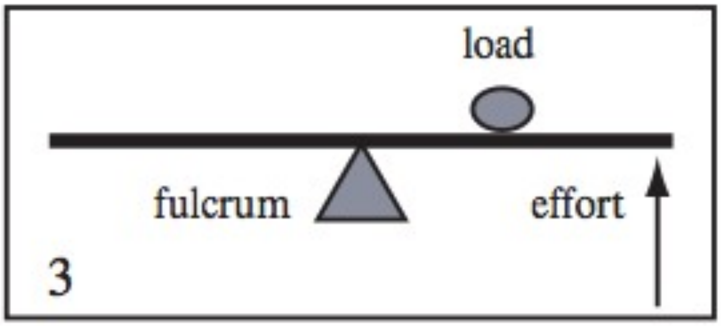
The fisherman catches the 'fish' which becomes the load at the end of the lever.

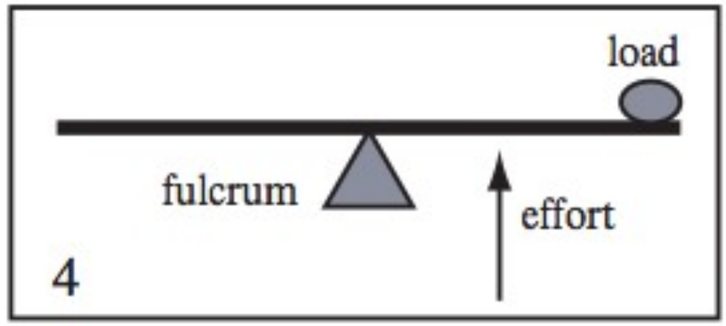
Attention should be paid to the amount of effort needed to lift objects, and the distance the objects are lifted. Students can experiment with the effort required to lift an object when it is closer or further away from the fulcrum (1 and 2).



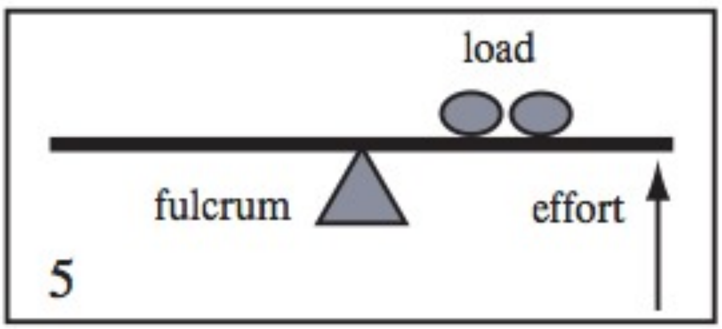


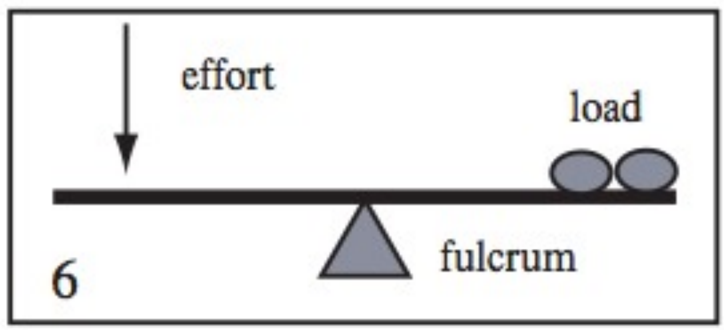
They can also try to lift the object up from the same side of the fulcrum and vary whether they are between the object and the fulcrum (4), or the object is between the lifting student and the fulcrum (3).





They may also try lifting two objects (5 and 6).
A teeter totter-like lever can be used for this exercise.303-18





Students can be given a variety of tasks. Depending on whether the task requires a force advantage (e.g., lifting an extremely heavy object) or a distance advantage (e.g., lifting something over a long distance), students can vary the position of the fulcrum to design a lever appropriate to the task. 303-19

Task

Design levers to:

- lift a book a distance of 0.5 m using the least amount of force possible
- project a marshmallow at a target
- crack a nut

Journal

Show the fulcrum, the load and the effort when you use a hammer to remove a nail from a board. 303-19

Assessment:Informal Formative
Ensure that students have participated with manipulative that differentiate between the position of the fulcrum, the load, and the effort when using a lever to accomplish tasks 303-18

Assessment: Formal Formative
Ensure that students have designed the most efficient lever to accomplish specific tasks 303-19

Ensure that students can respond to their journal entry appropriately about using a hammer to remove a nail from a board 303-19

Learning About Levers

Outcomes:
303-18 differentiate between the position of the fulcrum, the load, and the effort when using a lever to accomplish a particular task
303-19 design the most efficient lever to accomplish a given task

Lesson Activity Overview
Materials:
- Meter sticks
- Cardboard fulcrum
- Any sort of small, uniformly shaped weights (coins, gram weights , fishing weights, etc.)
- Masking Tape
- Cord, string, and/or fishing line
- Lightweight levers for the mobile (drinking straws, bamboo shish-kabob skewers, dowels, sticks or branches, sturdy wire such as cut-up clothes hangers, etc.)
- A variety of materials to act as weights in the mobile (cardboard cutouts, shells, leaves, feathers, aluminum foil shapes. old electronic components, etc.)
- Various art materials for mobile (paint , paste, or glue, etc.)

Inquiry Lesson:
1. Demonstrate the following for the class: Balance a meter stick on your horizontally held index finger. In this case , your finger (acting as the f*ulcrum*, or balance point) will be at the 50 cm mark. You could also use a cardboard fulcrum: a piece of sturdy cardboard bent and taped into a "tent" or wedge shape. and placed on a desk or table . Ask students,
    - What will happen to this "system" if I move my finger (or the cardboard fulcrum) to the 40 cm mark?

   Entertain hypotheses, and then demonstrate the results. Ask students. working in small groups, to explain why the stick did't fall when the fulcrum was at 50 cm, but it did when the fulcrum was shifted to the 40 cm mark. The responses will probably include the notions that in the first case the stick was balanced, but it was unbalanced in the second case. Ask,
    - What do you mean by *balanced*?

   Students should clarify their thinking on this point. Point out that a balanced system can be said to be at *equilibrium*. Inform students that the meter stick is acting as a lever. Ask,
    - Where else do we find levers? (seesaw, pry bar, catapult, long bones on the body, scales, etc.)

2. Next. give each student group a set of weights, a meter stick, and a cardboard fulcrum. Ask them to balance the stick on the fulcrum. Now, ***without changing the balance point*** of the stick (that is, keeping the 50 cm mark at the fulcrum) ask them

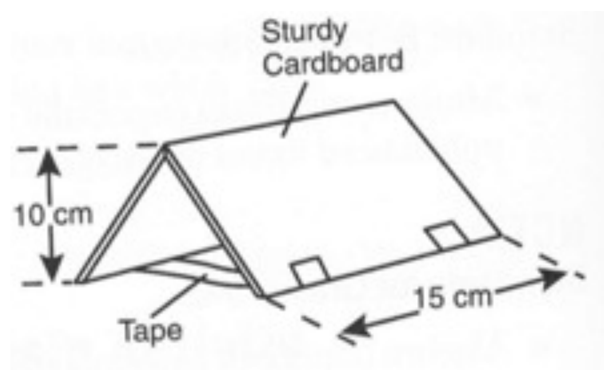
to tape a small weight (e.g., five pennies, five grams, on fishing weight) on top of one end of the meter stick. Does the stick balance? (No.) Ask,

- What can you do to make the stick balance again, *without moving the weight*?

Let the student groups puzzle over this and com up with their own solutions to the problem. You might mention that although they can't move or remove the weights, they can move the stick and they can add weights to the stick. Challenge students to devise as many solutions as they can, try them, and record (in words, drawings, and numbers) their ideas under Step 1 of Activity Sheet 1. Pose the following questions to students:

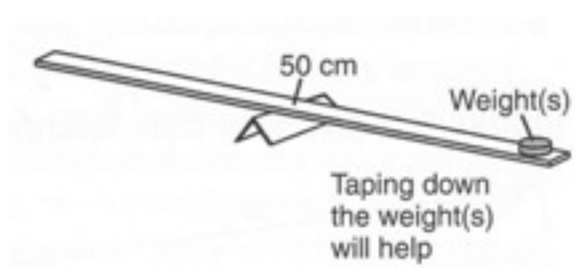
- What worked and what didn't?
- What did you think would work that didn't and why didn't it?
- What patterns do you see in the successful solutions? (the obvious solution may be to simply place an equal weight at the other end of the lever. But how was balance maintained if the balance point was changed, or if more weight was added to the original end of the lever?)
- What did you discover about levers and balance?

3. Remove all weights from the lever and move the fulcrum to the 45 cm mark. Does the lever balance? (No.) Challenge the students to groups to find as many ways as possible to make the lever balance, without moving the fulcrum from the 45 cm mark. Try using only one weight, then two weights, then three weights. Again, students must keep a written record of their attempts (Step 2, Activity Sheet 1), whether successful or not. After allowing sufficient time for exploration, discuss and analyze the results as a group. Ask students,



- What worked?
- What didn't?
- Why or Why not?
- What combinations of weights did you try?
- Do you notice any patterns?
- What have you learned about levers?
- What more do you want to know about levers?

4. The next step in this investigation is to collect numerical data about how the lever operates. Using the image as a guide, have students groups determine the relationship between the location of the fulcrum and the distance the weight must be placed from the fulcrum to make the lever balance. Using the meter sticks and a single weight, students should start with the fulcrum at the 45 cm point on the meter stick and determine

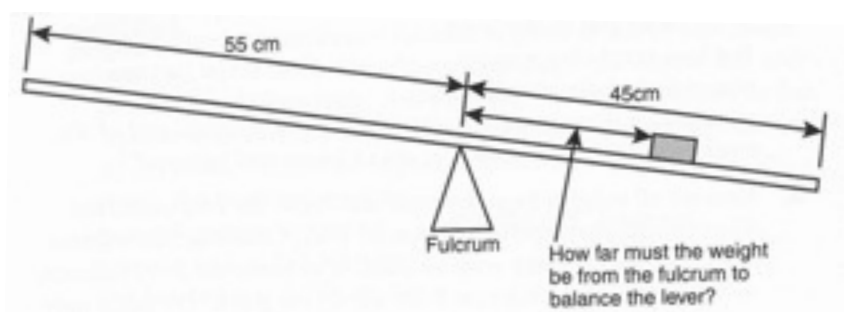


the distance form the fulcrum to the weight to make the lever balance. (The weight will vary depending on the sort of meter stick and the type of weights being used; experiment here, and then use the same weight throughout the procedure.) Students should record that distance in Step 3 on Activity Sheet 1. Next, students should move the fulcrum to the 40 cm mark and again determine and record the distance from fulcrum to weight when balanced. Have them repeat this step, moving the fulcrum to the 35, 30, 25, and 20 cm marks, each time recording the weight's distance from the fulcrum when balanced. Ask students,

- What do the results tell you about levers?

Based on your research, please complete the following statement:
To balance the lever as the fulcrum is moved farther from the center, the weight must _________.

5. For the next portion of the lesson each student group will need to have access to a dangling piece of cord. This can be accomplished by running several horizontal "clotheslines" from support at 5 or 6 ft. height across the classroom and hanging the cords from those - or use whatever means available (e.g., taped or tied to top of a doorway or to the ceiling). Direct the groups to then tie that string to the middle of a lightweight horizontal beam (e.g., drinking straw, sturdy wire, small diameter dowel. bamboo shish-kabob skewer, etc.) so that it hangs evenly. Ask student if this balancing horizontal beam reminds them of anything. That horizontal piece is actually a lever, although it is "upside down" compared to the earlier lovers the students have seen in this activity. The string by which it hangs is the fulcrum. Next, have students tie or tape a short string to each of the two small but unequal weights (e.g., a penny and a nickel), and tie the other end of each string to either end of the horizontal lever. By sliding the weights on the lever, they can try to balance it again. Ask students,
   - How is this lever like the levers used earlier?
   - How is it different?
   - How were you able to make it balance?



6. Have students use the "upside down" lever idea (see Procedure 5) to construct their own mobiles. Pick a science or mathematics theme (such as geometry, repeating number patterns, found objects from nature, planets, atomic structure, rain, organs of the body, etc.) Get some sticks, wires, driftwood, or other "lever" crosspieces and some string or fishing line. Also, students can help to compile objects related to their topic, such as shapes cut out of cardboard, photos pasted onto cardboard or other substances, shells, feathers, leavers, yarn bubbles (saturate yarn with paste, wrap it around a small balloon, allow yarn to dry, pop and remove balloon), crumpled aluminum foil, toothpick sculptures, papier-mache shapes.

Students should tie the objects onto each end of the levers, balancing each lever by moving the “weights” closer to or farther from the fulcrum (i.e., the supporting string). Older students with well-developed motor skills should try to make at least a three or four layer mobile. Encourage imagination. Consider making the levers of different lengths, tying another lever onto one end of a lever, or tying more than two objects onto a single lever.

After these experiments, ask students,

- Does the mobile lever have to be perfectly straight or could it be a curved wire?
- What other shapes would work?
- Does the lever have to be perfectly horizontal?
- How else could it be oriented?

Allow students or student groups to explain their mobiles to the class.

Extension:

1. Have each student find an adult who uses levers in his or her work.

Discussion Questions:

1. What is meant by *balance?* How were you able to make your lever balance? What have you discovered about levers?

2. As the fulcrum is moved farther from the center of the lever, what happens to the distance that a weight must be placed in order to keep the lever balanced? How do you know?

3. What does a mobile have to do with levers?

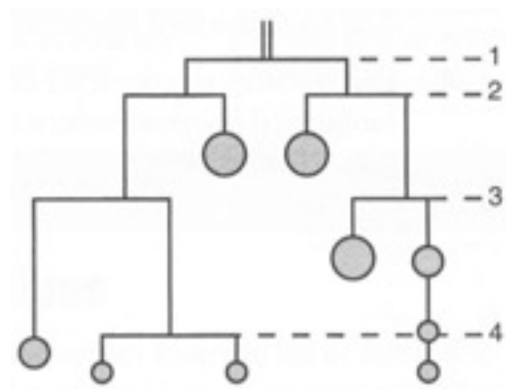
4. Why do you think the object is called a *mobile*?

Assessment:

1. Were students able to balance their levers in different ways and explain their techniques? (Use observations made during Procedures 2-4 as performance assessments.)

2. Were students able to explain how the lever and fulcrum interact and how balance is achieved? (Use Discussion Questions 1-3 as embedded assessments or as writing prompts for science journal entries.)

3. Were students able to determine the mathematical relationship between the location of the fulcrum and the distance the weight must be placed from the fulcrum to make the lever balance? (Use observations made during Procedure 4 and on



Activity Sheet 1as performance assessments, and use responses to Discussion Question 3 as an embedded assessment.)

4. Did students use the lever concept to build creative science/math mobiles? (Use observations made during Procedure 5 as a performance assessment.)

Rubric:

	Developing 1	Proficient 2	Exemplary 3
Were students able to balance their levers in different ways and explain their techniques?	Attempted to balance their levers but were not particularly successful	Successfully balanced their levers and made a basic explanation of their techniques	Successfully balanced their levers and made a detailed explanation of their techniques, including examples
Were students able to explain how the lever and fulcrum interact and how balance is achieved?	Attempted to explain their understanding of the lever. fulcrum, and balance, but were unable to do so to any significant extent	Offered a basic understanding of levers, fulcrum, and balance	Offered a detailed understanding of levers, fulcrum, and balance, and could identify several examples of levers in "real life"
Were students able to determine the mathematical relationship between the location of the fulcrum and the distance the weight must be place from the fulcrum to make the lever balance?	Attempted to determine the relationship but were unable to do so to any significant extent	Successfully recognized the relationship based on their data on Activity Sheet 1	Successfully recognized the relationship based on their data on Activity Sheet 1 and could explain it in depth using their numerical data
Did students use the lever concept to build creative science/math mobiles?	Attempted, but were unsuccessful	Successfully built a two or three layered mobile	Successfully built a four layered mobile

Activity Sheet 1

1. Find and list as many ways as possible to make the lever balance without moving or removing the taped weight.

2. Find and list as many ways as possible to make the lever balance without moving the fulcrum from the 45 cm mark.

3. Collect and analyze data to determine the mathematical relationship between the location of the fulcrum and distance the weight must be placed from the fulcrum to make the lever balance.

Location of Fulcrum	Distance From Weight to Fulcrum
45 cm	______ cm
40 cm	______ cm
35 cm	______ cm
30 cm	______ cm
25 cm	______ cm
20 cm	______ cm

To balance the lever as the fulcrum is moved farther from the center, the weight must

____

____

____

____

Forces and Simple Machines Strand - Simple Machines: Pulleys, Systems of Machines

General Curriculum Outcomes	Specific Curriculum Outcomes
303-20 compare the force needed to lift a load using a single pulley with that needed to lift it using a multiple pulley system	303-20, 204-3 compare the force needed to lift a load using a single pulley system with that needed to lift it using a multiple pulley system, and predict the effect of adding another pulley on the load-lifting capacity
204-3 state a prediction and a hypothesis based on a observed pattern of events	
204-7 plan steps to solve a practical problem and to carry out a fair test of a science-related idea	204-7 design a system of machines to solve a task
207-1 communicate question, ideas, and intentions, and listen to others while conducting investigations	207-1, 206-6 communicate questions, ideas, and intentions; listen to others; and suggest improvements to the systems of machines designed by students in the class
206-6 suggest improvements to a design or constructed object	
107-8 describe examples of technologies that have been developed to improve their living conditions	107-8 describe examples of how simple machines have improved living conditions
205-8 identify and use a variety of sources and technologies to gather pertinent information	205-8, 105-5 identify examples of machines that have been used in the past and have developed over time, using information sources such as books, software packages, and the internet
105-5 identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence	

Using Pulleys

Outcomes:
303-20, 204-3 compare the force needed to lift a load using a single pulley system with that needed to lift it using a multiple pulley system, and predict the effect of adding another pulley on the load lifting capacity

Lesson Activity Overview
Students can further their understanding of simple machines through investigations involving the use of pulleys.
They can explore various ways of lifting objects using pulleys, and compare, using a spring scale or their own measuring instruments, the differences which occur when two or more pulleys are used in various combinations. Students should note the distance the effort or force is applied. This is easily done with pulleys by simply measuring the length of the rope used to lift the object in the air. Students will find that while the object may only be lifted to a height of 0.5 m, it may take rope 2-4 times longer to lift it depending on the pulley combinations used. 303-20

They should record their observations in a chart. The focus of the analysis should be qualitative, that is, the easier it becomes to lift objects, the longer the rope needed to be used.
Compete the table shown below as you carry out investigations involving pulleys.

# of Pulleys	Force to lift weight 1 m	Length of rope used to lift the object 1 m
None		
1		
2		

What do you notice about the force required as the number of pulleys increased?
What do you notice about the length of rope?
204-3

Assessment: Formal Formative
Ensure that students, at each station, have described the effect of increasing and/or decreasing the amount of force applied to the objects at each station 303-14

Investigating Pulleys

Equipment:
Each group will have:
two single pulleys
Cord (nylon if possible)
Force Meter (spring scale or pasco probe - 2.5 Newtons or 250g)
Weight (water bottle half full)
Ruler
Round stick

Background info
A pulley is a simple machine which is useful for lifting things. It reduces the effort required to raise a load. It consists of a wheel with a groove through which a string or rope runs. The rope has a load on one end and someone or something pulling at the other end.

A simple fixed pulley is one which enables you to pull down while the load goes up (e.g. a pulley on top of a flagpole for hoisting a flag to a height). It requires the same force, but it is easier to pull down (i.e. in the same direction as gravity) than to pull up.

A moveable pulley does not change the direction of a force, but it lets you use less force to lift a load. But you must pull the rope a longer distance than the load moves

Method
A. **Weigh the bottle** of water using the force meter

B. **Using one fixed pulley**, lift the bottle of water and feel its weight
Put the stick between two desks or chairs which have a gap between them.
Hang a single pulley over the stick, and hang the cord over the pulley wheel. Attach one end of the cord to the bottle, and pull the other end.

_________________ N or g

Was it easier now to lift the bottle?

____

____

Attach that end to the Force Meter and pull. Note the reading on the meter

C. Using one moveable pulley
CI.Measuring Force: Attach the bottle of water to the hook on the moveable pulley. Tie one end of the cord to the stick and, putting the other end round the pulley wheel, attach it to the Force Meter. Lift up the bottle with the Force Meter

_________________ N or g

Is it easier to lift the bottle this way?

Note the reading on the meter.

Compare the two readings. __________________ N or g

Can you explain the difference?

CII.Measuring Distances: Repeat Ci, this time raising the force meter quite high off the ground

Measure

1. the distance the bottle was raised from the ground
2. the distance the meter (or your hand) moved.
3. how far do you need to raise your hand in order to lift the bottle 10 cm? 20cm?

They can compare these two measurements

Can you come to any conclusions regarding the connections between the forces measured and the distances travelled?

D. Using one fixed and one moveable pulley

Keeping the arrangement in C, take a second pulley and hang it over the stick. Run the cord around it and pull downwards with the force meter.

Note the reading on the meter.

Compare with the readings in C __________________ N or g

Designing a Simple Machine

Outcomes:
204-7 design a system of machines to solve a task
207-1, 206-6 communicate questions, ideas, and intentions; listen to others; and suggest improvements to the system of machines designed by students in the class
107-8 describe examples of how simple machines have improved living conditions
205-8, 105-5 identify examples of machines that have been used in the past and have developed over time, using information sources such as books, software packages, and the Internet

Lesson Activity Overview
Once students are familiar with various simple machines, they can be given a task to explore with a variety of them. They can be encouraged to use two or more simple machines in combination. Students can work in groups to try out various combinations of machines. 204-7

<u>Task</u>
From the simple machine you have used, select two ore more to use together as a system of machines. Use this system to raise a book one meter. Test your solution to see how much force it took, and see if you can improve it in any way.204-7

Following investigations, students can demonstrate their designs and discuss the various strategies applied and the simple machines used. 207-1
They can test their designs to see which group has best designed a system to match the assigned task. 206-6
Students could dismantle discarded, mechanical-based machines of various types (e.g., bathroom scales, fishing reel, clocks), label the parts and observe the simple machines at work inside. Caution: Do not use electrical appliances.107-8
Encourage students to look around their home and community to find example of machines, such as wheelbarrows and conveyor belts that facilitate the carrying and transportation of products, or pulleys, which are used in a clothesline or in lifting the platforms used by window cleaners. Students can analyze pictures they have collected of tractors, cranes, bicycles, scooters, skateboards, and other machinery to identify the simple machines in each of them. 105-5
Task
Students can research how simple machines have been used in the past. Examples such as the Egyptian pyramids, Britain's Stonehenge, the First Nation totem poles and inukshuks often intrigue students.
During field trips, students could be challenged to identify applications of simple machines.205-8

Journal
Two problems our group had today while designing our system of machines were...we tired to solve them by...204-7

Assessment:Informal Formative
Ensure that students have demonstrated their designs and discussed the strategies of their simple machines 207-1

Ensure that students have evaluated the best designed system 206-6

Ensure that students have participated in manipulating mechanical-based machines 107-8

Ensure that students were able to identify examples at home and their community of various simple machines and the way they make life easier 105-5

Assessment:Formal Formative
Ensure that students were able to build a simple machine to raise a book one meter 204-7

Ensure that students appropriately responded to the journal in which they identified two problems with their design and how they solved the problems 204-7

Ensure that students did research of simple machines used in the past and their application 205-8