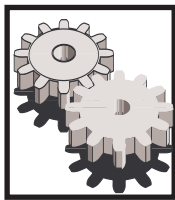




Classroom Adventures

TEACHER ENRICHMENT RESOURCE PACKET



Simple Machines

A Classroom Adventure for Grades K-4

Discover and experiment with the six main types of simple machines while exploring the forces of motion.

Think it.
Try it.
Explorit.

what's inside

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Sponsored by:

**WELLS
FARGO**



Welcome

Thank you for choosing Explorit Science Center's *Classroom Adventures* to supplement your ongoing science curriculum. Whether you use the program to kick off a new unit, wrap up a nearly completed unit, or purely to excite and interest your students in the wonderful world of science, advance preparation and follow up with your students are critical to achieving the greatest educational benefit from this unique science experience.

Explorit provides two resources to help prepare you and your students for *Classroom Adventures*. First, simple logistics of the program are detailed in the confirmation letter. Second, this **Teacher Enrichment Resource Packet** outlines appropriate science content and processes to help you:

- successfully prepare your students prior to Explorit's visit;
- participate fully in *Classroom Adventure* yourself; and
- follow-up with your students after Explorit staff leave.

Learning Objectives

Learning objectives provide a broad overall guide to what students will begin to experience and understand through participation in Explorit's **Simple Machines** *Classroom Adventure* designed for grades K-4. During this program, students will:

- investigate six main types of simple machines;
- discover how simple machines can apply pushes or pulls (forces) to make things move;
- discover how six types of simple machines help humans do work; and
- understand how humans use simple machines every day.

Science Standards

Explorit Science Center's *Classroom Adventures* programs address concepts teachers need to teach under the California Science Content Standards. The alignment of *Classroom Adventures* with the science standards allow you, the teacher, to bring exciting fun-filled science experiences to your students while at the same time fulfilling your requirements to teach particular science content and processes. For specific science standard concepts covered by **Simple Machines**, refer to Science Standard Alignment, page 8.

Our Mission:

To involve people in science experiences that touch our lives.

Background Information

Have you ever seen an ant carry away a crumb from your lunch? It seems the crumb is often much larger than the ant. If we weighed the crumb it would likely weigh more than the ant, too. Relative to their body size, humans cannot lift anything remotely close to what ants can lift. **Simple machines** and **compound machines** (made up of two or more simple machines) allow humans to do many things that would otherwise be impossible.

The *Simple Machines Classroom Adventures* program explores six specific simple machines: **lever**, **wheel and axle**, **pulley**, **inclined plane**, **screw** and **wedge**. First, let's learn more about machines in general.

WHAT IS WORK?

A machine is a tool designed to make work easier. Scientists define **work** as a **force** acting on an object to move it across a distance. Scientists use the mathematical equation, $W \text{ (work)} = F \text{ (force)} \times D \text{ (distance)}$, to calculate the amount of work accomplished. Common examples of work include pushing and pulling. Simple machines can magnify a force, change a force's direction or increase the speed with which a force is applied. This changes the rate at which work is done. Thus, simple machines increase our **mechanical advantage** -- the ability to accomplish work more easily. In other words, machines convert forces into a form most useful for the task. Now, let's take a look at each of the six types of simple machines.

WHAT IS A LEVER?

A lever consists of a rigid bar that pivots (turns) around a fixed point, the **fulcrum**. Levers come in three types:



First Class: We most commonly think of first class levers, like a teeter-totter or seesaw. In a first class lever the fulcrum lies between the force and the work to be done, or load. First class levers include such things as pliers, scissors and crowbars.

Second Class: In second class levers the load lies between the force and the fulcrum. Nutcrackers and wheelbarrows provide examples of second class levers.



Third Class: In third class levers the force exists between the work and the fulcrum. Examples of third class levers include your lower arm (your elbow is the fulcrum), a broom and tweezers.



WHAT IS A WHEEL AND AXLE?

A wheel and axle involves a circular rotating part (the **wheel**) that turns around a shaft (the **axle**). Turning one part turns the other. Examples include a doorknob, bike handlebars, and car wheels. Wheels with teeth that fit into one another are called **gears**. As one gear turns, that gear turns another gear. We find gears in can openers, bikes, cars, and mechanical clocks.



Background Information

continued

Simple Machines Trivia:

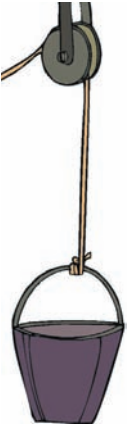
The plow, an example of a wedge, was invented in the Middle East in about 3500BC.

Simple Machines Trivia:

Wheels and axles provide lots of fun in bicycles, roller blades, skateboards and wagons. As an extra challenge, count ALL the wheels and axles on your bicycle -- guaranteed there are more than two.

WHAT IS A PULLEY?

A pulley is a grooved wheel that spins on a fixed axis with a rope or chain moving over the wheel. Fixed pulleys involve wheels and rope that are fixed in place. They make lifting easier by changing a push upward to a pull downward. Examples of fixed pulleys include flagpoles or miniblinds. Movable pulleys are attached to each other and move with resistance. They make work easier by changing the force. A pulley system called a **block and tackle** consists of both fixed and movable pulleys. It makes work easier by changing the direction of force and decreasing the force needed to perform the work.



WHAT IS AN INCLINED PLANE?



An inclined plane consists of a tilted flat surface.

The inclined plane allows us to move objects upward more easily than lifting the object directly. Raising an object to a particular height requires a certain amount of work. We cannot change the amount of work needed, but the inclined plane alters how we do the work: it increases the distance over which we do the work, but it decreases the **effort** needed. Examples of inclined planes include a ramp for loading a truck, a switchback road, and a ladder.

WHAT IS A WEDGE?

A wedge combines two inclined planes back to back. Wedges move objects apart by being forced under or between them. Wedges change the direction of force applied to them. When you push down on a wedge, the wedge pushes out on the two planes that it is in between. Examples of wedges include axe heads, cutting edges of scissors, points of nails, and door stops.



WHAT IS A SCREW?

A screw is really a type of inclined plane. The inclined plane is wound around a post. Screws can be used to lift things. Examples of screws include some car jacks and some piano stools in addition to the screws we typically buy at the hardware store.



CONCLUSION

Next time you're at a picnic, you'll still surely marvel at tiny ants carrying your bread crumbs away. But you now know that humans can move large loads, too. Since the building of the pyramids (and before), humans have used simple machines to make seemingly impossible tasks possible. Today, humans design and operate machines of all sizes, from gigantic cranes used to construct the highest skyscraper to microscopic machines found in our most advanced technology. While humans continue to directly provide the energy to operate some modern machines, the energy needed to operate many machines comes from other sources such as electricity or gasoline.



Vocabulary

This list includes words that may be used during *Classroom Adventures*. Specific vocabulary used depends on students' grade level and prior knowledge.

Axle - the shaft on which a wheel turns.

Block and Tackle - a rope and pulley system, used for lifting or hauling, in which the rope passes through one pulley anchored above (the block) and a second pulley suspended below it (the tackle).

Compound Machine - a machine that contains more than one simple machine.

Effort - the force that is applied to a machine to produce an action.

Energy - the capacity to do work.

Force - the push or pull that makes something move, slows it down or stops it, or the pressure that something exerts on an object.

Friction - force of rubbing between two surfaces that slows movement and also produces heat or sound.

Fulcrum - the pivot on which a device such as a lever is supported so that it can balance, tilt or swing.

Gear - wheel with notches, or cogs, cut around its edge; used to transmit the turning movement of one wheel to a second wheel.

Gravity - the force that gives everything weight and pulls objects toward the Earth's center.

Inclined Plane - a sloping surface; it enables a smaller force to lift a load over a longer distance.

Lever - a bar that tilts about a pivot to move a load.

Load - the weight of an object that is moved by a machine, or the resistance to movement that a machine has to overcome.

Machine - a manufactured device that consists of an arrangement of fixed and moving parts for doing work.

Mechanical Advantage - the time saved and energy gained by using a machine to do work.

Pulley - a wheel with a grooved rim through which a rope, chain or belt is pulled to lift a load.

Screw - a shaft with a helical thread or groove that turns either to move itself, or to move an object or material surrounding it.

Simple Machine - basic machines that include the lever, wheel and axle, pulley, inclined plane, wedge and screw.

Wedge - a machine with a sloping side that moves to exert force.

Wheel - a circular rotating part in a machine that moves around an axle.

Wheel and Axle - a class of rotating machines in which effort applied to the wheel produces a useful movement in the axle or vice versa.

Work - measure of the effort, or force, used to move an object over a distance.

Simple Machines Trivia:

One of the first people to use a screw as a lifting machine was the ancient Greek scientist, Archimedes (287-212BC). He invented a screw pump that could raise water, causing water to flow against the force of gravity.



Classroom Activities

Materials:

screws
paper
scissors
markers
pencils

Science Standards:

Investigation & Experimentation
Second: 4 g

Materials:

thick hardback books
stiff rulers and yardsticks
rubber bands
wooden blocks about 2x4x8
inches with an eye screw at-
tached to the 2x4 inch end

Science Standards:

Physical Science
Second: 1 c, d, e
Third: 1 c, d

Materials:

12-inch rulers
pennies or metal washers
pencils
tape

Science Standards:

Physical Science
Second: 1 c, d, e
Third: 1 c
Investigation & Experimentation
Fourth: 6 a, c, d, f

For your convenience, the following activities can be used as you deem most appropriate to integrate Explorit's **Simple Machines** into your curriculum. The activities are grade-level appropriate, but please note that this program is designed for a broad grade range (K-4) and thus all activities may not be appropriate for every group of children. Choose those activities that will work well for your students.

ACTIVITY #1: "HOW IS A SCREW RELATED TO AN INCLINED PLANE?"

Objective: To demonstrate the relationship between a screw and an inclined plane.

Procedure:

1. Allow each student or group to inspect a screw. Encourage them to examine the threads and the angle of the threads.
2. Give each student a piece of paper, a pencil, a marker and scissors. Have each student cut a right triangle from the paper. The short side should be no taller than the pencil. Draw a dark line on the edge of the long side of the triangle — the ramp side.
3. Have the students roll the paper around the pencil. Start with the short side of the triangle along the pencil and roll toward the opposite point.
4. The dark edge, or inclined plane, will spiral up the pencil forming the pattern of a screw. Students will see the relationship of a screw and an inclined plane.

ACTIVITY #2: "RAMP IT UP"

Objective: To show how the steepness of an inclined plane can affect the amount of force necessary to do work.

Procedure:

1. Make a stack of books about six inches high. Form two ramps of different lengths by leaning a ruler and a yardstick up against the top of the stack.
2. Loop a rubber band through the eye screw in the end of a wooden block. Place the block at the end of one ramp with the rubber band end toward the ramp.
3. Pull the block up one ramp. Try again using the other ramp.
4. Notice how much the rubber band stretches. How does the steepness of the ramp affect the rubber band? If you had to move a heavy piano into a moving van, would you rather have a short, steep ramp or a long, less steep ramp? The work to be done is the same in each case. Since $\text{work} = \text{force} \times \text{distance}$, moving the piano into the van over a longer distance means less force is required.

ACTIVITY #3: "LEVER LIFT"

Objective: To demonstrate how a lever functions. To test the advantage of the different types of levers.

Procedure:

1. Each student or group needs a ruler, a pencil and about ten pennies or washers. Have the students tape their pennies/washers together in a stack.
2. First place the pencil (a fulcrum) under the ruler (a lever) at the six-inch

Classroom Activities

continued

Materials:

discarded items (containing simple machines) that may be taken apart (i.e. kitchen items and toys provide great possibilities)

Science Standards:

Investigation & Experimentation

Fourth: 6 f

Materials:

paper (student journals)
pencils
colored pencils or crayons

Science Standards:

Investigation & Experimentation

Fourth: 6 c, d, f

- mark. Place the penny/washer stack at the one-inch mark. Push with one finger at the eleven-inch mark. How much force does it take to lift the stack?
3. Make hypotheses about how much force it will take with the fulcrum in various positions and with the stack in various positions. Test your hypotheses.
 4. The equation to determine work is: work = force x distance. The work (lifting the stack) remains the same, so when the distance from the fulcrum to the load lessens, the force is greater. If the distance becomes more, the force lessens. (For older students, discuss mechanical advantage, which is the number of times a machine multiplies a force. The mechanical advantage of a lever is calculated by dividing the force distance by the load distance. Have your students use the formula to calculate the mechanical advantage (MA) offered by the lever as the fulcrum and/or load are moved to different spots on the ruler.)

$$MA = \frac{\text{distance of the force from the fulcrum}}{\text{distance of the load from the fulcrum}}$$

ACTIVITY #4: "DISSECT A MACHINE"

Objective: To identify simple machines and their functions within compound machines.

Procedure: **SAFETY NOTE:** If any items use electricity, cut the plug off the cord, and remove any batteries.

1. Divide your students into small groups. Provide each group at least one item.
2. Encourage your students to take apart an item, inspecting each part carefully. Have your students list every simple machine they find. What function does each simple machine have? What did the students learn about how this item operates? What type of energy makes this machine operate?
3. Have each student group share their findings with the whole class. You may wish to do this with oral presentations, or posters for classroom display.

ACTIVITY #5: "INVENTOR'S PLANS"

Objective: To design and plan a machine that accomplishes a certain task.

Procedure:

1. Have your students think of a particular task they need to accomplish. Encourage creativity. Maybe a student is required to pick dirty clothes off their bedroom floor, but hates to bend over. Another student wants to beat a sibling at basketball, so they need an accurate basketball shooter that always hits the basket. Anything goes -- practical or not. Have your students complete the following sentence: "I would like to invent a machine that can _____."
2. Now ask your students to write and draw detailed plans for the construction of a machine to accomplish their task. This invention must make use of at least one of the six types of simple machines studied. You may want to require that the invention be able to be operated by the student's human power alone, with no additional energy sources such as heat or electricity. You will want to give your students appropriate challenges, such as: they may only use one type of simple machine; or they must use two or more types of simple machines, etc.
3. For enthusiastic inventors, you may have the students build models of their inventions using simple materials (i.e. toothpicks, rubberbands, cardboard, etc.).

**Supplemental
Resources****BOOKS**

- Macaulay, David. **The New Way Things Work**. Houghton Mifflin Company, 1998. *Revised edition of award-winning book with text and detailed illustrations. Text is at adult level; but illustrations and story fascinate children.*
- Mason, Adrienne and D. Hodge. **Simple Machines**. Kids Can Press, 1998. *Easy-to-follow experiments for younger elementary age children.*
- Oxlade, Chris. **Machines**. Gareth Stevens Publishing, 1998. *Children's book describing all six simple machines, as well as more complex machines.*
- Parker, Steve. **Science Works! Energy**. Gareth Stevens Publishing, 1997. *Text and experiments on energy at a level appropriate for upper elementary.*
- VanCleave, Janice. **Machines: Mind-boggling Experiments You Can Turn Into Science Fair Projects**. John Wiley & Sons, Inc., 1993. *Designed for ages 8-12.*
- Wells, Robert E. **How Do You Lift a Lion?** Albert Whitman & Company, 1996. *Lively text & watercolors make children laugh while learning about machines.*
- Wood, Robert W. **Science for Kids: 39 Easy Engineering Experiments**. TAB Books, 1992. *Experiments for children 8-13.*

WEB SITES

The Hands-On Technology Program Web Site

<http://www.galaxy.net/~k12/machines/>

Includes many experiments with simple machines.

MIKIDS.COM Web Site

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

Contains good pictures, descriptions and examples of simple machines. Activities included for each simple machine.

University of Rhode Island's Project SMART Web Site

<http://www.ed.uri.edu:80/SMART96/ELEMSC/SMARTmachines/machine.html>

Includes an overview and activities on simple machines.

EdHeads Simple Machines

<http://www.edheads.org/activities/simple%2Dmachines/>

Includes a flash game for kids, and lesson plans for teachers.



Science Standards Alignment

Below is the exact language of California's science standards that Explorit's **Simple Machines** program addresses either during our visit to your classroom or through materials in this Teacher's Packet that you may use.

CALIFORNIA SCIENCE CONTENT STANDARDS

Physical Sciences

Grade 2: 1. The motion of objects can be observed and measured. As a basis for understanding this concept, students know: c. the way to change how something is moving is to give it a push or a pull. The size of the change is related to the strength, or the amount of force, of the push or pull. d. tools and machines are used to apply pushes and pulls (forces) to make things move. e. objects near the Earth fall to the ground unless something holds them up.

Grade 3: 1. Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept, students know: c. machines...convert stored energy to motion.. d. energy can be carried from one place to another...by moving objects.

Investigation and Experimentation

Grades K-2, Concept 4 / Grade 3, Concept 5 / Grades 4, Concept 6:

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in the other three strands, students should develop their own questions and perform investigations.

Explorit's Classroom Adventures involve students' use of many science process skills. For grade level specific skills, see California Science Content Standards at www.cde.ca.gov/board.

Explorit Programs for Schools and Groups

At Explorit's Site

Discovery Lessons & Labs Visit one or more of the Changing Exhibitions throughout the year
Nature Safaris & Labs Visit Explorit's outdoor spaces at Mace Park Branch

Explorit in Your Classroom

Classroom Adventures Explorit educators visit your classroom for hour-long presentations
Young Scientist Series Science investigations through multiple visits

For the Whole School

Health in Your World Learn about keeping your body and the world healthy and safe
Science in Your World The ultimate family science night
Science Assembly A multimedia presentation for the whole school

Reservations required.
For information please call
530.756.0191

Think it.
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