Simple Machines

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Simple Machines
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Since the beginning of time, humans have searched for ways to make their work easier. Simple machines are the most basic of the machines that we use daily to make work easier. Simple machines have been around for thousands of years, and have accomplished such great things as the building of pyramids, the creation of Stonehenge, and other fantastic man-made architectural creations through time.

Machines, from simple to very complex, surround us as we go through our day. We use them as we go about our daily routines, to clean, move, create, repair, relax, have fun, and accomplish work. In this unit students will learn what the six simple machines are, how each of them can make work easier, and where we use them every day in our own lives.

Basic concepts:
A machine is a device that allows people to do work with less effort. Simple machines have few or no moving parts to them. These machines help us to move objects closer, apart, or to raise them to different levels by increasing the force or changing the direction of the force.

Simple machines offer a mechanical advantage; however, the same amount of work is needed to perform the same job. The simple machine lessens the effort needed to do the same amount of work, making it appear to be easier. The consequence is that we may have to exert the lesser force over a greater distance.

Vocabulary:

Simple Machine: one of six tools that make work easier
Machine: a device for doing some kind of work
Compound Machine: more than one simple machine working together
Lever: a stiff bar that moves on a fixed point called a fulcrum, used to lift or move heavy objects. There are first, second and third class levers.
First class lever: effort, fulcrum, load
Second class lever: effort, load, fulcrum
Third class lever: load, effort, fulcrum
Wheel and Axle: a wheel that turns on a center post or rod, used to move objects or change power, speed, or direction of movement
Pulley: a wheel with a groove that a rope fits into, used to lift or move objects
Inclined Plane: a sloping surface connecting a lower surface with a higher surface, used to move heavy loads up or down
Screw: an inclined plane wrapped around a shaft, used to hold objects together or lift objects
Wedge: two inclined planes put together to form a v-shape, used to split, separate, or raise an object
Energy: ability to do work
Force: a push or pull on an object that causes it to change direction, move or stop
Motion: movement
Friction: a rubbing force of one object against another causing movement to slow down.
Gravity: the force of one object pulling on another
Work: the result of a force moving an object work = effort force x distance
Effort: the amount of energy exerted
Distance: the amount of area an object will move
Load: the amount of weight that needs to be moved
Gears: a wheel with teeth, one gear connects to and turns another
Fulcrum: part of a lever that supports length of bar

Simple Machines Michigan Curriculum Framework Science Benchmarks

I.1.1 Generate scientific questions about the world based on observation.

I.1.2 Design and conduct scientific investigations.

I.1.3 Use tools and equipment appropriate to scientific investigations.

I.1.5 Use sources of information in support of scientific investigation.

I.1.6 Write and follow procedures in the form of step-by-step instructions, formulas, flow diagram, and sketches.

II.1.3 Show how common themes of science, mathematics, and technology apply in real-world contexts.

II.1.6 Recognize the contributions made in science by cultures and individuals of diverse backgrounds.

IV.3.5 Design strategies for moving objects by application of forces, including the use of simple machines.

Simple Machines Introductory Activity

Materials: pre-test
- Slideshow
- Index cards
- Index file card boxes
- Index card dividers with labels
- Variety of simple machine examples

Begin lesson by making a list on the board of what students already know about simple machines. Give unit test as a pre-test (see attached file).

Put out a display of simple machines (wedge, nails, scissors, screws, wheels, pulley, etc…). Ask students what they think these objects have in common. Answer: They make work easier. All of them are simple machines.

View slideshow with students (See attached file).

As you go through the slideshow, read each slide to students (skipping the experiment and project pages- tell students we will get back to those!). Discuss what a simple machine is; list the six simple machines on the board. Discuss what the purpose of simple machines is (to make a work easier). Discuss the work that each simple machine makes easier.

Create a list of what students want to know about simple machines.

Group students into partners for the unit. Give each group a set of index cards and an index file card box. Instruct students to move around the room and investigate. How many simple machines can they find in the classroom? For each simple machine they find, they should identify the object and which simple machine is being used, draw a picture of it, label the picture, and write a description of how it makes our work easier. Students will store their cards in their file box under the categories for the six simple machines. You can pre-label the dividers or have the students do so at this time.

Homework: Find at least one example of each simple machine in your home. Fill in worksheet (see attached document).

Simple Machines Introductory Activity 2

Materials: clipboards
Simple Machine collection sheet
Digital cameras (if available)

Students will go on a simple machines scavenger hunt in this activity. Discuss what kinds of simple machines they found in the classroom in the previous activity. Have students work with another group to share what they found, and verify their findings.

Give each student a ‘Simple Machine collection sheet’. Then take them to a variety of places in your school. At each location, they should find at least one example of each type of simple machine. If you have digital cameras available for student use, students should use them to collect examples, as these photos will come in handy later in the unit.

Some good locations would be:

Library	Cafeteria
Office	Gym
Art room	Playground

Upon return to the classroom, give students time to convert their findings into individual index cards to be filed in their file card boxes.

Return to this activity at the end of the unit and see if students can identify more simple machines after they have studied them.

Work and Mechanical Advantage

Review with students the idea of force and motion that was covered the previous year. Introduce Work and Mechanical Advantage.

The simple machines all require human energy in order to work. What does work mean? "Work" is only done when something is moved. For example, when you push on a building you actually are not doing work, because you cannot move it.

Work consists of two parts. One is the amount of force (push or pull) needed to do the work. The other is the distance over which the force is applied.

The formula for work is: Work = Force X Distance.
Force is the pull or the push on an object, resulting in its movement. Distance is the space the object moves.

When we say a machine makes it easier for us to do work, we mean that it requires less force to accomplish the same amount of work. Apart from allowing us to increase the distance over which we apply the smaller force, machines may also allow us to change the direction of an applied force.

Mechanical Advantage is the ratio of the existing weight or load to the acting force; or, the ratio of the distance through which the force is exerted to the distance the weight is raised. For example, a machine has a mechanical advantage of 5 if an applied force of 1 kg can counterbalance a weight of 5 kg.

The acting force times the distance it moves equals the work put into the machine. This work is called the input force. The resisting weight times the distance it moves equals the work accomplished by the machine. This work is called the output force.

Levers

Teacher information:

A lever consists of a rigid bar, which is free to turn about a fixed point called a fulcrum. The fulcrum is a pivot point. The effort force (push or pull) is exerted upon one lever arm, and the other lever arm will go up or down in the opposite direction. The resisting weight is the load, which is exerted upon the lever arm, which tends to move the lever in the opposite direction of the applied force.

The force is applied at a different point from the load. The closer the fulcrum to the load, the less force needed to lift the load. The force will move a greater distance, and the load will move a shorter distance. The closer the fulcrum to the force, the greater the force needed to lift the load. The force will move a shorter distance, and the load will move a greater distance.

Levers are divided into three classes according to the way the load and effort force arms are arranged around the fulcrum.

First class levers: When the fulcrum lies between the force arm and the lever arm, the lever is described as a first class lever. In fact many of us are familiar with this type of lever. It is the classic teeter-totter example. When the fulcrum is midway between the force and the load, there is no change in force, speed or distance. Other first class levers include: a car jack, a pair of pliers, a pair of scissors, a water pump, a balance or pair of weigh scales, a crowbar, a claw of a hammer taking out a nail, or a lever with a rock as its fulcrum trying to lift another rock.

Second class levers: In the second class lever, the load arm lies between the fulcrum and the force arm. A good example of this type of lever is the wheelbarrow. The axle of the wheel serves as the fulcrum, the handles are the force arm, and the load is carried between the two in the bucket part of the wheel barrow. In the second class lever, the fulcrum is usually closer to the load, which reduces the force needed to accomplish the work. Some other examples of the second class lever are: a pair of nutcrackers, and a bottle opener.

Third class levers: In this class of levers, the force arm lies between the fulcrum and the load arm. Because of this arrangement, a relatively large force is required to move the load. This is offset by the fact that it is possible to produce movement of the load over a long distance with a relatively small movement of the force arm. Think of a fishing rod! Because of this relationship, we often use this class of lever when we wish to produce large movements of a small load, or to transfer relatively low speed of the force arm to high speed of the load arm. When a hockey stick or a baseball bat is swung, a third class lever is in effect. The elbow acts as a fulcrum in both cases and the hands provide the force (hence the lower arm becomes part of the lever). The load (i.e. the puck or the ball) is moved at the end of the stick or bat. In a third class lever there is usually a loss in force needed to accomplish the work, but a gain in speed or distance. Examples of third class levers are: a fishing pole, a pair of tweezers, an arm lifting a weight, a pair of calipers, a person using a broom, a hockey stick, a tennis racket, a spade, or a shovel.

Lever introduction Activity

Materials: paint can with lid on
- Variety of levers
- Slideshow
- Rulers
- Pencils taped together in sets of three
- Cups of pennies
- Gram weights
- Lever graph worksheet
- Measuring tool

Have a display of different kinds of levers set up on a table or countertop.

Begin discussion by putting a can of paint on table and asking students how you can get it open. Can you do it without a tool? What kind of tool would you use? Does anyone know what kind of simple machine could do this job?

Discuss the definition of what a lever is. Refer to slideshow slide 6. A lever is a bar, which moves on a fixed point called the fulcrum. It lifts or moves a load. All levers have two parts, the bar and the fulcrum. Show examples of levers to class (both from slide 7 and from display).

Go to slide 11 in slideshow and read experiment. Give each group of students a ruler, three pencils taped together, a gram weight, and a cup of pennies, and the 'Lever graph worksheet'. Instruct students to create a table to record the distance of the fulcrum from the load, and the number of pennies it takes to lift the load at that distance. Instruct students to move the fulcrum at least 4 different trials and measure the distance from the load before they begin to add pennies to the ruler.

After students finish their trials, tell them to organize their data from least to greatest distance in a chart, and then graph the results in a bar graph. Students should use the Lever Graph Worksheet to create their table and chart, and to graph their results and record their conclusions.

Lever Activity

Materials:
- 24" boards
- Spring scales
- Rubber bands
- Prisms
- Textbooks
- Buckets
- Standard weights

In this activity students will use standard measurement to measure the effort force needed to move a given object using a lever. Hand out materials to students. Instruct them to set up a first class lever using the board, with the prism as the fulcrum. Have them place their science textbook on the load arm, and attach a rubber band to the effort force arm, which should be hanging off the edge of the table. Instruct them to hook the spring scale to the rubber band, hanging off the edge of the table. Attach a bucket to the spring scale and use standard weights to change the effort force in order to move the textbook.

Students should measure the effort force needed to move the book and record it in a table. Students should follow the same procedure to measure the effort with the fulcrum in at least four different positions. Students can use the Lever graph worksheet to record their findings.

Classes of Levers Activity

Materials: Large marshmallows
Rulers
Boards with a nail partially in them
Hammers
Wheelbarrow
Broom or shovel

Give each student a large marshmallow and a ruler. Tell them that they are going to attempt to hit the teacher with their marshmallow, but they must follow some rules. First, they cannot be touching the marshmallow when it is launched, they must use the ruler to launch the marshmallow. Second, the ruler must be touching the desk when it is launched. The teacher should stand about three yards away from students and try to catch any of the marshmallows with a box or basket. Tell students that their group can make one attempt for each person. After students have attempted their launch, have students describe how they used the ruler as a tool. Ask them what kind of simple machine they just used. Explain that levers can be used in many different ways.

Show students slide number 8 from the slide show, and discuss first class levers. A first class lever is effort, fulcrum, load. The fulcrum is located in between the effort and the load. Give each student group a board with a hammer nailed part way into it. Have each member try to pull the nail out using only one hand. Then give each group a hammer and tell them to try to pull the nail out now. Explain to students how the hammer works as a lever when it is pulling nails out of wood. Have students draw a diagram of the experiment and label the effort, fulcrum, and load. Discuss other examples of first class levers. Give students a ruler, three taped together pencils, a gram weight, and a cup of pennies, and have them create a first class lever.

Show students slide number 9 from the slide show, and discuss second class levers. A second class lever is effort, load, fulcrum. The load is located in between the effort and the fulcrum. Have students try to create a second class lever from the materials they have. Can they do it? Some won't be able to. Show them the wheelbarrow and how it works. Let them each come up and try to move the wheelbarrow. Have them draw the wheelbarrow and label the effort, load, and fulcrum. Have students try again to create a second class lever using their materials.

Show students slide number 10 from the slide show, and discuss third class levers. A third class lever is load, effort, fulcrum. The effort is located in between the load and the fulcrum. Have students try to create a third class lever from their materials. Can they do it? Show them a broom or shovel and how they work. Have each student use the broom or shovel. Have them draw the tool and label the load, effort, and fulcrum. Have them try again to create a third class lever using their materials.

Lever conclusion activities

Materials: Bricks
Bamboo skewers
Small pebbles
Lever Class worksheet

Students will complete an activity trying to lift a brick upright using only a skewer and pebbles. Pass out materials to each group. Tell students that the brick is an obelisk, a stone pillar that stands upright which usually narrows to a pyramid shape at the top.

"A great ruler would like it put up outside of his palace. You may not touch the brick with your hands. You will use the bamboo skewers for your lever, and the pebbles for support stones."

Give students an opportunity to explore ways that they might lift the brick. Tell groups to record what class of lever they are using, what difficulties they had trying to erect the obelisk, and how they overcame them. At the end of the allotted time, have students measure how far the top of their brick is from the desk.

As a follow up, you can have students visit http://www.pbs.org/wgbh/nova/lostempires/obelisk/lift.html to try to 'Lever an Obelisk' online. There are other links they can follow to explore building in ancient Egypt. Offer extra credit for those that can identify at least 3 ways simple machines were used during ancient Egyptian building. Students can also try to move a monolith using levers at http://www.pbs.org/wgbh/nova/lostempires/easter/game.html .

Have students complete the Lever Class worksheet for homework.

Inclined Plane Introduction Activity

Teacher Information:

The word "inclined" means "at an angle". The word "plane" means "a flat surface". An inclined plane is a slope or a ramp. It can be any slanted surface used to raise a load from a lower level to a higher level. Examples of an inclined plane include: a ramp used by a workman to push a heavy load on wheels up into a truck, ramps for wheel chairs, ramps to load luggage onto a plane, an escalator. An inclined plane was used to move huge stones to build the Egyptian Pyramids.

Notice that all these inclined planes are stationary (with the exception of the stairs moving on an escalator). Inclined planes don't move! An inclined plane helps a person to move or raise heavy objects. An inclined plane enables a load to be lifted with less force, but the distance over which it moves is greater.

In other words, when an inclined plane is used, less force is required to move the resisting weight up the slanted surface than to lift it up vertically. However the amount of work remains the same since:

Work = Force x distance.

As with all simple machines, the inclined plane can be used to trade increased distance for decreased force or effort. The force is applied in a different direction to that in which movement takes place.

The steepness of the inclined plane is a key factor. If a person uses a longer board to make the inclined plane, he or she will need less force to move the object up the ramp. If a shorter board is used (the angle of the slope is steeper), more force is required but the distance over which it must be applied is less.

Inclined Plane Activity

Materials: Set of boards with varying lengths (20”, 24”, 28”, 32”)
textbooks string
spring scales weights (standard or nonstandard)
Inclined Plane Height worksheet, Length worksheet

Introduce students to the inclined plane through the use of page 18 of the slideshow. An inclined plane is a slanted surface connecting a lower surface with a higher surface. Discuss with students the use of inclined planes to move objects from one surface to the other. Place a 5 foot long piece of board on a support and have students walk up the board. Add height to the support and have students attempt to walk up the board again. (You can also arrange to use an adjustable ramp, such as one that can be lowered from the back of a truck. Our foodservice utilizes a truck like this to move food between buildings.) Discuss which ramp was harder to walk up.

Hand out materials to each group. Students will first measure the effort force needed to lift the book without the ramp. They will need to tie the string around the textbook and then loop the other end of the string and hook it to the spring scale, using a T-bar with a bucket on the other side so they can use standard weights to measure the effort force needed to lift the textbook on its own. Students should record their findings.

Show students how to set their board up to make a ramp, using textbooks to set the ramp up at a particular height. Students will use the Inclined Plane worksheet to record their information. Then students will place a textbook at the bottom of the ramp. They will use the string around the textbook and run it up the ramp and attach a spring scale to the other end. The edge of the higher end of the ramp should be at the edge of the table, so that the spring scale can hang down. Attach a bucket to the end of the spring scale. Use standard weights to measure the effort force needed to move the textbook to the top of the ramp. Students should run trials at the listed heights and record the effort force needed each time. They will then use the table to create a line graph to see the change in effort force for each trial. Students should complete the Inclined Plane Height worksheet questions.

Extension: Repeat the same activity but instead of increasing the height of the ramp, increase the length of the ramp. Use Inclined Plane Length worksheet.

Screw

Teacher Information:

A screw is an inclined plane wrapped around a cylinder. The inclined plane forms ridges in a spiral along the cylinder. These ridges are called the threads of the screw. The distance between the threads is called "the pitch" of the screw.

It would be impossible to completely insert a screw into a piece of wood without using a screwdriver. Thus you trade the extra distance moved as you turn the handle of the screwdriver, for the reduced force required to turn the screw. As with the inclined plane, force is applied in a direction different from the movement of the load. The screw also resists pulling out much better than a nail and therefore provides a stronger joint.

The principle of the screw can be easily understood by cutting a right-angled triangle out of paper. Color the triangle's hypotenuse. Wrap it around a pencil. The triangle's hypotenuse becomes the inclined plane or threads of the screw. A screw depends on another simple machine, a screwdriver (a lever), for its operation. A screw works with rotating movement, which is provided by a lever. When the lever arm makes a full turn, the screw is moved a distance equal to the pitch, or the gap between adjacent threads.

A screw's mechanical advantage is the ratio of two dimensions: the length of the lever that turns it, and the distance between the threads. Thus, a screw can function in two ways. It can raise weights (liquids or solids), or it can press or fasten objects.

One of the first screw machines, invented in the third century B.C., is commonly attributed to the Greek geometer, Archimedes. It was to irrigate the fields, and to pump water out of a ship's hold. This machine had a watertight cylinder enclosing a spiral running from end to end, with its lower end immersed in water. The machine was turned by hand, and the water collected in the rotating spiral blades. These blades appeared to rise, as the screw turned. The water poured out a hole in the top of the cylinder.

Some modern examples of screws include:

1. To move or raise liquids or solids - a snowblower, a ship or airplane propeller, a worm gear, a corkscrew, a jack screw, a pig feeder, a grain thresher, a meat grinder, a piano stool, a corn sheller.
2. To press or fasten objects - book binding press, a vise, a screw hook, nut and bolt, an auger (hand drill), a monkey wrench, an ordinary screw, a jar lid, and a screw press for printing.

Screw Activity

Materials:	Paper pattern for triangles	poster putty
	New pencils	crayons
	String	tape
	Measuring tool	Screw worksheet
	Display of a variety of screws	

Introduce screws using page 18 of the slideshow. A screw is a curved ramp. A screw is an inclined plane that is wrapped around a center post. Pass out materials and worksheet. Discuss what kinds of objects can be called screws. Show display of variety of screws.

Read through experiment on page 19 of slide show. Instruct students to cut out their triangles and color the long edge with a crayon. Have students measure the length of the triangles using the bottom edge of the right triangle and record information on worksheet. Next students should tape the short edge of the first triangle to the pencil. Instruct them to twist the paper around the pencil and use putty to stick the point to pencil. Ask students what the pencil looks like now. How far apart are the threads? Measure the distance between threads. Record on worksheet. Instruct students to repeat the same procedure with the second triangle on another pencil. Does it look different? What is different? Discuss the distance between the threads and what made them different. Measure the distance between the threads. Ask students how they think the difference will affect how easy it is to turn the screw, how many turns it will take to get the screw all the way into an object, and how strong they think it will hold. Students should record their thoughts on the worksheet.

Give students a variety of screws to experiment with. Have them record their findings by tracing each screw, then measuring the incline by winding a piece of string around the threads and then measure the string. Record the data and then try to screw each into a piece of wood. How many turns did it take? Record the data. Have them revise their thoughts on worksheet questions if they need to!

Discuss with students that the farther apart the threads are, the more effort force is required to turn, but the screw moves farther with each turn. This type of screw is good for soft materials such as drywall. The closer together the threads are, the easier it is to turn, but the more turns you have to make. This type of screw is good for harder materials such as metal or hardwoods.

Wedge

Teacher Information:

A double wedge is made up of two inclined planes back to back. You find a double wedge on an axe blade. Single wedges resemble an inclined plane, because they have only one sloping surface. A doorstop is a single wedge. Remember that the inclined plane does not move.

Wedges can be used in several ways:

- Wedges can help you grip things to be lifted. Pushing one under an object provides a space for your fingers. The longer the wedge and the smaller the angle of slope, the less the force needed, but the wedge must be pushed in a greater distance.
- Wedges can also be used to tighten or hold things in place, for example, a wedge peg to hold a bench together, or a doorstop.
- Wedges are mostly used to push things apart, for example, pounding a nail into a block of wood. Other examples are a chisel, cutting tools, an axe (also a lever), a can opener (also a lever), plow blade, and the bow of a boat or ship.

The purpose or advantage of the wedge is to change the direction of the applied force. When the force is applied downward on a wedge, it is able to push outward in two directions.

Wedge Activity

Materials: Textbooks Apples and apple cutter
A variety of wedges (plastic knife, door wedge, nail, fork, toothpick)

Introduce wedges using page 20 from the slideshow. A wedge is two inclined planes put together to form a V shape. A wedge can be used to lift or pry apart heavy objects. A wedge can also be used to stop an object from moving.

Demonstrate a wedge that can stop something from moving. Have one student stand on one side of the door, and another stand on the other side. Have one student try to push the door open, while the other tries to hold it shut without holding the door handle. The demonstration will work better if you have someone strong trying to push the door open. Next put a wedge under the door, and have the student try again to push the door open. He should not be able to this time. The wedge raises the door enough to stop it from being able to be pushed open.

Demonstrate a wedge prying something apart by using an apple cutter to cut an apple into wedges. (This activity is ripe for jokes about using a wedge to cut wedges!) Ask students what the wedge was that we used. What did it do? What wedges that are in your mouth, that you use when you don't have an apple cutter? Are the wedges of apple that we cut simple machines? Why or why not?

Have students pile four textbooks on each other. Give them a variety of wedges to use to try to separate the textbooks. Have them predict if it is easier to use wedges that are narrower or wider?

Another activity you can use to demonstrate wedges would be to give students clay and let them experiment with a variety of wedges to see which ones make the work of separating the clay easier. A visit to a potter to see their tools could fit in well with this activity.

Have students complete Wedge worksheet.

Wheel and Axle

Teacher Information:

The wheel and axle is a first class lever in which the fulcrum has been replaced by an axle and the arms have been repeated around the axle to make up the spokes or disk of the wheel. This allows the lever to rotate through 360º instead of the limited rotation in the teeter-totter application.

Some examples of a wheel and axle are: a water wheel, a windmill, gears, doorknobs, faucet handles, and steering wheels.

Wheel and Axle Activity

Materials:	Thick cardboard	straight pins or small paperclips
	Straws	bendable wire
	Thick paper	pie tins
	Pencils	scissors
	Board for a ramp	measuring tool
	Wheel and axle worksheet	

Introduce the wheel and axle using slide 12 from slideshow. The wheel and axle is a lever that moves in a circle. A wheel and axle is made from a wheel that turns on a center post. Show display of wheels and axles and discuss that the larger the wheel, the more mechanical advantage you gain. Compare roller skate wheels, with bicycle wheels, with automobile wheels.

Demonstrate the mechanical advantage by having students try to turn a doorknob without the knob. Is it hard to turn? Try it with the knob attached. Is it easier?

Activity one: Have students create a variety of wheels and axles using cardboard for wheels and a straw and wire for the axle. Record the wheel diameter and the distance each set travels down a ramp. Make sure students are measuring from the bottom of the ramp to the wheel and axle stopping point straight out, not at an angle. Record information in a table, organize from smallest to largest wheel size and then graph data into a line graph.

Activity two: Cut a square from a sheet of thick paper. Cut a line on the diagonal from each corner to approximately ½ inch from center of square. Fold each corner over to meet at center and secure all corners and center of square to a straw with a straight pin or small paper clip. You have created a pinwheel. Draw a picture of your pinwheel and label the wheel and the axle.

Activity three: Cut eight even cuts into a pie tin, stopping approximately ¾ of an inch from the center of the pie tin. Twist each cut in the same direction to form a waterwheel. Put a pencil in the center of the pie tin and run water over the blades. (They should turn!) Draw a picture of your waterwheel and label the wheel and axle.

Pulley

Teacher Information:

A pulley is a wheel with a groove that allows a rope, belt or chain to ride securely on it. A pulley is a circular lever, with the wheel rotating freely on the axle. A fixed pulley is fastened to one spot, and does not move around. It provides no gain in force, distance or speed, but it changes the direction of the force. A fixed pulley acts as a first class lever. The fulcrum is the axle (the point at which the pulley is supported).

The force arm is the radius of the pulley - that is, the distance from the fulcrum (axle) to the side of the rope on which we pull. The load arm is also the radius of the pulley - the distance from the fulcrum (axle) to the load-carrying side of the rope. Examples of fixed pulleys can be seen on flag poles, drapes, or on a sail mast. In each case, the pulley changes the direction of the applied force, to enable work to be accomplished.

A movable pulley moves along a rope or wire. It provides a gain in force, but a loss in distance. (You have to pull the rope twice as far!) A movable pulley works like a turning second class lever. The fulcrum is at one rim of the pulley wheel, the load is at the axle, and the force is at the other rim of the pulley wheel.

Pulleys make lifting easier because more sections of rope are supporting the weight. This is like having someone help you carry something heavy. The more help you have, the lighter the load seems to be. Mechanical advantage is determined by the number of supporting ropes. A compound pulley, also called a block and tackle, is a combination of a fixed and a movable pulley. This type of pulley changes direction, and yields a gain in force at the same time.

Pulley Activity

Materials:	flag pole	4 x 5 paper
	Pencils	thread spools
	String	2 brooms
	Rope	2 liter bottles
	Single, double and triple pulley systems	
	Pulley worksheet	

Introduce pulleys using slides 13-16 from the slideshow. A pulley is a wheel and axle with a rope wrapped around a groove in the wheel. Pulleys can change the direction of the effort force, or change the amount of effort force needed to move the load.

Demonstrate how a fixed pulley works by taking students outside to the school flag pole. Show them how the flag can be raised to a height that we would not be able to reach without the pulley. Return indoors and see if students can find a pulley system in the classroom. (Our classroom has blinds which use a pulley system)

Activity: Have students decorate and color a flag on a 4 x 5 piece of paper. Instruct students to place a pencil through the hole of a thread spool, making sure that the spool can easily turn. Tie the ends of a piece of string together. Tape one side of the flag to the string. Place the loop of string over the spool, with the flag near the bottom of the loop. Have one student hold the ends of the pencil high over his/her head, and the other student pull down on the string opposite the flag. Have students observe the distance the string is pulled and the distance and direction the flag moves up. Explain that this is an example of a fixed pulley. A fixed pulley makes work easier by changing the direction of the effort force. Pulling down is easier because you can use the weight of your body and the force of gravity to help you.

Demonstrate the benefit of multiple pulleys by having students play broom tug of war. Have one student hold a broom horizontal to the ground. Tie a rope to it. Have another student hold another broom horizontal to the ground at approximately the same height. Wrap the rope around the second broom and pull it back to the first broom, wrapping it around the broom and then letting it dangle. The first student should hold onto the loose end. The students should pull on the brooms away from each other as if in a tug of war. Now pass the loose end of the rope back to the second broom and wrap it around it a second time, then pass it back and wrap around the first broom like you did before. Have students try the tug of war again. Is it harder this time or easier? The more pulleys used in a system, the less effort needed to lift or pull an object.

Give students several pulleys to experiment with, along with a 2 liter soda bottle filled ½ way with water. Have them rig a pulley to lift the bottle. On the other end of the rope attach a bucket and use standard weights to measure how much effort is needed to lift the bottle. Have them try the same procedure using two pulleys, and then three. Record data on the Pulley data sheet. Which pulley system required less effort?

Culminating Activities

Review slide show again, and complete KWL chart. There are several culminating activity options offered here, followed by a project page. You can require all students complete the project of your choosing, or you can let them choose which project interests them most. All projects require them to fill out a technology project packet, which includes making plans for the problem they need to solve, creating an object that incorporates what they have learned in this unit, and sharing it with others.

Culminating activity one: Brown Bag Identification
Place a variety of objects that incorporate a simple machine into their makeup in brown paper bags. Place these bags at stations around the room. Have groups move through the room to identify the object, its use, and the simple machine involved in its use. Give groups approximately 60 seconds at each station. Use Brown Bag Identification worksheet. (Some good items would be a manual can-opener, a corkscrew with arms, a clamp, scissors, picture of a bike, doorknob, mini blinds, tweezers, screw, a corkscrew without arms…)

Culminating activity two: The Simple Machines Important Book
Read “The Important Book” to students. This is a picture book about what is important in the story character’s life. There is a pattern to how each item is written about. In The Simple Machines Important Book, students will write about simple machines in general, and then individually about each. Follow the pattern in the attached worksheet. Students can either draw and color the book, or they can create a slideshow for the book.

Culminating activity three: Unload a truck
Students are told that there is a big order coming in to the school, and they have been asked to help unload it because the principal has heard they know all about simple machines, and that they can make the work easier. Students will brainstorm and then write a plan for unloading the order from the truck, bringing the order into the school, and delivering the items to their correct location.

Culminating activity four: Learn about an inventor

Read "Real McCoy: The life of an African-American Inventor" by Wendy Towle to class. Discuss what it means to say "It's the real McCoy!" Give each group a large piece of sandpaper, a matchbox car, and some oil. Have students push the matchbox car across the sandpaper. Instruct them to pour the oil into the center of the sandpaper. Now have them try to push the matchbox car across the sandpaper. Discuss the importance of lubrication and how it reduces friction in machines. Why was it important to have the real McCoy? How did McCoy come up with his invention? Discuss that engineer's jobs are to create things to solve problems they are faced with.

Culminating activity five: Inventor report

Students will research an inventor and his/her invention(s). Students will utilize the library, and the internet, including the site http://webtech.kennesaw.edu/sthroop/machinequest.htm which includes an alphabetical listing of inventors. Students will use the attached Inventor Report form and the Inventor rubric to plan and write report. Students will be required to present their information about both the inventor and the invention. Students will be required to provide some kind of visual.

Culminating activity six: Toy Expo

Students will work in groups to plan, design and create a simple machine toy. They must market their toy by creating posters, a price, a description of what the toy does, the simple machine included, the name of their company, and an exciting 'catch-phrase'. Persuasive writing will incorporate Language Arts, and economics will incorporate Social Studies and Math into the project. The class will set up a toy expo where other classes and parents can visit. They will be given toy expo dollars to spend at the expo to 'order' the toys they like best. Students will be set up at booths trying to market their toys and take in the most money for 'orders' of their product.

Culminating activity seven: Simple Machines WebQuest

Students will do the Simple Machines WebQuest. http://www.shps.org/central/simplemachineswebquest.htm They will visit the given sites to explore about simple machines. They will be required to visit at least one of the quiz sites and print the results of the quiz they took. They will visit the http://www.edheads.org/activities/simple-machines/ site and visit each room. They will print the score from each room. Students will take the Simple Machines Post test for this unit.

Projects

Students will choose one project to complete (or you can choose one and assign it to all students). All projects require the completion of the Tech-Folio, and an oral presentation to the class.

- Visit the Rube Goldberg website. Play the game 'Mousetrap'. This game is a series of simple machines connected together to catch a mouse. Use a variety of tubes, paint stirrers, pencils, string, spools, tape, cardboard, and other building materials to create a compound machine. Sketch a plan to build a compound machine that will dispense a gumball in the longest amount of time. Use a large box, such as a moving or appliance box, and create your compound machine within the box. The object is for the gumball to take the longest amount of time to dispense.

- Build a compound machine to move a pile of blocks across the room without lifting the blocks. The compound machine should consist of at least two simple machines. The most obvious choice would be a pull toy with a hinged ramp on the back. This would incorporate the wheel and axle and the inclined plane.

- Build a castle with a working drawbridge. To accomplish this task, students will need to create a hinged ramp that raises and lowers through the use of a pulley system. This will incorporate the inclined plane and the pulley. Students may choose to lever an obelisk in front of the castle as well!

- Build a catapult/trebuchet. Students will construct a working catapult and label the lever with effort, load and fulcrum.

- Create a game that incorporates at least two simple machines into it.

- Create a PowerPoint slideshow about simple machines. You must also include at least one hands-on visual to share with the class.

Resources

Books:

Mrs. Frisby and the Rats of NIMH In this book, the rats incorporate simple machines to make work easier in their daily life. Good read-aloud book.

Magic School Bus Plays Ball by Joanna Cole. Discusses forces.

From Indian Corn to Outer Space: Women Invent in America by Ellen H. Showell & Fred M.B. Arman.

Dr. DeSoto by William Steig. Uses simple machines in picture book story.

Aisha: Industrial Engineering and Making Work Easier by the Engineering is Elementary Team. Aisha's brother is an industrial engineer who takes her on a simple machines scavenger hunt through the city of Boston. They search for levers and pulleys as they explore landmarks of African American history, and then get to go to the potato chip factory where her brother Malcolm works. While there, they learn about how simple machines and the design of industrial systems make work easier. Back home, they design their own scale model of a potato chip factory. *There is a unit teacher's guide for this book which offers lessons about simple machines.

The simple story of the three pigs and the scientific wolf by Pieces of Learning. Explores what would happen if the son of the big bad wolf decided to use simple machines to catch the daughters of the three little pigs.

Videos:

Bill Nye The Science Guy: Simple Machines

Industrial Engineering: Making Work Easier. Engineering is Elementary.

Physical Science for Children: All About Simple Machines.

The Simple Machine by National Geographic

Teaching Physical Science: Simple Machines

Software:

Science Court: Work and Simple Machines

Adventures with Oslo: Tools and Gadgets

The Machine Expo by Science for Kids

Field Trips:

Frederick Meijer Gardens: The Farm Garden. A two hour teacher guided tour of the farm garden learning about simple machines.

Michigan Maritime Museum: The Friends Goodwill. They offer a visit to the museum and a learning experience aboard the ship at dock. They also offer sailing learning sailing excursions. Our fifth graders will be going out aboard the ship in the spring. Excellent opportunity to learn about many simple machines, especially the pulley. www.MichiganMaritimeMuseum.org

Websites:

http://www.beaconlearningcenter.com/WebLessons/MoveOurPrincipal/default.htm

http://www.beaconlearningcenter.com/WebLessons/SimpleMachines/default.htm

http://home.earthlink.net/~kandyhig/sm/

http://www.edheads.org/activities/simple-machines/

http://www.rubegoldberg.com/html/gallery.htm

http://www.edheads.org/activities/odd_machine/index.htm

http://sunshine.chpc.utah.edu/javalabs/java12/machine/stdntovrvw.htm

http://www.mos.org/sln/Leonardo/InventorsToolbox.html

http://www.mos.org/sln/Leonardo/SketchGadgetAnatomy.html http://www.quia.com/jg/450529.html

http://www.quia.com/jg/334982.html

http://www.quia.com/pop/36483.html

http://www.quia.com/pop/36854.html

http://www.quia.com/quiz/110999.html

http://www.coe.uh.edu/archive/science/science_lessons/scienceles1/finalhome.htm

http://www.mos.org/sln/Leonardo/GadgetAnatomy.html

http://www.museumsandpublicschools.org/Curriculum/grade2-new.html
Chicago children's museum grade unit

http://www.mos.org/sln/Leonardo/InventorsToolbox.html
inventors toolbox
http://www.mos.org/sln/Leonardo/SketchGadgetAnatomy.html
sketching gadgets lesson

http://www.pbs.org/wgbh/nova/egypt/raising/lever.html
lever an obelisk, download

http://teacher.scholastic.com/dirtrep/simple/index.htm
scholastic Dirtmeister science reporters lesson…write a report about a simple machine in your home
http://teacher.scholastic.com/dirtrep/simple/tguide.htm
teachers guide
http://teacher.scholastic.com/dirt/lever/index.htm
simple machines lever science lab

http://www.mikids.com/Smachines.htm
mikids site, real photos, quiz
http://www.mikids.com/SimpleMachines/smquiz.htm

http://lyra.colorado.edu/sbo/mary/play/
playground physics lessons

http://outreach.rice.edu/%7Edgabby/science/simp_mach/
simple machines webquest…based on rube Goldberg

http://www.enchantedlearning.com/physics/machines/Levers.shtml
enchanted learning page about levers and their classes

Name:______________________________

Simple Machines Unit Test

1. A simple machine
    a. Is used to make work easier
    b. Has an engine
    c. Is simple because it is easy to use

2. The definition of a compound machine is
    a. Something that is run with a battery
    b. Something that is complicated
    c. A machine that is made of two or more simple machines

3. An inclined plane lets you
    a. Move things up or down easier
    b. Move things from side to side
    c. Cut things

4. A wedge is made of
    a. Two screws put together
    b. Two pulleys put together
    c. Two inclined planes put together

5. A lever lets you
    a. Move things that weigh twice as much as you do
    b. Move things from side to side
    c. Cut things in half

6. A lever needs three things to work
    a. A top, a bottom, and a middle
    b. A fulcrum, an load, and effort
    c. A force arm, a lever, and a screw

7. The difference in 1^{st}, 2^{nd}, and 3^{rd} class levers is
    a. The order the fulcrum, load and effort are in
    b. The size of the load
    c. The amount of effort used

8. The farther away from the fulcrum the load is
    a. The more effort is needed
    b. The less effort is needed
    c. The longer the bar needs to be

9. A wheel and axle is
    a. A wheel that turns on a post
    b. A wheel that rolls up an inclined plane
    c. A pulley that moves things up or down

10. A pulley lets you
    a. Move things in circles
    b. Move things from a higher place to a lower place
    c. Move things up and down or from side to side

11. The definition of a screw is
    a. Two inclined planes put together
    b. An inclined plane wrapped around a cylinder
    c. A wheel that moves on a post

12. Screws are used to
    a. Move things from side to side
    b. Hold pieces of wood or metal together
    c. To hold ropes for pulleys

13. Energy is
    a. Something very powerful
    b. The ability to do work
    c. Something you get from batteries

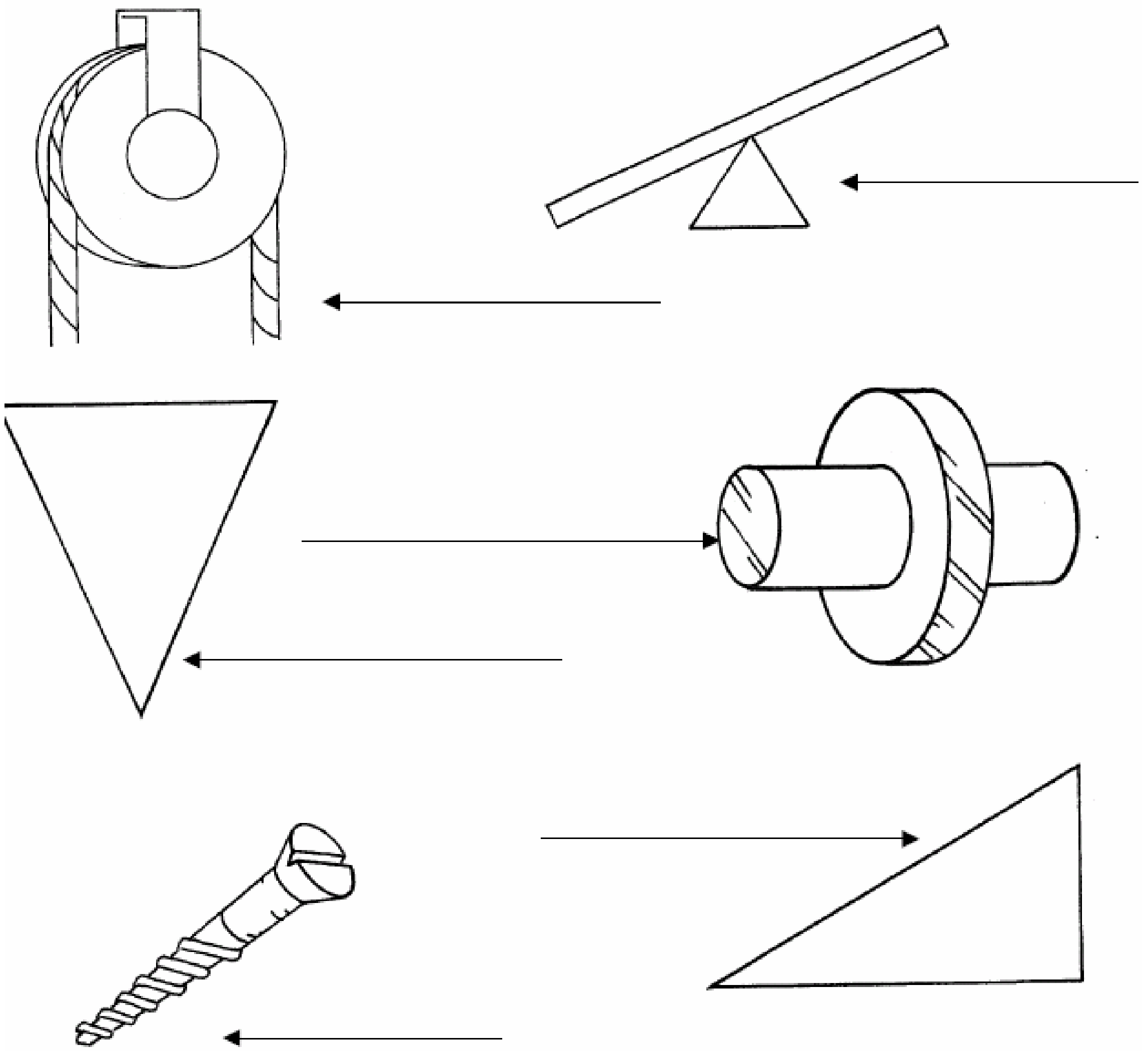
14. Effort is
    a. The amount of force that you use working
    b. How much work is done
    c. What you get from eating breakfast

Name:______________________________

Simple Machines Unit Test

Write the name of each simple machine on the arrow.

Word Bank:					
Wheel and Axle	Lever	Pulley	Wedge	Screw	Incline Plane



Simple Machines In Your Home

LEVER	INCLINED PLANE
Use and description of lever: ____________ ____________	Use and description of inclined plane: ____________ ____________
WHEEL AND AXLE	**SCREW**
Use and description of wheel and axle: ____________ ____________	Use and description of screw: ____________ ____________
PULLEY	**WEDGE**
Use and description of pulley: ____________ ____________	Use and description of wedge: ____________ ____________

Find at least one example of each type of simple machine located in your home. Draw a picture of it, label its parts, and write what it is used for and how it is a simple machine.

Simple machines collection sheet

Location: ____________________ **Name:** ____________________

LEVER	INCLINED PLANE
Wheel and axle	Screw
pulley	wedge

Lever graph worksheet

Draw table for data collection here:

Organize your data in a chart here:

Graph your results here:

What did you find out about the distance of the fulcrum from the load to the amount of pennies (effort force) you needed to use to lift the weight?

lever class worksheet

1. **A lever is a simple machine that makes __________ easier. It involves moving a ______________ around a pivot called a fulcrum using a force. Many of our basic tools use levers.**

2. **In a first class lever, the _____________ is between the effort and the load. In an off-center first class lever, like pliers, the load is larger than the effort, but is moved through a smaller _______________.**

3. **Examples of common tools that use a first class lever include:**
   ____
   ____
   ____

4. **In a second class lever, the _______________ is between the fulcrum and the effort. In a second class lever, the fulcrum is usually closer to the _________, which reduces the effort force needed to accomplish the work.**

5. **Examples of common objects that use a second class lever include:**
   ____
   ____
   ____

6. **In a third class lever, the _________________ is between the fulcrum and the load. In a third class lever, there is usually a loss in ____________ to gain speed or distance.**

7. **Examples of common objects that use a third class lever include:**
   ____
   ____
   ____

8. **The closer the fulcrum to the load, the __________ effort force is needed to lift the load. The effort force will move a ___________ distance, and the load will move a shorter distance.**

Inclined Plane Height worksheet

Effort force to lift textbook by itself: ____________________________

Moving a textbook up an Inclined Plane

Trial	Height	Effort Force
1	**10 cm**	
2	**20 cm**	
3	**30 cm**	
4	**40 cm**	

Create a line graph using the data from the table.

Did the ramp require more or less effort force than lifting the textbook? Explain.

____

____

Which height required less effort force?

____

Would it be easier to walk up a low or a high ramp? Explain.

____

Inclined Plane Length worksheet

Effort force to lift textbook by itself: ___________________________

Moving a textbook up an Inclined Plane

Trial	Length	Effort Force
1	**20 inches**	
2	**24 inches**	
3	**28 inches**	
4	**32 inches**	

Create a line graph using the data from the table.

Did the ramp require more or less effort force than lifting the textbook? Explain.

____

____

Which length required less effort force?

____

Would it be easier to walk up a short or a long ramp? Explain.

____

Screw worksheet

Paper Triangles

Triangle	Length: bottom edge	Thread distance (mm)
1		
2		

1. How will the difference affect how easy it is to turn the screw?

____

2. How many turns it will take to get the screw all the way into an object?

____

3. How strong do you think it will hold? Which screw would hold the best? ____

____

Screw Turns

Screw	Incline (mm)	Number of turns

Graph the results from your table.

Wedge worksheet

1. How was the wedge used to stop the door from opening?

____

2. Draw the apple cutting demonstration and label the wedge and what was separated.

3. What kind of wedge is used to sew? _______________________

4. Name three wedges that can be used at the dinner table?

__________________ _____________________ __________________

5. Name two wedges used in the garden. ________________________

____

6. Name three tools that are wedges. _____________________________

_________________________ ______________________________

7. Name two kinds of transportation that have noses that act as wedges and explain how they work.

____

____

____

8. Explain how frozen water in ground rock could be considered a wedge. (Hint: A wedge separates an object)

____

____

Wheel and Axle worksheet

Wheel Diameter	**Distance traveled**

Create a graph from your table:

Draw a picture of your pinwheel Draw a picture of your
waterwheel and label the wheel and axle. and label the wheel
and axle.

Pulley worksheet

Draw your flag pulley system.

Record your data from your pulley experiments.

Number of pulleys	**Standard weight**
1	
2	
3	

Graph your results.

Brown Bag Identification

Bag # 1
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 2
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 3
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 4
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 5
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Brown Bag Identification

Bag # 6
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 7
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 8
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 9
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

Bag # 10
Object: ______________________
Use: ______________________
____
Simple Machine: ______________

The Simple Machines Important Book Template

Page 1:
The Important thing about simple machines is that they make work easier.

They help us use less force to move things by spreading the effort over a greater distance. Some simple machines reverse the direction we have to push or pull to move things. Simple machines have few or no moving parts.

But the important thing about simple machines is that they make work easier.

Page 2:
The Important thing about levers is that they ________________________

**They ____
____**
Some examples are ____
But the important thing about levers is that they ______________________

Page 3:
The Important thing about the inclined plane is _______________________

**They ____
____**
Some examples are____
But the important thing about the inclined plane is _____________________

Page 4:
The Important thing about the screw is _______________________

They ____
____
Some examples are ____
But the important thing about the screw is ______________________

Page 5:
The Important thing about the wheel is ________________________

They ____
____
Some examples are ____
But the important thing about the wheel is ______________________

Page 6:
The Important thing about the wedge is ________________________

They ____
____
Some examples are ____
But the important thing about the wedge is ______________________

Page 7:
The Important thing about the pulley is ________________________

They ____
____
Some examples are ____
But the important thing about the pulley is ______________________

Page 8:
The Important thing about simple machines is that they make work easier.

They help us use less force to move things by spreading the effort over a greater distance. Some simple machines reverse the direction we have to push or pull to move things. Simple machines have few or no moving parts.

But the important thing about simple machines is that they make work easier.

Inventor Report

Name______________________ **Group:______________**

1. **Name of Inventor _________________________**
2. **Where was he/she born? _________________________**
3. **Date of birth ______________________ Death _________________**
4. **Invention: ______________________ Year invented: ____________**
   Location of invention: _____________________________________
   Types of simple machines it includes: _________________________
   ____
   Ways it has changed our lives: _______________________________
5. **Invention: ______________________ Year invented: ____________**
   Location of invention: _____________________________________
   Types of simple machines it includes: _________________________
   ____
   Ways it has changed our lives: _______________________________
6. **Invention: ______________________ Year invented: ____________**
   Location of invention: _____________________________________
   Types of simple machines it includes: _________________________
   ____
   Ways it has changed our lives: _______________________________
7. **Who helped or influenced your inventor?**
   ____
   ____
   ____
8. **Find 5 interesting facts.**
   - **____ ____**

- ____
  ____
- ____
  ____
- ____
  ____
- ____
  ____

Inventor Rubric

	3	2	1
Name of inventor/ Where he was born/			
Birth/ Death/ Influenced by			
Invention(s) listed/ year of invention			
Simple machines involved			
How invention changed our lives			
Interesting fact			
Interesting fact			
Interesting fact			
Interesting fact			
Interesting fact			

Tech-Folio

Name:	
Unit:	
Date:	

Technology Challenge:

Technology Specifications:

Design Changes: OK'd by:______________

Materials:

Tools:

Design Ideas

Final Design (Blueprint)

Length (l)		
Width (w)		

top view

Height (h)		

side view

Student Self Assessment

Did you understand what you had to do?	Yes	With help	No
How well did you solve the challenge?	Very well	OK	Not very well
How much of your work was completed satisfactorily?	All of it	Most of it	Some of it
How do you feel when you look at your work?	Very happy	Ok	Disappointed
Did you do your best work?	Yes	Could do better	No
How well did you share or present your work to others?	Very well	OK	No

Quality:		Effort:	
How well did you make your design?		How hard did you try?	
Excellent		**Really Hard**	
Good		**Hard**	
Average		**Average**	
Fair		**Not hard enough**	
Poor		**Poor effort**	

Describe your work

____
____
____
____
____
____
____
____
____

Things I was really happy with when the design was made…

____
____
____

Things I was not happy with when the design was made…

____
____
____

How could I improve the design?

____
____
____

What I learned when working on the challenge…

____
____
____
____
____

Assessment Rubric

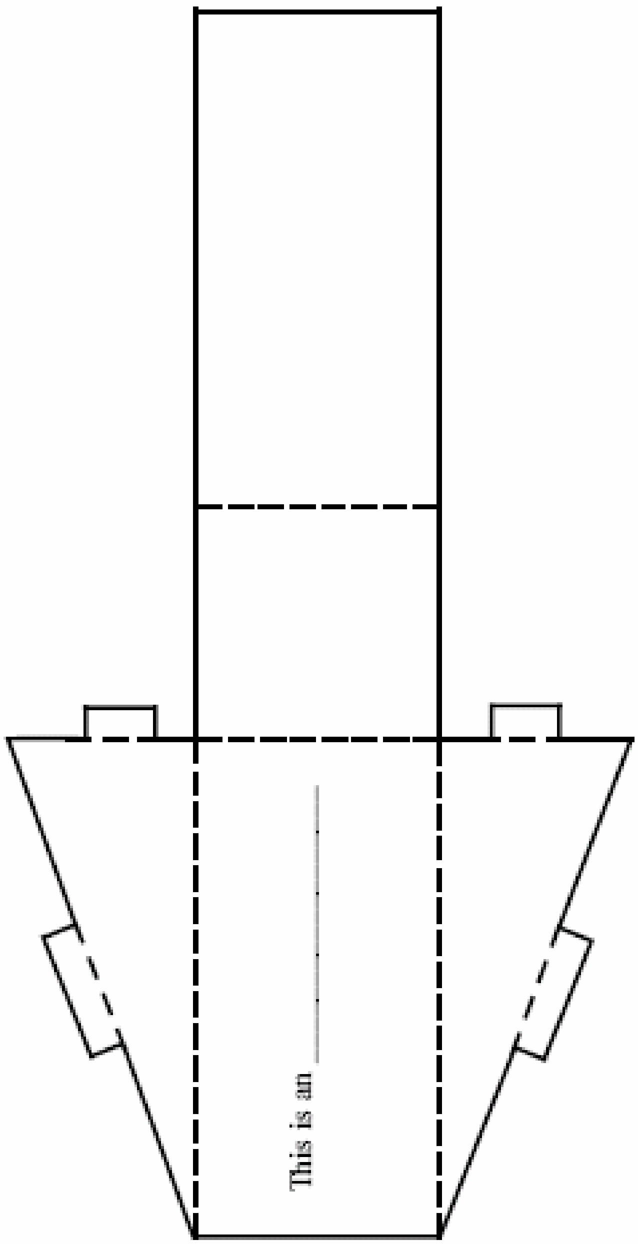
Identifying and Investigating a Design	Yes		Some		No	
1. Have you asked questions to find out what you might do?						
2. Have you used a Tech-folio, with pictures or drawings to show your ideas?						
3. Have you investigated a number of different ideas?						
4. Have you tried out different materials you could use?						
5. Have you written specifications for your design?						
6. Have you shown a final design with measurements?						
7. Have you drawn a top and side view of your design?						
8. Have you used math in your design?						
Planning and Making						
9. Have you produced a plan showing what you intend to make, and have you listed the materials and tools you need to make your design?						
10. Have you shown that you know about the materials that you used in your design, and did you use the most suitable materials for making your design?						
11. Have you used different tools safely when you made your design?						
12. Have you worked as a member of a team to get ideas and help in solving problems?						
13. Have you used complete sentences and correct sentence structure in the Tech-folio?						

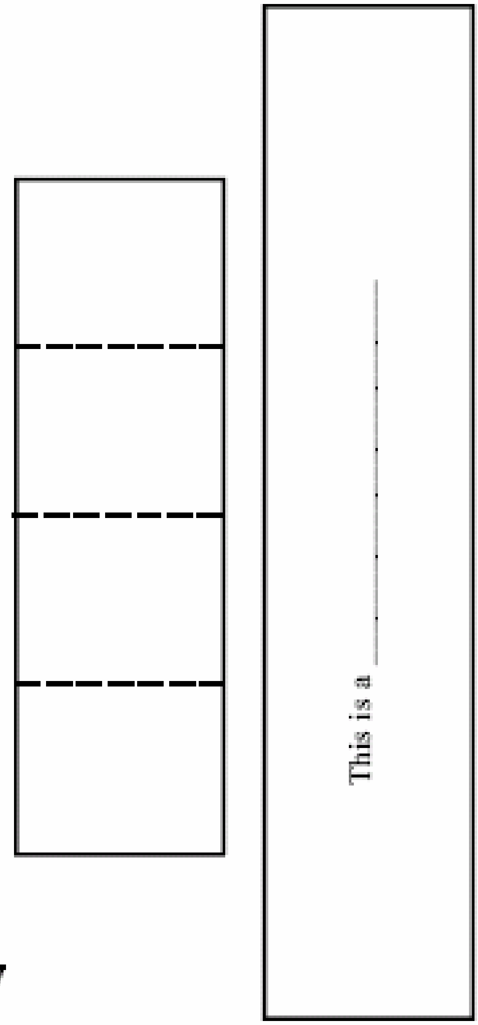
Testing and Evaluating	Yes		Some		No	
14. Have you talked with others about how well your design worked or didn't work?						
15. Did you record any design changes and get them OK'd by an adult?						
16. Have you described your design?						
17. Have you discussed and recorded what things you like and disliked about your final design?						
18. Have you recorded ways to improve your design?						
19. Have you recorded what your learned by completing the design?						
20. Have you looked at everyday technical things from another time, or from other countries or cultures?						
21. Did you look at how other people solved the challenge?						
22. Did you use and improve design ideas from others?						
Knowledge of Technology						
23. Have you shown that you understand ____________________ (unit of study)?						
24. Have you shown that you know how to use several common materials in the making of your design?						
25. Have your shown that you know that different materials do not weigh the same, and can be stronger or weaker than other materials, and they some materials work better than others for certain tasks?						
26. Have you shown that you know how to recognize, handle and use safely a variety of common tools?						
27. If your design has moving parts, do you know the energy source used to make them work?						
28. Have you used scientific and mathematical knowledge in your design?						
29. Have you shown that you know that people make things and that they can be sources of information?						

Inclined Plane and Lever

Inclined Plane

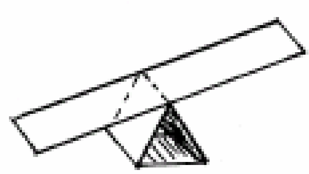
- Cut on solid lines.
- Fold on dotted lines.
- Use glue or tape to hold tabs in place.





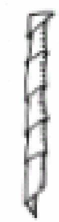
Lever

- Cut on solid lines.
- Fold on dotted lines.
- Tape to hold.



Screw, Wheel and Axle

This is a ______________________



Screw

- Cut on solid line.
- Roll in the direction of the arrows.
- Tape in place.

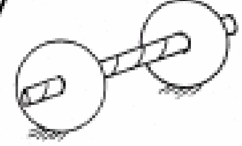
This is a

____

This is a

____

Wheel and Axle



- Cut the wheels out making the center holes just large enough to insert a straw.
- Insert a straw through both holes.
- Tape wheels to straw, if needed.