Simple Machines

Inclined Plane, Wedge, Screw, Lever, Pulley And Wheel And Axle

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Summary

This unit is designed to allow 8th grade students working in groups to investigate one of the six simple machines. Once the groups have completed their work, they will present their findings to the class.

Background

Six groups are needed so that each one can work with one type of machine. Each group will be given time to explore their machine with the goal of presenting their findings to the rest of the class. They will be asked to define what the machine does, determine the mechanical advantage, describe the advantages of their machine, and give some "real world"/common situations where their simple machine is used today. The groups will have to work out on their own how best to test their machines and how to measure the mechanical advantage.

Subject

Physical science

Audience

This activity is designed for eighth grade physical science students.

Time required: 3 - 4 periods

Period 1 – Give15 - 20 minute PowerPoint presentation with an overview of simple machines (downloadable from http://csip.cornell.edu/Curriculum_Resources/default.asp).

Hand out notes on machines (see below). Assign each group a machine. Have the groups do some initial research on the web or in the library before doing experiments. Sheets to guide students through research are provided below.

Period 2 - Group investigation of machine

Period 3 - More time to investigate and prepare presentations if needed. Start student presentations to class.

Period 4 – Finish student presentations to class

Note 1: The research portion can also be done as homework to shorten the number of class periods required for this unit.

Note 2: Some of the machines are easier to test than others. Encourage groups to do both research and experiments to prepare for their presentation. Also encourage the use of visual aids or demonstrations.

Note 3: Some of the machines such as levers and pulleys have multiple set-ups that can be tested. Students should be required to present the different possible set-ups to the class but they will only have time to test one or two of them.

Learning and Behavioral Objectives

Students will work on their research, experimental design, group work, and presentations skills while covering required content on simple machines.

National Science Education Standards

Science as inquiry
- -Abilities necessary to do scientific inquiry

Physical science
- -Forces

Content covered:
- Simple machines
- Work
- Efficiency
- Mechanical advantage
- Friction

Procedure

Materials and equipment

To build and test their machines the students will need spring scales, string, pencils, rulers, a wooden board, spools, pulleys, nails of different sharpness, screws with differently spaced threads, hammer, screw drivers, empty soda bottle, small blocks of wood, doweling, different sized wedges, paper cups, marbles, boxes, large protractor for measuring angles, textbooks, tape and markers. Students may ask for different materials depending on how they decide to construct and test their machines.

Worksheets

The following student pages can be used for this project. There are also two pages in the evaluation section that can be used by the students for peer review if they are mature enough to provide constructive criticism.

Notes on work and machines

Work: Work is done on an object when something exerts a force on the object that causes it to move some distance in the direction of the force.

-Work is not done if there is no motion.

-Work is not done if the motion is not in the same direction as the force.

Calculating work:

Work = Force X Distance (W=F*D)

Unit for work is Joule

Unit for force is Newton

Unit for distance is meter

1 Newton X 1 meter = 1 Joule

Machines: Machines make work easier but do not change the amount of work that is done. Machines either change the amount of force you exert, the distance over which you exert your force, or change the direction in which you exert your force.

Multiplying force: Less force is required but it must be applied over a longer distance.

Multiplying distance: Machine allows you to work over a shorter distance but more force is required

Changing direction: This only changes direction not the force required or distance applied.

Mechanical advantage: The mechanical advantage of a machine is the number of times the force exerted is multiplied by the machine.

$$\text{Mechanical advantage} = \frac{\text{Output force}}{\text{Input force}}$$

-If the mechanical advantage is greater than 1 the machine multiplies force.

-If the mechanical advantage is less than 1 the machine multiplies distance.

Efficiency: Efficiency compares the output work to the input work and is expressed as a percent. Machines can lose efficiency to frictional forces. Efficiency is never greater than 100%.

$$\text{Efficiency} = \frac{\text{Output work}}{\text{Input work}} \times 100\%$$

Inclined plane

1. What is an inclined plane?

2. How does it work?

3. Does it change the direction of applied force?

4. What is the advantage to using an inclined plane (How does it affect the work equation)?

5. List some common uses of an incline plane.

6.How would you test the advantage of using an inclined plane?

Wedge

1. What is a wedge?

2. How does it work?

3. Does it change the direction of applied force?

4. What is the advantage to using a wedge (How does it affect the work equation)?

5. List some common uses of a wedge.

6. How would you test the advantage of using a wedge?

Screw

1. What is a screw?

2. How does it work?

3. Does it change the direction of applied force?

4. What is the advantage to using a screw (How does it affect the work equation)?

5. List some common uses of a screw.

6. How would you test the advantage of using a screw?

Lever

1. What is a lever?

2. How does it work?

3. Does it change the direction of applied force?

4. What is the advantage to using a lever (How does it affect the work equation)?

5. List some common uses of a lever.

6. How would you test the advantage of using a lever?

Wheel and axle

1. What is a wheel and axle?

2. How does it work?

3. Does it change the direction of applied force?

4. What is the advantage to using a wheel and axle (How does it affect the work equation)?

5. List some common uses of a wheel and axle.

6. How would you test the advantage of using a wheel and axle?

Pulley

1. What is a pulley?

2. How does it work?

3. Does it change the direction of applied force?

4. What is the advantage to using a pulley (How does it affect the work equation)?

5. List some common uses of a pulley.

6. How would you test the advantage of using a pulley?

Assessment Strategy:

The following two pages can be printed back to back for assessment of the oral presentations. Any guests invited into the classroom to hear the presentations can also use them. If a class is mature enough they can also be used as peer review forms.

Categories	Evaluation system – points available and descriptions				Points awarded (fraction okay)
	1	2	3	4	
Participation	-Only one person talks -It is clear one person prepared presentation	-Most of group talk -Time not equally divided -Some members not as prepared as others	-All members talk -Time is equally divided -Everyone is prepared	-All members talk -Time is equally divided -Everyone is prepared -Well rehearsed	
Time	-Use less than half of class period	-Use more than half of class period	-Use entire class period	-Use entire class period well with no gaps	
Organization	-Cannot understand -No sequence of information	-Difficult to understand -Group jumps from topic to topic	-Audience can follow -Logical sequence -Smooth transitions	-Audience can follow -Logical sequence -Smooth transitions -Interesting/animated	
Communication	-Mumbling -Poor pronunciation -Not loud enough	-Spoken in low voice -Audience can hear but with difficulty -Not all members speak clearly	-Clear voices used -Well pronounced -Heard well by most of audience	-All speakers have a clear and audible voice with correct pronunciation	
Graphics	-No graphics or few graphics -Not used well -Hard to see	-Some graphics used -Don't add much to presentation -Can see but with some difficulty	-Good amount of graphics used -Add to presentation -Easily seen by most of audience	- Good amount of graphics used -Add to presentation -Easily seen by all -Aesthetically pleasing	
Eye contact	-Most of presentation read from cards	-Occasional eye contact but a lot is read off cards -Not all members make good eye contact	-All members make eye contact most of the time but still dependent on notes	-All members make good eye contact seldom using notes	
Total points out of 24 available					

-Room for comments are on the back of this sheet

Categories	Comments and constructive criticism
Participation	
Time	
Organization	
Communication	
Graphics	

Eye contact	

Teaching Tips:

The students should be encouraged to do as much research and experimental planning on their own as possible. The following is a short list of possible experiments for the teachers to have in the back of their minds while guiding the students. It is not intended for the students to have access to the list directly.

1. Inclined plane
   - -Set up a board at different angles. At each different angle pull an object up the surface with a spring gauge to measure force.
2. Wedge
   - -Test nails of different sharpness. Measure how many blows it takes to pound them in a certain distance, or give them a specific number of similar blows and then measure how far they go into a board. This would bring up issues with repeatability of the hammer blows.
   - -Set two heavy objects with flat sides next to each other. Place different sized wedges in the seam and test to see how much weight is required to separate the objects. They will need to convert the weight applied into a force unit.
3. Screw
   - -Test different types of screws. They should have differently spaced treads. Students will need to mark the screwdriver so that they can measure the number of turns required to insert the screws into the board. They should also be making observations about how the difficulty of turning the screws compare. This is an opportunity to talk about observations and consistency of opinion between different members of the group.
4. Lever (only require them to test one type of lever completely)
   - -Set up a ruler on a wedge or some other fulcrum. Set a weight at one end to be the resistance force. Apply effort force at different distances from the fulcrum. The weight applied will have to be converted to a force unit or the students can set up the experiment so that they can pull down on the lever with spring gauges to measure the force.
5. Wheel and axle
   - -Set up a soda bottle so that two strings hang down. One should be attached to the large part of the bottle, the other to the thin part of the bottle. Attach cups or weights to the strings so that they both rest on the floor. Turn the bottle to raise both strings (one end of the bottle can rest on the table). The weights will have traveled different distances. The students can measure the radii and the distance traveled. They will have to do some research to find the relationship between mechanical advantage and radius ratio.

6.Pulley (Students should have time to look at a simple pulley system that changes direction of force and to test one that gives a mechanical advantage.)

-The students can use spools of thread on doweling or actually pulleys to set up the system that they want to test. The system can be hung from doweling or screwed into a board suspended between two tables. Students can measure the length of string and force required to raise objects on the simple pulley system compared to their pulley system that offers a mechanical advantage.

Potential Problems:

-Students may have a hard time starting their investigations. A list of possible experiments is listed in the teacher's tips section if they really get stuck truly cannot get started. Since a collection of materials will be provided the teacher can try to jump-start the students by asking them if they seen any objects in the collection that relate to their machine or can be used to make their machine.

-Students may have a hard time doing research about the machines in the library or on the web. This is a pretty good topic to have students practice their research skills on. There is a lot of information available on the web and in books so they should be encouraged to find the information themselves.