Simple Machines Part 2

Elementary Curriculum Week 2

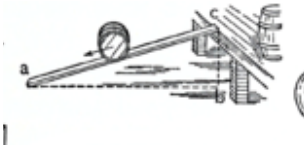
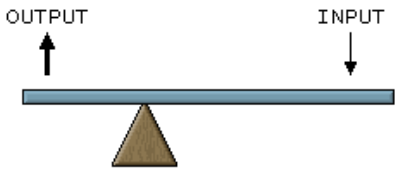
3128 aluminum narwhals

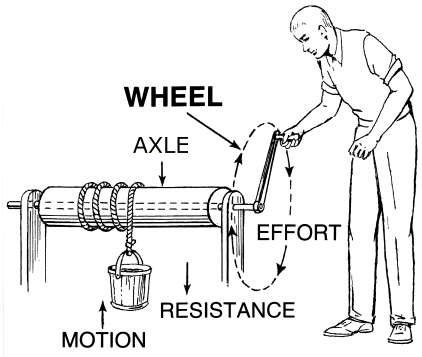
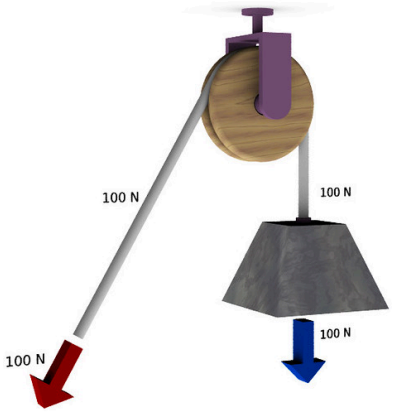
Welcome!

This is Week #2 of Team 3128's Virtual Outreach. This week, we're going to be learning about some more simple machines. This week, we'll be covering levers, inclined planes, and screws. You'll learn the fundamentals of how these machines work and where they are applied in everyday life and even design your own simple machines. As always, if you have questions about the topic, you can join our weekly livestreams or ask a question here. Happy learning!

Last Week Summary

Last week, we introduced you to what simple machines are. They help us magnify force to complete tasks. We learned that this ability of simple machines to amplify forces is called **mechanical advantage**, which is the ratio of the output force to the input force. (Or, how many times greater the force we get out is, than the force we put in.)
We also introduced you to the 6 main classes of simple machines. Here is a table of all of them:

Inclined Plane (Ramp)	Wedge	Lever
		

Screw	Wheel and Axle	Pulley
		

This week, we will be introducing you to levers, inclined planes, and screws.

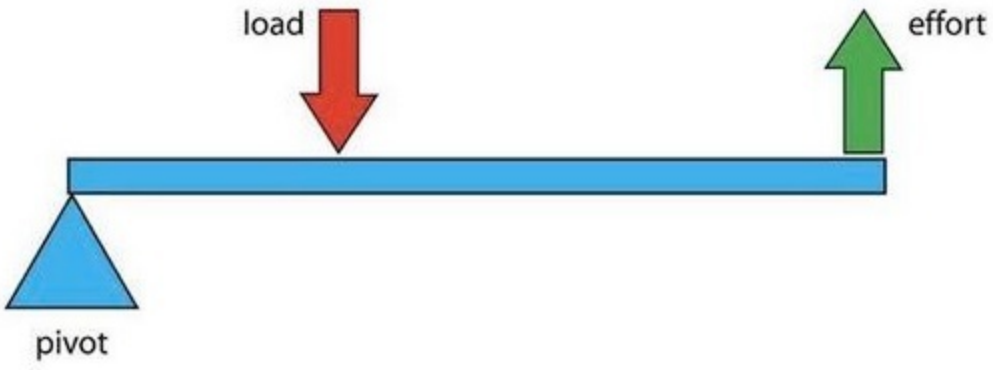
Levers

A lever is a simple machine that consists of a long beam that pivots about a fulcrum, used to move heavy objects.

Activity

A door is one of the most common examples of a third class lever.

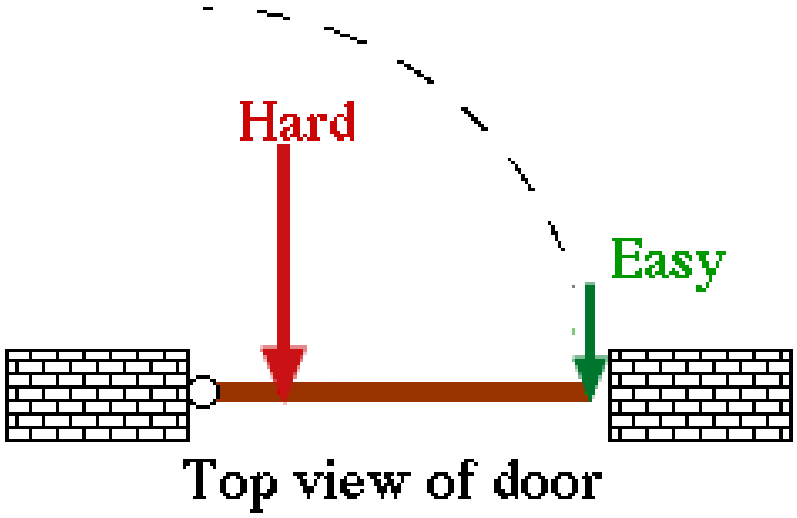
Remember, a third class lever has a fulcrum on one end and the effort on the other end. The load is in the center.



Instructions:

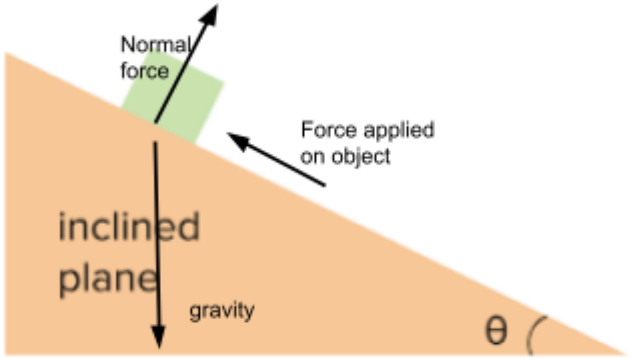
1. Try pushing a door open near the handle. Is it difficult?
2. Next, try opening the door by pushing one inch away from the hinge. Notice how much harder it is to do.

The reason why it's so much easier to open a door by a handle than by the hinge is mechanical advantage! When you apply an effort force farther away from the fulcrum (hinge), the amount of force needed to open the door is much less.



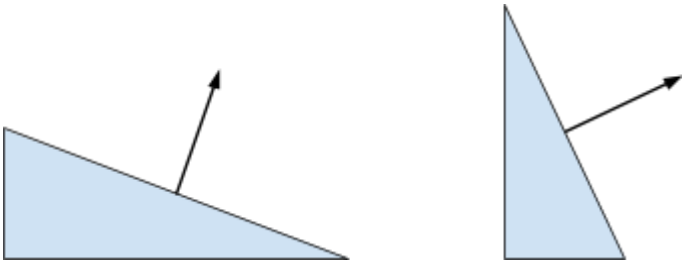
Inclined Planes

Inclined planes are found in all sorts of places, like wheelchair ramps. They help us move things upward easier. When we pick something straight up, we are having to oppose gravity with a force equal or greater than the force of gravity on the object. However, with an inclined plane, the inclined plane applies its own upwards force against gravity, helping us, so we don't have to put as much force to lift an object. We can call the upwards force that the inclined plane applies, the normal force. The diagram below shows the force of gravity, normal force, and the force we apply to push the object upwards.



Now, just from experience, we know that pushing an object up a steeper ramp is harder than a less steep ramp. This is because the normal force of steeper inclined

plane doesn't go against gravity as much as a less steep inclined plane.



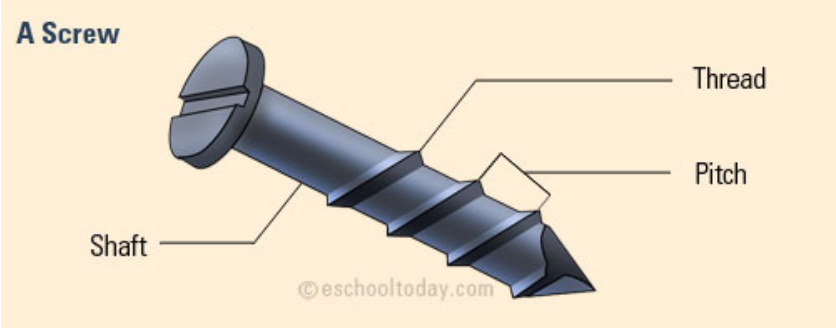
Compare the normal forces of the inclined planes above. The steeper inclined plane on the right has a normal force that is going somewhat against gravity, while the less steep inclined plane has a normal force that is greatly opposing gravity, helping you when you try to oppose gravity with your force.

We can represent this difference with the mechanical advantages of the inclined planes. The mechanical advantage is how much the force is amplified, or how much greater the output force is than what you input. So, the inclined plane we had to apply less force in, has a greater mechanical advantage. We can find the inclined plane's mechanical advantage by dividing its length by its height. The less steep inclined plane with a longer length and a shorter height has a greater mechanical advantage than the steeper ramp.

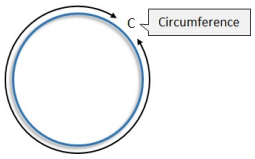
Screws

Screws are simple machines that convert rotational motion into linear motion. Basically, they convert the motion of something rotating around and around, into motion that is forwards or backwards. One example you probably see in your everyday life is water bottle caps. When you screw on a water bottle cap, note how by turning the cap around, you can make the cap move and lower onto the bottle. Screws are very useful in our lives for this purpose of converting rotational motion to linear motion, and for how they can reduce the force we need to apply to do things, like all simple machines.

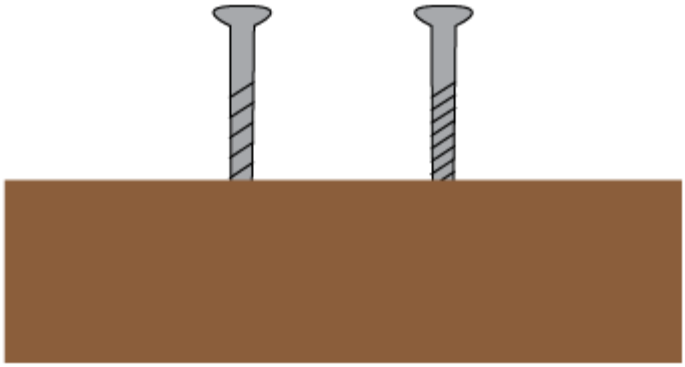
Screws have a few important parts:



The shaft is the long rod which the threads run along. The space between the threads is the pitch. We find the mechanical advantage of a screw by dividing the circumference of the shaft by the pitch. The circumference of a circle is how long the outer edge of the circle is. (shown in the picture to the right)



For example, a screw with a shaft circumference of 3 cm and a pitch length of 1 cm, would have a mechanical advantage of 3. We can also see that the smaller the pitch (compared to the circumference) the greater the mechanical advantage. So, in the drawing below, the screw on the right has a greater mechanical advantage because the threads are closer together. But why is this? With the screw on the right, it takes less force to turn the screw around. We will have to make more rotations to get the screw into the wood, but it will still take less force as the threads are closer together and the screw moves a smaller distance with each turn. With the screw on the left, the threads are farther apart, and with each rotation, the screw will go farther, and will therefore take more force on our part to turn the screw. So, the closer the threads (and smaller the pitch), the greater the mechanical advantage.



Questions

1. Name the 6 types of simple machines.
2. Does a screw with a larger pitch have a greater or smaller mechanical advantage?
3. Fill in the blank: Screws convert _____ motion into linear motion.
4. What are 3 examples of levers in your life?
5. Fill in the blank: A lever is a long beam or rod that rests on a _____.
6. What is the mechanical advantage of an inclined plane with a length of 4 m and a height of 2 m?
7. When we push something up an inclined plane, what force are we opposing?

Solutions to questions

1. Pulleys, Wedges, Wheel and Axles, Levers, Inclined Planes, Screws
2. Smaller
3. Rotational
4. (Answers may vary)
5. Fulcrum
6. 2
7. Gravity