

# The physics behind six simple (but important) machines

By ThoughtCo.com, adapted by Newsela staff on 03.19.20 Word Count **913** Level **680L** 



Image 1. A pulley on a sailboat. A pulley is an example of a simple machine. Photo by: Susan E. Degginger/Science Source

Whenever a force moves an object over a distance, work is being done. There are six simple machines that perform work. For a machine to perform work, an initial force must be put into the machine. This is called input force. The machine then exerts a force. This is called output force. Machines create a greater output force than the input force. The relationship between the forces is the advantage of the machine. It is called the machine's "mechanical advantage."

Six simple machines have been used for thousands of years. Archimedes was Greek philosopher. He lived more than 2,200 years ago. He studied the physics behind some of these machines.

The six machines can be combined to create an even greater mechanical advantage. One example of this is a bicycle. It uses many types of simple machines.

#### Lever

One of these simple machines is a lever. It is made of two parts. The first is a rigid object, which is often a bar of some kind. The second part is a fulcrum, or a pivot. A fulcrum is the point on which

something moves or turns.

Think of a seesaw. A seesaw is a type of lever. The fulcrum is the part of the seesaw that does not move. It is in the middle. The rigid object is the part of the seesaw that moves. It is where you sit. It rests on the fulcrum. Applying a force to one end of the seesaw causes it to move on the fulcrum. This action increases the force at the opposite end of the seesaw.

There are three types of levers. The type depends on the input force, the output force and the fulcrum. It depends on how these three things relate to each other. The earliest lever ever used was a balance scale. Other examples of levers include crowbars and wheelbarrows.

## Wheel And Axle

A wheel is a circular device that is attached to a rigid bar, or axle, in its center. You can apply force to a wheel, and this will cause the axle to rotate. You can also apply force to an axle, and this will cause the wheel to rotate.

A wheel is like a type of lever that rotates around a center fulcrum. In this case, the fulcrum is the axle.

The earliest wheel and axle combination was a toy model of a four-wheeled cart. This model was made in Mesopotamia in about 3,500 B.C. Ferris wheels and tires are examples of wheels and axles. A rolling pin is another example.

## Inclined Plane

An inclined plane is a plane surface, or flat surface, that is tilted on an angle. The most basic inclined plane is a ramp. Inclined planes make work easier. It requires less force to climb up a ramp to a certain height than to climb to that height vertically. For example, imagine a ramp that leads to the top of a wall. Walking up a ramp is less work than climbing up the wall.

No one invented the inclined plane. It can be found in nature. However, humans have been using man-made planes for a long time. People used ramps to build large buildings. They did this as early as 10,000–8,500 B.C.

## Wedge

The wedge is like a double inclined plane. This means that both sides are inclined. When a double inclined plane moves, it exerts a force along the lengths of the sides. It pushes two objects apart. Axes, knives and chisels are all wedges.

The common "door wedge" is an example of a wedge. However, it does not push two objects apart. Instead, it uses the force on its surfaces to provide friction. Friction is a force that resists the motion of an object.

The wedge is the oldest simple machine. It was made by our ancestors about 1.2 million years ago. They used wedges to make stone tools.

## Screw

A screw is a shaft, like a pole or a stick. It has a groove, or narrow cut, along its surface. The groove is on an incline.

When you rotate a screw, you apply torque. This is a twisting force. When the screw is rotated, the force is applied at a right angle to the groove. When this happens, the rotating force becomes a linear force. Linear means progressing in a straight line.

Screws are often used to lock objects together. Examples of screws include the hardware screw and bolt. The Babylonians in Mesopotamia developed the screw in the seventh century B.C.

#### Pulley

A pulley is a wheel with a groove along its edge. A rope or cable can be placed in the groove. In a pulley, force is applied over a long distance. This force combines with the tension in the rope or cable. It lets you reduce the amount of force you need to first apply when you move an object. This is how many complex pulleys work.

Simple pulleys were used by the Babylonians in the seventh century B.C. The first complex one had several wheels. It was invented by the Greeks. Archimedes perfected the pulley. He made the first "block and tackle." This is a system of at least two pulleys. The pulleys have a rope or cable threaded between them.

#### Who Coined The Word "Machine"?

The word "machine" was first used by Homer in the eighth century B.C. He was an ancient Greek poet. He used the word when he talked about politics.

#### Quiz

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- How does the "mechanical advantage" work?
  - (A) It happens when many different simple machines are combined.
  - (B) It happens when a machine does more work than it is supposed to.
  - (C) It happens when a person can do the same work as a machine.
  - (D) It happens when the output force is more than the input force.

2 Complete the sentence.

Using an inclined plane causes \_\_\_\_\_.

- (A) less work to be done and more force to be used
- (B) more work to be done and less force to be used
- (C) less work to be done and less force to be used
- (D) more work to be done and more force to be used
- 3 Read the following paragraph from the section "Wedge."

The common "door wedge" is an example of a wedge. However, it does not push two objects apart. Instead, it uses the force on its surfaces to provide friction. Friction is a force that resists the motion of an object.

What does the author mean by "resists"?

- (A) helps to move
- (B) is similar to
- (C) works against
- (D) does not affect
- Read the following paragraph from the section "Screw."

When you rotate a screw, you apply torque. This is a twisting force. When the screw is rotated, the force is applied at a right angle to the groove. When this happens, the rotating force becomes a linear force. Linear means progressing in a straight line.

Which word from the paragraph helps the reader to understand the meaning of "rotate"?

- (A) twisting
- (B) angle
- (C) groove
- (D) straight