

## Simple Machines—Teacher Background Information

### Glossary

Force is energy exerted or brought to bear on an object. *Pushes* and *pulls* refer to the direction of the force. Everything around you is pushing or pulling, and being pushed and pulled. Whenever you push on something, it pushes back. When you increase the distance of movement, you use less force. This is Newton's Third Law of Motion.

Gravity is a pulling (attracting) force between one object and another. The more matter, the bigger the pull.

A simple machine is a device that helps us to perform work more easily. The three fundamental simple machines are the lever, pulley, and inclined plane, and three adaptations of these are the wheel and axle, wedge, and screw. To make any simple machine do work, we need to apply a force on it.

Work is defined as force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. Machines make work easier by changing force or distance, or by changing the direction of the force. A force can be applied and still not be considered work if there is no movement. Imagine pushing on a huge boulder with all your might. You are exerting a force against the object, but since you cannot cause it to move, no work has occurred. You are doing work when you use a force to cause motion. To measure the amount of work you do, multiply the force by the distance the object moved. The work that comes out of a machine can never be greater than the work put into a machine.

### Simple Machines

There are six simple machines. The lever, pulley, and inclined plane, and the wheel and axle, wedge, and screw which are modifications of these machines.

A lever is a simple machine made up of a stiff arm or arms that pivot or turn. The point on which a lever turns is called the *fulcrum*. The load is the force of the object you are trying to move. Levers are classed by the relative position of the arm, fulcrum, and load. The three types of levers are:

- **First class lever**—A first class lever has the fulcrum in the center. A playground seesaw is a first class lever. One end lifts an object up just as far as the other end is pushed down.
- **Second class lever**—A second class lever has the load in the center. A wheelbarrow is a second class lever. The long handles are the arms of the lever, and the fulcrum is the front wheel.
- **Third class lever**—A third class has the effort and load on the same side of the fulcrum with the effort in the middle. The effort is always more than the load (which is a mechanical disadvantage), meaning that you always get less force out than you put in. A fishing pole is a third class lever. When the pole is given a tug it pivots around the fulcrum that is your wrist. One end stays still as the other end flips in the air catching the fish (moving the load).

A pulley is a simple machine made of a rope or chain wrapped around a wheel. It extends the force on a load over a longer distance for mechanical advantage. We use a pulley twice a day here at school, as we raise and lower our flag on the flagpole.

An inclined plane is a kind of simple machine with no moving parts; it is simply a straight slanted surface, like a wheelchair ramp or playground slide. An inclined plane functions by extending the force on a load over a longer distance for mechanical advantage.

## Modified Simple Machines

A wheel and axle is a modified pulley. A wheel and axle is made of a large wheel attached to a post or axle. Sometimes, the wheel or axle has a crank or handle. Together the wheel and axle move to create machines, like your bicycle or skateboard.

A wedge is the active twin of the inclined plane. A wedge does useful work by moving. In contrast, the inclined plane always remains stationary. A wedge consists of a pair of inclined planes set back-to-back, that can sustain sliding or rolling motion. Instead of the resistance being moved up an inclined plane, the inclined plane moves the resistance. We use wedges to keep our door open with our doorstop.

A screw is an inclined plane wrapped around a post or shaft. We use a screw when we change the height of our swivel chair. An auger is a good example of a load moving along a spiraling inclined plane. Also see Archimedes' water screw:

[www.mcs.drexel.edu/~corres/Archimedes/Screw/SourcesScrew.html](http://www.mcs.drexel.edu/~corres/Archimedes/Screw/SourcesScrew.html)\*

## Composite or Complex Machines

Composite machines are any machines that incorporate two or more simple machines. Some complex machines are a winch, hoist, windmill, sail-powered land yacht, and propeller-powered car.

Simple to composite machines:

[www.cosi.org/visitors/exhibits/gadgets](http://www.cosi.org/visitors/exhibits/gadgets)\*

Aspire Simple and Complex Machines tutorial:

<http://sunshine.chpc.utah.edu/javalabs/java12/machine>\*

Leonardo's Mystery Machines: [www.mos.org/sln/Leonardo/LeosMysteriousMachinery.html](http://www.mos.org/sln/Leonardo/LeosMysteriousMachinery.html)\*