

Simple Machines

Have you ever seen an ant carry away a crumb from your lunch? It seems the crumb is often much larger than the ant. If we weighed the crumb it would likely weigh more than the ant, too. Relative to their body size, humans cannot lift anything remotely close to what ants can lift. Simple machines and compound machines (made up of two or more simple machines) allow humans to do many things that would otherwise be impossible.

WHAT IS WORK?

A machine is a tool designed to make work easier. Scientists define work as a force acting on an object to move it across a distance. Scientists use the mathematical equation, $W \text{ (work)} = F \text{ (force)} \times D \text{ (distance)}$, to calculate the amount of work accomplished. Common examples of work include pushing and pulling. Simple machines can magnify a force, change a force's direction or increase the speed with which a force is applied. This changes the rate at which work is done. Thus, simple machines increase our mechanical advantage -- the ability to accomplish work more easily. In other words, machines convert forces into a form most useful for the task. Now, let's look at each of the six types of simple machines.

WHAT IS A LEVER?

A lever consists of a rigid bar that pivots (turns) around a fixed point, the fulcrum. Levers come in three types:

First Class: We most commonly think of first-class levers, like a teeter-totter or seesaw. In a first class lever the fulcrum lies between the force and the work to be done, or load. First class levers include such things as pliers, scissors and crowbars.

Second Class: In second class levers the load lies between the force and the fulcrum. Nutcrackers and wheelbarrows provide examples of second-class levers.

Third Class: In third class levers the force exists between the work and the fulcrum. Examples of third-class levers include your lower arm (your elbow is the fulcrum), a broom and tweezers.

WHAT IS A WHEEL AND AXLE?

A wheel and axle involve a circular rotating part (the wheel) that turns around a shaft (the axle). Turning one-part turns

the other. Examples include a doorknob, bike handlebars, and car wheels. Wheels with teeth that fit into one another are called gears. As one gear turns, that gear turns another gear. We find gears in can openers, bikes, cars, and mechanical clocks.

WHAT IS A PULLEY?

A pulley is a grooved wheel that spins on a fixed axis with a rope or chain moving over the wheel. Fixed pulleys involve wheels and rope that are fixed in place. They make lifting easier by changing a push upward to a pull downward. Examples of fixed pulleys include flagpoles or miniblinds. Movable pulleys are attached to each other and move with resistance. They make work easier by changing the force. A pulley system called a block and tackle consists of both fixed and movable pulleys. It makes work easier by changing the direction of force and decreasing the force needed to perform the work.

WHAT IS AN INCLINED PLANE?

An inclined plane consists of a tilted flat surface.

The inclined plane allows us to move objects upward more easily than lifting the object directly. Raising an object to a height requires a certain amount of work. We cannot change the amount of work needed, but the inclined plane alters how we do the work: it increases the distance over which we do the work, but it decreases the effort needed. Examples of inclined planes include a ramp for loading a truck, a switchback road, and a ladder.

WHAT IS A WEDGE?

A wedge combines two inclined planes back to back. Wedges move objects apart by being forced under or between them.

Wedges change the direction of force applied to them. When you push down on a wedge; the wedge pushes out on the two planes that it is in between. Examples of wedges include axe heads, cutting edges of scissors, points of nails, and door stops.

WHAT IS A SCREW?

A screw is really a type of inclined plane. The inclined plane is wound around a post. Screws can be used to lift things. Examples of screws include some car

jacks and some piano stools in addition to the screws we typically buy at the hardware store.

CONCLUSION

Next time you're at a picnic, you'll still surely marvel at tiny ants carrying your bread crumbs away. But you now know that humans can move large loads, too. Since the building of the pyramids (and before), humans have used simple machines to make seemingly impossible tasks possible. Today, humans design and operate machines of all sizes, from gigantic cranes used to construct the highest skyscraper to microscopic machines found in our most advanced technology. While humans continue to directly provide the energy to operate some modern machines, the energy needed to operate many machines come from other sources such as electricity or gasoline.

VOCABULARY WORDS

Axle - the shaft on which a wheel turn.

Block and Tackle - a rope and pulley system, used for lifting or hauling, in which the rope passes through one pulley anchored above (the block) and a second pulley suspended below it (the tackle).

Compound Machine - a machine that contains more than one simple machine.

Effort - the force that is applied to a machine to produce an action.

Energy - the capacity to do work.

Force - the push or pull that makes something move, slows it down or stops it, or the pressure that something exerts on an object.

Friction - force of rubbing between two surfaces that slows movement, and produces heat or sound.

Fulcrum - the pivot on which a device such as a lever is supported so that it can balance, tilt or swing.

Gear - wheel with notches, or cogs, cut around its edge; used to transmit the turning movement of one wheel to a second wheel.

Gravity - the force that gives everything weight and pulls objects toward the Earth's center.

Inclined Plane - a sloping surface; it enables a smaller force to lift a load over a longer distance.

Lever - a bar that tilts about a pivot to move a load.

Load - the weight of an object that is moved by a machine, or the resistance to movement that a machine must overcome.

Machine - a manufactured device that consists of an arrangement of fixed and moving parts for doing work.

Mechanical Advantage - the time saved, and energy gained by using a machine to do work.

Pulley - a wheel with a grooved rim through which a rope, chain or belt is pulled to lift a load.

Screw - a shaft with a helical thread or groove that turns either to move itself, or to move an object or material surrounding it.

Simple Machine - basic machines that include the lever, wheel and axle, pulley, inclined plane, wedge and screw.

Wedge - a machine with a sloping side that moves to exert force.

Wheel - a circular rotating part in a machine that moves around an axle.

Wheel and Axle - a class of rotating machines in which effort applied to the wheel produces a useful movement in the axle or vice versa.

Work - measure of the effort, or force, used to move an object over a distance.