Simple Machines

A machine is a device that helps make work easier to perform. (Remember, Work = Force X Distance). A machine makes work easier to perform by accomplishing one or more of the following functions:

1. transferring a force from one place to another,
2. changing the direction of a force,
3. increasing the magnitude of a force, or
4. increasing the distance or speed of a force.

MECHANICAL ADVANTAGE

When a machine takes a small input force and increases the magnitude of the output force, a mechanical advantage has been produced. If a machine increases an input force of 10 pounds to an output force of 100 pounds, the machine has a mechanical advantage (MA) of 10. This is shown below:

MA = Output Force = 100 lbs. = 10

Input Force 10 lbs.

The automobile jack is a common device used to produce a mechanical advantage. The jack multiples the amount of force applied to the jack handle so that a small force (exerted by the operator) can be used to produce the larger force necessary to lift the automobile.

THE SIX SIMPLE MACHINES

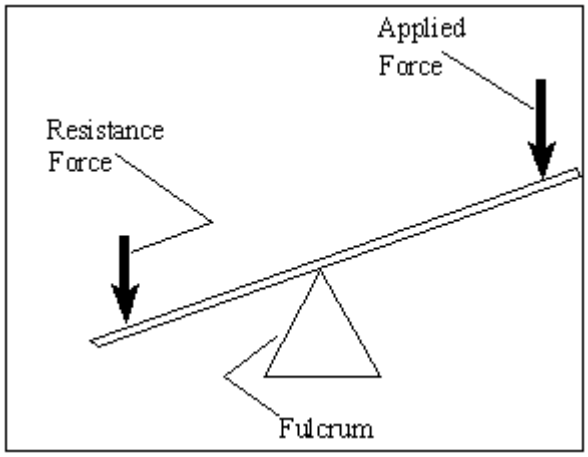
You are probably familiar with many different machines. Some of these machines appear highly complex. However, all machines, no matter how complex, are made up of one or more of the six simple machines. The six simple machines are:

1. Lever
2. Wheel and Axle
3. Pulley
4. Inclined Plane
5. Wedge
6. Screw

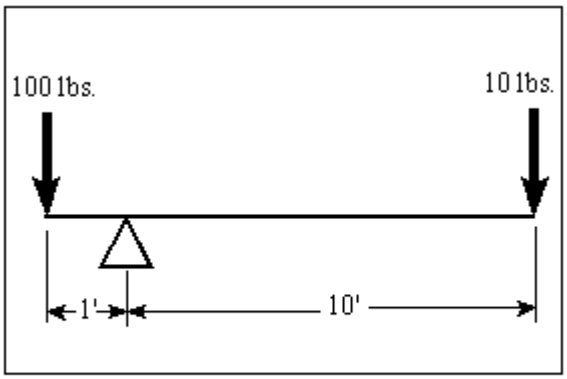
Individually, each of these machines is a simple machine. When two or more simple machines are combined in such a way that they work as a single mechanism, the device is classified as a complex machine.

LEVER

A lever is a rigid bar that rotates around a fixed point called the fulcrum. The bar may be either straight or curved. In use, a lever has both an applied force and a resistance force.



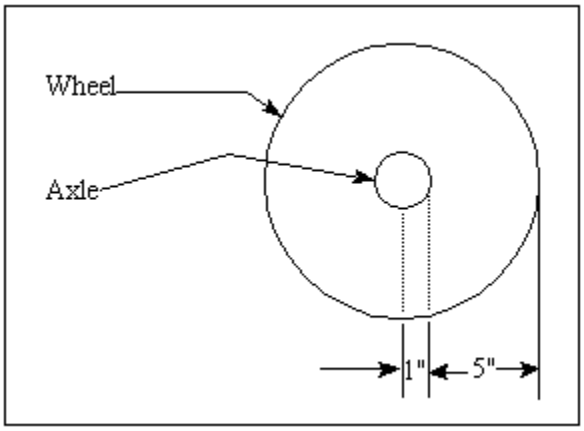
The mechanical advantage of a lever is the ratio of the length of the lever on the applied force side of the fulcrum to the length of the lever on the resistance force side of the fulcrum. The mechanical advantage of the lever below is 10:1. Therefore, an applied force of 10 pounds will balance a resistance force of 100 pounds. However, the applied force end of the lever must move 10 feet for every one foot the resistance force s raised.



WHEEL AND AXLE

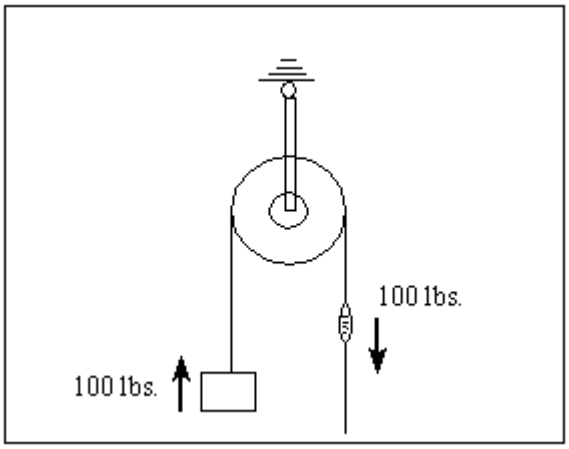
The wheel and axle is a simple machine consisting of a large wheel rigidly secured to a smaller wheel or shaft, called an axle. When either the wheel or axle turns, the other part also turns. One full revolution of either part causes one full revolution of the other part. If the wheel turns and the axle remains stationary, it is not a wheel and axle machine.

When the force is applied to the wheel in order to turn the axle, force is increased and distance and speed are decreased. When the force is applied to the axle in order to turn the wheel, force is decreased and distance and speed are increased.



PULLEY

A pulley consists of a grooved wheel that turns freely in a frame called a block. A pulley can be used to simply change the direction of a force or to gain a mechanical advantage, depending on how the pulley is arranged.

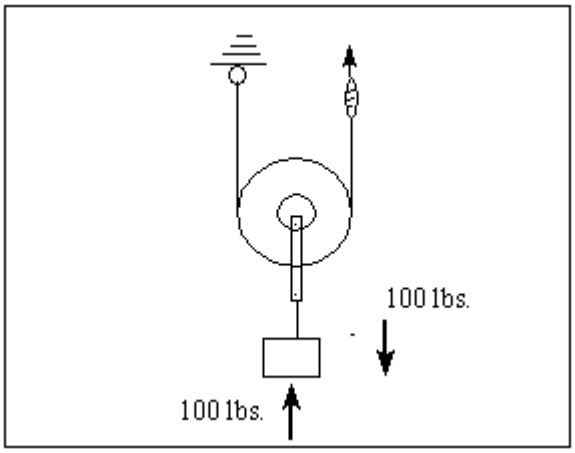


A pulley is said to be a fixed pulley if it does not rise or fall with the load being moved. A fixed pulley changes the direction of a force; however, it does not create a mechanical advantage. A fixed pulley is illustrated below.

A moveable pulley rises and falls with the load that is being moved. A single moveable pulley creates a mechanical advantage; however, it does not change the direction of a force.

The mechanical advantage of a moveable pulley is equal to the number of ropes that support the moveable pulley. (When calculating the mechanical advantage of a moveable pulley, count each end of the rope as a separate rope). As shown in the following illustration, two rope ends support the moveable pulley. Therefore, an effort force of 50 pounds will lift a resistance

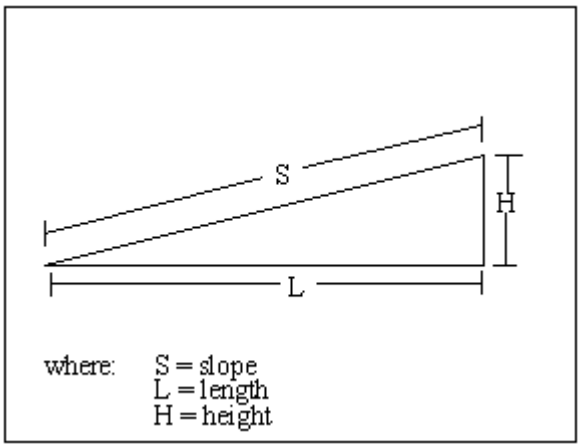
force of 100 pounds. The mechanical advantage is 2.



In many applications, both fixed and moveable pulleys are used in combination to form a device known as a block and tackle. A block and tackle is capable of both changing the direction of a force and creating a mechanical advantage.

INCLINED PLANE

An inclined plane is an even sloping surface. The inclined plane may slope at any angle between the horizontal (----------) and the vertical (|). The inclined plane makes it easier to move a weight from a lower to higher elevation. An inclined plane is illustrated below:

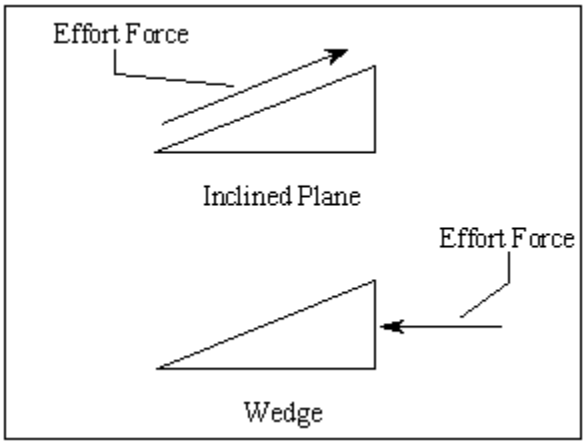


WEDGE

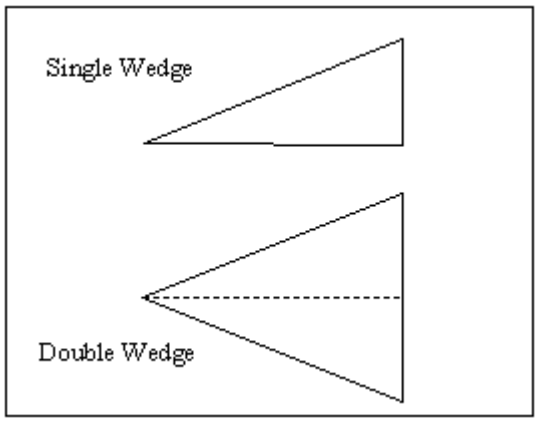
The wedge is a modification of the inclined plane. Wedges are used as either separating or holding devices.

There are two major differences between inclined planes and wedges. First, in use, an inclined plane remains stationary while the wedge moves. Second, the effort force is applied parallel to the slope of an inclined plane, while the effort force is applied to the vertical edge (height) of the wedge. See the

illustration below:



A wedge can either be composed of one or two inclined planes. A double wedge can be thought of as two inclined planes joined together with their sloping surfaces outward. Single and double wedges are illustrated below:



SCREW

The screw is also a modified version of the inclined plane. While this may be somewhat difficult to visualize, it may help to think of the threads of the screw as a type of circular ramp (or inclined plane).

The vertical distance between two adjacent screw threads is called the pitch of a screw. One complete revolution of the screw will move it into an object a distance to the pitch of the screw.