

**Work and Machines** ▪ *Section Summary***How Machines Do Work****Guide for Reading**

- How do machines make work easier?
- What is a machine's mechanical advantage?
- How can you calculate the efficiency of a machine?

A **machine** is a device that allows you to do work in a way that is easier or more effective than if you did not use the machine. A machine can be as complex as a motor or as simple as a shovel.

A machine does not decrease the amount of work you do but changes the way you do the work. **A machine makes work easier by changing at least one of three factors. A machine may change the amount of force you exert, the distance over which you exert your force, or the direction in which you exert your force.**

The force you exert on the machine is called the **input force**. The force exerted by the machine is called the **output force**. The input force multiplied by the input distance is the **input work**. The output force multiplied by the distance is called **output work**.

A machine makes work easier by multiplying either force or distance, or by changing the direction of the force. **A machine's mechanical advantage is the number of times a machine increases a force exerted on it.**

$$\text{Mechanical Advantage} = \frac{\text{Output force}}{\text{Input force}}$$

For a machine that increases force, the mechanical advantage is greater than 1 because the output force is greater than the input force. For a machine that increases distance, the output force is less than the input force. The mechanical advantage is less than 1. If a machine only changes the direction of the force, the input force is the same as the output force. The mechanical advantage is 1.

The **efficiency** of a machine compares the output work to the input work. Efficiency is expressed as a percent. The higher the percent, the more efficient the machine is. An ideal machine would have an efficiency of 100%. However, all machines have an efficiency of less than 100% because some work is wasted due to friction. **To calculate the efficiency of a machine, divide the output work by the input work and multiply the result by 100%.**

$$\text{Efficiency} = \frac{\text{Output work}}{\text{Input work}} \times 100\%$$