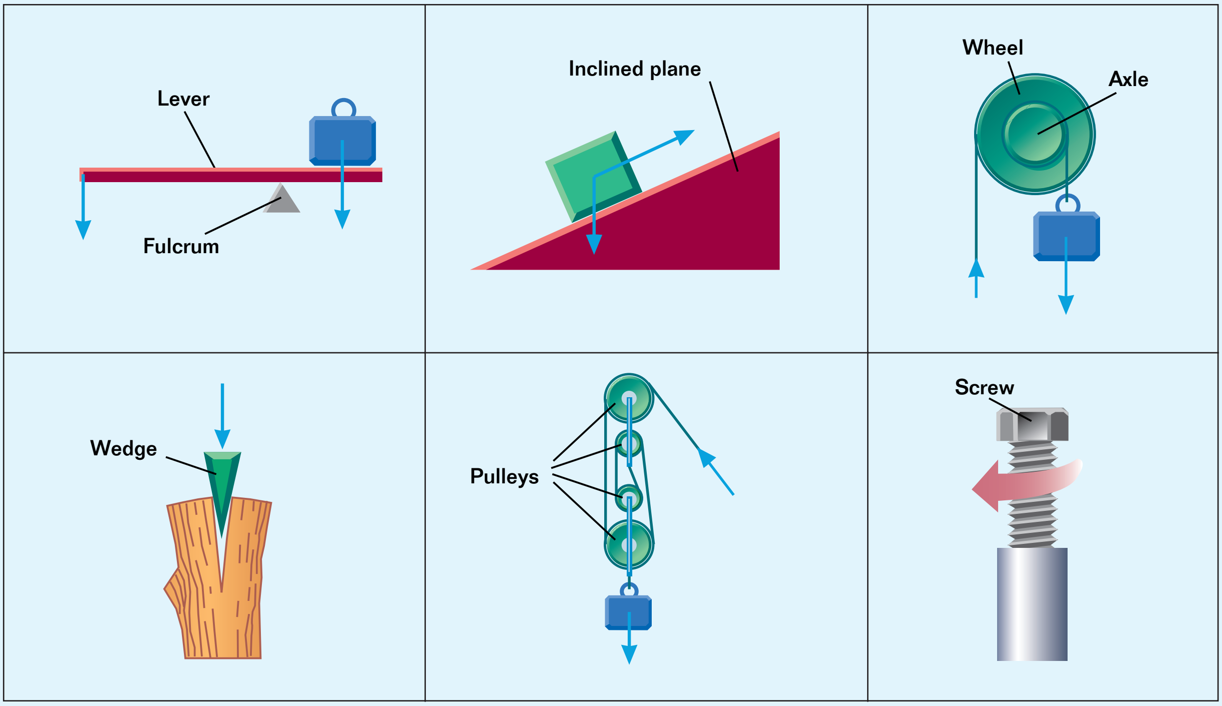
Table 2 Six Simple Machines



One example of mechanical advantage is the use of the back of a hammer to pry a nail from a board. In this example, the hammer is a type of lever. A person applies an input force to one end of the handle. The handle, in turn, exerts an output force on the head of a nail stuck in a board. If friction is disregarded, the input torque will equal the output torque. This relation can be written as follows:

$$\tau_{in} = \tau_{out}$$
$$F_{in}d_{in} = F_{out}d_{out}$$

Substituting this expression into the definition of mechanical advantage gives the following result:

$$MA = \frac{F_{out}}{F_{in}} = \frac{d_{in}}{d_{out}}$$

The longer the input lever arm as compared with the output lever arm, the greater the mechanical advantage is. This in turn indicates the factor by which the input force is amplified. If the force of the board on the nail is 99 N and if the mechanical advantage is 10, then an input force of 10 N is enough to pull out the nail. Without a machine, the nail could not be removed unless the input force was greater than 99 N.

TIP *This equation can be used to predict the output force for a given input force if there is no friction. The equation is not valid if friction is taken into account. With friction, the output force will be less than expected, and thus* $\frac{d_{in}}{d_{out}}$ *will not equal* $\frac{F_{out}}{F_{in}}$.