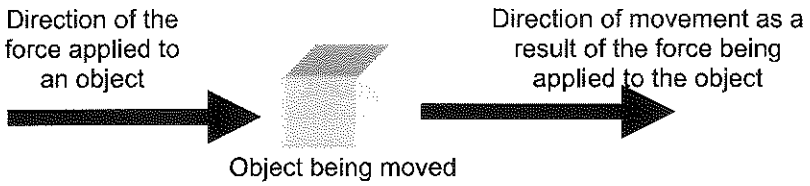
2.2 The Science of Work

The Meaning of Work

Scientifically, work is done when **a force** acts on an object to make that object **move**.

In order to say that work is being done, there must be movement. If there is no movement, no matter how much force is used, no work is done.



For example; a worker uses force to move a large carton up a ramp. Energy (pushing) is transferred to the carton from the worker. Thus, we say that the worker did work on the carton as long as the carton moved up the ramp as a result of the worker's pushing action (force).

Calculating Work

The amount of work is calculated by multiplying the force times the distance the object moves.

The formula looks like this: $\mathbf{W = F \times d}$

Force is measured in Newtons and distance is measured in meters. The resulting work unit is called a **joule**, named after the English scientist James Joule.

Energy and Work

Energy and work are closely related, because without energy there would be no work. Work is done when there is a transfer of energy and movement occurs. Energy provides the force needed to make an object move. The energy can be in the form of human energy (muscle power – chemical reactions in the body producing energy) or it can be in the form of another energy source, such as gasoline (for a car). A machine transfers energy from its source to the object, causing the object to move. There is a very complicated chain of events that make a car move - beginning with it being fueled up with gasoline - all the way through its many subsystems (each doing work) - to eventually the tires rotating to make the car move forward or backward.

Work and Machines

There are different types of simple machines that can help us do work. The work done with a machine is the same as the work done without it. This can be shown by calculating work input and work output.

Work input is the work needed to use, or operate the machine

$$\text{Work}_{\text{input}} = \text{Force}_{\text{input}} \times d_{\text{input}}$$

Work output is the work done by the machine.

$$\text{Work}_{\text{output}} = \text{Force}_{\text{output}} \times d_{\text{output}}$$

Work and Friction

Friction is the reason that work input does not equal work output in real situations. Friction affects the machine's efficiency. Efficiency can be calculated using work input and work output.

$$\textbf{Efficiency} = \frac{\textbf{Work}_{\text{output}}}{\textbf{Work}_{\text{input}}} \times 100$$