Micro-Scale Energy & Machines

By: Elise, Luke, and Audrey

Micro-Scale Energy

Can be either Potential or Kinetic Energy

- Kinetic Energy: Energy an object possesses due to being in motion. Kinetic energy increases when speed or mass of an object is increased.
- Potential Energy: Energy an object possesses due to the position of the object relative to others, internal stresses, electric charge, etc. The higher the tension, height, or internal stress, the higher the potential energy.

Types of Micro-Scale Energy include:

- Thermal - Kinetic Energy
- Nuclear - Potential Energy
- Electric - Potential Energy
- Chemical - Potential Energy

$E = mc^2$

Energy equals **mass** times **the speed of light** squared

- This equation was originally written as $M=\frac{E}{c^2}$
- This equation is really meant to describe mass.
- Explains nuclear fission, how matter can be destroyed and converted into energy, and how it can be converted back. It also explains the energy produced by nuclear power plants and atomic bombs

Mass Energy

Mass depends on

1. How the components are arranged
2. How the parts move inside of the larger object
3. How fast the object's particles are moving

A crank toy wound up and running would have more mass energy than a static toy

Or a cold watch would have less mass than one that's heated up

$M_{toy} = m_{parts} + m_{extra}$

$M_{extra} = KE + PE = E_{thermal} / C^{2} \rightarrow 1 \times 10^{-18}$

Atoms

A hydrogen atom has less mass than the combined masses of its components

When infinitely far away, protons and electrons have a potential energy of zero

When they are brought closer together, they attract each other, and their potential energy will drop into the negatives

An electron will always have positive Kinetic energy as it orbits the proton.

TAKE AWAY

Mass is a **property** that all energy exhibits

Mass does <u>not</u> equal the amount of stuff but the **amount of energy** contained by an object.

Simple Machines

Simple machines are devices that use only the force directly applied to them. They accomplish their task with a single motion.

Machines are designed to take advantage of the relationship between work, force, and distance.

Examples of simple machines include:

- Gears
- Levers
- Ramps
- Pulleys
- Screws
- Wheels and Axles

Machines work in terms of input and output.

For example, the force you apply to a lever is the input, while the force the lever applies to the object you are trying to move is the output. This even applies to things such as simply pushing a toy car.

Mechanical Advantage

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

Mechanical Advantage = the ratio of output force to input force

Mechanical advantage is how much “help” you get from the machine you applied a force to.

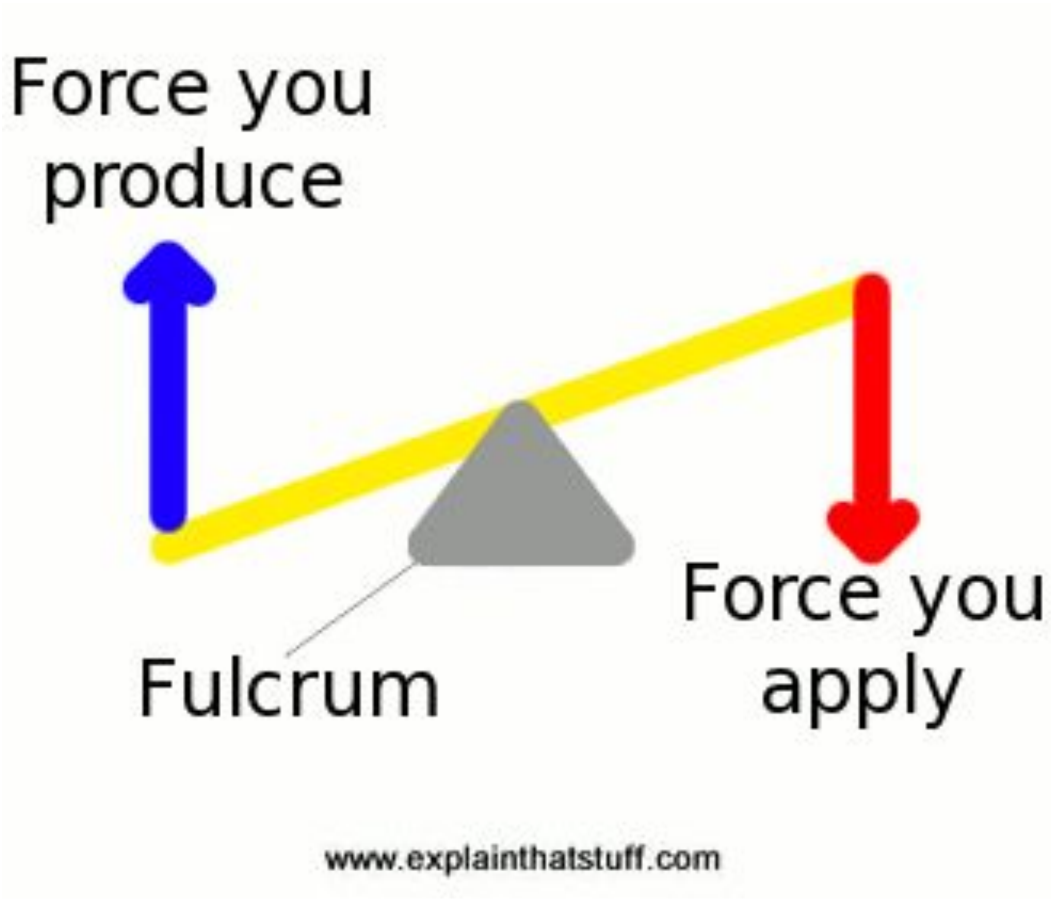
Lever

A lever is a stiff structure that rotates around a fulcrum.

$MA_{lever} = L_{in}/L_{out}$

L_{in} - length of input arm

L_{out} - length of output arm



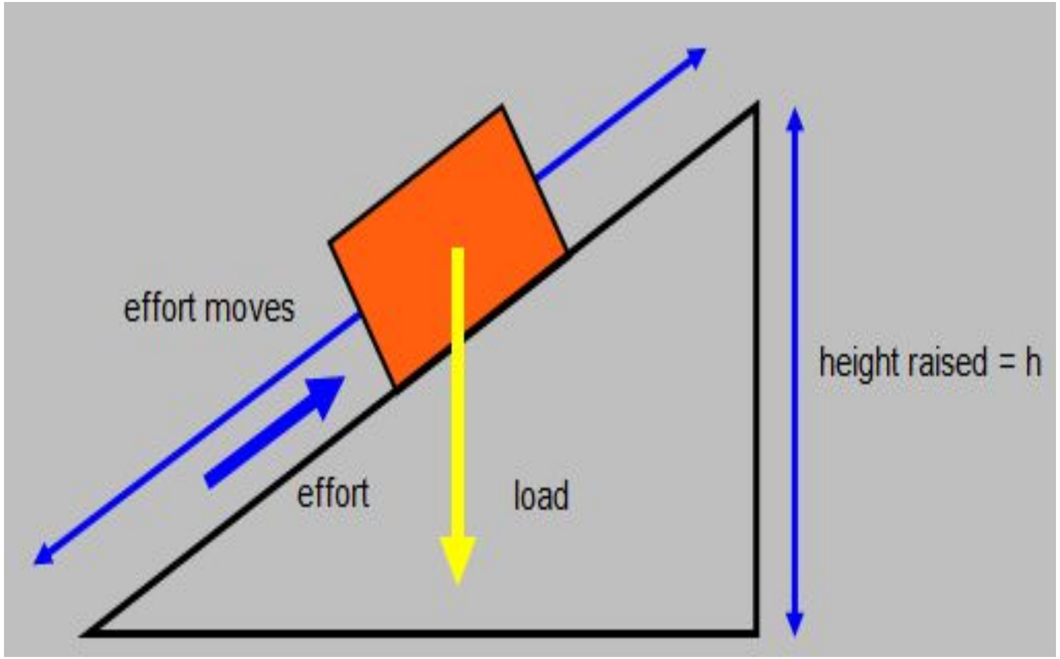
Ramp

You can use a slope or "inclined plane" to move an object to a higher position than before.

A gentle slope means less force is required but a longer distance needs to be covered.

A steep slope means more force is required but over a shorter distance.

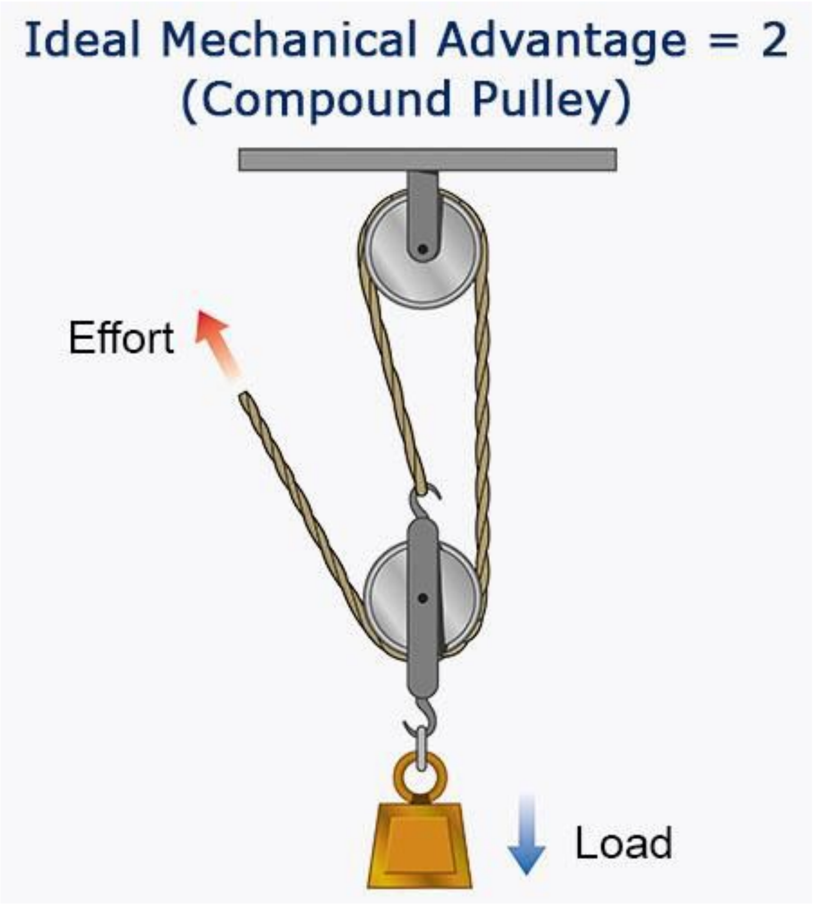
$MA_{ramp} = L/h$



Pulley

Pulleys change the direction of the force applied, which makes an object easier to lift. The more pulleys you have, the greater the mechanical advantage.

MA_{pulley} = # of pulleys



Efficiency

Efficiency = Input Work/Output Work

- The more efficient a machine is, the better.
- If a machine is inefficient, that means the majority of its energy is lost due to friction.
- The goal is to have the highest efficiency possible, so you get the most work done for how much force is applied.