Energy Transfer

Energy transfer is the exchange of energy between the system and the environment.

Work is the mechanical transfer of energy, while *heat* is the non-mechanical transfer of energy.

We will be focusing on work. The total energy of a system changes by the amount of work done on the system:

$$\Delta E = \Delta K + \Delta U_g + \Delta U_s + \Delta E_{th} + \ldots = W$$

The Law of Conservation of Energy

If the system is isolated, or separated from its environment such that no energy transfer happens, then the work done on the system (and therefore the change in energy) equals zero.

While energy cannot be transferred to or from isolated systems, it can be transformed from one type of energy to another.

Because the sum of the changes in all of the energies is zero, energy is conserved:

$$\Delta E = \Delta K + \Delta U_g + \Delta U_s + \Delta E_{th} + \ldots = W = 0$$

Work

As we said before, work is the mechanical transfer of energy - an external force being applied on an object over some distance, parallel to the object's course of motion:

$$W = F_{\parallel} d$$

The unit for work is the joule (J), which equals 1 N·m

Kinetic Energy

Translational kinetic energy is an object's energy of motion:

$$W = \Delta K = K_f - K_i$$

$$K_t = \frac{1}{2} m v^2$$

Rotational kinetic energy is an object's energy due to rotation:

$$K_r = \frac{1}{2} I \omega^2$$

In the case where a ball is rolling down a ramp, the ball has both translational kinetic energy and rotational kinetic energy.

Potential Energy

Gravitational potential energy is a "stored energy" that has the potential to be converted into other forms of energy, and is directly proportional to the height of an object above a surface:

$$U_g = mgh$$

Elastic potential energy is the energy stored in a compressed or extended spring:

$$U_s = \frac{1}{2} k \Delta x^2$$