Energy- the capacity to do work or produce heat.

Law of Conservation of Energy-

The energy in the universe is constant; it can neither be created nor destroyed but only transferred and transformed.

Potential Energy-

Energy due to position or composition.

Kinetic Energy-

Energy due to motion.

Kinetic energy depends on the mass and velocity of an object.

$$K.E. = \frac{1}{2}mv^2$$

Temperature-

A measure of the hotness or coldness of something and proportional to the average molecular kinetic energy of the atoms, molecules, or ions present.

Heat-

A form of energy.

Heat involves a transfer of energy between two objects due to a temperature difference.

State Function-

The value of a state function depends only on the initial and final states of the system, and not on the path taken to get from the initial to final state.

Ex. P, V, T, H, S, and G.

Work and heat are **not** state functions, they depend on the pathway.

System- The part of the universe which we are concerned with.

Surroundings- Everything else.

Exothermic -

Heat is given off.

The potential energy of the products is less than the potential energy of the reactants.

$$CH_{4(g)} + 2O_2 \rightarrow CO_{2(g)} + H_2O_{(g)} + \text{heat}$$

Potential energy reaction coordinate diagram.

Endothermic-

Energy is absorbed from the surroundings.

The potential energy of the products is greater than the potential energy of the reactants.

$$N_{2(g)} + O_{2(g)} + \text{energy} \rightarrow 2NO_{(g)}$$

Potential energy reaction coordinate diagram.

Thermodynamics-

The study of energy and its interconversions.

The study of the laws that govern the energy and entropy changes of physical and chemical events.

E is the internal energy of a system.

ΔE represents the change in the internal energy of a system.

First Law of Thermodynamics-

Law of Conservation of Energy, the energy of the universe is constant.

Mathematically:

$\Delta E = q + w$

q = heat **added to** a system

w = work done **on** the system

We will study the expansion and compression of gasses.

An expanding gas is doing work, "w" is negative.

A gas being compressed is having work done on it, "w" is positive.

When we work on a system (a gas), it compresses; when the system (the gas) expands it is doing work.

We will study a gas in an enclosed cylinder with a movable piston.

The pressure outside the cylinder pushes on the piston, if the gas expands it must expand against the outside pressure.

In order to compress the gas the pressure outside the cylinder must be greater than the pressure inside the cylinder. Work can then be done on the system (compression).

Pressure is force per area: $P = \frac{F}{A}$

Work is the application of a force over a distance:

Work = force x distance

$W = F \times d = F \times \Delta h$

We can rearrange $P = \frac{F}{A}$ to $F = P \times A$.

$Work = F \times \Delta h = P \times A \times \Delta h$

ΔV = final volume - initial volume = $A \times \Delta h$

$Work = P \times A \times \Delta h$

$Work = P\Delta V$

This formula gives the magnitude of the work done on or by a gas. We also must assign a sign to the work.

Compression is "+"

Expansion is "-"

For expanding gasses ΔV is positive, but we said this is "negative work."

Note that ΔV and work have opposite signs.

$$\mathbf{w = -P\Delta V}$$