**1st Law Thermodynamic Processes**

Here is a diagram of a generic thermodynamic process. A system has an initial internal energy. Heat is added to the system, or taken away from the system. Work may be done on the system or the system may do work or there may be no work involved at all.

The system ends up at some new internal energy state. This means that any of the following may change: temperature, pressure, or volume.

It can be very complicated to have all these things change at the same time, so the clever physicist is always looking for a way to make things simpler. This can be done by only having two of the three things change.

**Adiabatic Processes**: In an adiabatic process, heat is neither added or taken away from the system.



The word “adiabatic” is of Greek origin and means “impassible". The idea being that heat does not pass into or out of the system.

An adiabatic process has the following jolly definition:

***Adiabatic process ≡ a process in which there is no net heat transfer.***

This means that the first law can be simplified:



What this means is that work is done by the system at the expense of internal energy.

Adiabatic processes are very common. There are two simple ways to have one take place:

1. The system can be insulated so that heat can neither enter nor leave. Joule’s “heat equivalent” experiment was adiabatic. The tub of water was insulated so the water would not absorb heat from its surroundings. Instead the work done on the water by the paddles increased the internal energy of the system - the temperature went up.

Note that the system did no work because ***PΔV*** was zero.

2. The other way to have an adiabatic process (this is actually called a “near adiabatic process”) is to have it happen very quickly. The process happens so fast that there is no time for heat to be transferred.

The combustion of gasoline in an engine is considered to be adiabatic because each combustion step happens in a very short time – a few hundredths (or less) of a second.

In an adiabatic process the following can happen:

1. a gas that is adiabatically expanded will lose internal energy (Δ*U* ) and become cooler.
2. a gas that is adiabatically compressed will gain Δ*U* and become warmer.

**Isothermal Process:**The isothermal process happens at a constant temperature. The pressure and volume change, so work is done, but Δ*U* is zero.



**Isochoric Process*:*** In this type of process, the volume stays constant. This means that ***ΔV*** is zero. If ***ΔV*** is zero, then the work must also be zero.

 Thus:



Examples of isochoric processes:

Cooking food

Pressure cooker

The key points for this type of process is:

No work is done.

The internal energy is changed by the addition or extraction of heat from the system.

**Isobaric Process:** - ***pressure stays constant***

Work can be done if the volume of the system undergoes a change. Without the change in volume, can’t get no work out of the system.