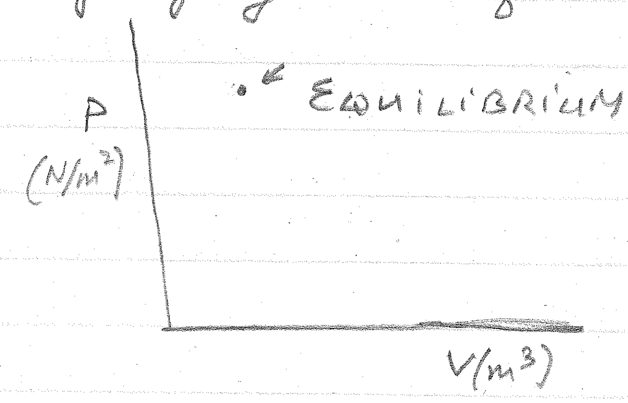
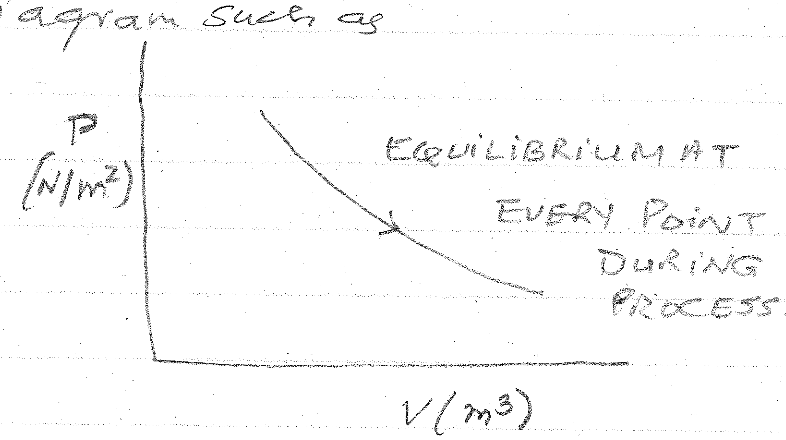
Thermodynamic Processes
– IDEAL and Natural

We have defined and analyzed several thermodynamic processes and must remind ourselves that a process implies that one or more of the parameters P, V and T vary with time. We must now ask the question. How do you carry out such a process?

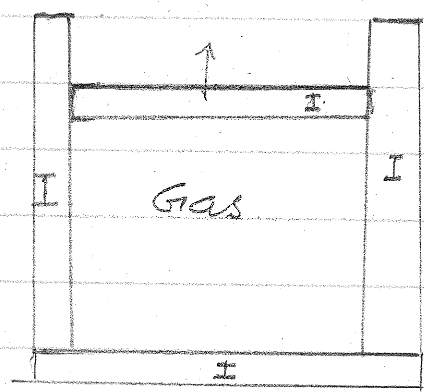
We begin with recognizing that if we plot a point to represent the state of a system in a P-V diagram then the system must be in equilibrium, single values of P, V and T represent it.



So if we draw a process as a continuous line in a PV-Diagram such as

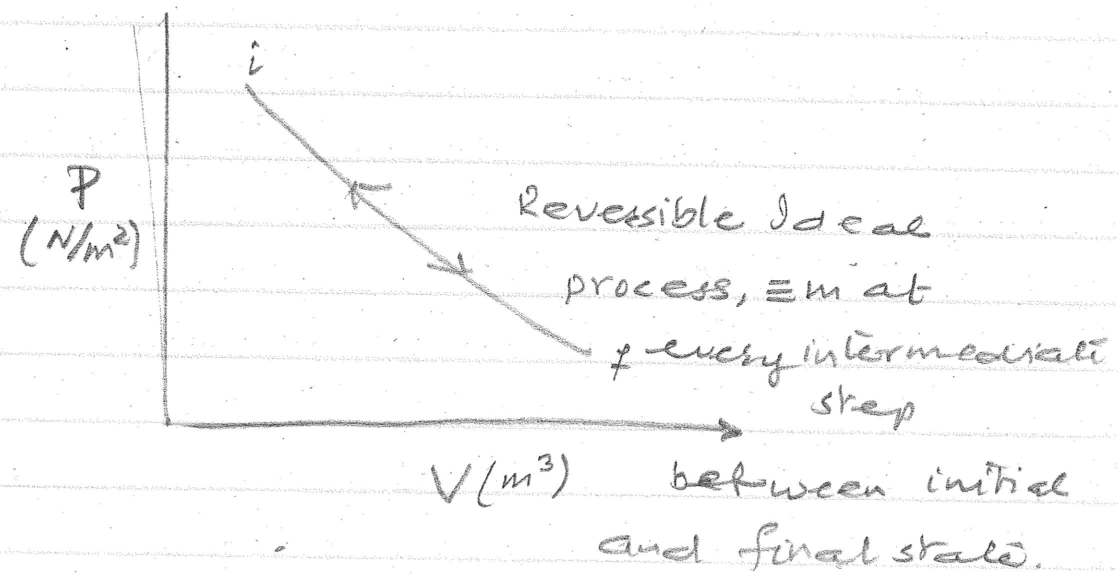


then it means that system is in Em at every point during the process. How do you peform such an experiment? Consider for example the Adiabatic process. No heat enters or leaves the system and the gas is allowed to expand so it uses its

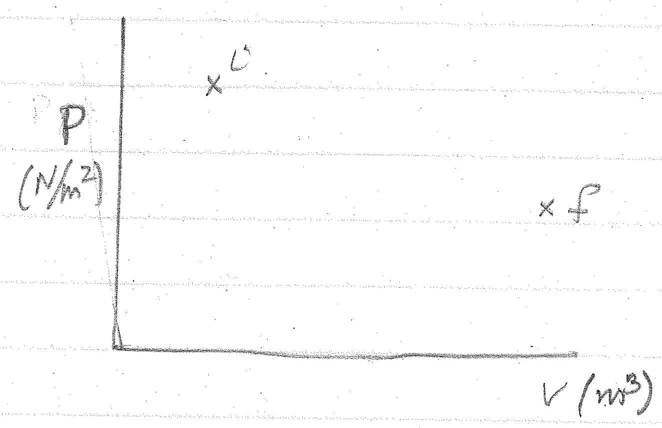


internal energy to get the piston to move and do work. If we want Em at all times the change must be done infinitely slowly. Typically, a piston would have a mass of 0.05kg (wt 0.49N). To move it ever so slowly let us pretend that we can take away 1 electron (9×10^{-31}kg) at a time. Piston reduces weight slides up. All the changes are very small and so Em is maintained but of course the experiment would take for-ever. However, because the steps are so small at any point we can stop and start adding electrons and make the system go back to its original state. That is, if the process proceeds through pts. such that there is Em at every point we have the possibility of going forward or backward –

A CONTINUOUS LINE IN PV-DIAGRAM REPRESENTS AN IDEAL PROCESS WHICH IS REVERSIBLE



The above experiment could, of course, not be done in a laboratory because it would take a very long time (1el every sec and expt. would last for 2×10^{22} yrs to reduce pressure by 20% (~0.1N) (age of universe ~10^{10} yrs). When the actual expt is done there is equilibrium only in the initial and the final states. The natural process is therefore represented by



The intermediate points are totally undefined so such a process is

IRREVERSIBLE

you cannot retrace a "non-existent" path

For example, in an actual experiment one lets the piston move quickly, allowing the pressure immediately below it to drop and setting up motion within the gas totally uncontrolled. Eventually equilibrium prevails but there is no way to go back to the initial state.

Moral of the story is:

Natural Processes have a direction.