Statistical Physics I

Based on the lectures of Manuela Kulaxizi
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1 Lecture: 1

Thermodynamics can be defined as the study of the physical behaviours of macroscopic system properties. It is loosely defined in terms of a large number of constituents, N ($\sqrt{N} >> 1$). Behaviours arises as a consequence of physical laws, symmetries. Thermodynamics treats systems as approx. static. Macroscopic observations sense course spatial averages of the constiuents' motion.

1.1 Determining Appropriate Variables

Focus on **simple, macroscopic** systems. Simple meaning homogeneous, isotropic and uncharged. The system must be large enough to not consider interactions at the boundaries of the system.

1. V: **volume** of the system.
2. N_i: **number of constituents** of system or subsystem i; chemical composition.
3. E: **intrinsic energy** of the system.

Proposition 1.1 (Postulate I). *There exist states, **equilibrium states**, that are completely characterised by some variables of the system:*

$$\{V, N_i, E | i = 1, 2, ..., n\} \tag{1}$$

equilibrium states are defined in relation to the surroundings.

1.2 Walls and Constraints (Boundaries)

A thermodynamic description requires the specification of 'walls', constraints that seperate the system from the surroundings, and provide boundary conditions.

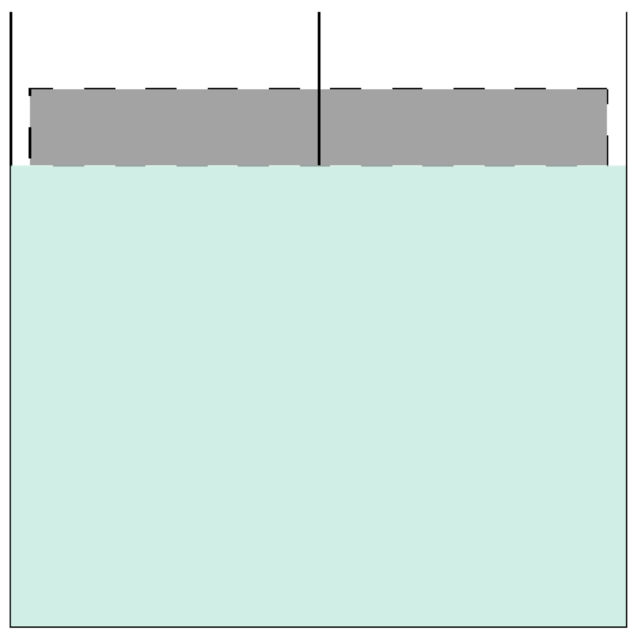

Figure 1: An example of a thermodynamic system, a gas under mechanical pressure.

In general, if a wall or boundary constrains an extensive variable, we call it **restrictive** w.r.t. that variable. Restriction of energy corresponds to thermal isolation (E conserved), volume to mechanical isolation ($V = \text{const.}$), and number of constituents to chemical isolation ($N_i = \text{const.}$).

Proposition 1.2 (Postulate II)**.** *There exist walls,* ***adiabatic walls****, such that the work done in taking an adiabatically enclosed system between two equilibriuum states is determined entirely by the beginning and end states themselves, independent of external conditions, i.e.* $W = \Delta E \equiv$ *difference in intrinsic energy.*
