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Course 565/665 Lecture Number ____ Date 2/21/03

Lecturer Dr. Silvia Cavagnero Note Taker Eric Fulmer

Last Time

$$p_i^* = \frac{e^{-\beta \varepsilon_i}}{\sum_{i=1}^{\infty} e^{-\beta \varepsilon_i}}$$ } Boltzmann Distribution

The denominator is the partition function (Q)

- Dice Rolling – Find out distribution function features for different values of $\langle \varepsilon \rangle$.

– If $\langle \varepsilon \rangle = 3.5$, $x = 1$ (Remember, $e^{-\beta} = x$, $\varepsilon_i = i$)

$$p_i^* = \frac{x^i}{x + x^2 + x^3 + x^4 + x^5 + x^6}$$

All p_i^*'s are $\frac{1}{6}$ ⇒ Flat distribution.

– If $\langle \varepsilon \rangle = 3.0$, $x = 0.84$ (We are only solving for x in the below $\langle \varepsilon \rangle$ equation.)

$p_i^* = 0.25, 0.21, 0.17, \ldots$

$$\langle \varepsilon \rangle = \frac{x + 2x^2 + 3x^3 + 4x^4 + 5x^5 + 6x^6}{x + x^2 + x^3 + x^4 + x^5 + x^6} = \sum_{i=1}^{6} \frac{i x^i}{Q} = \frac{\sum \varepsilon_i e^{-\beta \varepsilon_i}}{Q}$$

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If $\langle \varepsilon \rangle = 4$, $x = 1.19$

$p_i^* = 0.10, 0.12, 0.15, \ldots$

Exponentially increasing ...

Thus, if $\langle \varepsilon \rangle = 3.5$, $p(i)$ is a <u>flat</u> distribution

if $\langle \varepsilon \rangle < 3.5$, $p(i)$ is an exponentially <u>decreasing</u> distribution fn.

if $\langle \varepsilon \rangle > 3.5$, $p(i)$ is an exponentially <u>increasing</u> distribution fn.

① The first corresponds to random events.

② The second is biased towards "lower energies."

③ The last case is biased towards "higher energies."

Read the Philosophical Implications of Entropy at the end of chapter 6 for a deeper description of entropy.

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Chapter 7 - Thermodynamic Driving Forces

Quantities to be discussed:

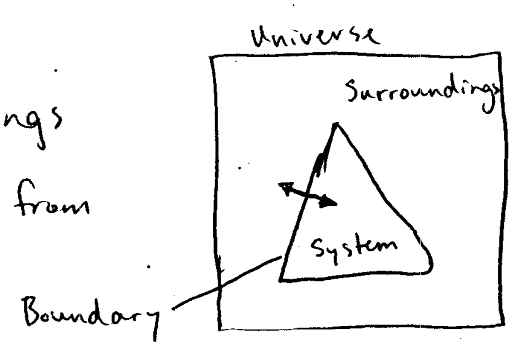
U	Internal Energy	T	Temperature
S	Entropy	P	Pressure
V	Volume	μ	Chemical Potential (Greek mu).
N	Number of particles/molecules		

Thermodynamics = Heat - Motion (Analyzing the Word)

Thermodynamics is all about energy transfer between systems at equilibrium and its surroundings. We can also use thermodynamics to study systems not in equilibrium, too.

Universe = System + Surroundings

Boundary - Separates System from its surroundings.



Boundaries govern exchanges of energy between the system and the surroundings.

Most simple system → Open Systems.

OPEN: Exchange Energy, V, mass w/ the surroundings.

CLOSED: Exchanges Energy and V, but NOT mass.

ISOLATED: No Exchange of Energy, mass, or V.

ADIABATIC: System exchanges (or can exchange) energy as work but not as heat. No heat is transfered. Systems which cannot exchange heat (q) are thermally isolated. The system can still generate heat, but none is transfered to the surroundings.

ISOTHERMAL: The system can exchange energy with the surroundings, but T stays constant. We generally think of the surroundings in this case as a large bath or sink which can absorb the energy of the system quite easily

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but maintain a constant T throughout.

Simple Thermodynamic System

- 1 phase (ie. a collection of matter with homogeneous V, P, mass, T, such as a gas, liquid, ...)
- Not any electrical, magnetic, or gravitational fields perturbing the system.

Properties of Systems

- Extensive - Depends on the size of the system (U, S, V, N)

- Intensive - Does not depend on the size of the system (T, P, μ)