Lecture 1

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Contents

0.1 Thermodynamics and Statistical Physics differences

Thermodynamics:

- Macroscopic
- Continuous Matter
- differentiable
- Necessary relations based on some axioms
- All properties of matter ($\Delta H_m, \Delta S_v, c_v, \lambda, D$) must be measured

Statistical Physics

- microscopic
- discrete particles
- Mechanics
- statistical behavior of simplified models
- Bottom up explanation of thermodynamics
- Properties of model matter ($\Delta H_m, \Delta S_v, c_v, \lambda, D$) can be calculated or measured in a simulation

0.2 Thermodynamics is omnipresent

- Climate: basis for modelling
- Sustainability:
  - Efficiency in the process industry
  - Energy efficient heating and cooling of buildings
  - Efficient engines and refrigerators
- Basic research:
  - Condensed matter physics
  - High energy physics
  - Cosmology
  - Biophysics
  - Meteorology
  - Geology
  - Chemistry
- $\Rightarrow$ Relevant for jobs

0.3 Statistical Mechanics, the secret weapon of physicists

- Make microscopic models of new phenomena
- Models follow laws of physics and statistics
- Derive macroscopic models

1 Basic Concepts

T is the temperature of an object.
If you have an object with T_1 and one with T_2, then they are at thermal equilibrium iff $T_1 = T_2$.

Heat is related to Energy, such that heat is the microscopic kinetic energy. In a macroscopic picture, heat is the transport of Energy. Heat is written as Q.

Work is the mechanical energy acting on a system. It is written as W. Mechanically, it is $W = F\Delta x$. Work is an Energy.

A system is isolated from the rest of the world, but there can be energy exchange between them. They can exchange work or heat for example. The internal energy of a System is denoted as U, E.

1.1 First Law of Thermodynamics

Energy is conserved, that is, energy cannot be destroyed or created, only exchanged.

Any change of energy in a system is caused by a transfer of energy with the outside world. That being, $\Delta U = Q + W$.