Lecture #1

THERMODYNAMIC TERMS AND DEFINITIONS

Thermodynamics deals with the relations between the properties and the energies of the systems at equilibrium. There are special terms used in thermodynamics.

System: a particular part of the universe under investigation. A system is confined to a definite place by the **boundary**.

Surroundings: all the points outside the system.

Universe: the system plus the surroundings.

Types of Systems

Systems are divided into three groups according to heat and mass flows.

1. **Open System:** There can be energy and mass flows through the boundary.
2. **Closed System:** There is no mass flow, but energy can be transferred.
3. **Isolated System:** Neither mass nor energy can flow through the boundary.

A system is described by its properties. The properties of a system may be of two kinds:

1. **Extensive Property:** If the value of the property depends upon the quantity of the system, the property is said to be an "extensive property". For example, volume, mass, mole number are extensive properties. Extensive properties obey the "additivity rule". Assume we divide the system into N parts. The total volume and the mole number are;

$$V = V_1 + V_2 + ... + V_N = \sum_{i=1}^{N} V_i$$

$$n_T = n_1 + n_2 + ... + n_N = \sum_{i=1}^{N} n_i$$

2. **Intensive Property:** If the value of the property does not change with the quantity of the system, the property is an "intensive property". For example, temperature, pressure are intensive properties. At equilibrium, the value of an intensive property is the same at all points of the system.

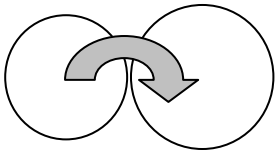
Intensive properties do not obey the additivity rule. They can not be added to obtain the property of the system.

The ratio of two extensive properties is an intensive property. For example, the density. It is the ratio of mass and volume, two extensive properties.

State: The state of a system is described by its properties. If each of the properties has a definite value, the system is in a definite state. If heat flows through the boundaries, then the properties of the system change. We say that the system undergoes a change from an "initial state" to a "final state".

Process: If the temperature is constant, the process is **"isothermal"**. If the pressure is constant, it is **"isobaric".** If there is no heat flow during the process, it is **"adiabatic".** If the system undergoes a series of changes and reaches to its initial state at the end, the process is **"cyclic".**

The Zeroth Law of Thermodynamics



The zeroth law of thermodynamics develops the temperature concept. If two closed systems are brought in contact with each other, heat flows from one system to the other. Hot system cools down, cold system heats up. Finally, "thermal equilibrium" is reached. In thermal equilibrium, both of the systems are at the same temperature.

- Systems in thermal equilibrium with each other have the same temperature.
- Systems not in thermal equilibrium with each other have different temperatures.
- Two systems which are both in thermal equilibrium with a third system are in thermal equilibrium with each other.

Work

The term "work" is defined as the quantity of energy flowing through the boundary of the system. Work is designated by **W**. This quantity of energy can lift a weight in the surroundings.

- Work is not an accumulated energy either in the system or in the surroundings, instead it is the energy flowing across the boundary.
- If there is work, the properties of the system and the surroundings change.
- The quantity of work is;

  W = Mgh

  where; M is the mass lifted, g is the acceleration due to gravity, h is the height to which the weight has been raised.
- Work is an algebraic quantity. It is positive, if work is produced by the system in the surroundings (*weight is lifted*). It is negative if work is destroyed in the surroundings (*weight is lowered*).

Heat

Heat is also a quantity of energy flowing across the boundary of the system. Heat is designated by **Q.** This quantity of energy can heat up water in the surroundings.

- Heat is not an accumulated energy either in the system or in the surroundings, instead it is the energy flowing across the boundary.
- If there is heat flow, the properties of the system and the surroundings change.
- The quantity of heat is equal to the number of grams of water in the surroundings which are increased by one degree in temperature.
- Heat is an algebraic quantity. It is positive, if heat flows from the surroundings to the system (*water is cooled*). It is negative, if heat flows from the system to the surroundings (*water is warmed*).