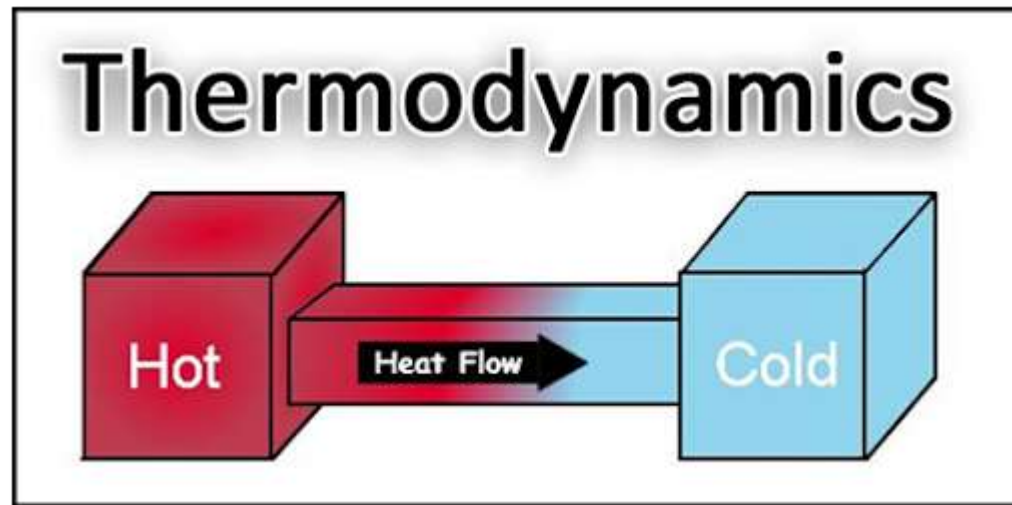


# Basics of Thermodynamics



By: Mohit Sir

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## ▶ BASIC CONCEPTS

### ▶ Definition of Thermodynamics

- ▶ It is the science of energy transfer and its effect's on properties. The main aim of thermodynamic study is to convert disorganized form of energy into organized form of energy in an efficient manner.

### ▶ SYSTEM:

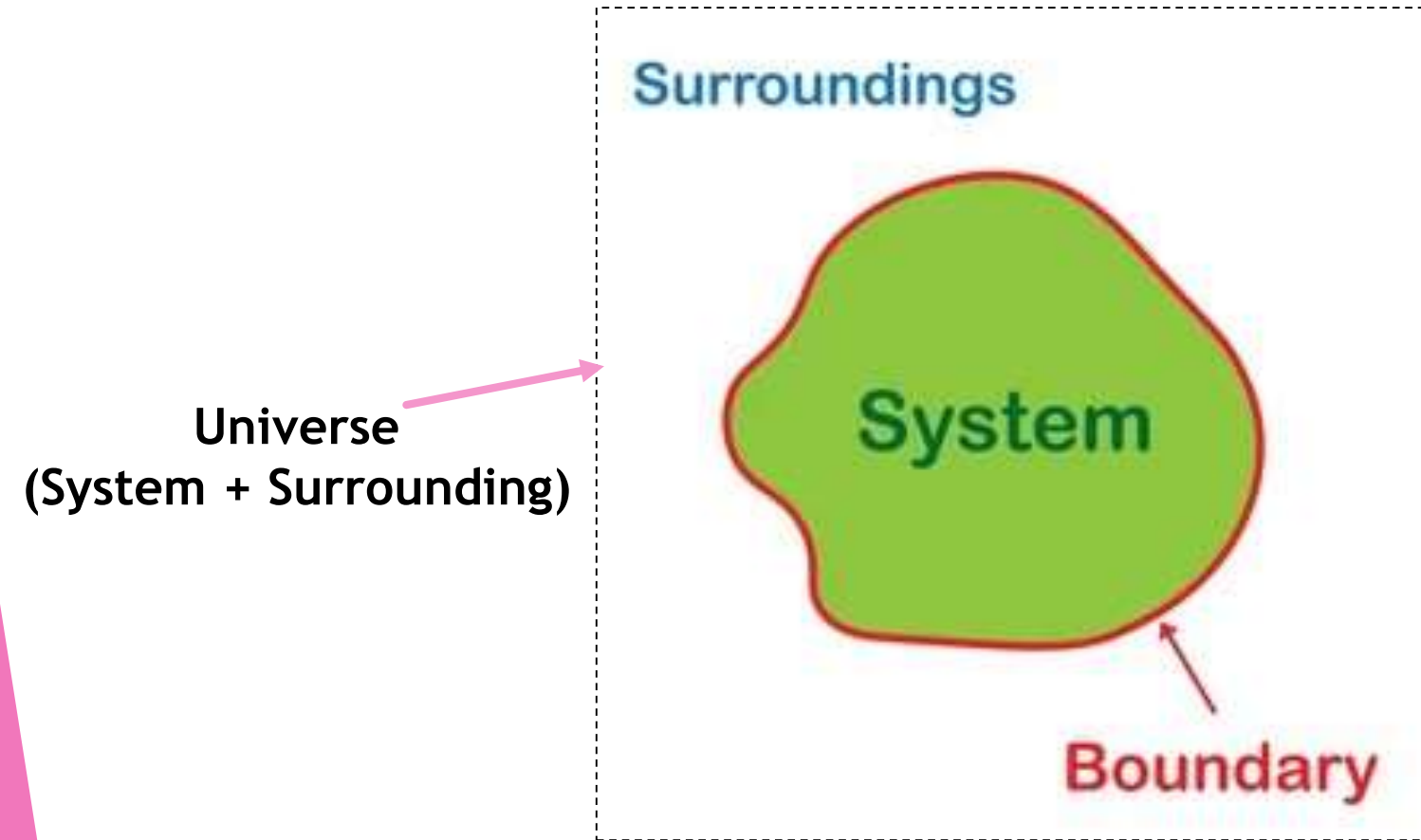
- ▶ It is a region in space on which the study is focused or concentrated.

### ▶ SURROUNDINGS:

- ▶ Any thing external to the system is known as surrounding's

### ▶ BOUNDARY:

- ▶ The separation between system and surroundings is known as boundary.



Universe is equal to system + surroundings.

Note: Boundary can be rigid or flexible and real or imaginary

# Types of System

Types of System	Mass Transfer	Energy Transfer	Examples
(i) Closed System	X	√	Piston cylinder without valves, gas in a sealed container.
(ii) Open System	√	√	Turbines compressor pump boiler.
(iii) Isolated System	X	X	Hot coffee in a well insulated flask universe

▶ **Microscopic and Macroscopic approach of thermodynamics**

- ▶ In microscopic approach the behavior of individual molecule's taken into consideration. This approach is also known as statistical thermodynamics.. This approach is generally used at low densities (higher altitudes)
- ▶ In macroscopic approach the behavior of individual molecules is not taken into consideration but the average behavior of molecules is taken into consideration. This approach is also known as classical thermodynamics.

▶ **THERMODYNAMIC EQUILIBRIUM:**

- ▶ A system is said to be in thermodynamic equilibrium. It is in
  - i. Thermal equilibrium (Equality of temperature/ pressure)
  - ii. Mechanical equilibrium (Equality of forces/ pressure)
  - iii. Chemical equilibrium (Equality of chemical potential)

► **PURE SUBSTANCE**

► A substance is said to be a pure substance. If it is homogeneous in chemical composition and homogeneous in chemical aggregation (bonding).

STEAM  
H<sub>2</sub>O 2:1

WATER  
H<sub>2</sub>O 2:1

H<sub>2</sub> + O  
2:1

WATER  
H<sub>2</sub>O 2:1

STEAM  
H<sub>2</sub>+O<sub>2</sub> 1:1

WATER  
H<sub>2</sub>O 2:1

Pure substance		Not a pure substance		Not a pure substance	
Conditions	√	Satisfied	√	Not satisfied	X
i) Homogeneous in chem.comp					
ii) Chemical aggregation	√	Not satisfied	X	Not satisfied	X

▶ **PROPERTY OF A SYSTEM**

▶ All measurable characteristics are known as properties

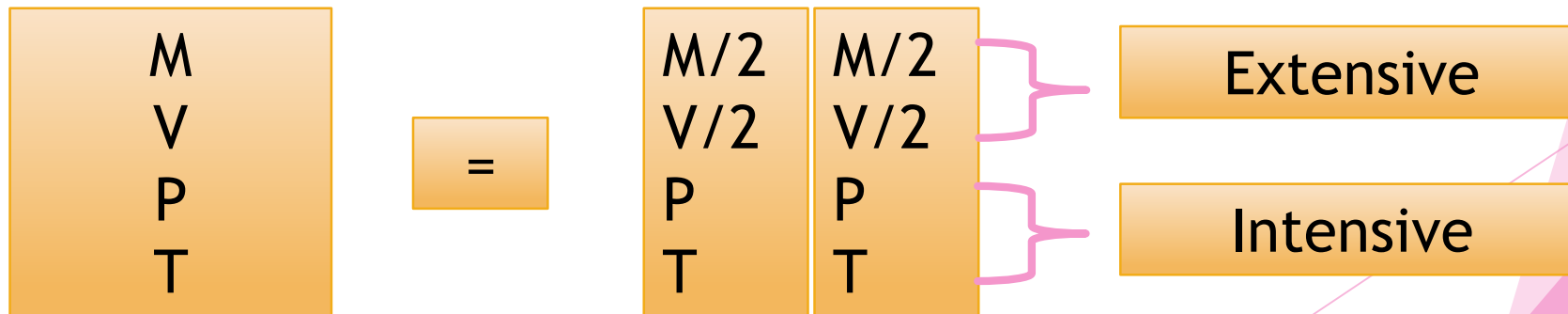
▶ Properties are of two types

i) Intensive properties

ii) Extensive properties

▶ **Intensive properties:** are independent of mass or size of the system eg: pressure, temperature, density, thermal conductivity, velocity.

▶ **Extensive properties:** depend upon size or mass of the system eg: volume, all forms of energy etc.



▶ **STATE OF SYSTEM:**

▶ **Important points w.r.t. properties**

- i) Properties are point functions or state functions.
- ii) Properties are independent of past history.
- iii) Properties are exact differentials

▶ **STATE OF SYSTEM**

- ▶ The condition of a system is known as a state of system.
- ▶ The condition of a system is known with the help of its properties.

▶ **PROCESS:**

- ▶ A change of state is known as a process.



▶ **REVERSIBLE AND IRREVERSIBLE PROCESS:**

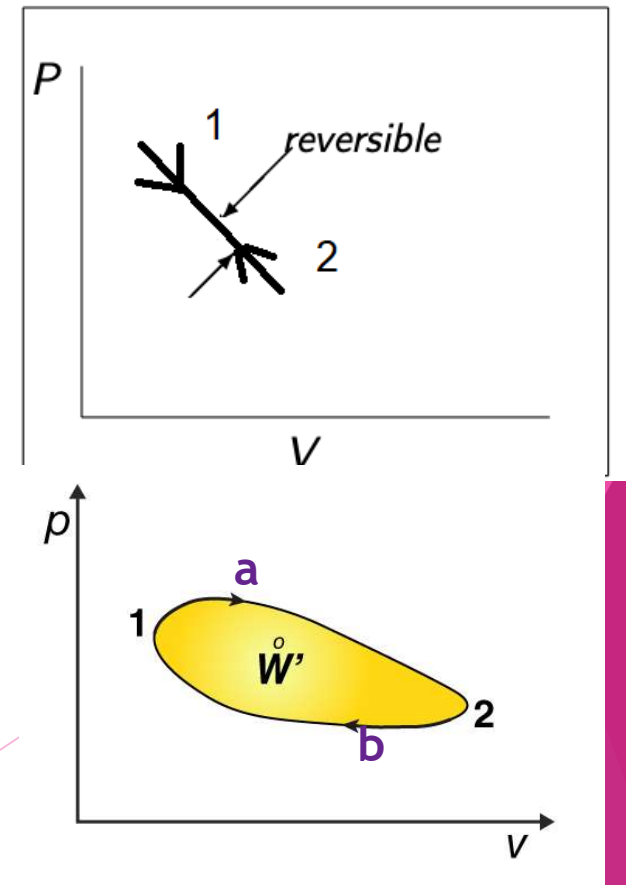
- ▶ As process is said to be reversible process if when reversed in direction follows the same path as that of the forward path without leaving any effect on systems and surroundings. Reversible process is the most effective process. A process which is not a reversible is an irreversible process.
- ▶ Friction is one of the reasons for making a process irreversible

▶ **QUASISTATIC PROCESS**

- ▶ A process which is carried out in a very slow manner with small ingredient is known as a quaststatic process.
- ▶ Friction less quasi-statis process is a reversible process.

▶ **THERMODYNAMIC CYCLE (CYCLIC PROCESS)**

- ▶ A system is said to have undergone a cycle if the initial and final points are same. For a cycle change in property is zero.
- ▶ 1-a - 2 - b - 1 is a thermodynamic cycle.



## ▶ GIBBS PHASE RULE

▶ According to Gibbs phase rule:

$$P + F = C + 2$$

Where

P = No. of Phases

F = Degree of freedom or minimum no. of independent intensive variables required to fix the state.

C = No. of components.

▶ Ex:

O<sub>2</sub>

$$\begin{aligned} P &= 1 \\ C &= 1 \\ 1 + F &= 1 + 2 \\ F &= 2 \end{aligned}$$

Water  
Steam

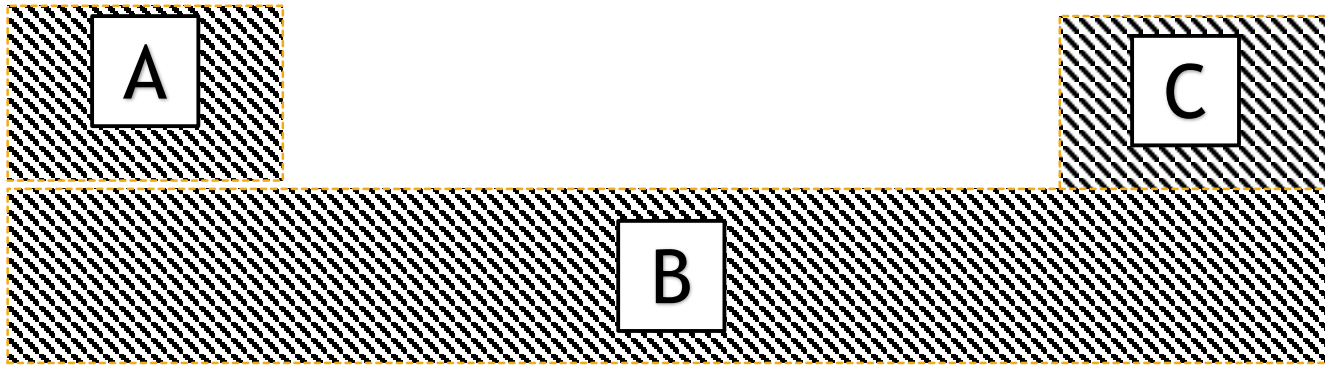
$$\begin{aligned} P &= 2 \\ C &= 1 \\ 2 + F &= 1 + 2 \\ F &= 1 \end{aligned}$$

ICE WATER  
STEAM

$$\begin{aligned} P &= 3 \\ C &= 1 \\ 3 + F &= 1 + 2 \\ F &= 0 \end{aligned}$$

## ▶ ZEROTH LAW OF THERMODYNAMICS (concept of temperature)

- ▶ When a body A is in thermal equilibrium with body B and body C is in thermal equilibrium with body B then A and C are in thermal equilibrium
- ▶ In zeroth law of thermodynamics one body acts as thermometer.



## ▶ THERMOMETRIC PRINCIPLE

- ▶ The property which changes with temperature is found first and with the help of this property temperature is then found.
- ▶ The property which help in founding out the temperature is known as thermometric property. (it can be P,V, Resistance, Voltage etc.)