1) Thermodynamics

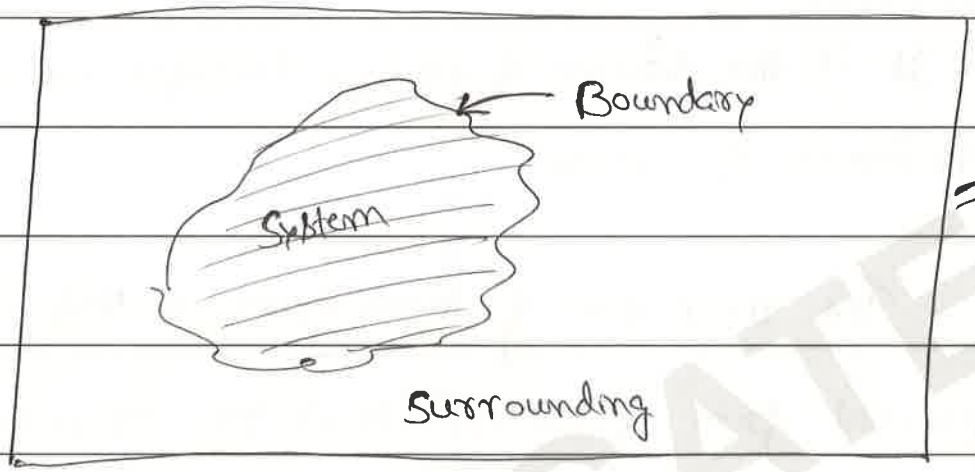
- It is the Science of energy transfer and its effect on Properties of System.

The main aim of thermodynamics study is to convert disorganized form of energy (heat) into organized form of energy (work) in an efficient manner.

2) System

Definition: It is a region in Space upon which study is focused or organized.

- System: A quantity of matter in Space which is analyzed during a Problem.
- Surroundings: Everything external to the System.
- Boundary: It separates System and surroundings.
  - It can be flexible or movable.
  - Fixed boundary e.g. rigid box containing gas
  - Movable boundary e.g. cylinder with Piston.



Universe : System + Surrounding.

2.1 Type of System.

Type of System	Mass Transfer	Energy Transfer	Example
Closed	No	Yes	Piston cylinder w/o valve
Open	Yes	Yes	Turbine, Pump, Compressor
Isolated	No	No	Universe, Hot coffee in a perfectly insulated cup.

Ques1: An Isolated thermodynamic system executes a process, choose the correct statements from the following:

a) No heat is transferred.

b) No work is done

c) No mass flow across the boundary of the system

d) No chemical reaction takes place within the system

[GATE 1999]

Soln: a, b, c

for an isolated System no mass and energy transfer through the System.

$dQ = 0$, $dW = 0$, $\therefore dE = 0$, or E = constant.

3) Property of System

Properties are Point function and are exact or Perfect differentials e.g. internal energy, enthalpy, entropy.

- Intensive Property: whose value is independent of the size or extent i.e, mass of the System

Ex: Pressure P, Temperature T, density ρ, Thermal conductivity K etc.

- Extensive Property: whose value depends on the size or extent i.e, mass of the system.

Ex: all forms of energy

⇒ NOTE: Specific Property: It is the value of an extensive Property Per unit mass of the System.

Specific volume, Specific internal energy, Specific entropy, Specific enthalpy are intensive Properties.

4) Process: Change of State is known as a Process.

- Reversible Process: A Process when reversed in direction follows the same Path as that of the forward Path without leaving any effect on System and Surroundings.
- Irreversible Process: The Process which is not reversible is known as Irreversible Process.

5) Quasi-Static Process

A Process which is carried out in a very slow manner so that the Pressure difference is very small is known as Quasi-static Process.

⇒ NOTE: Frictionless Quasi-Static Process is a reversible Process.

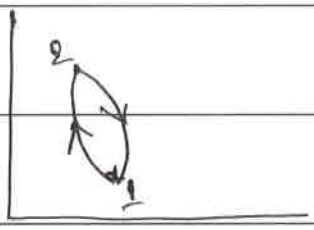
6) Thermodynamic Equilibrium

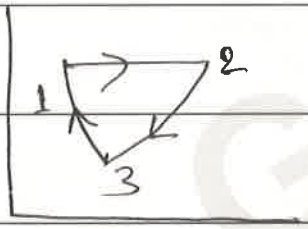
A body is said to be in thermodynamic equilibrium if it is in:

- Thermal equilibrium: Equality of Temperature
- Mechanical equilibrium: Equality of forces and couples
- Chemical equilibrium: Equality of chemical Potentials

7) Thermodynamic Cycle (Cyclic Process)

A system is said to have undergone a cycle if the initial and final points, minimum number of processes required for a cycle are two.





⇒ **Note:** For a cycle, change in property is equal to zero.

8) Gibb's Phase Rule

$$P + F = C + 2$$

Where,

P = Number of Phases

C = Number of components

F = Degree of Freedom (minimum no. of independent intensive variables required to fix the state.)

Ex:

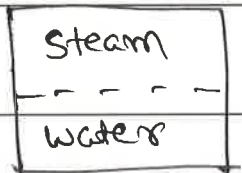
$P = 1, \quad C = 1$

$P + F = C + 2$

$\Rightarrow 1 + F = 1 + 2$

$\Rightarrow F = 3 - 1$

$\therefore F = 2$



$P = 2, \quad C = 1$

$P + F = C + 2$

$\Rightarrow 2 + F = 1 + 2$

$\Rightarrow F = 3 - 2$

$\therefore F = 1$

$P = 3, \quad C = 1$

$P + F = C + 2$

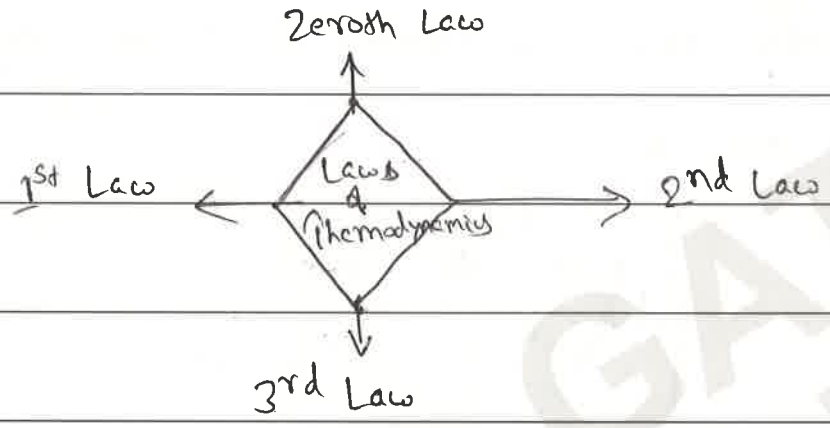
$\Rightarrow 3 + F = 1 + 2$

$\Rightarrow F = 3 - 3$

$\therefore F = 0$

⇒ Note! At Triple Pt., Degree of Freedom (F) is equal to zero.

9.) Laws of Thermodynamics



Zeroth Law: It deals with thermal equilibrium and provide a means of measuring temperature

when a body is in thermal equilibrium with a body B & also separated with a body C then body B & C will be in thermal equilibrium with each other.

⇒ Note: Zeroth Law of thermodynamics is the basis of the temperature measurement.

1st Law: The 1st Law deals with the conservation of energy and introduces the concept of internal energy.

2nd Law: The 2nd Law of Thermodynamics provides with the guidlines on the conversion heat energy of matter into work. It also introduces the concept of entropy.

IIIrd Law: The IIIrd Law of Thermodynamics defines the guidlines on the absolute zero of entropy. The entropy of a pure crystalline substance at absolute zero temperature is zero.

Ques 2: Two blocks which are at different states are brought into contact with each other and allowed to reach a final state of thermal equilibrium. The temperature is specified by the :

a) Zeroth Law of thermodynamics

b) First Law of thermodynamics

c) Second Law of thermodynamics

d) Third Law of thermodynamics

Soln: (a) Zeroth Law gives the concept of temperature

Ques 3: Zeroth Law of thermodynamics states that

a) Two thermodynamic systems are always in thermal equilibrium with each other.

b) If two systems are in thermal equilibrium, then the third system will also be in thermal equilibrium with each other

c.) Two systems not in thermal equilibrium with a third system are also not in thermal equilibrium with each other

d.) When two systems are in thermal equilibrium with a third system, they are in thermal equilibrium with each other.

Soln: (d).

Ques 4: Internal energy is defined by

a) Zeroth Law of thermodynamics

b) First Law of thermodynamics

c) Second Law of thermodynamics

d) Law of entropy

Soln: (b)

10.) Thermometric Principle

In this Principle the Properties which is changing with temperature is found first, with the help of this Property the temperature is found.

The Property which helps in finding the temperature is known as thermometric Property.