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Krishna Institute of Allied Sciences

B. Sc. I, Sem-I, Paper-III

Fundamentals of Chemistry for Biologist

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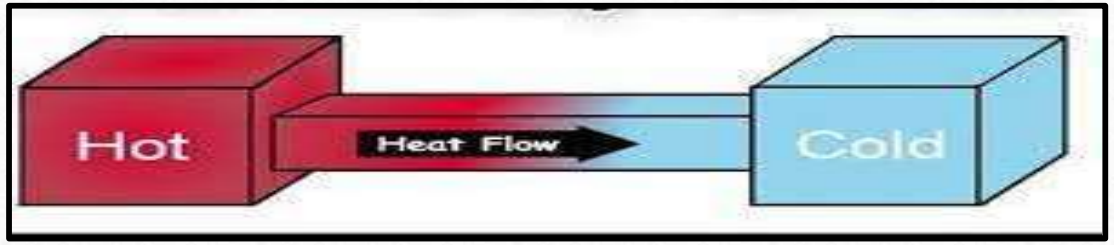
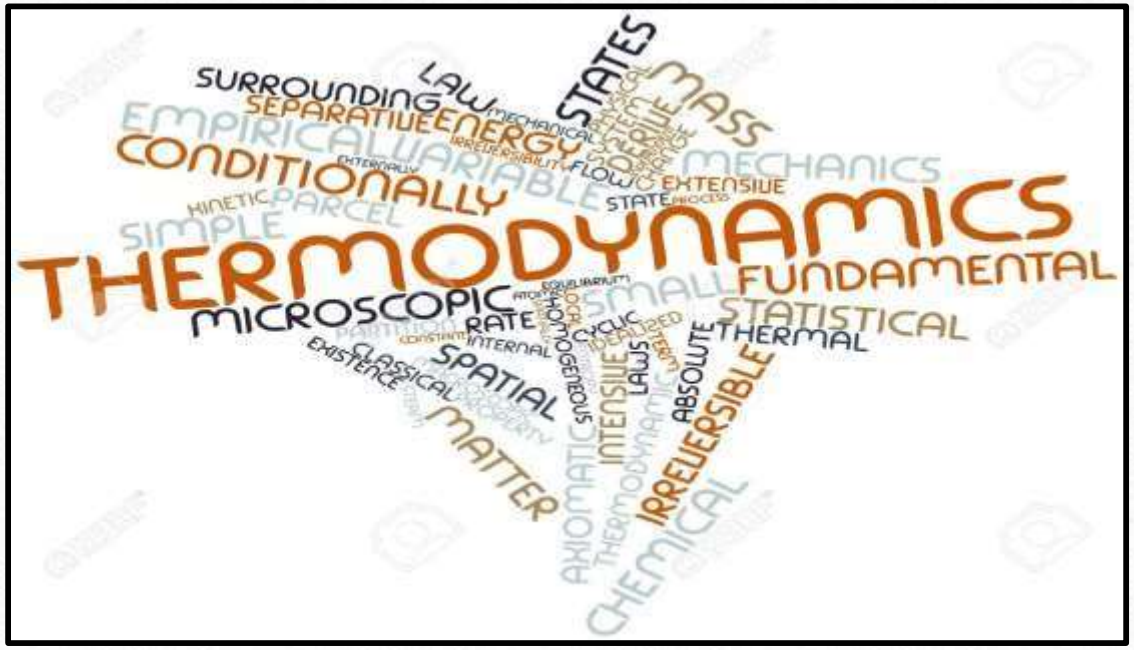
P-III: Fundamentals of Chemistry for Biologist

Thermodynamics



Introduction:

- What is thermodynamics?



- Different and distinct & interconvertible.

- It is applicable only to macroscopic systems i.e. matter in bulk and not to internal structure like atom or molecule.

Basic concepts of Thermodynamics

1. **Energy** : Capacity to do work.
2. **Work** : Motion against an opposing force. Expressed as W = F x dx where S.I. Unit joule & C.G.S. Unit erg respectively.
3. **Heat** : Heat is a transfer of energy as a result of temperature. Units S.I. Joules & C.G.S. Calories.
4. **System & Surroundings**:In thermodynamics, a system is the specific part of the universe under study, while the surroundings are everything else that interacts with it, and the boundary separates them.

Types of Systems:

i]Open System-Exchanges both matter and energy with the surroundings.

ii] Closed System-Exchanges energy (heat and work) but not matter with the surroundings.

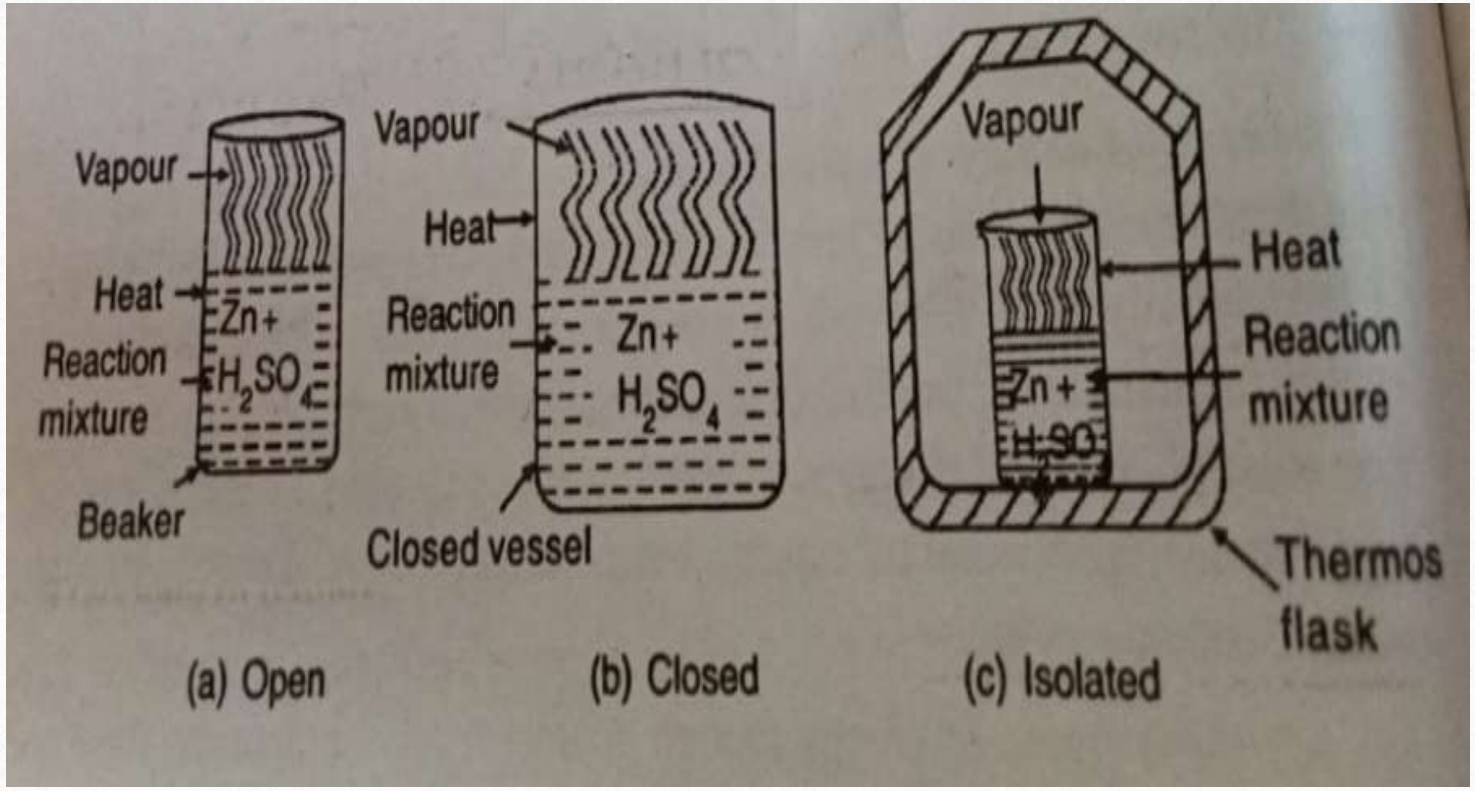
iii] Isolated System- Exchanges neither matter nor energy with the surroundings.

Types of Systems:

i) Open System

ii) Closed System

iii) Isolated System



- **Thermodynamic variables:**

  - Temperature (T)
  - Pressure (p)
  - Volume (V)
  -
  - Conc. (C)
  - Work (W) and heat(q)

Thermodynamic Functions

Relation	Function	Name
$dE = dq - dW$	E	Internal Energy
$dS = dq_{rev} / T$	S	Entropy
$H = E + PV$	H	Enthalpy
$G = H - TS$	G	Gibbs Free Energy
$A = E - TS$	A	Helmholtz free energy

Properties of thermodynamic systems:

i) Extensive properties: The properties which depend on the amount of the substance present in the system are called extensive properties. Thus, an extensive property depends upon the size of the system.

e.g., Mass, volume, energy, heat capacity, area etc.

ii) Intensive properties: The properties which are independent of the amount of the substance present in the system are called intensive properties. This property depends upon the nature of the substance and not on the size of the system.

e.g., Density, viscosity, surface tension, pressure, concentration etc.

Thermodynamic processes: The operation that bring the change in state of system is called thermodynamic process.

The process carried out under various conditions and named as,

1] Isothermal Process:

It is a thermodynamic process in which temperature remains constant.

2] Adiabatic Process: $q = 0$.

It is a thermodynamic process in which no heat is exchanged between the system and the surrounding.

3] Isochoric Process: $\Delta V = V_2 - V_1 = 0$

In isochoric process the change in volume of thermodynamic system is zero. A volume change is zero, so the work done is zero.

4] Isobaric Process: $\Delta P = P_2 - P_1 = 0$

The pressure remains constant during this process.

4. Cyclic Process :It is a process in which the final state of the system is equal to the initial state. As we know, change in internal energy is a state function

$\Delta T = \Delta P = \Delta V = \Delta E = \Delta H = 0$

5. Reversible process: A process that can be reversed without leaving any net change in the system or its surroundings.

- Occurs infinitely slowly, allowing the system to remain in equilibrium at all times.
- Involves infinitesimal changes in conditions.
- Is an idealized concept, not achievable in reality.
- The work done is maximum in a reversible process.

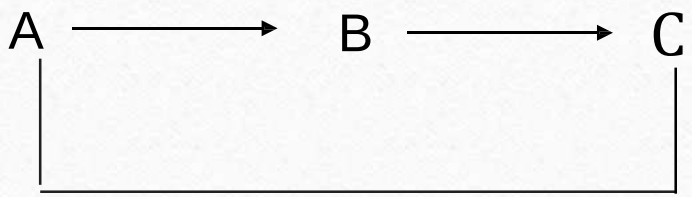
6. Irreversible Process: A process that cannot be reversed to return both the system and its surroundings to their original states.

- Occurs with finite changes in conditions, leading to a departure from equilibrium.
- Involves dissipative forces like friction, leading to a loss of energy.
- All natural processes are irreversible.
- The work done is less than the maximum possible in a reversible process.

Laws of Thermodynamics

1] Zeroth law of thermodynamics: The Zeroth law of thermodynamics states that if two bodies are individually in equilibrium with a separate third body, then the first two bodies are also in thermal equilibrium with each other.

This means that if system A is in thermal equilibrium with system C and system B is also in equilibrium with system C, then system A and B are also in thermal equilibrium.



2] First law of thermodynamics: q = ΔE+ W

First law of thermodynamics, also known as the law of conservation of energy, states that energy can neither be created nor destroyed, but it can be changed from one form to another.

•Plants convert the radiant energy of sunlight to chemical energy through photosynthesis. We eat plants and convert the chemical energy into kinetic energy while we swim, walk, breathe, and scroll through this page.

•Switching on light may seem to produce energy, but it is electrical energy that is converted.

3) Second law of thermodynamics: Cold ⟶ Hot

Second law of thermodynamics states that the entropy in an isolated system always increases. Any isolated system spontaneously evolves towards thermal equilibrium—the state of maximum entropy of the system.
The entropy of the universe only increases and never decreases. Many individuals take this statement lightly and for granted, but it has an extensive impact and consequence.

4) Third law of thermodynamics: S = 0, 0K

Third law of thermodynamics states that the entropy of a system approaches a constant value as the temperature approaches absolute zero.

The entropy of a pure crystalline substance (perfect order) at absolute zero temperature is zero. This statement holds true if the perfect crystal has only one state with minimum energy.