Chemistry study Materials for Class 11

(NCERT Based Notes of Chapter -06)

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Thermodynamics

Introduction

The study of energy transformations forms the subject matter or thermodynamics.

Thermodynamic Terms

The system and the surroundings

A system in thermodynamics refers to that part of universe in which observations are made and remain-ing universe constitutes the surroundings. The surroundings include everything other than the system. System and the surroundings together constitute the universe.

Types of the system

1. Open System:

In an open system, there is exchange of energy and matter between system and surroundings

2. Closed System:

In a closed system, there is no exchange of matter, but exchange of energy is possible between system and the surroundings

3. Isolated System:

In an isolated system, there is no exchange of energy or matter between the system and the surroundings. The presence of reactants in a thermos flask or any other closed insulated vessel is an example of an isolated system.

The State of the System

The state of a system means the condition of the system when is macroscopic properties have definite values. If any of the macroscopic properties of the system changes, the state of the system will change. A process is said to occur when the state of the system changes.

The measurable properties required to describe the state of a system are called state variables or state functions. Temperature, pressure, volume, composition etc. are state variables.

The Internal Energy as a State Function

1. Work:

The system which can't exchange heat between the system and surroundings through its boundary is called adiabatic system. The manner in which the state of such a system may be changed will be called adiabatic process. Adiabatic process is a process in which there is no transfer of heat between the system and surroundings.

Internal energy, U, of the system is a state function. The positive sign expresses that wad is positive when work is done on the system. Similarly, if the work is done by the system, wad will be negative.

2. Heat:

A system change its internal energy by ex-change of heat. The q is positive, when heat is transferred from the surroundings to the system and q is negative when heat is transferred from system to the surroundings. first law of thermodynamics, which states that The energy of an isolated system is constant.

$$\text{i. e., } \Delta U = q + w$$

It is commonly stated as the law of conservation of energy i.e., energy can neither be created nor be destroyed.

Applications

Work

The work done due to expansion or compression of a gas against an opposing external pressure is called the pressure – volume type of work. It is a kind of mechanical work.

If Y is the initial volume and V_f is the final volume of a certain amount of gas and P_{ex} is the external pressure, then the work involved in the process is given by

$$w = – P_{ex} (V_f – V_i) \text{ or } w = -P_{ex} \Delta V$$

The negative sign of this expression is required to obtain conventional sign for w.

It must be noted that the above expression gives the work done by the gas in irreversible expansion or compression

Work done in isothermal reversible expansion (or compression) of a gas is given by the relation

$$w_{rev} = -2.303 \text{ nRT log VfVi}$$

Where n = the number of moles of the gas

Free expansion

Expansion of a gas in vaccum is called free expansion.

Since P = 0 in vacuum, work done in free expansion = 0

Isothermal and free expansion of an ideal gas.

1. For isothermal irreversible change $q = -w = p_{ex} (V_f – V_i)$
2. For isothermal reversible change

$$q = -w = nRT \text{ In VfVi}$$

$$= 2.303 \text{ nRT log VfVi}$$

3. For adiabatic change $q = 0$, $\Delta U = w_{ad}$

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