**1.2.4 Energy, Heat and Work:**

When a system undergoes a change, the change is accompanied by a change in the energy content of the system. It is the purpose of thermodynamics to be able to describe the change in energy content, and to relate it to the performance of work and the transfer of heat between the system and the surroundings. For any change in the system (for a defined system), we can define an initial state and a final state, and we must look for parameters which define the energy content of the system in terms of values which are a unique function of the state of the system. Such parameters are called variables of state.

**1.3 The First Law of Thermodynamics:**

The First Law is a conservation law,- Energy can neither be created nor destroyed. It requires that we balance the energy budget when we describe a change in state. A change in energy content (dE) is accompanied by the performance of work (w), and/or the transfer of heat (q) between the thermodynamic system under consideration, and its surroundings.

**System**- A set of entities which undergoes a change, and can be formally separated out from the surroundings. A thermodynamic system might be a simple weight, a chemical reaction, an organism, an engine, a solar system, etc.

In order to describe a change in the system, we have to be able to define and measure the properties of the system which might change, and which characterize it in terms of energy, work and heat content. Variables of state are parameters which have specific values which define the state of the system.

The First Law requires that for any change of state of a system:

dE = dEsystem= - dEsurroundings

dE = w + q

(w and q are positive for work done on, or heat transferred to the system from the surroundings)

**1.4Second Law of Thermodynamics:**

Some important statements are-

1. All the spontaneous (natural) processes are thermodynamically irreversible and tend to change in direction which leads to equilibrium.
2. All processes in nature tend to occur with an increase in entropy.
3. It is impossible by a cyclic process for conversion of heat into work without converting certain amount of work to heat.
4. It is impossible to transfer heat from cold to hot reservoir without converting a certain amount of work to heat.

## 1.5 Conceptof Standard State and Standard Enthalpies of

## Formations----

The standard state of a materialis a pure substance, mixture, or solution, is a reference point used to calculate its properties under different conditions. The standard state of a gas is conventionally chosen to be 1 bar for an ideal gas, regardless of the temperature.

## The standardenthalpyof formation is defined as the change in enthalpy when one mole of a substance in the standard state (1 atm of pressure and 298.15 K) is formed from its pure elements under the same conditions.

The standard enthalpy of formation is a measure of the energy released or consumed when one mole of a substance is created under standard conditions from its pure elements. The symbol of the standard enthalpy of formation is ΔH°f.

Δ = A change in enthalpy

= A degree signifies that it's a standard enthalpy change.

f = The f indicates that the substance is formed from its elements

C (graphite, s) +2H2 (g) →CH4 (g)ΔfH = −74.81kJmol−1

Enthalpy of formation is basically standard enthalpy of reaction in which two or more reactants combine to form one mole of the product.

Example –a) Formation of hydrogen bromide from hydrogen and bromine.

H2(g)+Br2(l)→2HBr(g)ΔrH=−72.81kJmol−1

b) The heat of formation of methane

(i)CH4+2O2→CO2+2H2ΔH=−890.2kJmol−1

(ii)C+O2→CO2ΔH=−393.4kJmol−1

(iii)H2+1/2O2→H2OΔH=−285.7kJmol−1

C+2H2→CH4,ΔH=?

To get this thermo chemical equation, multiply eqn. (iii) by 2 and it to eqn. (ii) and then subtract eqn. (i) from their sum. Weget,

C+2H2→CH4ΔH=−393.4+2(−285.7) − (−890.2) kJmol−1=−74.6kJmol−1

Hence, the heat of formation of methane isΔfH°=−74.6kJmol−1

The equation for the standard enthalpychangeof formation is commonly used:

ΔHreaction=∑ΔH (products)−∑ΔH (Reactants)

## The standard enthalpychangeof formation is equal to the**sum of the standard enthalpies of formation of theproducts**minus the**sum of the standard enthalpies of formation of thereactants**.