Important Questions for Class-XI Chemistry

Chapter-6

These Important Questions for Biology consist of four types of Questions for CBSE Schools and Home-tution.com Students.
Type-1 Questions of 1 Mark
Type-2 Questions based on 2 Marks
Type-3 Questions Based on 3 Marks
Type-4 Questions Based on 4 & 5 Marks

11-Che
Unit-6
Name of Unit: Thermodynamics
Chapter-6
Name of Chapter: Thermodynamics

Q.1 Define the term Thermodynamics? (1-Marks)
Ans. The branch of science which deals wit the study of different forms of energy and the quantitative relationships between them is known as thermodynamics.

Q.2 Explain the term system, surrounding and universe with example? (2-Marks)
Ans. System: The part of the universe under consideration (to study the effect of temperature, pressure, etc.) is called a system.
Surrounding: The remaining portion accept the system is called surrounding.
Universe: The system and the surrounding together constitute the universe, i.e.,
Universe = System + Surrounding

Q.3 Explain Open, Closed and Isolated system with examples? (2-Marks)
Ans. If a system can exchange both matter and energy with its surroundings, it is called an *Open System.*
Example: Water kept in an open vessel.
If a system can exchange energy but no matter with its surroundings, it is called a *Closed System.*
Example: Water placed in a closed vessel.
If a system can neither exchange energy or matter with its surroundings, it is called an *Isolated System.*
Example: Water kept in a closed, insulated vessel.

Q.4 Explain macroscopic system and properties? (3-Marks)
Ans. If a system contains large number of chemical species like atoms ions or molecules, it is called a macroscopic system.
Properties like temperature, pressure, volume, density etc. are called macroscopic properties. It is basically classified into two types:
Extensive Properties: Those properties which depend upon the quantity of the matter contained in the system.
Those properties which depend upon the nature of the substance and are independent of the amount of the substance present in the system.

Q.5 Define the term Thermodynamic Equilibrium? **(1-Marks)**

Ans. A system is said to be in thermodynamic equilibrium if its macroscopic properties like temperature, pressure etc. do not change with time.

Q.6 Define the term adiabatic process? **(1-Marks)**

Ans. When a process is carried out such that no heat can flow from the system to the surroundings or vice versa, i.e., the system is completely insulated from the surroundings, it is called an adiabatic process.

Q.7 Define Isothermal process? **(1-Marks)**

Ans. When a process is carried out such that the temperature remains constant through out the process, is called an isothermal process.

Q.8 Define Isochoric process? **(1-Marks)**

Ans. When a process is carried out such that the volume of the system remains constant is called an Isochoric process.

Q.9 Define Isobaric process? **(1-Marks)**

Ans. When a process is carried out such that the pressure of the system remains constant is called an Isobaric system.

Q.10 Differentiate between Reversible and Irreversible process? **(5-Marks)**

Ans.

S.No.	Reversible Process	Irreversible Process
1	This process is carried infinitesimally slowly.	This process is carried out rapidly.
2	At any stage during the process, equilibrium is not disturbed.	Equilibrium may exist only after the completion of the process.
3	It may take infinite time for the completion.	It takes a finite time for completion.
4	It is an imaginary process.	This is an actual process.
5	Work obtained is maximum.	Work obtained in this process is not maximum.

Q.11 Explain the term in brief: Internal energy is a state function with example? **(3-Marks)**

Ans. Internal energy is a state function because it depends only on the state of the function (temperature, pressure, etc.) and is independent of the method by which this state has been attained.

Example: One mole of CO_2 375 K and 2 atm. pressure will always have the same internal energy irrespective of the fact that it has been brought to these conditions from 550 K and 5 atm. pressure.

Q.12 Give the first law of thermodynamics. Derive a mathematical expression for the first law of thermodynamics. **(5-Marks)**

Ans. First Law of Thermodynamics**:** It is simply the law of conservation of energy which states that**:**

Energy can neither be created nor destroyed. It can be converted from one form to another.

Mathematical expression for the first law of thermodynamics: **(relationship between internal energy, work and heat)**

State 1 U = Internal Energy   State 2

$$U_2 - U_1 = Q - W$$
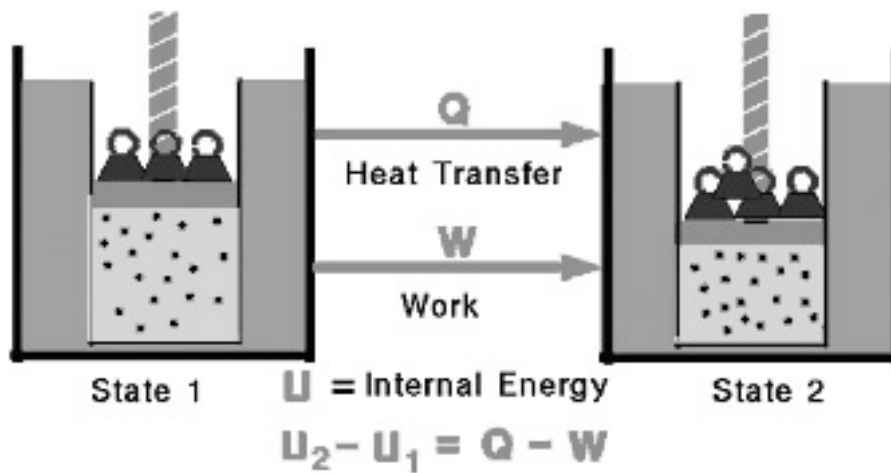
Suppose the internal energy of the system = U_1

If it absorbs heat Q its internal energy will become = $U_1 + Q$

If further work W is done on the system, the internal energy will further increase and become $U_1 + Q + W$ **Let the final internal energy be represented as** U_2. **Then**

$U_2 = U_1 + Q + W$

$U_2 - U_1 = Q + W$

$\Delta U = Q + W$

If the work done is the work of expansion, then W = -P ΔV, where ΔV is the change in the volume and P is the external pressure. The above equation can then be written as

$\Delta U = Q - W$

Q.13 Define Reversible and Irreversible process? **(2-Marks)**

Ans. Reversible Process: A process which is carried out infinitesimally slowly so that all the changes occurring in the direct process can be exactly reversed and the system remains almost in a state of equilibrium with the surroundings at every stage of the process. Irreversible Process: A process which is not carried out infinitesimally slowly so that the successive steps of the direct process cannot be retraced and any change in the external conditions disturb the equilibrium.

Q.14 Derive an expression for the work done in an isothermal, reversible process?

(5 Marks)

Ans. The small amount of work done, cc, when the gas expands through a small volume, dV, against the external pressure, $P_{ext.}$ is given by

$$\delta w = - P_{ext.} \; dV$$

However, for reversible expansion

$$P_{ext.} = P_{int} - dp$$

$$\therefore \; \delta w = -(P_{int} - dp) \, dV$$

$$= - P_{int} \, dV (\because dp \times dV \text{ is negligible})$$

∴ Total work done when the gas expands from initial volume V_1 to final volume V_2, will be

$$w = -\int_{V_1}^{V_2} P_{int}\,dv$$

$$\int_{V_1}^{V_2} p_{int}\,dV$$

For an ideal gas, PV=nRT, i.e.,

$$P_{int} = \frac{nRT}{V}$$

Hence, $w = -\int_{V_1}^{V_2} \frac{nRT}{V}\,dV$

For isothermal expansion, T = constant so that

$$w = -nRT \int_{V_1}^{V_2} \frac{1}{V}\,dV = -nRT \ln \frac{V_2}{V_1}$$

or $w = -2.303\ nRT \log \frac{V_2}{V_1}$

Q.15 Define the term Enthalpy? (1-Marks)
Ans. The sum of the increase in internal energy of the system and the pressure-volume work done is called Enthalpy.

$$q = \Delta U + P\Delta V$$

Q.16 Express the change in internal energy of a system when (5 Marks)

(i) No heat is absorbed by the system from the surroundings, but work (w) is done on the system. What type of wall does the system have? (1 Marks)

(ii) No work is done on the system, but q amount of heat is taken out from the system and given to the surroundings. What type of wall does the system have? (2 Marks)

(iii) w amount of work is done by the system and q amount of heat is supplied to the system. What type of system would it be? (2 Marks)
Ans. Here, q = 0
∴ $\Delta U = q + w = 0 + W_{ad} = W_{ad}$
As no heat is absorbed by the system, the wall is adiabatic.
(ii) Here, w = 0, q = -q.
∴ $\Delta U = q + w = -q + 0 = -q$.
As heat is taken out, the system must be having thermally conducting walls.
(iii) w = -w, q = +q
∴ $\Delta U = q + w = q - w$.
As work is done by the system on absorbing heat, it must be a closed system.

Q.17 A 5-liter cylinder contained 10 moles of oxygen gas at $27°C$. due to sudden leakage through the hole, all the gas escaped into the atmosphere and the cylinder got empty. If the atmospheric pressure is 1.0 atmosphere, calculate the work done by the gas.
   (3 Marks)

Ans.

$V_{initial} = 5L$

$T = 27°C = 27 + 273 \text{ K} = 300K$

$V_{final} = \dfrac{nRT}{P} = \dfrac{10 \times 0.0821 \times 300}{1.0} = 246.3 \text{ L}$

$\Delta V = V_{final} - V_{initial} = 246.3 - 5 = 341.3 \text{ L}$

$W_{exp} = -P\Delta V = -1 \times 241.3 \text{ L atm}$

$\qquad = -241.3 \times 101.3 \text{ J} = -24443.7 \text{ J}$

Q.18 Two moles of an ideal gas initially at $27°C$ and one atmospheric pressure are compressed isothermally and reversibly till the final pressure of the gas is 10 atm. Calculate q, w and ΔU. for the process.   (3 Marks)

Ans. Here, n = 2 moles

$T = 27°C = 300 \text{ K}$

$P_1 = 1 \text{ atm}, P_2 = 10 \text{ atm}.$

$w = 2.303nRT \log \dfrac{P_2}{P_1}$

$\quad = 2.303 \times 2 \times 8.314 \text{ JK}^{-1}\text{mol}^{-1} \times 300 \text{ K} \times \log \dfrac{10}{1}$

$\quad = 11488 \text{ J}$

For isothermal compression of ideal gas,

$\Delta U = 0$

Further, $\Delta U = q + w$

$\therefore q = -w = -11488 \text{ J}$

Q.19 Define Heat capacity, specific heat capacity and molar heat capacity of a system?
   (3 Marks)

Ans. *The Heat capacity* of a system is defined as the amount of heat required to raise the temperature of the system through $1°$ C.

The Specific heat capacity (or specific heat), c, of a substance is defined as the amount of heat required to raise the temperature of 1 gm of the substance through $1°$ C.

Molar heat capacity of a substance is defined as the amount of heat required to raise the temperature of one mole of the substance through $1°$ C.

Q.20 Define Specific heat capacity at constant volume and specific heat capacity at constant pressure. Also give the relationship between both.   (2 Marks)

Ans. The heat required by a system to raise its temperature through $1°$ C keeping the volume of the system constant is called heat capacity at constant volume.

The heat required by a system to raise its temperature through $1°$ C keeping the external pressure constant is called heat capacity at constant pressure.

$$C_p - C_v = nR \text{; For n moles of gas.}$$

Q.21 Write a short note on Bomb Calorimeter?   (5 Marks)
Ans.
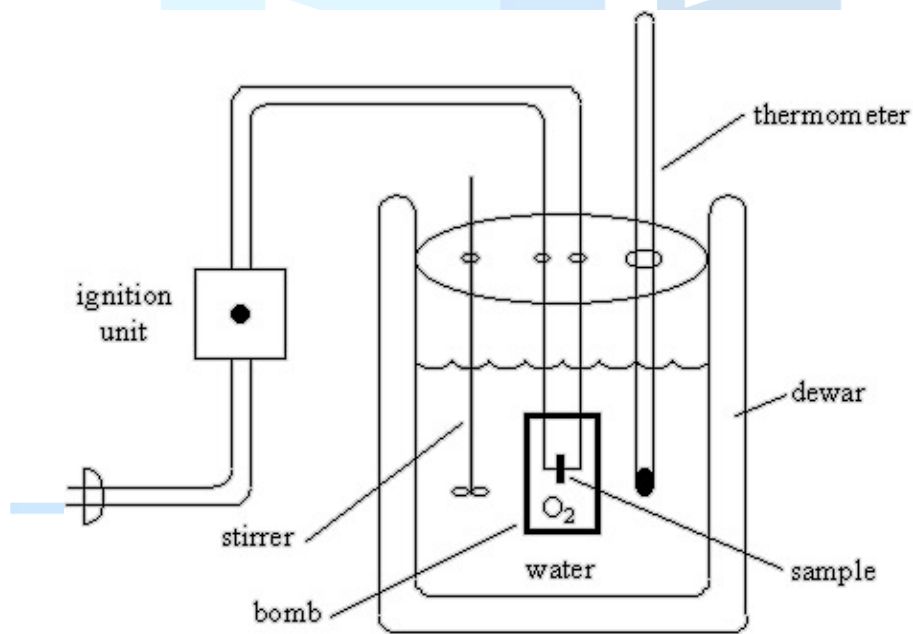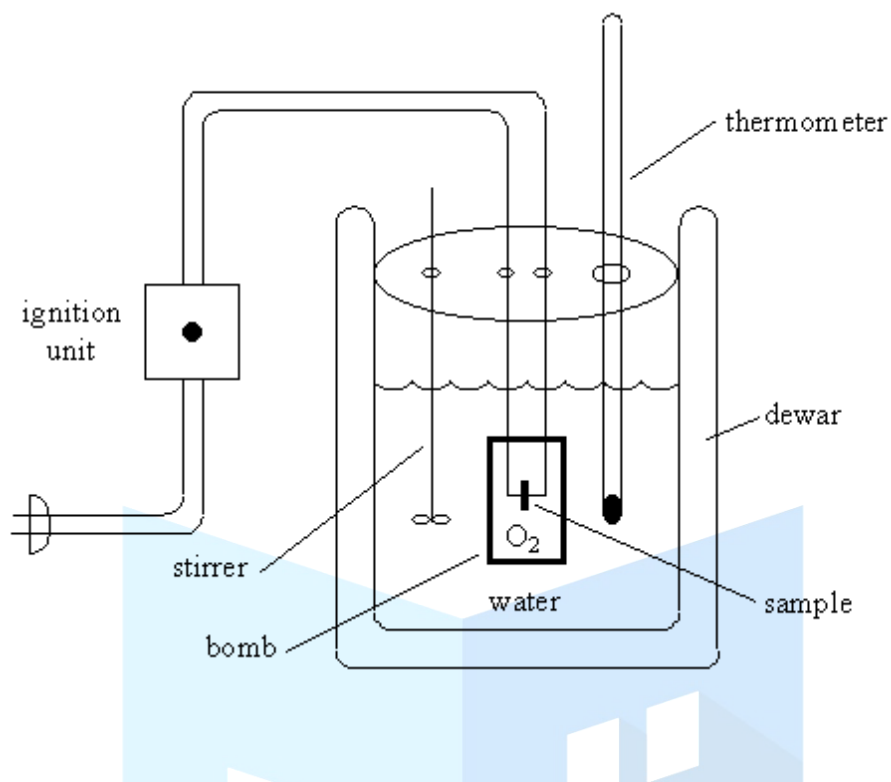
Construction: It consists of a strong vessel (called 'bomb') which can stand high pressures. It is surrounded by a bigger vessel which contains water and is insulated. A thermometer and a stirrer are suspended in it.

Determination of ΔU: The change in the internal energy (ΔU) can be calculated using the formula

$$\Delta U = Q \times \Delta t \times \frac{M}{m}$$

where, Q = heat capacity of the calorimeter.

Δt = rise in temperature.

m = mass of the substance taken, and

M = molecular mass of the substance

Determination of ΔH: The change in enthalpy of a reaction can be calculated with the help of internal energy and pressure volume of work. It is given by using the formula

$$H = U + PV$$
$$\therefore \Delta H = \Delta U + P \Delta V + V \Delta P$$

At constant pressure, $\Delta P = 0$
Hence, $\Delta H = \Delta U + P \Delta V$

At constant volume, $\Delta V = 0$
Hence, $\Delta H = \Delta U + V \Delta P$

Q.22 Define Exothermic and Endothermic reactions?   (2 Marks)
Ans. The reactions which occur with the evolution of heat are called exothermic reactions. The reactions which take place due to the absorption of heat energy are called endothermic reactions.

Q.23 Define the term, Enthalpy change of a reaction or heat of reaction?(2 Marks)
Ans. The amount of heat evolved or absorbed in a chemical reaction when the number of moles of the reactants as represented by the chemical equation have completely reacted, is called the heat of reaction or enthalpy of reaction or enthalpy change of reaction. It is represented by $\Delta_r H$.

Q.24 Explain the enthalpy of combustion of a reaction?   (2 Marks)
Ans. The enthalpy of combustion of a substance is defined as the heat change when 1 mole of substance is completely burnt or oxidized in oxygen.

Q.25 Explain the enthalpy of formation of a substance?   (2 Marks)
Ans. The enthalpy of formation of a substance is defined as the heat change, i.e., heat evolved or absorbed when one mole of its substance is formed from its elements under given conditions of temperature and pressure. It is usually represented by $\Delta_f H$.

Q.26 Define the Enthalpy of neutralization of a reaction?   (2 Marks)
Ans. The enthalpy of neutralization of an acid or base is defined as the heat change when one gram equivalent of the acid is neutralized by a base, the reaction being carried out in dilute aqueous solution.

Q.27 Define the term Enthalpy of atomization?   (2 Marks)
Ans. When one mole of a given substance dissociates into gaseous atoms, the enthalpy change accompanying the process is called enthalpy of atomization.

Q.28 Define the term Enthalpy of ionization?   (2 Marks)
Ans. When a covalent compound on dissociation in water splits to produce ions in the solution, the enthalpy change accompanying the process is called enthalpy of ionization.

Q.29 Define the term Enthalpy of hydration?   (2 Marks)
Ans. The amount of enthalpy change when one mole of the anhydrous salt combines with the required number of moles of water so as to change into the hydration salt, is called the enthalpy of hydration or heat of hydration.

**Q.30 Define the term Enthalpy of fusion? (2 Marks)**

Ans. Enthalpy of fusion is the enthalpy change accompanying the transformation of one mole of a solid substance into its liquid state at its melting point. It is also called molar enthalpy of fusion.

Q.31 Define Enthalpy of vaporization of a reaction?   (2 Marks)
Ans. It is the amount of heat required to convert one mole of a liquid into its vapour state at its boiling point. It is also called molar enthalpy of vaporization.

Q.32 Give the Hess's Law of constant heat?   (3 Marks)
Ans. The total amount of heat evolved or absorbed in a reaction is the same and does not depends upon the number steps involved to complete the reaction.
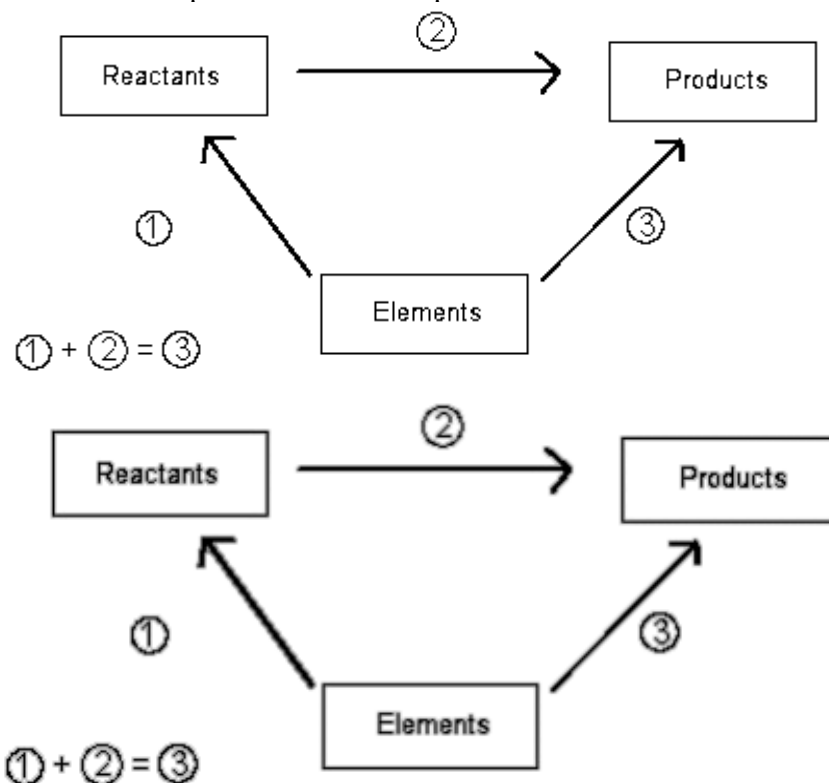
Q.33 Define the term calorimetry?   (1 Marks)
Ans. The technique used to determine energy changes in chemical or physical processes by an experimental technique is called Calorimetry.

Q.34 Give the second law of thermodynamics?   (1 Marks)
Ans. The Second law of thermodynamics states that: "the entropy of universe is continuously increasing due to spontaneous process taking place in it.

$$\Delta S_{system} + \Delta S_{surrounding} > 0$$
$$\text{i.e. } \Delta S_{Total} > 0$$

Q.35 Give the third law of thermodynamics?   (1 Marks)
Ans. The entropy of a perfect crystalline substance is zero at zero Kelvin.

Q.36 Define the Gibb's free energy? Give an expression for the Gibb's Helmholtz equation.   (3 Marks)
Ans. It is defined as the maximum amount of energy available to a system during the process that can be converted into useful work. It is the measure of capacity to do useful work.

Gibb's Helmholtz equation: $\Delta G = \Delta H - T \Delta S$

If ΔG is negative, process is spontaneous,

If $\Delta G = 0$, process is in equilibrium.

If ΔG is positive, the process does not take place.

Q.37 Explain the Born-Haber Cycle in detail?   **(5 Marks)**

Ans. The Born-Haber cycle method is based on Hess's law. Let us consider energy changes in formation of NaCl from metallic sodium and chlorine gas.

$$Na (s) + \tfrac{1}{2} Cl_2 (g) \longrightarrow NaCl (s), \ \Delta_f H = ?$$

Steps:

    (i)   Conversion of metallic sodium into gaseous sodium atom.

$$Na (s) + \text{sublimation energy (s)} \longrightarrow Na (g)$$

The energy required is called **sublimation energy** per mole.

    (ii)   Dissociation of chlorine molecule into chlorine atoms. This step requires energy and the energy required per mole of chlorine is called **bond dissociation energy (enthalpy)**

$$\tfrac{1}{2} Cl_2 (g) + D \longrightarrow Cl (g)$$

(iii) Conversion of gaseous atom into gaseous cation. The energy required in this process is called **Ionization Enthalpy (I.E.)**

$$Na (g) + I.E. \longrightarrow Na^+ (g) + e^-$$

(iv) Conversion of gaseous chlorine atom into gaseous anion.

$$Cl (g) + e^- \longrightarrow Cl^- (g) + E.A.$$

This step involves release of energy called **electron affinity**.

(v) Combination of oppositely charged gaseous ions to form solid crystals involves release of energy called known as **lattice energy (U).**

$$Na^+ (g) + Cl^- \longrightarrow NaCl (s) + U$$

The sum of energy changes taking place during various steps is equal to $\Delta_f H^0$, heat of formation of NaCl(s)

$$= S + \tfrac{1}{2} D + I.E. + E.A. + U$$

Q.38 Give the statement of the Joule-Thomson Effect?   **(2 Marks)**

Ans. The phenomenon of lowering of temperature when a gas is made to expand adiabatically from a region of high pressure into a region of low pressure, is known as *Joules-Thomson Effect.*

Q.39 Give the applications of Born Haber Cycle?   **(3 Marks)**

Ans.

    (i)   It is used to calculate lattice energy of ionic solids.

    (ii)   It is used to calculate $\Delta_f H^0$ values.

    (iii)   It is used for calculation of electron gain enthalpy.

    (iv)   It is used for calculation of proton affinity.

Q.40 What are the necessary conditions for a spontaneous and non-spontaneous reactions?   **(5 Marks)**

Ans.

S.No.	$\Delta_r H^0$	$\Delta_r S^0$	$\Delta_r G^0$	Description
1	-ve	+ve	-ve	Reaction is

				spontaneous at all temperature.
2	+ve	-ve	+ve	Non-spontaneous at all temperature.
3	-ve	-ve	-ve (at low T)	Reaction will be spontaneous at low temperature.
			+ve (at high T)	Reaction will be non-spontaneous at high temperature.
4	+ve	+ve	+ve (at low T)	Reaction will be non-spontaneous at low temperature.
			-ve (at high T)	Reaction will be spontaneous at high temperature.

Q.41 Define the term Entropy?   **(3 Marks)**

Ans. Entropy is the measure of randomness or degree of disorderness of a system. Higher is the randomness, higher is the entropy of the system. E.g. solid < liquid < gas.

Entropy is a state function which depends upon the initial and final states of the system. When the state of a system changes, the entropy also changes.

$$\Delta S = \frac{q_{rev}}{T} = \frac{\Delta H_{rev}}{T}$$ where q is the heat supplied isothermally, T is absolute temperature.

(i)   For an irreversible spontaneous process $\Delta S = +ve$

(ii)   For a reversible change at equilibrium $\Delta S = 0$

(iii)   Entropy increases with increase in temperature, decreases with decreases in temperature.