Chemistry Study Materials for Class 11
(NCERT Based Notes of Chapter- 07)
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Equilibrium Top Concept

1. When the reactants in a closed vessel at a particular temperature react to give products, the concentrations of the reactants keep on decreasing, while those of products keep on increasing for some time after which there is no change in the concentrations of either of the reactants or products. This stage of the system is the dynamic equilibrium. At equilibrium rates of the forward and reverse reactions become equal.

2. General characteristics of equilibrium involving physical processes

- Measurable properties of system becomes constant at equilibrium
- Equilibrium can be established only in case of closed system
- Equilibrium is always dynamic in nature i.e. the process does not stop but changes take place in forward and reverse direction with same rate
- When equilibrium is attained for a physical process, it is characterised by constant value of one of its parameters at a given temperature.
- For example, for equilibrium

  $H_2O\ (l) \rightleftharpoons H_2O\ (g)$, the pressure becomes constant
- The magnitude of the constant value of the concentration related expression gives an indication of the extent to which the reaction proceeds before acquiring equilibrium.

3. During a chemical reaction when the rates of the forward and reverse reactions become equal, the concentrations of the reactants and the products remain constant. This is the stage of chemical equilibrium. Chemical equilibrium is dynamic in nature.

4. General characteristics of equilibrium involving chemical processes

- Chemical equilibrium is dynamic in nature
- Properties of system becomes constant at equilibrium and remains unchanged thereafter
- Equilibrium can be established only in case of closed system
- Equilibrium can be approached from either direction
- A catalyst does not alter the equilibrium point

5. Law of mass action: Rate of a chemical reaction is directly proportional to the product of molar concentration of the reactants at a constant temperature at any given time.

6. Equilibrium Law or Law of Chemical Equilibrium: At a given temperature, the product of concentrations of the reaction products raised to the respective stoichiometric coefficient in the balanced chemical equation divided by the product of concentrations of the reactants raised to their individual stoichiometric coefficients has a constant value

7. Equilibrium reactions in which all reactants and products are in same phase are called homogeneous equilibrium reactions.

8. Equilibrium reactions in which all reactants and products are in different phases are called heterogeneous equilibrium reactions

For a general reaction of the type: $aA + bB \rightleftharpoons cC + dD$

The equilibrium constant may be represented as

$$K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

A and B are reactants C and D are products

Exponents a, b, c and d have same values as in balanced chemical equation

If the concentration expressed is in molar concentrations then $K=K_c$

$$\text{i.e. } K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

For a gaseous reaction of the type: $aA + bB \quad cC + dD$

The equilibrium constant may be represented as

$$K_p = \frac{[p_C]^c[p_D]^d}{[p_A]^a[p_B]^b}$$

p_A, p_B, p_C, p_D are the partial pressures of A, B, C and D respectively

Exponents a,b,c and d have same values as in balanced chemical equation

9. Relation between K_p and K_C

$$K_p = K_C (RT)^{\Delta n}$$

Δn=(number of moles of gaseous products) - (number of moles of gaseous reactants) in the balanced chemical equation.

10. In heterogeneous equilibrium pure solids or liquids are present but their concentrations or partial pressures do not appear in the expression of the equilibrium constant.

11. Characteristic of equilibrium constant

- Equilibrium constants is applicable only when the concentration of reactants and products have attained their equilibrium state
- The value of equilibrium constant is independent of initial concentrations of the reactants and products
- Equilibrium constant has a definite value for every reaction at a particular temperature
- Equilibrium constant for the reverse reaction is the inverse of the equilibrium constant for the reaction in the forward direction
- The value of equilibrium constant tells the extent to which a reaction proceeds in forward or reverse reaction
- Equilibrium constant is independent of presence of catalyst

12. Applications of equilibrium constant

1) Predicting the Extent of a Reaction

(a) If $K_C > 10^3$, products predominate over reactants,

i.e., if K_C is very large, the reaction proceeds nearly to completion

(b) If $K_C < 10^{-3}$, reactants predominate over products,

i.e., if K_C is very small, the reaction proceeds rarely

(c) If K_C is in the range of 10^{-3} to 10^3, considerable concentrations of both reactants and products are present

2) Predicting the Direction of the Reaction.

Reaction quotient (Q) is the ratio of product of concentration (or partial pressure) of products to that of reactants at any stage of the reaction

(a) If $Q_c > K_C$, the reaction will proceed in the direction of reactants (reverse rk^n).

(b) If $Q_c < K_C$, the reaction will proceed in the direction of the products (forward rk^n)

(c) If $Q_c = K_C$, the reaction mixture is already at equilibrium.

13. Substances that conduct electricity in their molten states or in form of their aqueous solutions are called electrolytes

14. Substances which ionize almost completely into aqueous solutions are called strong electrolytes

15. Ionic Equilibrium: Equilibrium established between unionized molecules and ions in solution of weak electrolytes.

16. Substances which ionize to a small extent in aqueous solution are called weak electrolytes

17. Acids, bases and salts which are electrolytes, conduction of electricity by their aqueous solutions is due to anions and cations produced by the dissociation or ionization of electrolytes in aqueous solution.

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