

Law of Mass Action

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In Chemistry, the law of mass action is the proposition that the rate of the chemical reaction is directly proportional to the product of the concentrations of the reactants. It explains the predict behaviours of solutions in dynamic equilibrium. For a chemical reaction mixture that is in equilibrium, the ratio between the concentration of reactants and products is constant.

Two aspects are involved in the initial formula of the law:-

- 1) Equilibrium aspect concerning the composition of a reaction mixture at equilibrium.
- 2) Kinetic aspect concerning the rate equations of elementary reactions.

The law can be used to explain the behaviours exhibited by solutions in dynamic equilibrium. The law of mass action

also suggests that the ratio of the reactant concentration and the product concentration is constant at a state of chemical equilibrium.

### Equilibrium Constant ( $K_c$ ) :-

The concentration of reactants and products at equilibrium are constant at a given temperature. Consider the simple reversible reaction where A and B are the reactants for an equilibrium mixture and C and D are the products.



A mixture of products and reactants in a state of chemical equilibrium is known as an equilibrium mixture. There exists a relation between the concentration of products and the concentration of reactants for an equilibrium mixture. This relation can be equated as follows

$$K_c = \frac{[C][D]}{[A][B]}$$

Here  $K_c$  is called the equilibrium constant

In this equation the concentration of A at equilibrium is represented as  $[A]$  (Similarly for B, C and D) and the stoichiometric coefficients of the reactants and the products are 1. It has been experimentally observed that the equilibrium constant is also dependent on the stoichiometric coefficients of the reactants and products.

Therefore the law of mass action dictates that the equilibrium constant at a given constant temperature is equal to the product of the concentration of products raised to the respective stoichiometric coefficients divided by the product of the reactant concentration. This is also known as the equilibrium law or law of chemical equilibrium.

Representation of the equilibrium constant

For a balanced reaction of the type



According to the law of mass action the constant value obtained by relating equilibrium concentrations of

reactants and products is called the equilibrium constant. For the forward reaction, this is given by

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

The equilibrium constant for the reverse reaction is the inverse of the forward reaction and is given by:

$$K_c' = \frac{1}{K_c} = \frac{[A]^a [B]^b}{[C]^c [D]^d}$$

If the coefficients of the chemical equation are multiplied by a factor 'n' then the equilibrium constant is raised by the power 'n' i.e. the constant becomes  $K_c^n$

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