Mathematical Characteristics of Simple Chemical Reactions

The rate of a chemical reaction changes continuously as the reaction proceeds because the concentrations of the reactants decrease with time. The relationship between the reaction rate and the concentration of reactants can be expressed mathematically by integrated rate equations. These equations describe how the concentration of reactants varies with time and help in determining important kinetic parameters such as the rate constant, half-life, and mean life. Depending on the dependence of the reaction rate on reactant concentration, reactions are classified as zero-order, first-order, and second-order reactions. Each type of reaction follows a characteristic rate law and possesses unique mathematical expressions that are useful in understanding reaction kinetics and predicting the progress of chemical reactions.

In this section, the mathematical treatment of simple chemical reactions is discussed under the following categories:

- Zero-order reaction
- First-order reaction
- Second-order reaction
- Half-life of a reaction
- Mean life of a reaction

The derivation of the rate equations for each order of reaction provides the basis for determining the rate constant and understanding how the concentration of reactants changes with time. These mathematical relationships are extensively used in chemical kinetics, pharmaceutical sciences, environmental chemistry, and industrial process design.