# Chapter Summary: Rates of Reactions - Kinetics

**Rate of reaction**: change in concentration of product in unit time.
Rate of reaction = $\Delta$[product] / $\Delta$ t  [ ] indicate concentration

## Rate law of a reaction

Expresses the relationship of concentration of reactants to rate of reaction.

e.g. aA + bB $\longrightarrow$ cC + dD

Rate = k $[A]^m$ $[B]^n$

Where k is rate constant and *m*, *n* are small positive integers 0, 1, 2 etc. determined experimentally only.

## Reaction Order

Zero Order Reaction: reaction rate is independent of the concentration of reactants.
First Order Reaction: sum of *m* and *n* is 1
Second Order Reaction: sum of *m* and *n* is 2
Integrated Rate Law: used to determine concentrations of reactions at different times.
**Half life of Reaction** (t ½): is the time in which half of the reactants are consumed.

| Order | Rate Law | Integrated Rate Law | Half-Life | Straight-Line Plot |
|---|---|---|---|---|
| 0 | Rate = $k$ | $[A]_t = -kt + [A]_0$ | $\frac{[A]_0}{2k}$ | [A] vs $t$ |
| 1 | Rate = $k$[A] | $\ln\frac{[A]_t}{[A]_0} = -kt$ | $0.693/k$ | ln[A] vs $t$ |
| 2 | Rate = $k[A]^2$ | $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$ | $1/(k[A]_0)$ | $\frac{1}{[A]}$ vs $t$ |

## Theories of Chemical Kinetics

Collision theory: rate of reaction depends on how many collisions the reactants molecules undergo and the effectiveness of the collisions. Activation energy is the minimum energy required for a reaction to occur.
Effect of temperature on reaction rates
**Arrhenius equation**: Rate constant $k = Ae^{-Ea/RT}$

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

## Speed of reactions

Dependence of speed of reactions on:
1) concentration of reactants
2) temperature
2) surface area
4) catalysis

## Key Words

| | | | |
|---|---|---|---|
| Speed of reaction | Rate of reaction | Rate law | Rate constant |
| First order reaction | Zero order reaction | Second order reaction | Half life |
| Collision theory | Activation energy | Transition state | Activated complex |
| Rate determining step | Catalyst | Catalysis: Homogeneous, heterogeneous, enzyme | |