

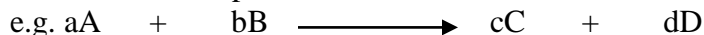
## Chapter Summary: Rates of Reactions - Kinetics

**Rate of reaction:** change in concentration of product in unit time.

Rate of reaction =  $\Delta[\text{product}] / \Delta t$  [ ] indicate concentration

### Rate law of a reaction

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



$$\text{Rate} = k [A]^m [B]^n$$

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** ( $t_{1/2}$ ): 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  $k = Ae^{-E_a/RT}$

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

### 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	