Reaction Kinetics – Key Concepts and Mechanisms

Educational Content for Undergraduate Chemistry Students

1. Introduction to Reaction Kinetics

Reaction kinetics is the study of the rates at which chemical reactions occur.
It explains how different conditions influence reaction speed and provides insights into the reaction me

2. Rate Laws and Rate Expressions

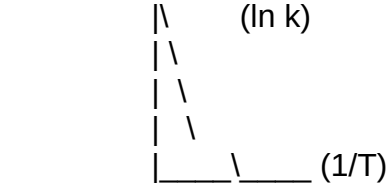
Rate law expresses the relationship between the rate of a reaction and the concentration of its reactan
Differential rate laws: Describe how the rate depends on concentration.
Integrated rate laws: Express concentration as a function of time.
Common orders: Zero-order (rate independent of concentration), First-order (rate $\propto$ [A]), Second-order

3. Factors Affecting Reaction Rates

Temperature: Increasing temperature increases kinetic energy and collision frequency.
Concentration: Higher concentration typically leads to a faster reaction.
Catalysts: Provide alternative pathways with lower activation energy.
Theories: Collision theory explains rate in terms of collisions; Transition state theory involves activated

4. Arrhenius Equation & Temperature Dependence

Arrhenius equation: k = Ae^(-Ea/RT)
ln(k) = -Ea/R * (1/T) + ln(A)
Plotting ln(k) vs. 1/T yields a straight line with slope = -Ea/R.
[Text Diagram: Arrhenius Plot]

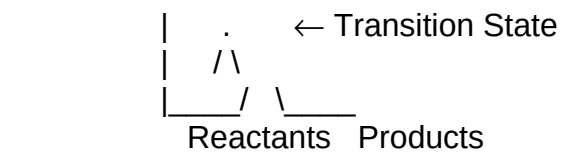


5. Reaction Mechanisms

A reaction mechanism breaks down the overall reaction into elementary steps.
Rate-determining step: The slowest step that limits the rate of the overall reaction.
Approximations:
- Steady-state: Intermediate concentration remains constant.
- Pre-equilibrium: Early step reaches equilibrium quickly.

6. Energy Profile Diagrams

[Text Diagram: Energy Profile]



Catalyzed reactions have lower peaks (Ea).

7. Practice Problems with Solutions

Q1: A reaction is first-order in A. If [A] = 0.5 M and k = 0.2 s^-1, find the half-life.
A1: t1/2 = 0.693 / k = 0.693 / 0.2 = 3.465 s
Q2: Sketch the energy diagram for an exothermic reaction with a catalyst.
A2: See Section 6 text diagram for structure.

8. Summary Tables and Key Equations

Rate Laws:
- Zero Order: [A] = [A]■ - kt
- First Order: ln[A] = ln[A]■ - kt
- Second Order: 1/[A] = 1/[A]■ + kt

Arrhenius: k = Ae^(-Ea/RT)