

# Chapter 4: Introduction to Reaction Kinetics

Department of Chemistry

## 1 Overview

Reaction kinetics is the study of chemical reaction rates and the factors influencing them. It is essential for predicting product formation and optimizing reaction conditions.

## 2 Rate Laws

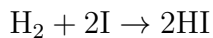
**Rate Law Definition:** Expresses reaction rate as a function of reactant concentration.

**General Form:**

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

where  $k$  is the rate constant,  $m, n$  are the orders with respect to reactants.

**Example:**



$$\text{Rate} = k[\text{H}_2][\text{I}]^2$$

## 3 Order of Reactions

- Zero Order: Rate independent of  $[A]$
- First Order: Rate proportional to  $[A]$
- Second Order: Rate proportional to  $[A]^2$  or  $[A][B]$

Order	Differential Rate Law	Integrated Rate Law
0	$\text{Rate} = k$	$[A] = [A]_0 - kt$
1	$\text{Rate} = k[A]$	$[A] = [A]_0 e^{-kt}$
2	$\text{Rate} = k[A]^2$	$1/[A] = 1/[A]_0 + kt$

Table 1: Order of reaction and integrated rate laws

## 4 Experimental Determination of Rate Laws

- Method of Initial Rates: Measures rates at various concentrations.
- Graphical Analysis: Plots to determine the order.

## 5 Factors Affecting Rates

- Concentration: Higher molarity increases rate.
- Temperature: Each 10°C rise often doubles rate (Arrhenius equation).
- Catalysts: Lower activation energy.

## 6 Sample Problems

### Problem 1:

A first-order reaction has  $k = 0.25 \text{ min}^{-1}$ . If  $[A]_0 = 0.40 \text{ M}$ , what is  $[A]$  after 10 min?

**Solution:**

$$[A] = 0.40 \times e^{-0.25 \times 10} = 0.40 \times e^{-2.5} \approx 0.0328 \text{ M}$$

### Problem 2:

For a zero-order reaction, what time is required for  $[A]$  to drop from 1.00 M to 0.25 M if  $k = 0.10 \text{ mol L}^{-1}\text{min}^{-1}$ ?

**Solution:**

$$t = \frac{[A]_0 - [A]}{k} = \frac{1.00 - 0.25}{0.10} = 7.5 \text{ min}$$

## 7 Summary Points

- Kinetics links molecular structure, mechanism, and real-world process control.
- Rate, order, and mechanism are core exam concepts.

## 8 References

1. Atkins, P., Jones, L. *Chemical Principles*, 5th Ed.
2. Carey, F. *Organic Chemistry*, 9th Ed.