

Chem Kinetics



Comparative Table of Zero Order, First Order, and Second Order Reactions

Feature	Zero Order Reaction	First Order Reaction	Second Order Reaction
Rate Equation	$\text{Rate} = k[A]^0 = k$	$\text{Rate} = k[A]$	$\text{Rate} = k[A]^2$
Integrated Rate Law	$[A] = [A]_0 - kt$	$[A] = [A]_0 e^{-kt}$	$\frac{1}{[A]} = \frac{1}{[A]_0} + kt$
Graph (Linear Plot)	$[A]$ vs. t (slope = $-k$)	$\ln[A]$ vs. t (slope = $-k$)	$1/[A]$ vs. t (slope = k)
Half-Life Period ($t_{1/2}$)	$\frac{[A]_0}{2k}$	$\frac{0.693}{k}$	$\frac{1}{k[A]_0}$
Units of Rate Constant (k)	$\text{M} \cdot \text{s}^{-1}$	s^{-1}	$\text{M}^{-1} \cdot \text{s}^{-1}$
Examples	- Decomposition of NH_3 on platinum - Photochemical reactions - Catalytic reactions	- Radioactive decay (e.g., C-14) - Hydrolysis of esters - Decomposition of hydrogen peroxide	- Saponification of esters - Reaction between hydrogen and bromine - Decomposition of NO_2

Key Concepts and Examples

• Zero Order Reactions:

- **Rate Equation:** $\text{Rate} = k$
- **Integrated Rate Law:** $[A] = [A]_0 - kt$
- **Half-Life Period:** $t_{1/2} = \frac{[A]_0}{2k}$
- **Examples:**
 - Decomposition of ammonia on a platinum surface: $2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$
 - Photochemical reactions where light intensity is constant.

• First Order Reactions:

- **Rate Equation:** $\text{Rate} = k[A]$
- **Integrated Rate Law:** $[A] = [A]_0 e^{-kt}$
- **Half-Life Period:** $t_{1/2} = \frac{0.693}{k}$
- **Examples:**
 - Radioactive decay (e.g., decay of Carbon-14): $\text{C}^{14} \rightarrow \text{N}^{14} + \beta$
 - Hydrolysis of esters in acidic conditions: $\text{CH}_3\text{COOCH}_3 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{CH}_3\text{OH}$
 - Decomposition of hydrogen peroxide: $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$

• Second Order Reactions:

- **Rate Equation:** $\text{Rate} = k[A]^2$
- **Integrated Rate Law:** $\frac{1}{[A]} = \frac{1}{[A]_0} + kt$

- **Half-Life Period:** $t_{1/2} = \frac{1}{k[A]_0}$
- **Examples:**
 - Saponification of esters: $\text{CH}_3\text{COOCH}_3 + \text{OH}^- \rightarrow \text{CH}_3\text{COO}^- + \text{CH}_3\text{OH}$
 - Reaction between hydrogen and bromine: $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$
 - Decomposition of nitrogen dioxide: $2\text{NO}_2 \rightarrow 2\text{NO} + \text{O}_2$

Summary

This comparative table provides a clear overview of the differences and key characteristics of zero-order, first-order, and second-order reactions, including their rate equations, integrated rate laws, half-life periods, units of rate constants, and typical examples.