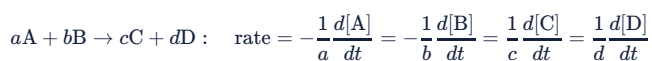


Chemical Kinetics: one-page cheat sheet

NEET Chemistry · Unit 8 · Physical Chemistry

1 · Rate of reaction



Rate law $\text{rate} = k[A]^x[B]^y$; overall order $n = x + y$

Instantaneous slope of the tangent on the $[R]$ vs t curve

Order from data vary one reactant; if rate $\times 2^x$ when its concentration is doubled, order = x

Zero order heterogeneous catalysis on a saturated surface, e.g. ammonia decomposition on Pt

2 · Units of k

$$\text{unit of } k = (\text{mol L}^{-1})^{1-n} \text{ s}^{-1}$$

Order	Unit of k
0	$\text{mol L}^{-1} \text{ s}^{-1}$
1	s^{-1}
2	$\text{L mol}^{-1} \text{ s}^{-1}$
3	$\text{L}^2 \text{ mol}^{-2} \text{ s}^{-1}$

3 · Order vs molecularity

	Order	Molecularity
From	experiment	mechanism
Values	0, fractional, integer	1, 2, 3 only
Applies to	any reaction	elementary steps only

Overall order matches the molecularity of the **slowest** step.

4 · Integrated rate laws

	Zero order	First order
Rate law	k	$k[R]$
Integrated	$[R] = [R]_0 - kt$	$\ln[R] = \ln[R]_0 - kt$
k	$\frac{[R]_0 - [R]}{t}$	$\frac{2.303}{t} \log \frac{[R]_0}{[R]}$
Plot, slope	$[R]$ vs t , $-k$	$\ln[R]$ vs t , $-k$
$t_{1/2}$	$[R]_0/2k$	$0.693/k$

Half-life first order: independent of $[R]_0$; generally $t_{1/2} \propto [R]_0^{1-n}$

Gas phase $A(g) \rightarrow B(g) + C(g): k = \frac{2.303}{t} \log \frac{p_i}{2p_i - p_t}$

Trap · Doubling $[R]_0$ doubles $t_{1/2}$: zero order. It halves $t_{1/2}$: second order. No change: first order.

Six traps to remember

- Unit of k is $(\text{mol L}^{-1})^{1-n} \text{ s}^{-1}$; first order is s^{-1} .
- Molecularity is never zero or fractional; order can be.
- First-order $t_{1/2} = 0.693/k$ does not depend on concentration.

5 · Pseudo first order

Idea second-order reaction with one reactant in large excess

Ester hydrolysis $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O} \xrightarrow{\text{H}^+} \text{acid} + \text{alcohol}$; rate = $k[\text{ester}]$, $k = k'[\text{H}_2\text{O}]$

Cane sugar inversion to glucose + fructose; rate = $k[\text{sucrose}]$

6 · Arrhenius equation

$$k = Ae^{-E_a/RT}, \quad \log k = \log A - \frac{E_a}{2.303 RT}$$

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303 R} \cdot \frac{T_2 - T_1}{T_1 T_2}$$

Plot $\ln k$ vs $1/T$: slope = $-E_a/R$, intercept = $\ln A$

Rule of thumb rate constant roughly doubles per 10°C rise

E_a needs rate constants at two temperatures

7 · Catalysis & collision theory

Catalyst lowers E_a by a new path; speeds forward and backward equally; ΔH , ΔG and K unchanged

$$\text{rate} = P \cdot Z_{AB} \cdot e^{-E_a/RT}$$

Effective collision energy $\geq$ threshold (E_a + reactant energy) **and** correct orientation (P)

8 · First-order shortcuts

Completion	Time
50%	$t_{1/2}$
75%	$2 t_{1/2}$
87.5%	$3 t_{1/2}$
99.9%	$\approx 10 t_{1/2}$

Mechanism the slowest step fixes the rate; intermediates cancel in the overall equation

Seen in NEET 2023

Rate = $k[A]^2[B]$. $[A]$ is tripled, $[B]$ constant. New rate?

$$\text{rate}' = k(3[A])^2[B] = 9 \times \text{rate}$$

Seen in NEET 2025

First order, $t_{1/2} = 1$ min. Time for 99.9% completion?

$$t = \frac{2.303}{k} \log 10^3 = \frac{6.909}{k} = \frac{6.909}{0.693} t_{1/2} \approx 10 \text{ min}$$

Seen in NEET 2024

Rate constant quadruples from 27°C to 57°C . Find E_a .

$$\log 4 = \frac{E_a}{2.303 \times 8.314} \cdot \frac{30}{300 \times 330} \Rightarrow E_a = 38.04 \text{ kJ mol}^{-1}$$

- Zero-order $t_{1/2}$ is **proportional** to $[R]_0$.
- E_a comes from k at two temperatures, via the slope of $\ln k$ vs $1/T$.
- A catalyst lowers E_a but leaves ΔH and K unchanged.