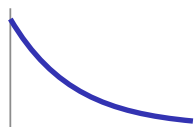


Reaction Kinetics

A-Level Chemistry ■ Topic 26

A-Level Chemistry



Reaction Kinetics

What we will cover

- 1 Rate equations & orders
- 2 Order graphs
- 3 Half-life & rate constant
- 4 Reaction mechanisms
- 5 Catalysts



measures gas made over time

1 Rate equations

Rate equations and orders

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

Worked example

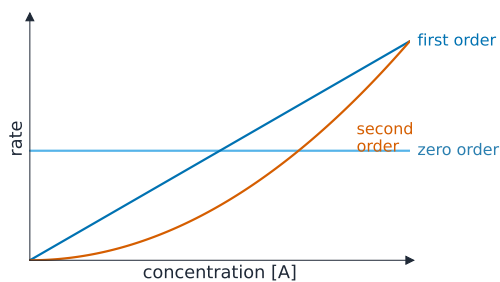
doubling [A] doubles the rate (order 1);
doubling [B] quadruples it (order 2) $\Rightarrow$
 $\text{rate} = k[A][B]^2$, **overall order 3**

The **order** 反应级数 and **rate constant** 速率常数 k are found by **experiment**, not from the equation.



Catalyst pellets

Order graphs



Rate against concentration:

- **zero order** – a flat line
- **first order** – a straight line through the origin
- **second order** – an upward curve

Half-life and the rate constant

A **first-order** reaction has a **constant half-life** 恒定半衰期 $t_{1/2}$.

$$k = \frac{0.693}{t_{1/2}}$$

$$t_{1/2} = 120 \text{ s}$$

$$k = \frac{0.693}{120} = 5.8 \times 10^{-3} \text{ s}^{-1}$$

Half-life and the rate constant

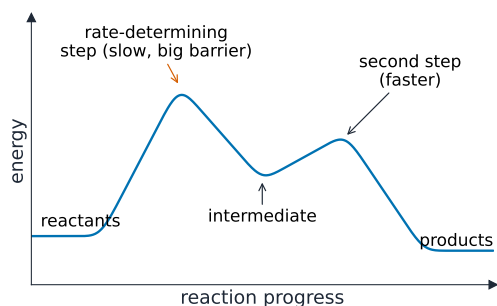
For a first-order reaction the **half-life** 半衰期 is constant:

$$t_{1/2} = \frac{\ln 2}{k} \approx \frac{0.693}{k}$$

A constant half-life on a concentration–time graph **proves** first order. Zero-order half-life gets shorter as concentration falls; second-order half-life gets longer.

2 Mechanisms and catalysts

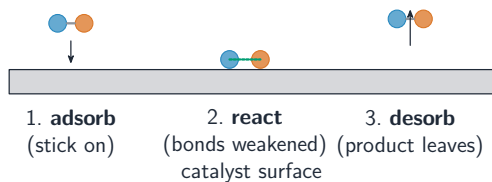
Reaction mechanisms



The slowest step is the **rate-determining step** 决速步骤 – it controls the overall rate.

Only species up to & including it appear in the rate equation. An **intermediate** 中间体 is made then used up – not in the overall equation.

Catalysts



A **heterogeneous catalyst** 多相催化剂 works in three stages:

- **adsorption** 吸附 onto the surface
- weakened bonds react
- **desorption** 脱附 of the product

A **homogeneous** 均相 one is reformed unchanged.

3

Recap

Topic 26 – key takeaways

1 Rate equation

rate = $k[A]^m[B]^n$; found by experiment

2 Orders

0 flat, 1 straight, 2 curved

3 Half-life

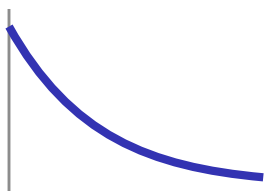
first order: constant $t_{1/2}$; $k = 0.693/t_{1/2}$

4 Mechanism

the rate-determining step controls the rate

Check yourself

- 1 How is a rate equation found?
- 2 What graph shape is a first-order rate-conc plot?
- 3 What is special about a first-order half-life?
- 4 Which step controls the overall rate?



Answers 1. by experiment 2. a straight line through the origin 3. it is constant
4. the rate-determining step