

Reaction Kinetics

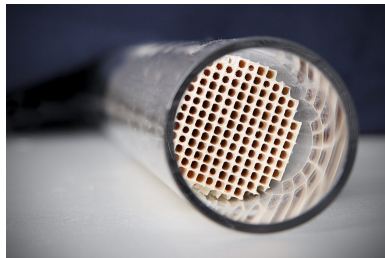
A-Level Chemistry ■ Topic 8

A-Level Chemistry



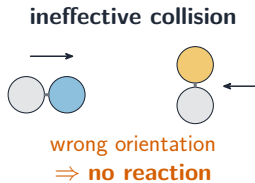
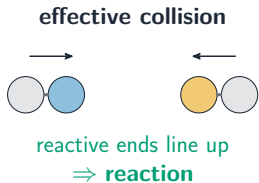
What we will cover

- 1 Rate & collisions
- 2 Concentration & pressure
- 3 The Boltzmann distribution
- 4 Catalysts
- 5 Types of catalyst



a catalyst speeds reactions

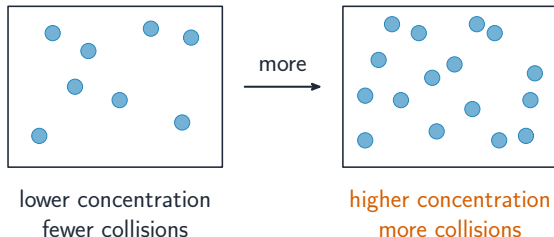
Rate and collisions



To react, particles must **collide** 碰撞.

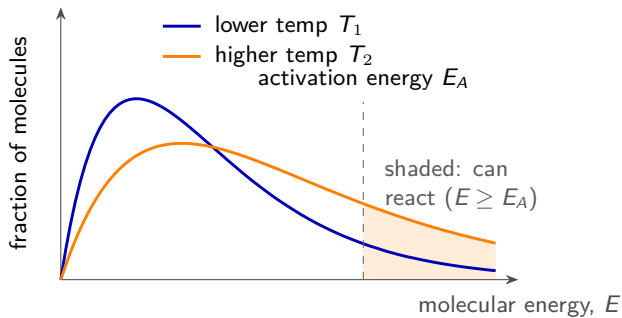
An **effective collision** 有效碰撞 has enough **energy** and the right **orientation**. The rate depends on how many happen each second.

Concentration and pressure



Higher **concentration** 浓度 (or gas **pressure** 压强) packs particles closer. They **collide** 碰撞 more often, so there are more effective collisions each second – the rate **rises**.

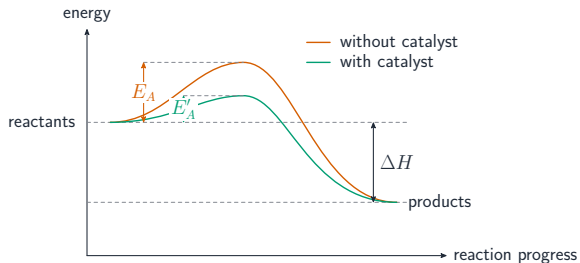
The Boltzmann distribution



Only molecules past the **activation energy** 活化能 E_A can react.

Raising the temperature spreads the **Boltzmann distribution** 玻尔兹曼分布 to the right, so a **much larger fraction** exceed E_A – a small rise gives a big rate increase.

Catalysts



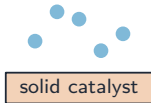
A **catalyst** 催化剂 speeds a reaction without being used up, via a route with **lower** E_A .

More molecules now exceed E_A , so the rate rises – but the **enthalpy change** 焓变 ΔH is **unchanged**.

Types of catalyst



homogeneous
(same state, mixed in)



heterogeneous

- a **homogeneous catalyst** 均相催化剂 is in the **same** state as the reactants
- a **heterogeneous catalyst** 多相催化剂 is in a **different** state (a solid surface, like a catalytic converter)

Worked example – average rate

A reaction gives off CO_2 . In the first 30 s, 48 cm^3 is collected. Find the average rate.

- $\text{Rate} = \frac{\text{change in amount}}{\text{time taken}}$
- $= \frac{48 \text{ cm}^3}{30 \text{ s}} = 1.6 \text{ cm}^3 \text{ s}^{-1}$
- That is the **average** over the 30 s, not the rate at any instant.

Average rate = total change $\div$ total time. **Instantaneous** rate = gradient of the **tangent** – always steepest at $t = 0$.

Topic 8 – key takeaways

1

Collisions

effective = enough energy + right angle

2

Concentration

more particles → more collisions
→ faster

3

Temperature

spreads Boltzmann right; big rate rise

4

Catalyst

lower E_A ; ΔH unchanged

Check yourself

- 1 What two things make a collision effective?
- 2 Why does higher concentration speed a reaction?
- 3 What does raising temperature do to the Boltzmann curve?
- 4 Does a catalyst change ΔH ?



Answers 1. enough energy and the right orientation 2. more frequent collisions
3. spreads it to the right 4. no