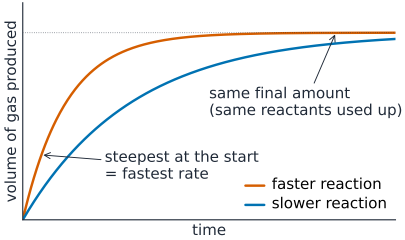
Chemical Reactions

IGCSE Chemistry ▪ Topic 6

IGCSE Chemistry

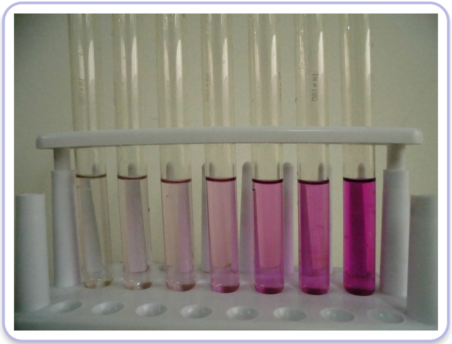
What we will cover

1. Physical vs chemical change
2. Collision theory & rate
3. Catalysts & measuring rate
4. Reversible reactions
5. Equilibrium & industry
6. Redox



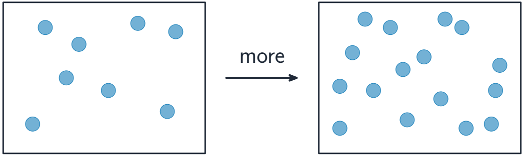
rate is fastest at first

Physical vs chemical change



Colour changes can track redox progress

Collision theory and rate



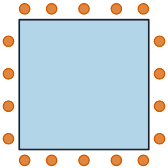
lower concentration
fewer collisions

higher concentration
more collisions

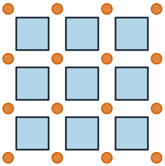
Collision theory 碰撞理论: particles must collide with enough energy ($\geq E_a$). Faster when collisions are more frequent or more energetic:

- more **concentration** 浓度 / pressure
- more **surface area** 表面积
- higher temperature

Surface area



one big lump
small surface
area $\longrightarrow$ slower

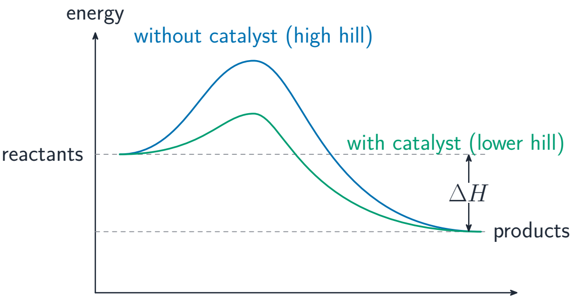


same mass
as powder
large surface
area $\longrightarrow$ faster

A powder has far more surface than one lump, so acid touches many more particles.

> More exposed particles $\Rightarrow$ more collisions $\Rightarrow$ a faster rate.

Catalysts

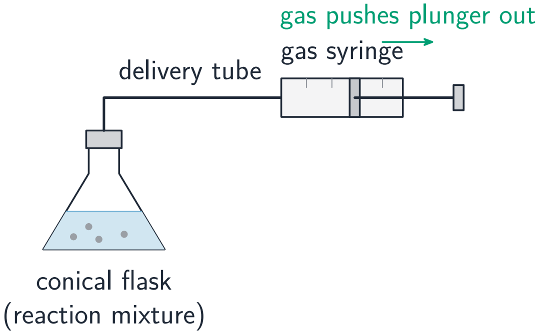


a catalyst lowers the activation energy; ΔH is unchanged

A **catalyst** 催化剂 speeds a reaction but is not used up.

- it lowers the **activation energy** 活化能
- ΔH is unchanged
- **enzymes** 酶 are biological catalysts

Measuring the rate

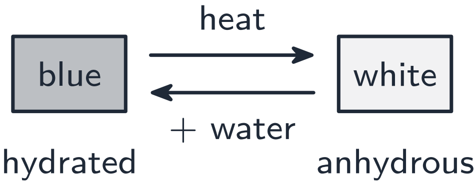


Follow a reaction by:

- loss of mass on a balance
- gas volume in a **syringe** 注射器
- time for a **precipitate** 沉淀 to hide a mark

The graph is steepest at the start, then flat.

Reversible reactions



A **reversible reaction** 可逆反应 ($\rightleftharpoons$) can go both ways.

> Blue **hydrated** 水合 $CuSO_4$ $\rightleftharpoons$ white **anhydrous** 无水 $CuSO_4$ + water. Adding water turns it blue – a test for water.

Equilibrium

At **equilibrium** 平衡 (closed system): rate forward = rate reverse

concentrations stop changing (but the reaction is still going)

To shift the position: **heat** → endothermic side; **pressure** → fewer-molecules side; **add a substance** → the other side. A catalyst does not shift it.

Industry: Haber and Contact

Haber 哈伯法 – ammonia

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

450°C, ~200 atm, iron catalyst

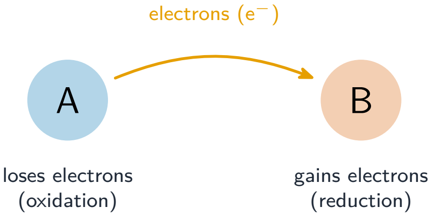
Contact 接触法 – SO_3

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

450°C, ~2 atm, V_2O_5 catalyst

Conditions are a **compromise** 折中: medium pressure (safe), fairly high temperature (good rate).

Redox



Oxidation 氧化 & **reduction** 还原 happen together.

> **OIL RIG**: Oxidation Is Loss, Reduction Is Gain – of electrons.

An **oxidising agent** 氧化剂 is itself reduced (purple MnO_4^- fades).

Worked example – speeding up a reaction

Powdered marble reacts with acid faster than a single lump. Explain using collision theory.

- A reaction needs particles to collide with at least the **activation energy** 活化能.
- Powder has a much larger surface area exposed to the acid.
- So there are more collisions per second between acid particles and the marble.
- More successful collisions per second ⇒ a faster rate.

Surface area, concentration and pressure work by giving more collisions. Temperature also gives more energetic ones; a catalyst lowers E_a.

Topic 6 – key takeaways

1 Rate

more frequent / energetic collisions = faster

2 Catalyst

lowers E_a; not used up; ΔH unchanged

3 Equilibrium

forward = reverse in a closed system

4 Redox

OIL RIG; oxidation & reduction together

Check yourself

1. Why does a powder react faster than a lump?
2. How does a catalyst speed up a reaction?
3. What is equal at equilibrium?
4. In OIL RIG, what is oxidation?

Answers **1.** more surface, so more collisions **2.** it lowers the activation energy **3.** the forward & reverse rates **4.** loss of electrons