

Chemical Reactions

IGCSE Chemistry • Topic 6

IGCSE Chemistry



Chemical Reactions

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

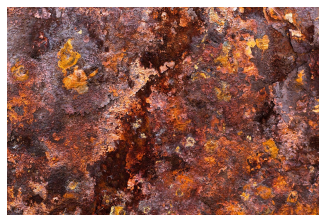
1

Change and rate

Chemical Reactions

Change and rate

Physical vs chemical change



- Explain a faster rate with **collision theory**: successful collisions happen more often. Concentration, pressure and surface area all raise...
- A **catalyst** lowers the activation energy and speeds the reaction up, but is not used up and does *not* change ΔH or the...
- At **equilibrium** the forward and reverse rates are equal and the concentrations stop changing – it does *not* mean the amounts of...

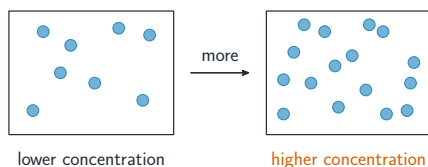
Chemical Reactions

Change and rate

Collision theory and rate

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

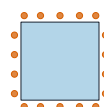
- more **concentration** 浓度 / pressure
- more **surface area** 表面积
- higher temperature



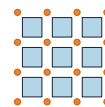
Chemical Reactions

Change and rate

Surface area



one big lump
small surface
area → slower

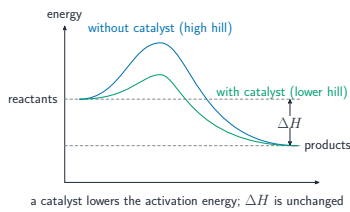


same mass
as powder
large surface
area → faster

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

More exposed particles ⇒ more collisions ⇒ a faster rate.

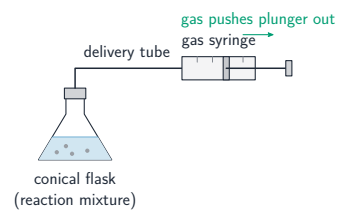
Catalysts



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

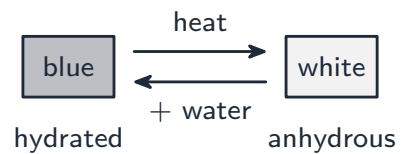
The graph is steepest at the start, then flat.

2 Equilibrium

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** $\rightarrow$ endothermic side; **pressure** $\rightarrow$ fewer-molecules side; **add a substance** $\rightarrow$ the other side. A **catalyst** **does not** shift it.

Industry: Haber and Contact

Haber 哈伯法 – ammonia
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$
 450°C, ~200 atm, iron catalyst

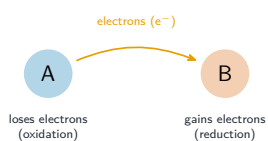
Contact 接触法 – SO_3
 $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$
 450°C, ~2 atm, V_2O_5 catalyst

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

3 Redox

Chemical Reactions
└ Redox

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).

4 Recap

Chemical Reactions
└ Recap

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 $\Rightarrow$ a **faster rate**.

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

Chemical Reactions
└ Recap

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

Chemical Reactions
└ Recap

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 forward & reverse rates 2. it lowers the activation energy 3. the forward & reverse rates 4. loss of electrons