

Equilibria

A-Level Chemistry ■ Topic 7

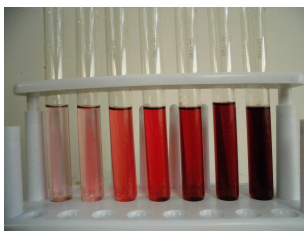
A-Level Chemistry



Equilibria

What we will cover

- 1 Dynamic equilibrium
- 2 Le Chatelier's principle
- 3 Equilibrium constants
- 4 Haber & Contact
- 5 Brønsted–Lowry acids
- 6 Strong



a shifting equilibrium

1 Equilibrium

Dynamic equilibrium

A **dynamic equilibrium** 动态平衡 is a closed system where the forward and reverse rates are equal. Concentrations stay constant, but both reactions still run.



It is **dynamic**: molecules keep reacting. It is **equilibrium**: nothing measurable changes.

Le Chatelier's principle

the equilibrium shifts to **oppose** the change you make

- increase [reactant] → towards the **products**
- increase pressure → to the **fewer-gas-molecules** side
- increase temperature → in the **endothermic** direction

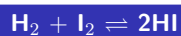
a **catalyst** speeds both directions equally, so it gives *no shift*

Le Chatelier's principle 勒夏特列原理: the equilibrium shifts to **oppose** a change.

- more reactant → towards products
- more pressure → fewer-gas side
- more heat → endothermic way
- a **catalyst** 催化剂 → no shift

Equilibrium constants

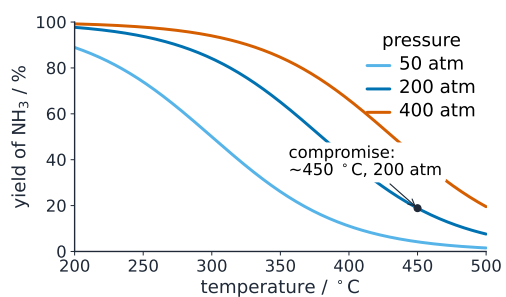
$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$



$$K_c = \frac{1.6^2}{0.20 \times 0.20} = 64 \text{ (no units here)}$$

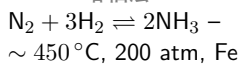
Only **temperature** changes K_c or K_p . For gases use **partial pressure** 分压 = **mole fraction** 摩尔分数 × total pressure.

The Haber and Contact processes

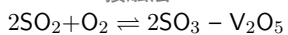


Conditions balance yield, rate & cost:

■ **Haber** 哈伯法:



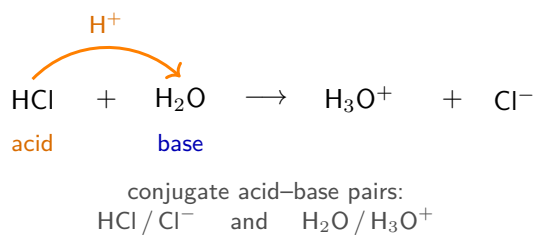
■ **Contact** 接触法:



Low temperature gives more yield but too slowly.

2 Acids and bases

Brønsted–Lowry acids and bases

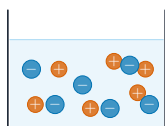


■ an **acid** 酸 is a **proton donor** 质子供体

■ a **base** 碱 is a **proton acceptor** 质子受体

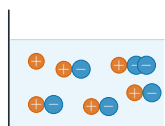
The reaction makes two **conjugate** 共轭 acid–base pairs.

Strong and weak acids



strong acid

fully dissociated: many ions



weak acid

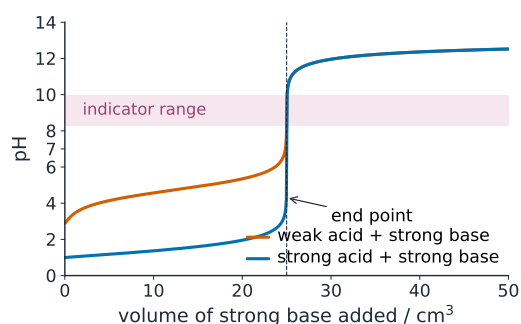
mostly molecules: few ions

This is about **ionisation**, not concentration:

- **strong acid** 强酸 – fully dissociated 解离
- **weak acid** 弱酸 – only partly dissociated

A strong acid has a lower **pH** pH & conducts better.

Titration curves



Neutralisation 中和: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$, forming a **salt** 盐.

A **titration curve** 滴定曲线 has a steep pH jump at the end point – pick an **indicator** 指示剂 that changes colour inside it.

3

Recap

Topic 7 – key takeaways

1 Equilibrium

equal forward & reverse rates

2 Le Chatelier

the equilibrium opposes any change

3 K_c

products over reactants; only T changes it

4 Acids

donate protons; strong = fully dissociated

Check yourself

1 At equilibrium, how do the forward & reverse rates compare?

2 Raising pressure shifts to which side?

3 What only changes the value of K_c ?

4 A proton donor is an acid or a base?



Answers 1. they are equal 2. the side with fewer gas molecules 3. temperature
4. an acid