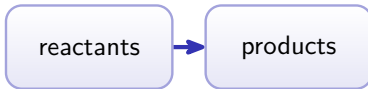


Chemical Reactions

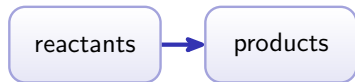
AP Chemistry ■ Unit 4

AP Chemistry



What we will cover

- 1 Recognizing a chemical reaction
- 2 Net ionic equations
- 3 Stoichiometry
- 4 Titration
- 5 Types of reactions
- 6 Acid-base reactions
- 7 Oxidation-reduction



Recognizing a chemical reaction

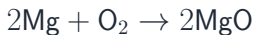
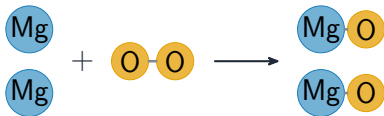
A **chemical reaction** 化学反应 rearranges atoms: old **bonds** 化学键 break, new ones form – atoms are **conserved**.

A **chemical change** 化学变化 makes new substances; a **physical change** 物理变化 only moves molecules apart.



Evidence of reaction: heat, light, gas, solid

Recognizing a chemical reaction



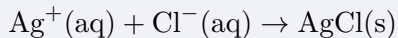
2 Mg and 2 O on each side: balanced

Net ionic equations

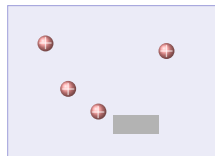
A **precipitation reaction** 沉淀反应 makes an insoluble solid. Strip out the **spectator ions** 旁观离子 that do not change:

Silver + chloride

molecular: $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl}\downarrow + \text{NaNO}_3$

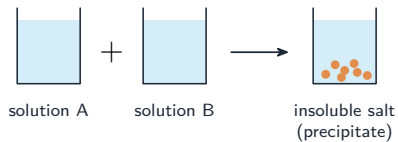


Use **solubility rules** 溶解度规则 to see which product is insoluble.



AgCl solid

Net ionic equations



Stoichiometry

Use the **mole ratio** 摩尔比 from the balanced equation: moles $\rightarrow$ ratio $\rightarrow$ moles.

Worked example

8.0 g H_2 burns ($2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$):

$$n = \frac{8.0}{2.02} = 3.96 \text{ mol} \Rightarrow 71 \text{ g H}_2\text{O}$$

The **limiting reactant** 限量反应物 runs out first and caps the product.

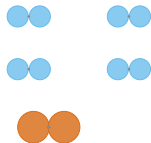
Percent yield

$$\frac{\text{actual}}{\text{theoretical}} \times 100\%$$

Stoichiometry



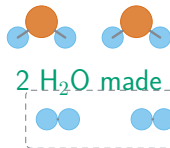
start with



4 H₂ 1 O₂

O₂ runs out first:
limiting reagent

you get



2 H₂O made

2 H₂ left over (excess)

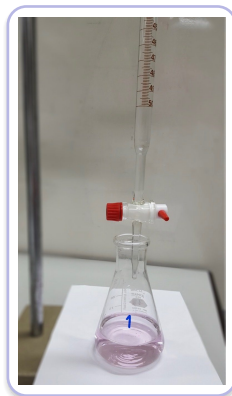
Titration

A **titration** 滴定 finds an unknown concentration. Add **standard solution** 标准溶液 until the reaction is just complete – the **equivalence point** 等当点 (an **indicator** 指示剂 shows it).

Worked example

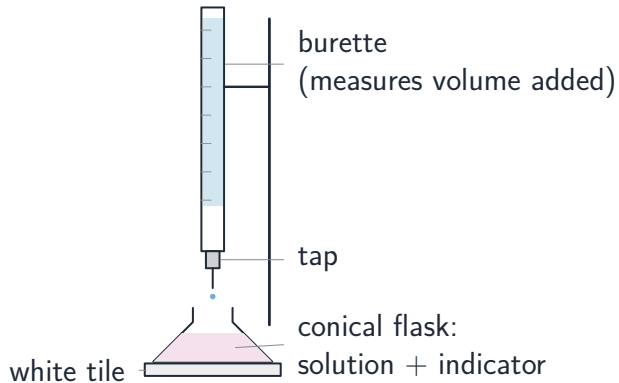
25 mL of 0.100 M NaOH neutralizes 20 mL HCl:

$$n = 0.00250 \Rightarrow c_{\text{HCl}} = 0.125 \text{ M}$$



Titration finds concentration by volume

Titration



Types of chemical reactions

Knowing the family helps you predict the products:

Synthesis 化合: $A + B \rightarrow AB$

Decomposition 分解:
 $AB \rightarrow A + B$

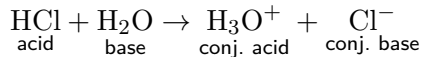
Precipitation: an insoluble solid forms

Acid-base: transfers a **proton** 质子 H^+

Redox: transfers **electrons** 电子

Acid-base reactions

Bronsted-Lowry 布朗斯特-劳里: an **acid** 酸 **donates** a proton, a **base** 碱 **accepts** one.

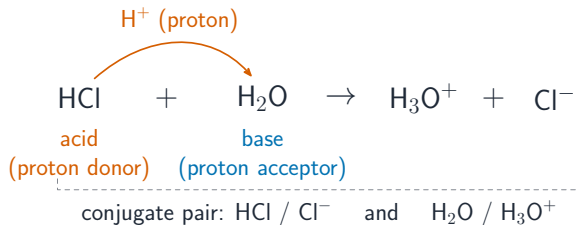


Conjugate pairs 共轭酸碱对 differ by one H^+ .

- **strong** 强 – ionizes almost completely (HCl, NaOH)
- **weak** 弱 – ionizes only slightly (vinegar)

Acid + base $\rightarrow$ salt + water
(**neutralization** 中和).

Acid-base reactions



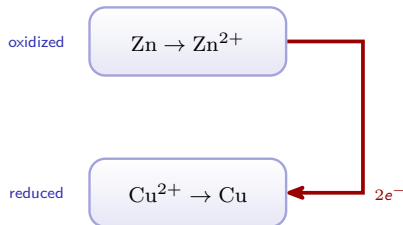
Oxidation-reduction

A **redox** 氧化还原反应 transfers electrons, tracked by **oxidation numbers** 氧化数:

OIL RIG

Oxidation Is Loss, Reduction Is Gain

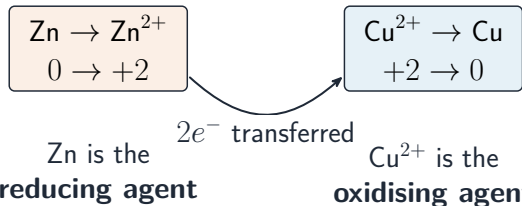
The **oxidizing agent** 氧化剂 is itself reduced; the **reducing agent** 还原剂 is oxidized.



Oxidation-reduction

oxidation: loses $2e^-$
(oxidation number $\uparrow$)

reduction: gains $2e^-$
(oxidation number $\downarrow$)



Unit 4 – key takeaways

1 Net ionic

drop spectator ions; keep only what changes

2 Stoichiometry

mole ratio; limiting reactant caps the yield

3 Acid-base

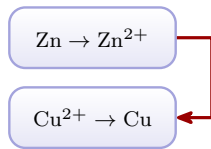
Bronsted-Lowry proton transfer; conjugate pairs

4 Redox

OIL RIG electron transfer; oxidation numbers change

Check yourself

- 1 What are the ions removed from a net ionic equation called?
- 2 Which reactant caps how much product can form?
- 3 In Bronsted-Lowry terms, what does an acid do?
- 4 $\text{Zn} \rightarrow \text{Zn}^{2+}$: is zinc oxidized or reduced?



Answers 1. spectator ions 2. the limiting reactant 3. donates a proton 4. oxidized