

Chemical Reactions

AP Chemistry ■ Unit 4

AP Chemistry



Chemical Reactions

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



1 Recognizing

Chemical Reactions

Recognizing

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

Chemical Reactions

Recognizing

Three ways to represent the same reaction

Symbolic

The balanced equation: formulas, coefficients, states. Compact, and the only level you can calculate with.

Particulate

A drawing of the atoms and molecules – how many of each particle before and after. AP asks you to draw and to read these.

Macroscopic

What you actually observe in the beaker: a colour change, a gas, a precipitate, a temperature change.

Moving between the levels – equation → particles → beaker – is a core AP skill; questions routinely give you one level and ask for another.

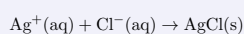
2 Net ionic

Net ionic equations

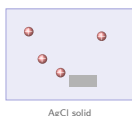
A **precipitation reaction** 沉淀反应 makes an insoluble solid. Strip out the **spectator ions** 旁观离子 that do not change:

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.



3 Stoichiometry

Stoichiometry

Use the **mole ratio** 摩尔比 from the balanced equation: **moles** → **ratio** → **moles**.

Worked example

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

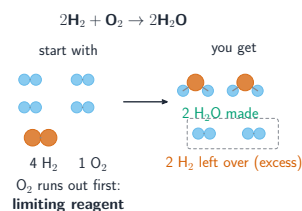
$$n = \frac{8.0}{2.02} = 3.96 \text{ mol} \Rightarrow 71 \text{ g } \text{H}_2\text{O}$$

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

Percent yield

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

The limiting reactant runs out first and



The limiting reactant runs out first and decides how much product forms

4 Titration

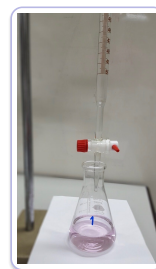
Titration

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

5 Types

Chemical Reactions
└ Types

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^+

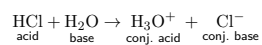
Redox: transfers **electrons** 电子

6 Acid-base

Chemical Reactions
└ Acid-base

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).

7 Redox

Chemical Reactions
└ Redox

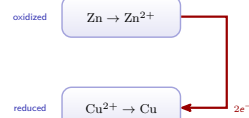
Oxidation-reduction

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

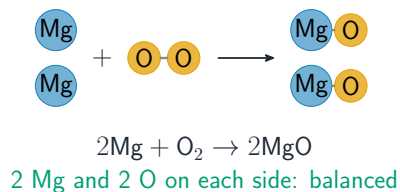
OIL RIG

Oxidation Is Loss, Reduction Is Gain

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

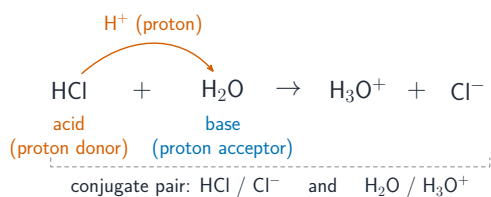


Three Ways to Represent a Reaction



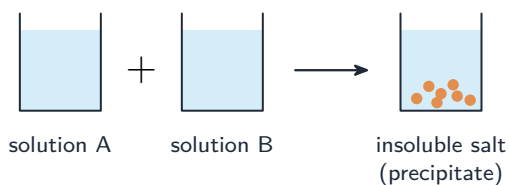
A balanced equation has the same number of each atom on both sides

Acid-Base Reactions, continued



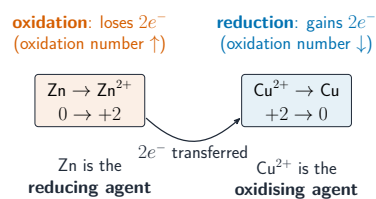
Bronsted-Lowry: an acid donates a proton to a base, forming two conjugate pairs

Net Ionic Equations, continued



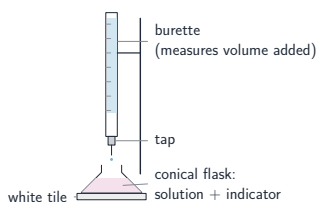
Mixing two solutions can form an insoluble precipitate

Oxidation-Reduction (Redox) Reactions



Redox is electron transfer: the reducing agent is oxidised, the oxidising agent reduced

Introduction to Titration



Titration apparatus: a burette delivers a known solution into a conical flask

Exam tips

- Balance every equation and work in **moles** – convert grams→moles, cross the mole ratio, then convert back.
- Find the **limiting reactant** by comparing mole ratios; it sets the maximum product (theoretical yield).
- In redox, remember **OIL RIG**: oxidation is loss of electrons, reduction is gain; every oxidation is paired with a reduction.
- For titrations use the balanced ratio to link the known and unknown at the **equivalence point**.
- A **net ionic equation** shows only the species that change; leave out spectator ions.

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Recap

Chemical Reactions
↳ Recap

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

Chemical Reactions
↳ Recap

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