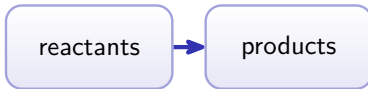


Chemical Reactions

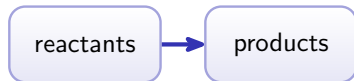
AP Chemistry ■ Unit 4

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** rearranges atoms: old **bonds** break, new ones form – atoms are **conserved**.

A **chemical change** makes new substances; a **physical change** only moves molecules apart.



*Evidence of reaction: heat, light, gas,
solid*

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 $\rightarrow$ particles $\rightarrow$ beaker – is a core AP skill; questions routinely give you one level and ask for another.

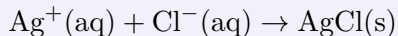


Net ionic equations

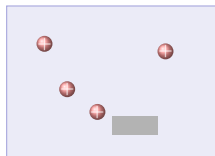
A **precipitation reaction** makes an insoluble solid. Strip out the **spectator ions** that do not change:

Silver + chloride

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



Use **solubility rules** to see which product is insoluble.



AgCl solid



Stoichiometry

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

Worked example

8.0 g H₂ burns ($2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$):

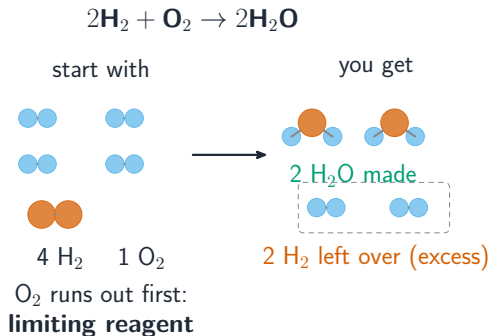
$$n = \frac{8.0}{2.02} = 3.96 \text{ mol} \Rightarrow 71 \text{ g H}_2\text{O}$$

The **limiting reactant** runs out first and caps the product.

Percent yield

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

The limiting reactant runs out first and caps the product



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



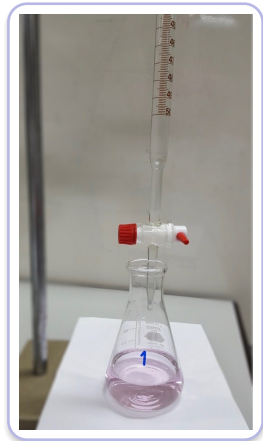
Titration

A **titration** finds an unknown concentration. Add **standard solution** until the reaction is just complete – the **equivalence point** (an **indicator** 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



Types of chemical reactions

Knowing the family helps you predict the products:

Synthesis : $A + B \rightarrow AB$

Decomposition : $AB \rightarrow A + B$

Precipitation: an insoluble solid forms

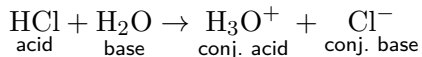
Acid-base: transfers a **proton**
 H^+

Redox: transfers **electrons**



Acid-base reactions

Bronsted-Lowry -: an **acid** donates a proton, a **base** accepts one.



Conjugate pairs differ by one H^+ .

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

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



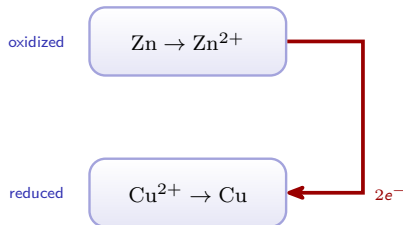
Oxidation-reduction

A **redox** transfers electrons, tracked by **oxidation numbers** :

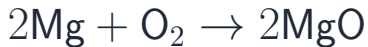
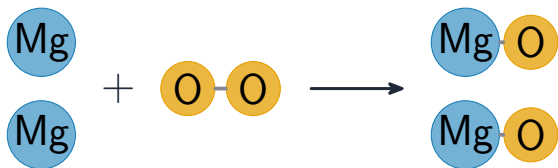
OIL RIG

Oxidation Is Loss, Reduction Is Gain

The **oxidizing agent** is itself reduced; the **reducing agent** is oxidized.



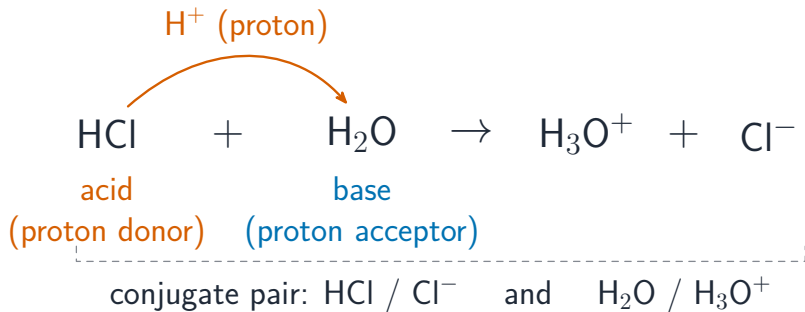
Three Ways to Represent a Reaction



2 Mg and 2 O on each side: balanced

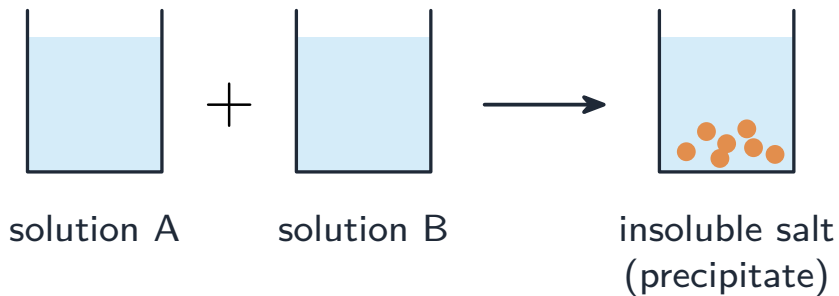
A balanced equation has the same number of each atom on both sides

Acid-Base Reactions, continued



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

Net Ionic Equations, continued

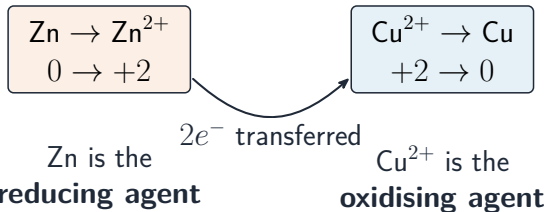


Mixing two solutions can form an insoluble precipitate

Oxidation-Reduction (Redox) Reactions

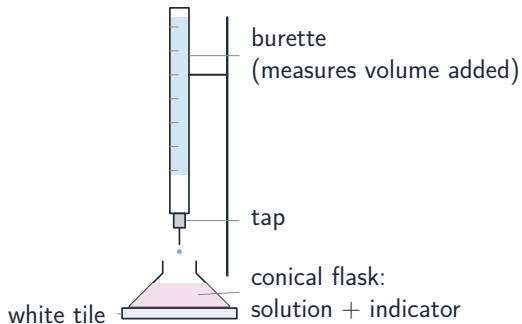
oxidation: loses $2e^-$
(oxidation number $\uparrow$)

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



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.



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

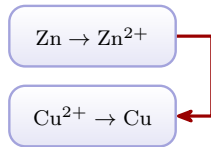
4

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