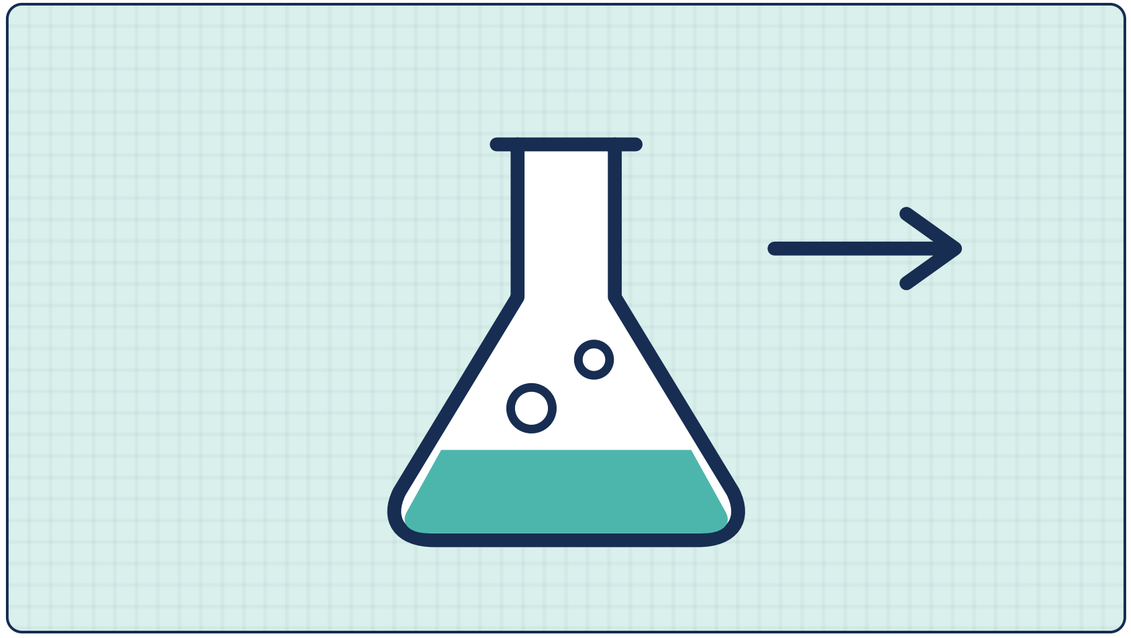
Chemistry · Writing, balancing and classifying reactions

Chemical Reactions and Equations



Goals

By the end of this lesson you can

- Spot the signs of a chemical reaction
- Write and balance a chemical equation
- Name the four main types of reactions
- Tell exothermic from endothermic reactions
- Explain oxidation, reduction, corrosion and rancidity

What is a chemical reaction?

- Starting substances (reactants) change into new substances (products)
- Products have different properties from the reactants
- Atoms are rearranged; no atom is created or destroyed
- Examples: milk souring, food cooking, iron rusting

Signs that a reaction has happened

- A change of colour
- A gas is given off (bubbles or fizzing)
- The mixture gets hotter or colder
- A change of state, or a solid (precipitate) appears

From words to a chemical equation

- Word equation: magnesium + oxygen → magnesium oxide
- Replace names with formulas: $Mg + O_2 \rightarrow MgO$
- Reactants go on the left, products on the right
- The arrow means 'forms' or 'changes into'

Why equations must be balanced

- Law of conservation of mass: mass is neither created nor destroyed
- Each element needs the same number of atoms on both sides
- Balance with coefficients (numbers in front of formulas)
- Never change the subscripts inside a formula

Worked example

Balancing the burning of methane (natural gas)

- Skeleton equation: $CH_4 + O_2 \rightarrow CO_2 + H_2O$
- Carbon: one on each side, already balanced
- Hydrogen: 4 on the left, so write $2H_2O$
- Oxygen: now 4 on the right, so write $2O_2$
- Balanced: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Making equations more informative

- State symbols: (s) solid, (l) liquid, (g) gas
- (aq) means dissolved in water, an aqueous solution
- Conditions go above or below the arrow: heat, light, catalyst
- Example: $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

Combination and decomposition

Combination

- Two or more reactants form one product
- $CaO + H_2O \rightarrow Ca(OH)_2$ (slaked lime)
- Gives out a lot of heat
- Slaked lime is used to whitewash walls

Decomposition

- One reactant breaks into simpler products
- $CaCO_3 \rightarrow CaO + CO_2$ on heating
- Needs energy: heat, light or electricity
- Used to make quicklime from limestone

Three ways to break a compound down

- Heat (thermal): $2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$
- Electricity (electrolysis): $2H_2O \rightarrow 2H_2 + O_2$
- Light (photolysis): $2AgCl \rightarrow 2Ag + Cl_2$
- White silver chloride turns grey in sunlight

Displacement and double displacement

Displacement

- A more reactive metal pushes out a less reactive one
- $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
- Blue solution fades; iron gets a brown copper coat

Double displacement

- Two compounds swap their ions
- $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$
- White $BaSO_4$ precipitate forms

Exothermic and endothermic reactions

Exothermic

- Release heat to the surroundings
- Burning natural gas or LPG
- Respiration in our cells
- Quicklime reacting with water

Endothermic

- Absorb energy from the surroundings
- Heating limestone to make quicklime
- Electrolysis of water
- Silver chloride splitting in sunlight

Oxidation and reduction

- Oxidation: a substance gains oxygen or loses hydrogen
- Reduction: a substance loses oxygen or gains hydrogen
- $CuO + H_2 \rightarrow Cu + H_2O$
- Here CuO is reduced and H_2 is oxidised
- Both happen together: a redox reaction

Worked example

Oxidation at home: corrosion and rancidity

- An iron gate rusts faster in damp, humid weather
- Silver jewellery and cutlery slowly turn black
- Copper vessels develop a green coating
- Old crisps and cooking oil smell and taste stale (rancid)
- Crisp (chip) packets are filled with nitrogen to slow rancidity

Quick check

In $CuO + H_2 \rightarrow Cu + H_2O$, which substance is oxidised?

A. CuO

B. H_2

C. Cu

D. H_2O

Summary

Key takeaways

1. Reactions rearrange atoms into new substances
2. Balanced equations obey conservation of mass
3. Four types: combination, decomposition, displacement, double displacement
4. Reactions either release heat or absorb energy
5. Oxidation and reduction always happen together