

LESSON SLIDES

Chemical Reactions and Equations

Chemistry · Writing, balancing and classifying reactions

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: $\text{Mg} + \text{O}_2 \rightarrow \text{MgO}$
- 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

 Example

Balancing the burning of methane (natural gas)

- 1 Skeleton equation: $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- 2 Carbon: one on each side, already balanced
- 3 Hydrogen: 4 on the left, so write $2\text{H}_2\text{O}$
- 4 Oxygen: now 4 on the right, so write 2O_2
- 5 Balanced: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

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: $\text{Zn(s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{H}_2\text{(g)}$

Combination and decomposition

Combination

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

Decomposition

- One reactant breaks into simpler products
- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ on heating
- Needs energy: heat, light or electricity
- Used to make quicklime from limestone

Three ways to break a compound down

- Heat (thermal): $2\text{FeSO}_4 \rightarrow \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$
- Electricity (electrolysis): $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$
- Light (photolysis): $2\text{AgCl} \rightarrow 2\text{Ag} + \text{Cl}_2$
- White silver chloride turns grey in sunlight

Displacement and double displacement

Displacement

- A more reactive metal pushes out a less reactive one
- $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$
- Blue solution fades; iron gets a brown copper coat

Double displacement

- Two compounds swap their ions
- $\text{Na}_2\text{SO}_4 + \text{BaCl}_2 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$
- 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
- $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$
- Here CuO is reduced and H₂ is oxidised
- Both happen together: a redox reaction

 Example

Oxidation at home: corrosion and rancidity

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

 Quick check

In $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$, which substance is oxidised?

A CuO

B H_2

C Cu

D H_2O

Key takeaways

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