Science 10

Unit A: Energy and matter in chemical change

Predicting products and balancing

Predicting products

- Iron placed in copper(II) sulfate solution can form iron(II) sulfate and solid copper because iron is above copper in the activity series.
- The prediction tells the chemist what colour, solid product, and hazards to expect before mixing substances.
- After predicting correct formulas, coefficients are adjusted so every element has the same atom count on both sides.

Products and solubility

- Because iron is above copper in the activity series, the prediction is $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$.
- For two aqueous ionic compounds, exchange the ions and check the solubility chart.
- Write a precipitate only when a product is relatively insoluble.
- For complete hydrocarbon combustion, predict carbon dioxide and water, then balance carbon, hydrogen, and oxygen.

Key terms

activity series

A ranking used to predict whether one element can replace another in a reaction.

solubility

Maximum amount of a substance that dissolves under stated conditions.

complete combustion

Combustion with sufficient oxygen that produces carbon dioxide and water for a hydrocarbon fuel.

Synthesis and decomposition

- Synthesis has several reactants and one product; establish the product formula before balancing.
- Decomposition has one reactant and multiple products; use the taught reaction family or supplied conditions to identify products.
- Atom counts verify a completed prediction; product identity comes from the reaction pattern.

Synthesis and decomposition

Synthesis: A + B ⟶ AB

Decomposition: AB ⟶ A + B

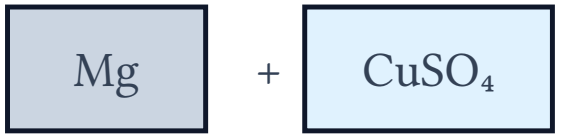
Name the product formula, then balance coefficients

Single replacement

- A free metal replaces a metal ion only when the activity series places the free metal higher.
- Magnesium is above copper, so Mg + $CuSO_4$ ⟶ $MgSO_4$ + Cu is supported.
- Copper is below magnesium, so Cu + $MgSO_4$ is recorded as no reaction under the stated conditions.

Single replacement

Mg + $CuSO_4$ ⟶ $MgSO_4$ + Cu



Mg is higher on the activity series than Cu

Double replacement and combustion

- Double replacement: exchange ions, write charge-balanced formulas, then use the solubility chart to decide whether a precipitate supports reaction.
- Complete hydrocarbon combustion: predict CO_2 and H_2O, then balance carbon, hydrogen, and oxygen in that order.
- These pathways use different evidence and should be checked in separate panels.

Synthesis: $A + B \longrightarrow AB$

Decomposition: $AB \longrightarrow A + B$

Single replacement: $A + BC \longrightarrow AC + B$

Double replacement: $AB + CD \longrightarrow AD + CB$

Combustion (hydrocarbon): $C_xH_y + O_2 \longrightarrow CO_2 + H_2O$

Full workflow

- Classify Mg + $AgNO_3$ as possible single replacement, then use the activity series to test the prediction.
- Write $Mg(NO_3)_2$ and Ag from ion identity and charge balance before adding coefficients.
- Balance and verify: $Mg + 2AgNO_3 \longrightarrow Mg(NO_3)_2 + 2Ag$.

Four prediction stations

- Station 1: synthesis and decomposition: identify the family, establish products, then balance.
- Station 2: single replacement: include one supported reaction and one no-reaction decision.
- Stations 3 and 4: double replacement with chart evidence, then complete hydrocarbon combustion.

Product-prediction retrieval check

- Predict and balance the products for magnesium reacting with oxygen.
- Use the activity series to decide whether copper replaces zinc in zinc sulfate.
- For sodium chloride mixed with silver nitrate, predict products and identify any precipitate.