Science 10

Unit A: Energy and matter in chemical change

Word equations and balancing

Lavoisier and the balance

- In a closed system, total mass before a chemical reaction equals total mass after, within measurement uncertainty.
- Atoms are rearranged during a reaction. None are created or destroyed.



Same atoms: rearranged, not created or destroyed

aw of conservation of mass ↔ balanced equations ↔ mole ratio

Mass in a closed system

- A closed system keeps all of its matter inside its boundary.
- Its measured mass stays constant during a chemical reaction, within the precision of the balance.
- Lavoisier compared masses before and after reactions in closed containers.

Key terms

reactant

A starting substance in a chemical reaction; written on the left side of an equation.

product

A substance formed in a chemical reaction; written on the right side of an equation.

coefficient

A whole number placed before a formula that multiplies every atom in that formula.

subscript

A number within a chemical formula that states the fixed atom ratio in that substance.

Key terms

conservation of mass

In a closed system, total mass remains constant during physical and chemical changes.

Word equations

- A word equation names substances: methane + oxygen ⟶ carbon dioxide + water.
- A skeleton equation uses correct formulas and states: $CH_4(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(g)$.

Word and skeleton equations

Words: methane + oxygen ⟶ CO_2 + water

$CH_4(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(g)$

Skeleton uses formulas and state symbols

Skeleton and balanced equations

- Keep every chemical formula fixed.
- Choose whole-number coefficients so each element has the same atom count on both sides.

Unbalanced:

$H_2 + O_2 \longrightarrow H_2O$

H: 2 = 2 ✓ · O: 2 ≠ 1 ×

Balanced:

$2\ H_2 + O_2 \longrightarrow 2\ H_2O$

H: 4 = 4 · O: 2 = 2

Coefficients multiply entire formulas: never change subscrip

Combustion of propane

- Skeleton: $C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$.
- Balanced: $C_3H_8 + 5\ O_2 \longrightarrow 3\ CO_2 + 4\ H_2O$.
- Balance carbon first, then hydrogen, then oxygen, and recount every element.

Unbalanced:

$H_2 + O_2 \longrightarrow H_2O$

H: 2 = 2 ✓ · O: 2 ≠ 1 ×

Balanced:

$2\ H_2 + O_2 \longrightarrow 2\ H_2O$

H: 4 = 4 · O: 2 = 2

Coefficients multiply entire formulas: never change subscrip

Practice set

- Synthesis: $Mg + O_2 \longrightarrow MgO$.
- Single replacement: $Zn + HCl \longrightarrow ZnCl_2 + H_2$.
- Double replacement: $NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$.

Unbalanced:

$H_2 + O_2 \longrightarrow H_2O$

H: 2 = 2 ✓ · O: 2 ≠ 1 ×

Balanced:

$2\ H_2 + O_2 \longrightarrow 2\ H_2O$

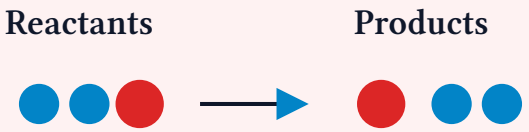
H: 4 = 4 · O: 2 = 2

Coefficients multiply entire formulas: never change subscrip

Safety

Lab conservation demo

- Measure a sealed flask before and after an effervescent reaction at room temperature.
- Keep a reacting sealed container closed and away from heat; follow the teacher's procedure.



Same atoms: rearranged, not created or destroyed

aw of conservation of mass ↔ balanced equations ↔ mole ratio

Review

- Translate: hydrogen + oxygen ⟶ water.
- Balance the skeleton equation and verify both atom counts.
- Count the atoms of each element on both sides before you call the equation balanced.

Unbalanced:

$H_2 + O_2 \longrightarrow H_2O$

H: 2 = 2 ✓ · O: 2 ≠ 1 ×

Balanced:

$2\ H_2 + O_2 \longrightarrow 2\ H_2O$

H: 4 = 4 · O: 2 = 2

Coefficients multiply entire formulas: never change subscrip

Industrial equations

- Electrolysis: $2\ H_2O(l) \longrightarrow 2\ H_2(g) + O_2(g)$.
- The coefficients show twice as many hydrogen molecules as oxygen molecules.
- Industrial decisions also consider electricity source, gas storage, cost, and worker safety.

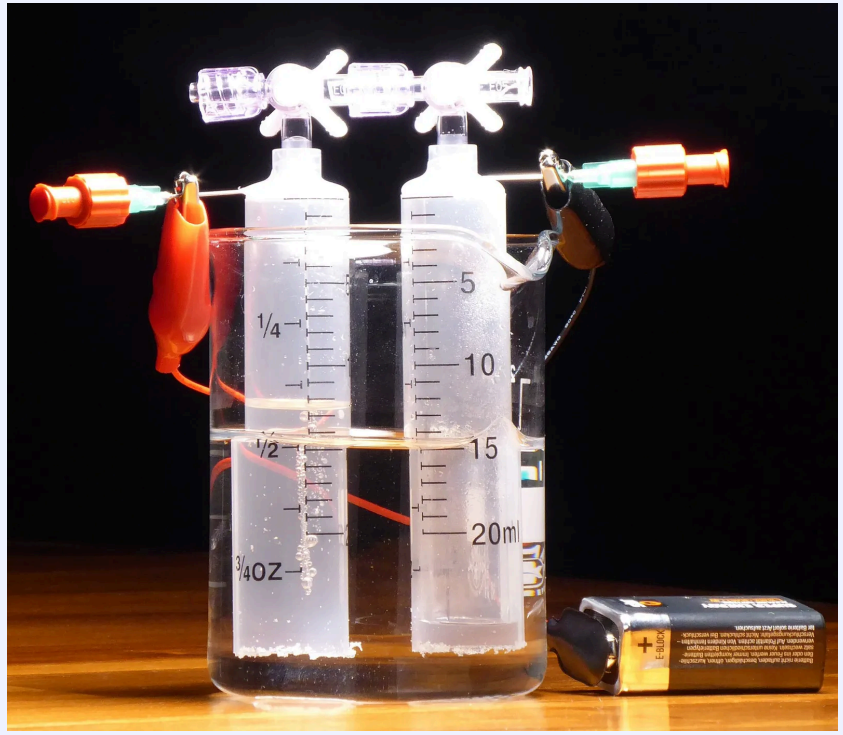


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