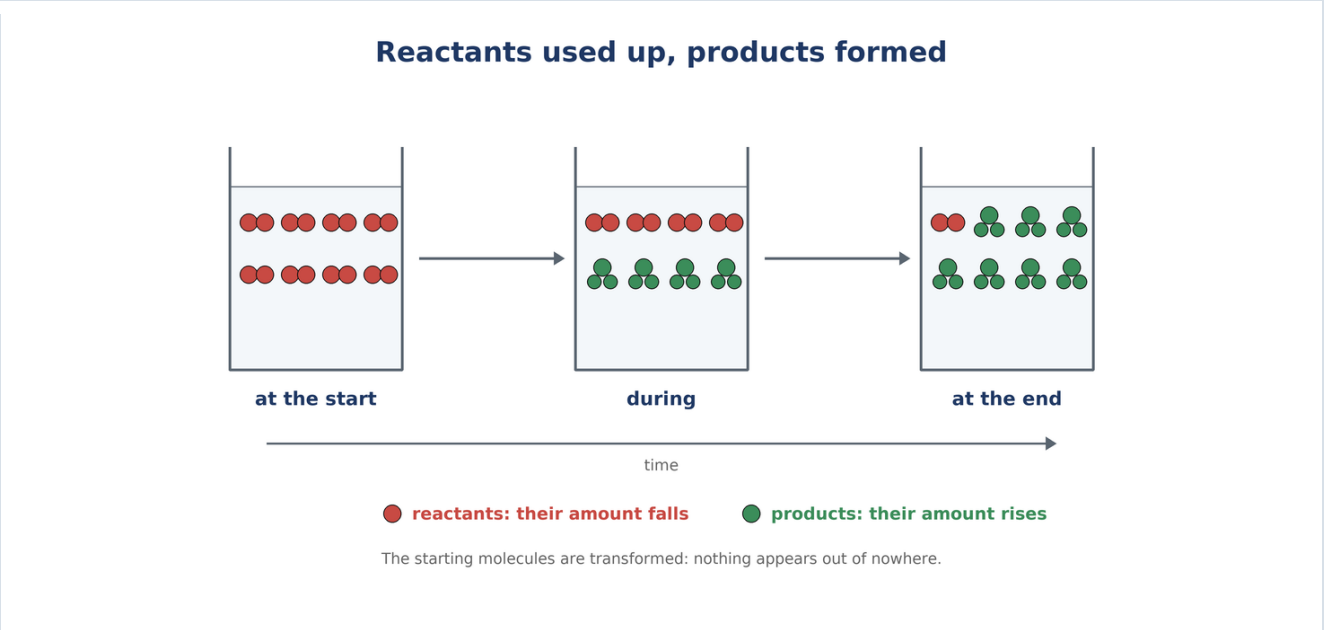
Chemical reactions

Printable revision sheet — Galaxscia

LEVEL 1

What happens during a reaction



Example :

Methane reacts with oxygen to form carbon dioxide and water.

Methane + Oxygen → Carbon dioxide + Water

In this reaction the amounts of methane and oxygen fall as the reaction goes on, because each reacts with the other and is transformed. Conversely the amounts of carbon dioxide and water rise, because the reaction makes them.

Note: the reactants are always on the left of the arrow and the products on the right.

Key points — revision questions

What are reactants?

What are products?

What happens to the amounts of each species in a reaction?

LEVEL 2

From the word equation to the chemical equation

The **word equation** can be turned into a **chemical equation** by replacing each species with its **chemical formula.**

Example : Word equation:

$$\text{Methane} + \text{Oxygen} \rightarrow \text{Carbon dioxide} + \text{Water}$$

Chemical equation:

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

The **physical state** can be shown: (s) solid, (l) liquid, (g) gas, (aq) dissolved in water, after each formula (if needed)

Examples :

$CH_4\,(g) + O_2(g) \rightarrow CO_2\,(g) + H_2O\,(g)$

$HCl\,(aq) + NaOH\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l)$

Key points — revision questions

How do you go from the word equation to the chemical equation?

What are the symbols (s), (l), (g), (aq) for?

LEVEL 3

Lavoisier's law

"Nothing is lost, nothing is created, everything is transformed"

All the matter present at the start of the reaction is still there at the end of the reaction.

For this to hold, the atoms in the molecules must not disappear during chemical reactions. So the number of atoms of each kind **must be the same** before and after the reaction. This is the **conservation of atoms**

So in some reactions several identical molecules react at the same time, or several identical molecules are produced.To show this we **balance** the chemical equation

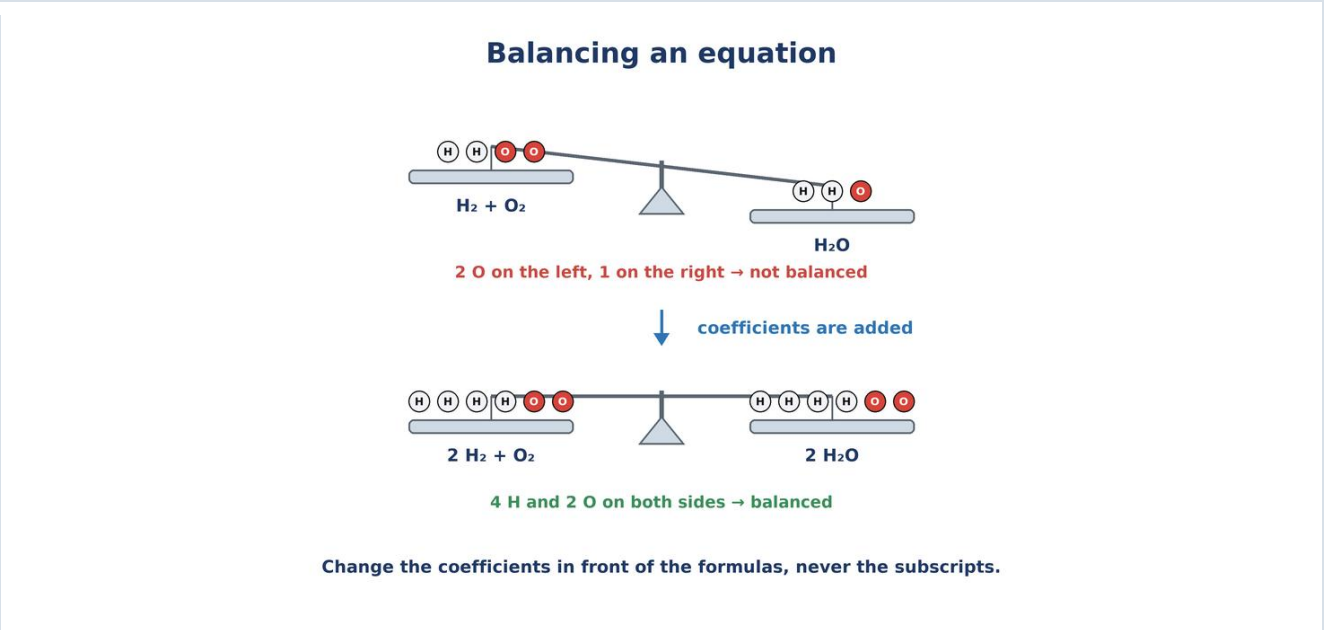
How do you balance an equation?

Count the atoms on both sides.

Add **coefficients** in front of the formulas of the molecules.

Never change the **subscripts** inside the formulas.

Check, and simplify if possible.



Other examples:

Combustion of hydrogen

Hydrogen reacts with oxygen to form water.

$H_2 + O_2 \rightarrow H_2O$ (not balanced: 2 H and 2 O ==> 2 H and 1 O)

$2\ H_2 + O_2 \rightarrow 2\ H_2O$ (balanced: 2 H and 2 O ==> 2 H and 2 O The conservation of atoms is respected.)

Sodium reacts with chlorine to form sodium chloride

$Na + Cl_2 \rightarrow NaCl$ (not balanced: 1 Na and 2 Cl ==> 1 Na and 1 Cl)

$2\ Na + Cl_2 \rightarrow 2\ NaCl$ (balanced: 2 Na and 2 Cl ==> 2 Na and 2 Cl The conservation of atoms is respected.)

The link with mass

When a chemical reaction takes place:

Reactants → Products

The stoichiometric coefficients show the proportions in which the substances react or are formed.

However the mass of the reactants that have reacted **must be equal** to the mass of the products (Lavoisier's law)

Example : Combustion of carbon: $C + O_2 \rightarrow CO_2$

Coefficients: $1\ C + 1\ O_2 \rightarrow 1\ CO_2$

shows that one carbon atom reacts with 1 molecule of O_2 and forms 1 molecule of CO_2

Mass: 12 g of carbon + 32 g of oxygen → 44 g of carbon dioxide

The masses differ from one molecule to another, because the molecules are different.

But **the total mass of the reactants and of the products is the same**

Key points — revision questions

What does Lavoisier's law say?

What happens to the number of atoms during a reaction?

What are the numbers placed in front of the formulas in an equation called?

How do you balance an equation?

How does the mass change during a reaction?

LEVEL 4

On the microscopic scale

A chemical reaction is a **rearrangement of the atoms**: bonds break and new ones form. The atoms themselves do not disappear.

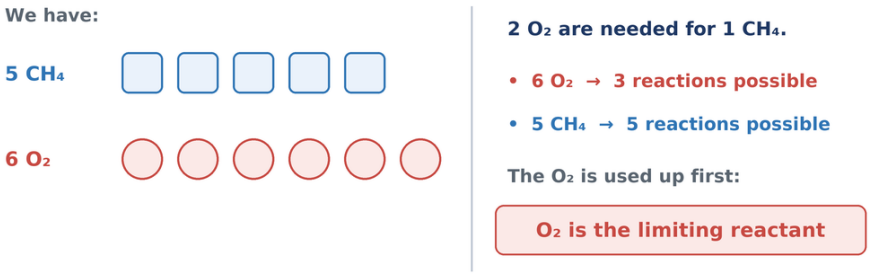
The limiting reactant

The **limiting reactant** is the one that is used up first and that stops the reaction going any further.

Example : Combustion of methane $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$, if we have 5 CH_4 and only 6 O_2, the reaction can only happen 3 times: O_2 is the **limiting** reactant.

The limiting reactant

$CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O$



The limiting reactant is the one used up first: it stops the reaction.

Conditions for a reaction

The reactants must be in **contact**.

Energy sometimes has to be supplied (heat, a spark).

A **catalyst** can speed the reaction up without being used up.

Key points — revision questions

What happens on the microscopic scale during a chemical reaction?

What is a **limiting reactant**?

What conditions are needed for a chemical reaction to take place?