Physical and chemical transformations

Printable revision sheet — Galaxscia

LEVEL 1

What is a transformation?

A **transformation** is the passage of a system from an *initial state* to a *final state*. By "state" we mean all the observable characteristics of an object:

its temperature (hot, cold),

its position (up, down),

its volume (large, small),

its mass (heavy, light),

its shape (round, square),

its physical state (solid, liquid, gas).

Example : An ice cube melting, water warming up, or a ball moving are all transformations.

The two main families of transformation

Physical transformation

A **physical transformation** is a transformation that **does not change the nature of the matter**. The molecules and atoms stay the same, only the appearance changes.

Examples :

Ice melting: solid H2O → liquid H2O

Salt dissolving in water: the salt is still there, dissolved in the water

The air in a balloon expanding when heated

Chemical transformation

A **chemical transformation** is a transformation that **changes the nature of the matter**. The molecules of the reactants disappear and new molecules (the products) appear.

Examples :

Paper burning: paper + oxygen → ash + smoke

Cooking an egg: the proteins change structure permanently

Rust: iron + oxygen → iron oxide

How to tell them apart

Can you easily go back? Yes → probably physical / No → probably chemical

Do new substances appear? Yes → chemical / No → physical

Key points — revision questions

What is a transformation?

What are the two main families of transformation?

What happens at the level of the molecules during a physical transformation?

What happens at the level of the molecules during a chemical transformation?

How exactly can a physical transformation be told apart from a chemical one?

Give two examples of each type of transformation.

LEVEL 2

Changes of state (physical)

Changes of state are physical transformations: **melting**, **freezing**, **vaporisation**, **condensation**, **sublimation**. The molecules stay the same; only their arrangement changes. It is therefore **a physical transformation**

Example : Liquid water → water vapour (vaporisation) when water boils.

Dissolving, expansion, deformation

Dissolving: a solid spreads out through a liquid. The solid is still there but scattered (reversible by evaporation). **Expansion / contraction:** a change of volume linked to temperature (rails, thermometers). **Deformation:** the shape is changed (bending, stretching) without changing the nature.

In all these situations, the molecules stay the same; only their arrangement changes. These are **physical transformations.**

Clues of a chemical transformation

Signs that often point to a chemical transformation:

A gas forming: bubbles appear that are not caused by boiling (effervescence).

A solid appearing (a precipitate): a solid forms inside a solution that was clear.

A lasting colour change: the colour changes and does not come back (not to be confused with simply mixing shades).

A large change in temperature: the reaction gives out heat (exothermic) or takes it in (endothermic).

Light being given off: some reactions, such as burning, produce light.

Example : Vinegar + bicarbonate → bubbles (CO_2): a clue of a **chemical transformation** because a new species forms

Key points — revision questions

Why is dissolving considered to be a physical transformation?

Give 3 clues that suggest a chemical transformation.

Are physical transformations generally reversible?

LEVEL 3

Writing a chemical equation

During a chemical transformation, the starting species — the **reactants** — turn into new species — the **products**. This transformation is summed up by an **equation of reaction**:

reactants ⟶ products

Conservation of atoms

During a chemical reaction, atoms are neither created nor destroyed: they are **rearranged**. There must therefore be **as many atoms of each kind** on the reactant side as on the product side. This is the **conservation of atoms** (and therefore of mass).

Example — burning carbon:

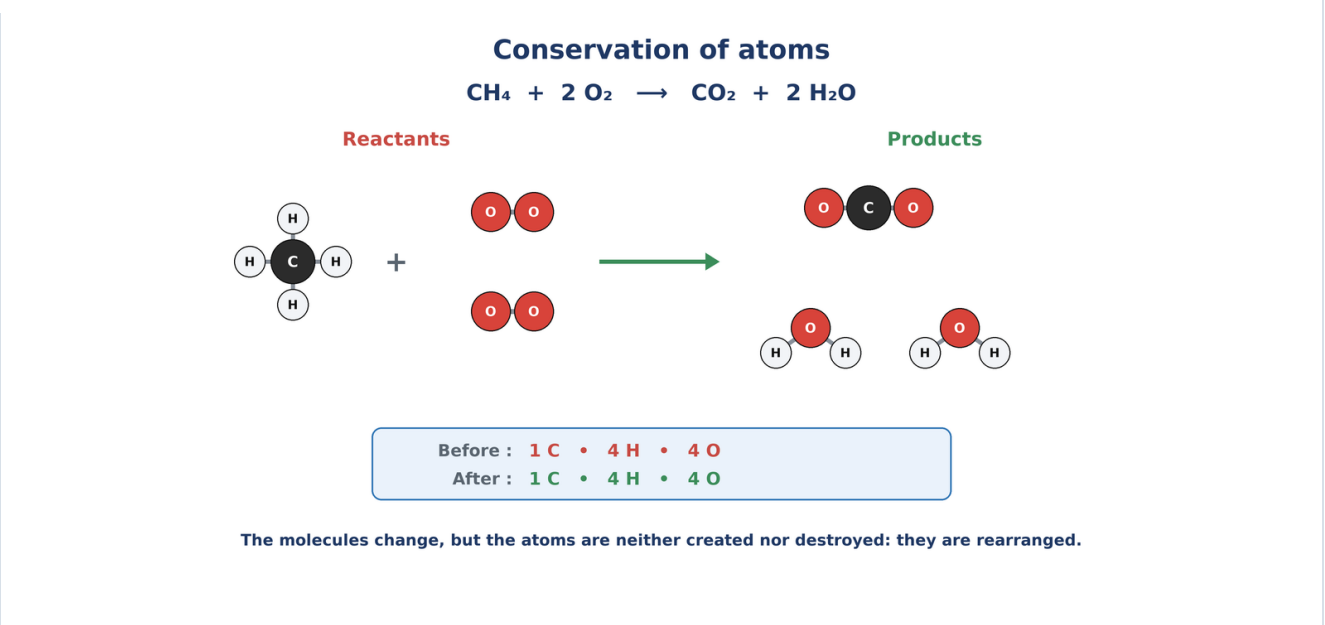
$$C + O_2 \longrightarrow CO_2$$

Reactants: 1 carbon atom (C) and 2 oxygen atoms (O_2).

Product: 1 molecule of CO_2, that is 1 carbon atom and 2 oxygen atoms.

The count is the same on both sides: the equation is balanced.

When the count does not balance, **numbers (coefficients)** are placed in front of the formulas to restore the equality. Example: burning methane, $CH_4 + 2\ O_2 \longrightarrow CO_2 + 2\ H_2O$.



Key points — revision questions

What are the starting species and the species formed in a chemical reaction called?

What is conserved during a chemical transformation?

Why must there be as many atoms of each kind before and after the reaction?

What is placed in front of the formulas to balance an equation of reaction?