

Changes of state

Printable revision sheet — Galaxscia

LEVEL 1

What is a change of state?

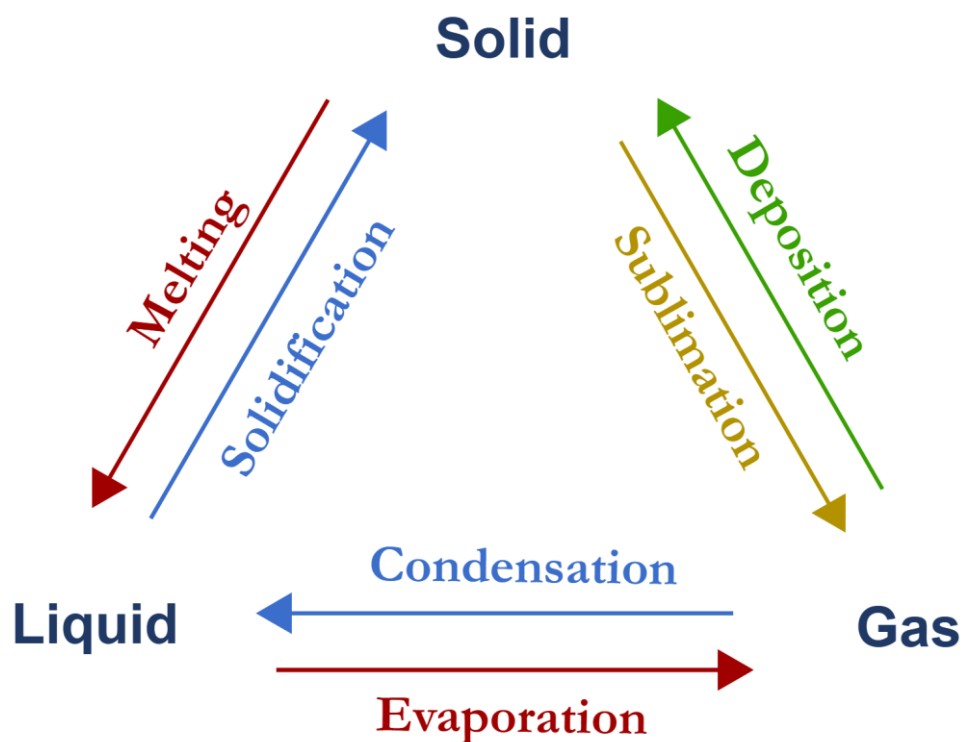
Matter exists in three states: solid, liquid and gaseous.

When it passes from one state to another, we speak of a change of state.

Examples:

- An ice cube melting goes from the solid state to the liquid state; this is melting (fusion)
- Water boiling goes from the liquid state to the gaseous state; this is vaporisation
- Mist on a cold window is water going from the gaseous state to the liquid state; this is condensation

The 6 changes of state



The six changes of state

Change-of-state temperatures

Each transformation takes place at one precise temperature, called the change-of-state temperature.

Example with pure water:

- At 0 °C: solid ↔ liquid
- At 100 °C: liquid ↔ gas

The melting temperature is the same as the freezing temperature: 0 °C

Measuring the temperature: the plateau

You can measure these temperatures yourself with a thermometer. You heat (or cool) a substance and record its temperature over time.

A surprising observation: throughout the whole change of state, the temperature stops moving! For example, as long as there is still ice melting, the water + ice mixture stays stuck at 0 °C. This "pause" in the temperature is called a plateau.

The temperature only starts rising again once all the solid has melted. The plateau is therefore the sign that a change of state is taking place.

Key points — revision questions

- Name all the changes of state.
- Which quantity does a change of state depend on?
- What is the melting temperature of pure water? And the freezing temperature?
- What is the condensation temperature of pure water? And the vaporisation temperature?
- What is a temperature plateau? What happens to the temperature during a change of state?

LEVEL 2

Characteristic temperatures

Each material changes state at its own temperatures. They are like "thermal fingerprints"!

Material	Melting / Freezing	Vaporisation / Condensation	State at 20 °C
Water	0 °C	100 °C	Liquid
Vinegar	-17 °C	118 °C	Liquid
Aluminium	660 °C	2470 °C	Solid
Oxygen	-219 °C	-183 °C	Gas

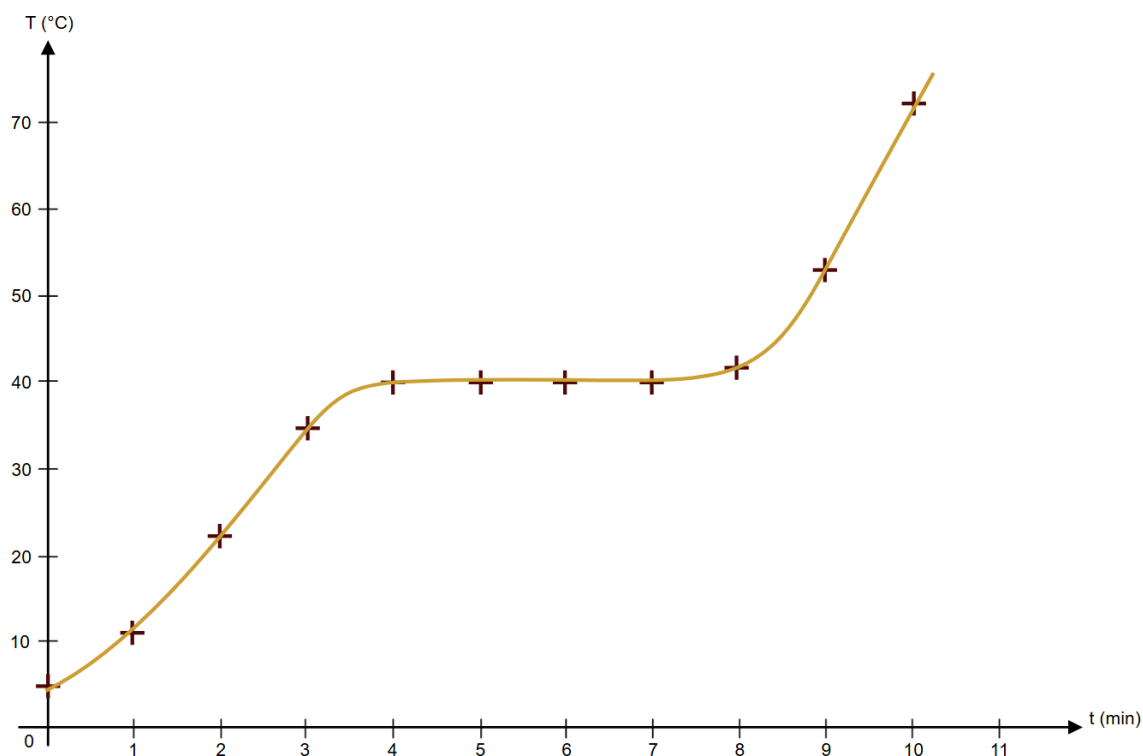
Reading the table at 20 °C: water and vinegar are liquid, aluminium is solid and oxygen is gaseous.

Reading and describing a temperature curve

To study a change of state, we record the temperature minute by minute and obtain a curve.

The temperature can:

- Rise / increase: the points get higher and higher. The curve then goes up.
- Stay constant: the points are all at the same level. The curve is flat.
- Fall / decrease: the points get lower and lower. The curve then goes down.



Printable version of the animation: how the temperature changes over time

Let us take the example of an unknown solid being heated. Here is a description of the curve:

1. Phase 1: the temperature rises from 5°C to 40°C
2. Phase 2: the temperature stays constant at 40°C (this is the change of state)
3. Phase 3: the temperature rises again up to 70°C

The flat part is the temperature plateau. It shows when and at what temperature the change of state happens.

Here the change of state therefore takes place at 40°C .

Key points — revision questions

- Why can a chemical species be identified from its change-of-state temperature?
- What is a temperature plateau? What does it show?
- What vocabulary is used to describe a curve?

LEVEL 3

Analysing a graph

Analysing a graph means looking for information about the material being studied. Three different pieces of information can be taken from a change-of-state curve:

Analysis 1: change-of-state temperature

Spotted from the temperature plateau. You can find the temperature at which the substance changes state.

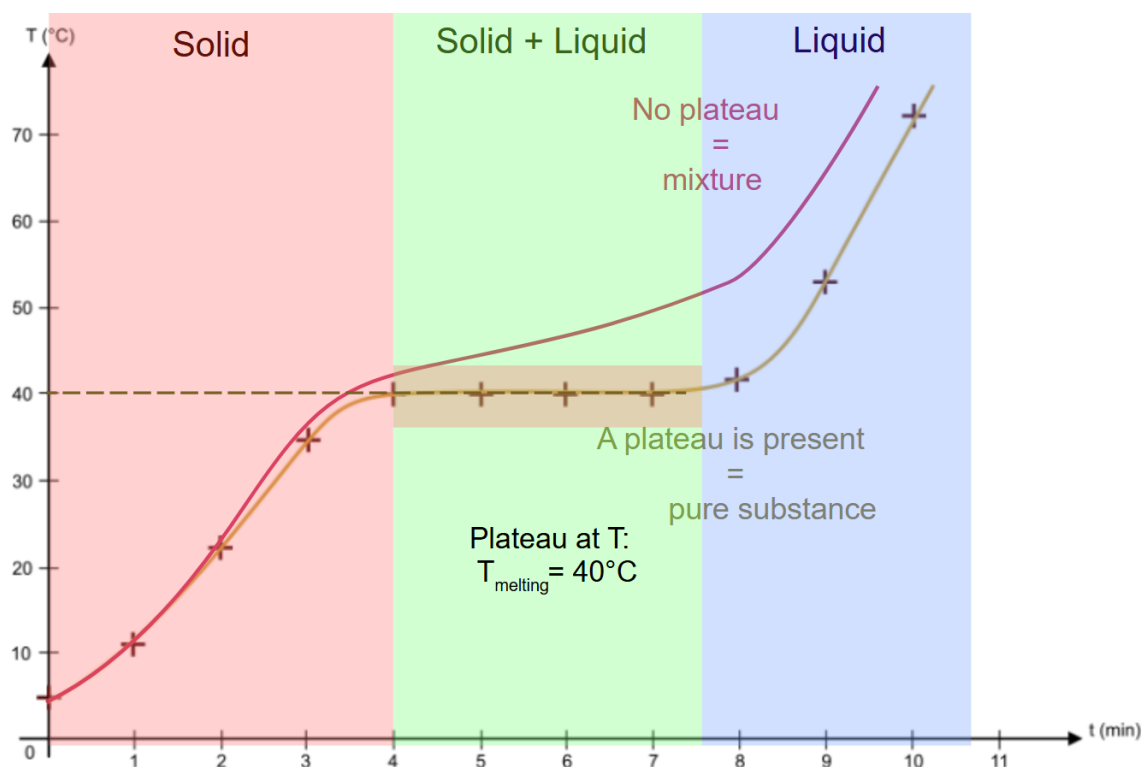
Analysis 2: state of the matter

- Before the plateau → a single state, the initial state
- During the plateau → two states exist together
- After the plateau → a new state, the final state

Analysis 3: purity of the substance

- Pure substance → a clear, horizontal plateau
- Mixture → no clear plateau, a gentle slope

Example: analysing the melting curve of a solid.



Printable version of the interactive analysis: states of matter, plateau and purity

Key points — revision questions

- What are the 3 things that can be deduced from a temperature curve?
- How can a pure substance be told apart from a mixture using the curve?
- How do you spot the temperature plateau?
- At what moment do 2 states exist together?

LEVEL 4

What heat does to the molecules

When a material is heated, thermal energy is supplied to it.

This energy is absorbed by the molecules, which:

1. Move about more and more
2. Break their bonds
3. Become less organised

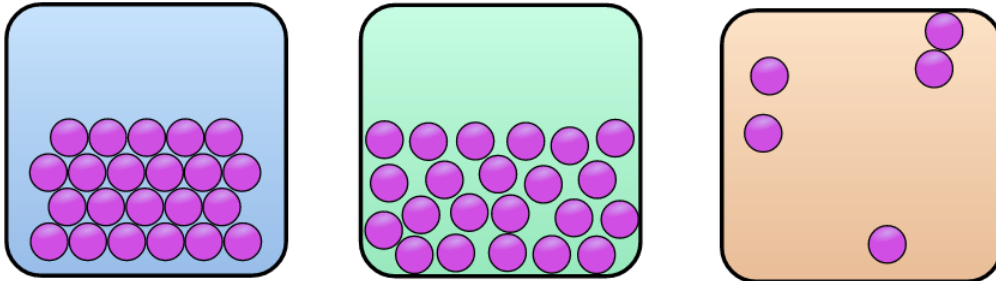
This is how a solid becomes a liquid, then a gas.

The other way round...

When it is cooled:

- The molecules lose energy
- They slow down and can form bonds again.
- They move closer together and become better organised

Heating → solid → liquid → gas



Arrangement of the molecules in the three states of matter

Cooling ← solid ← liquid ← gas

We can see that a change of state only changes the arrangement and the movement of the molecules. The nature of the molecules does not change, so it is a physical transformation (see transformations)

Key points — revision questions

- What does a rise in temperature cause?
- What does cooling cause?
- What causes changes of state?
- Why is a change of state a physical transformation?