Edexcel GCSE Chemistry

Your notes

States of Matter

Contents

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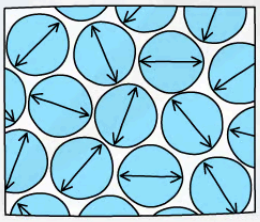
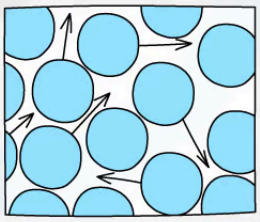
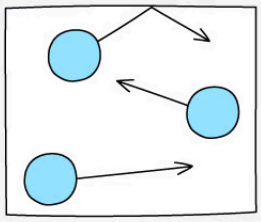
The Three States of Matter

- The three states of matter are **solids**, **liquids** and **gases**
- A substance can usually exist in all three states, dependent on temperature (and pressure)
- State changes occur at the **melting point** (solid to liquid, liquid to solid) and at the **boiling point** (liquid to gas and gas to liquid)
  - Melting and freezing occur at the melting point
  - Boiling and condensing take place at the boiling point
- Individual atoms themselves do not share the same properties as bulk matter
- The three states of matter can be represented by a simple model
  - In this model, the particles are represented by small solid spheres

Summary of the Properties of Solids, Liquids and Gases

State	Solid	Liquid	Gas
Density	High	Medium	Low
Arrangement of particles	Regular pattern	Randomly arranged	Randomly arranged
Movement of particles	Vibrate around a fixed position	Move around each other	Move quickly in all directions
Energy of particles	Low energy	Greater energy	Highest energy
2D diagram			

Interconversions

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- The amount of energy needed to change state from solid to liquid and from liquid to gas depends on the strength of the forces between the particles
  - The stronger the forces of attraction, the more energy that is needed to overcome them for a state change to occur
  - Therefore, the stronger the forces between the particles the higher the melting point and boiling point of the substance
- When matter changes from one state to another due to changes in temperature or pressure, the change is called an **interconversion** of **state**
- It is a **physical change** involving changes in the **forces** between the particles of the substances, the particles themselves remain the **same**, as do the chemical properties of the substance
- Physical changes are relatively easy to reverse as no new substance is formed during interconversions of state
- The interconversions have specific terms to describe them:

A Summary of State Changes

Interconversion	Change
Melting	Solid to a liquid
Boiling	Liquid to a gas (from below surface as well as at surface)
Freezing	Liquid to a solid
Evaporation	Liquid to a gas (at surface only)
Condensation	Gas to a liquid
Sublimation	Solid to a gas

Melting

- Melting is when a solid changes into a liquid
- The process requires heat energy which transforms into **kinetic** energy, allowing the particles to move
- It occurs at a specific temperature known as the **melting point** which is **unique** to each pure solid

Boiling

- Boiling is when a liquid changes into a gas
- This requires heat which causes bubbles of gas to form **below** the surface of a liquid, allowing for liquid particles to escape from the surface and from within the liquid
- It occurs at a specific temperature known as the **boiling point** which is **unique** to each pure liquid

Freezing

- Freezing is when a liquid changes into a solid
- This is the reverse of melting and occurs at exactly the **same temperature** as melting, hence the melting point and freezing point of a pure substance are the same
    - Water for example freezes and melts at 0 °C
- It requires a significant decrease in temperature (or loss of thermal energy) and occurs at a specific temperature which is **unique** for each pure substance

Evaporation

- When a liquid changes into a gas
- Evaporation occurs only at the **surface** of liquids where high energy particles can escape from the liquids surface at **low** temperatures, below the boiling point of the liquid
- The larger the surface area and the warmer the liquid/surface, the more quickly a liquid can evaporate
- Evaporation occurs over a **range** of temperatures, but heating will speed up the process as particles need energy to escape from the surface

Condensation

- When a gas changes into a liquid, usually on cooling
- When a gas is cooled its particles lose energy and when they bump into each other, they lack energy to bounce away again, instead grouping together to form a liquid

Sublimation

- When a solid changes directly into a gas


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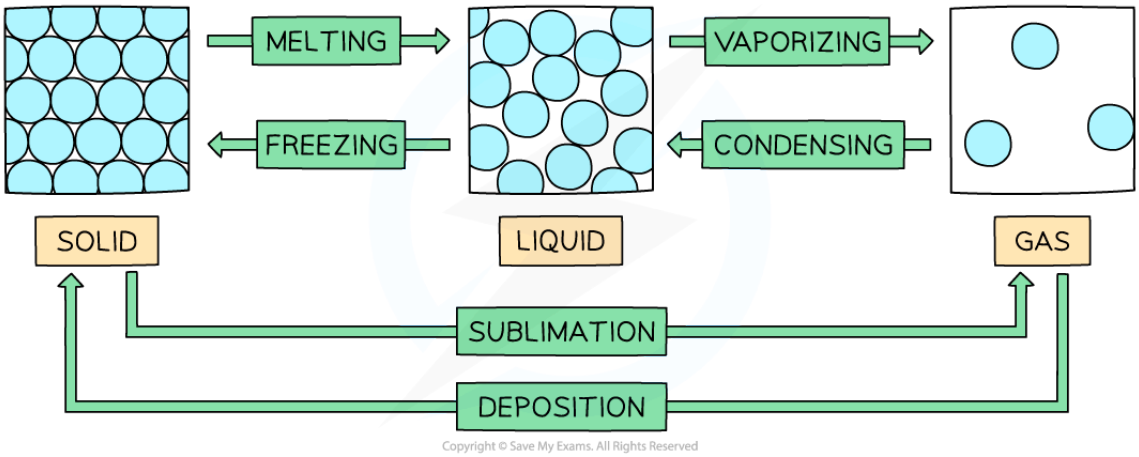
- This happens to only a few solids, such as iodine or solid carbon dioxide
- The reverse reaction also happens and is called desublimation or deposition



Interconversion between the three states of matter

Examiner Tips and Tricks

Solids, liquids and gases have different physical properties. The difference in these properties comes from differences in how the particles are arranged in each state.

Predicting Physical State

- The physical state of a substance under certain conditions can be predicted from a given set of data.
- Normally you are given **melting** and **boiling** point data for a substance and asked to predict its physical state in specified conditions.
- At temperatures **below** the **melting** point:
  - The substance is will be in the **solid** state
- At temperatures **above** the **melting** point but **below** the **boiling** point:
  - The substance will be in the **liquid** state
- At temperatures **above** the **boiling** point:
  - The substance will be in the **gaseous** state.

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Worked Example

Predicting the state

The table below indicates melting and boiling point data for four different substances named A, B, C and D. Predict the states of the following substances:

- Substance A at -150 °C
- Substance B at 50 °C
- Substance C at 1400 °C
- Substance D at 400 °C

Melting & Boiling Points Table

Substance	Melting point / °C	Boiling point / °C
A	−215.6	−173
B	1736	2800
C	1105	1450
D	650	1560

Answer

- A boils at temperatures above -173 °C so at -150 °C A is a **gas**
- B melts at 1736 °C so at 50 °C it is a **solid**
- C melts at 1105 °C and boils at 1450 °C so at 1400 °C it is a **liquid**
- D melts at 650 °C so at 400 °C it is a **solid**