Pure substances

4.8.1.1 · Chemical analysis · revision notes

What 'pure' means in chemistry, and how melting point and boiling point data tell a pure substance from a mixture. Expect short definitions and questions where you interpret melting or boiling temperatures from tables or heating curves.

Key facts

- Pure substance = a single element or compound, not mixed with any other substance
- Pure substance: melts and boils at a specific temperature
- Impurities lower the melting point and widen the melting range
- Pure water: melts at 0 °C, boils at 100 °C
- Everyday 'pure' = nothing added, natural state (it can still be a mixture)
- Mixture: melts and boils over a range of temperatures
- Dissolved impurities raise the boiling point
- Heating curve: flat section = pure substance changing state

Notes

What 'pure' means in chemistry

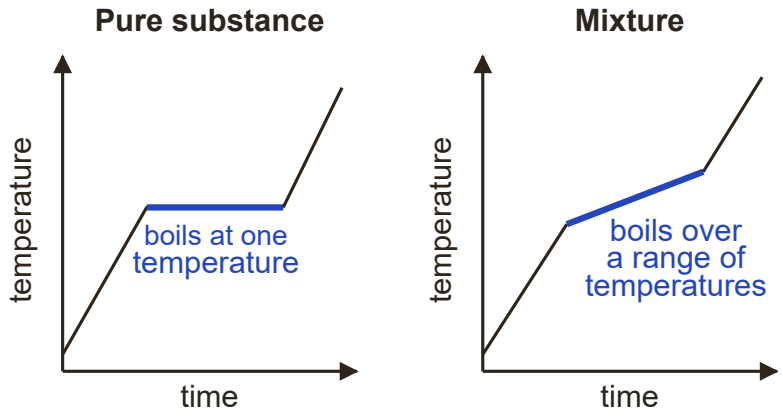
- In chemistry, a **pure substance** is a single element or a single compound, not mixed with any other substance.
- Examples: oxygen, copper, distilled water, sodium chloride. Air, sea water, steel and milk are mixtures, so they are not pure.
- In everyday language, 'pure' means that nothing has been added, so the substance is in its natural state, e.g. 'pure orange juice' or 'pure milk'. These products are still mixtures of many substances.

Using melting and boiling points

- A pure element or compound melts and boils at a **specific temperature**. For example, pure water melts at 0 °C and boils at 100 °C.
- A mixture (an impure substance) melts and boils over a **range of temperatures**.
- Impurities **lower the melting point** and widen the melting range. The more impurity, the lower and wider the range.
- Dissolved impurities **raise the boiling point**. Salty water boils above 100 °C, and its temperature keeps rising as it boils.
- To test purity, measure the melting point or boiling point and compare it with the value for the pure substance.

Reading heating curves

- On a heating curve (temperature against time) for a pure substance, the line is **flat** while it melts or boils: the temperature stays constant.
- For a mixture, the line **slopes** during melting or boiling, because the change of state happens over a range of temperatures.



Pure: flat line while it boils (or melts). Mixture: the line slopes.

- A sharp melting point shows a sample is pure, but it does not prove which substance it is: different compounds can have the same melting point. Grade 7+ only

How to answer each type of question

Define pure, or explain the everyday and chemical meanings 1 to 3 marks Grade 3

1. Use the chemical definition: a single element or compound, not mixed with any other substance.
2. For the everyday meaning, say that nothing has been added / it is in its natural state.
3. Explain why the product is not chemically pure: it contains more than one substance, so it is a mixture.

Example. A bottle of water is labelled 'Pure spring water'.
(a) What does the word 'pure' mean on this label?
(b) Explain why the spring water is **not** pure in the chemical sense.

Model answer.

(a) Nothing has been added to it / it is in its natural state (1)

(b) A pure substance is a single element or compound, not mixed with anything else (1). Spring water contains dissolved substances as well as water, so it is a mixture (1).

Use melting point data to pick out the pure sample

2 marks **Grade 4**

1. Look for the sample that melts at a single, specific temperature.
2. Check that this temperature matches the value given for the pure substance.
3. Give the reason using the data: 'melts at a specific temperature', not 'has a melting point'.

Example. Pure compound Z melts at 114 °C. A student measured the melting temperatures of three samples labelled Z.

Sample	Melting temperature in °C
A	105 to 111
B	114
C	110 to 113

Which sample is pure Z? Give a reason for your answer.

Model answer. Sample B (1). It melts at a specific temperature, 114 °C, which is the melting point of pure Z (1).

Interpret a heating curve

2 marks **Grade 5**

1. Find the part of each curve where the substance is changing state.
2. Flat (constant temperature) means a pure substance; still rising means a mixture.
3. Name the substance and give the reason from the graph.

Example. Two colourless liquids, P and Q, were heated until they boiled.
The temperature of P rose to 82 °C and then stayed at 82 °C for 5 minutes while P boiled.
The temperature of Q rose to 85 °C and then kept rising slowly, to 91 °C, while Q boiled.
Which liquid is a mixture? Explain your answer.

Model answer. Q (1). Its temperature keeps rising while it boils, so it boils over a range of temperatures instead of at a fixed temperature (1).

Explain what data show about the purity of a sample 2 to 3 marks **Grade 5**

1. Compare with the pure value: is the melting point lower, or the boiling point higher?
2. Say whether it changes state at a fixed temperature or over a range.
3. State your conclusion: pure, or impure (a mixture).

Example. Pure water boils at 100 °C. A student heated a sample of river water. It started to boil at 101 °C and the temperature rose to 103 °C as it boiled.
Explain what these results show about the river water.

Model answer. The river water is not pure / is a mixture (1). It boils at a higher temperature than pure water (1) and over a range of temperatures, not at one fixed temperature (1).

Don’t lose marks

- Giving the everyday meaning ('nothing added', 'natural') when the question asks for the chemical meaning.
- Saying impurities raise the melting point. They lower it and make it melt over a range.
- Writing 'it has a melting point' as the reason. Every solid has one: say it melts at a specific (fixed) temperature.
- Picking a sample as pure just because it melts at a high temperature. Purity is shown by melting at one specific temperature that matches the pure substance.
- Calling an alloy, air or a food 'pure'. They are all mixtures.

More tips

Memory tricks

- Count the substances: one substance means pure; two or more means a mixture.
- Sharp means pure; a range means impure.
- Impurities push the melting point DOWN and the boiling point UP: 'melt down, boil up'.
- Quick check: the purer sample has the narrower melting range, closer to the pure value.

Exam technique

- Learn the definition word for word: 'a single element or compound, not mixed with any other substance'.
- Quote the data, e.g. 'it melts from 105 °C to 111 °C, which is a range, and is below 114 °C'.
- In 'explain' questions give both ideas: lower (or higher) than the pure value AND a range instead of a fixed temperature.
- On a heating curve, find the flat section and read its temperature carefully from the axis.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 **Define a pure substance in chemistry**
A single element or a single compound, not mixed with any other substance.

Grade 4

Contrast everyday and chemical meanings of pure

In everyday language 'pure' means nothing has been added (e.g. pure milk), but the product can still be a mixture.

Grade 4

Use melting points to spot pure samples

A pure substance melts at a specific temperature; a mixture melts over a range of temperatures.

Grade 5

Describe how impurities change melting and boiling

Impurities lower the melting point and widen the melting range; dissolved impurities raise the boiling point.

Grade 5

Interpret heating curves to judge purity

A flat section at a fixed temperature shows a pure substance changing state; a sloping section shows a mixture.

Grade 5

Compare data to rank samples by purity

The purer sample melts closer to the pure value and over a narrower range of temperatures.

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