

Alkane boiling points

This resource is from the **Johnstone's triangle** series, which can be viewed at: rsc.li/43jMfSn. In this series you will also find our Johnstone's triangle worksheet which introduces the triangle in the context of alkane boiling points: rsc.li/4wl4B2G.

Learning objectives

LO	Objective	Where assessed
1	Write the formula and displayed formula of any of the first four alkanes	Q1
2	Determine the state of an alkane at a given temperature from boiling point and melting point data	Q2
3	Explain why the alkanes have different boiling points	Q3
4	Explain the trend in boiling point of the alkanes	Q4

How to use this resource

This resource aims to develop learners' understanding of the different boiling points of alkanes.

When to use?	 Introduce	 Develop	 Revise	 Assess
	Use after initial teaching or discussion of this topic to develop ideas further. You can also use it as a revision activity.			
Group size?	 Independent	 Small group	 Whole class	 Homework
	Suitable for independent work either in class or at home. Or you can use the questions for group or class discussions.			
How long?			15–30 mins	

The questions encourage learners to think at the macroscopic, sub-microscopic and symbolic levels about why different alkanes have different boiling points and the trend in boiling points. As a result, learners should develop more secure mental models to support their thinking about this topic.

Johnstone's triangle

Johnstone's triangle is a model of the three different conceptual levels in chemistry: macroscopic, sub-microscopic and symbolic. You can use Johnstone's triangle to build a secure understanding of chemical ideas for your learners.

Find further reading about Johnstone's triangle and how to use it in your teaching at rsc.li/4wRGd8E.

Johnstone's triangle and this resource

The icons in the margin indicate which level of understanding each question is developing so as to help prompt learners in their thinking.



Macroscopic: what we can see. Think about the properties that we can observe, measure and record.



Sub-microscopic: smaller than we can see. Think about the particle or atomic level.



Symbolic: representations. Think about how we represent chemical ideas using symbols and diagrams.

The levels are interrelated; for example, learners need visual representation of the sub-microscopic in order to develop mental models of the particle or atomic level. Our approach has been to apply icons to questions based on what the learners should be thinking about.

Questions may be marked with two or all three icons, indicating that learners will be thinking at more than one level. However, individual parts of the question may require learners to think about only one or two specific levels at a time.

Support

This worksheet is ramped so that the earlier questions are more accessible. The activity becomes more challenging in the later questions, so you may want to give extra explanations for these. If completing the worksheet as an in-class activity, it is best to pause and check understanding at intervals, as often one question builds on the previous one.

Give learners physical models to use and manipulate, such as Molymod kits.

Additional support may be needed for any learners still lacking in confidence in the required symbolic representation, for example, by sharing and explaining a diagram or a simulation that can show movement of the particles.

Answers



1. *Guidance note:* This question reinforces learners' understanding of the representation of the first four alkanes with a chemical formula or displayed formula (symbolic understanding). It also consolidates understanding of the alkane molecules consisting of carbon and hydrogen atoms only (sub-microscopic understanding).

Alkane name	Formula	Displayed formula
methane	CH ₄	<pre> H H-C-H H</pre>
ethane	C ₂ H ₆	<pre> H H H-C - C-H H H</pre>
propane	C ₃ H ₈	<pre> H H H H-C - C - C-H H H H</pre>
butane	C ₄ H ₁₀	<pre> H H H H H-C - C - C - C-H H H H H</pre>



2. *Guidance note:* This question develops learners' understanding of how to use melting and boiling points to determine the state of a substance at a given temperature (macroscopic understanding).

- (a)
- gas
 - liquid
 - solid
- (b) boiling
- (c) condensing
- (d) The boiling point of butane is the temperatures at which it **boils** and **condenses**.
[Accept in either order]



3. *Guidance note:* This question develops learners' understanding of how different alkanes are in different states at room temperature (macroscopic understanding) and of why this is in terms of differences in forces of attraction between molecules (sub-microscopic understanding).

- (a) The temperature of the lab is **below** the boiling point of hexane so hexane is in the **liquid** state. The temperature is **above** the boiling point of methane so methane is in the **gas** state.

- (b)
- i. true
 - ii. false
 - iii. true
- (c) forces of attraction between molecules
- (d) The forces of attraction between hexane molecules are larger than between methane molecules.



4. Guidance note: This question develops learners' understanding of the trend in boiling points of the alkanes (macroscopic understanding) and of why this occurs in terms of the connection between the length of the molecules and the strength of the forces of attraction between them (sub-microscopic understanding).

- (a) The longer the carbon chain, the higher the boiling point. (Accept: the larger the molecule, the longer the molecule, the larger the M_r , or another description linked to the size of the molecule.)
- (b) The longer the carbon chain (or the longer the molecule or other acceptable answer), the stronger the forces of attraction between the molecules and the higher the boiling point.