**Bubbles during boiling**



The water inside this kettle is boiling. You can see bubbles.

What is inside the bubbles?

A Nothing

B Air particles

C Water particles

D Water particles and air

*Chemistry > Big idea CPS: Particles and structure > Topic CPS1: Substances and mixtures > Key concept CPS1.1: Particle model for the solid liquid and gas states*

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| **Diagnostic question** |
| **Bubbles during boiling** |

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| Learning focus: | Understand a basic particle model of matter that can explain the properties of substances in the gas state. |
| Observable learning outcome: | Use the basic particle model to explain observations of boiling. |
| Question type: | Diagnostic, simple multiple choice |
| Key words: | liquid, gas, state, particle, boiling |

**What does the research say?**

Research by Johnson and Papageorgiou (2010) included a question about the bubbles in boiling water.

In order to understand the formation of bubbles during boiling, students need to understand that a sample of water can change into a body of gas and that this gas is still the substance water. They should then recognise that a bubble formed during boiling consists of water particles that are further apart inside the bubble than in the surrounding liquid.

Some students in the study recognised that the bubbles were made of a ‘gas’ but were unclear as to the identity of that gas. They struggled with idea that the ‘gas’ could actually be water.

**Ways to use this question**

Students should complete the question individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

The answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

It may help some students to demonstrate boiling water rather than using only the photo provided. Alternatively, they could be prompted to think about what they have observed when water boils at home during cooking.

**Expected answers**

C

**How to respond - what next?**

A student who considers the bubbles to contain nothing (option A) is thinking very much at the macroscopic level. The bubbles look empty and therefore the student has inferred that they contain nothing. This may suggest that the student has still not fully understood the concept of the gas state.

Selection of option B indicates that the student considers the bubbles to contain only air. They have not thought about the change of state of the water from the liquid to the gas state as forming the bubbles.

Option D implies that the students think that the water particles enter a bubble formed from air. They are not recognising the water in the gas state can form a bubble. Instead, they think that the bubbles must be made of air.

A student with more advanced thinking may suggest that bubbles contain a mixture of air particles and water particles and may comment that this is not one of the options provided. When water is boiling, it could be argued that there may be some dissolved air which is yet to escape and therefore there could be a small amount of air in the large bubbles, so this answer would not be incorrect.

If students have misunderstanding about the formation of bubbles during boiling it is important to link the boiling process to a change of state and a change in arrangement of the water particles.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Explaining bubbles during boiling

**Acknowledgments**

Developed by Helen Harden (UYSEG), adapted from a question selected from a collection of ASK items devised for research by Philip Johnson and teacher support material developed for York Science by Andrew Hunt.

Images: Pixabay/Josch13

**References**

Johnson, P. and Papageorgiou, G. (2010). Rethinking the Introduction of Particle Theory: A Substance-based framework. *Journal of Research in Science Teaching.* 42(2) 130-150