**Predicting mass after changes of state**

Imagine that drop of water has been placed in a sealed plastic bag (with all air excluded). It is then warmed until the water has all changed into the gas state.

Which statement best describes how the mass will change and why?

A The mass will decrease because the water has disappeared.

B The mass will increase because there are now water and air particles in the bag.

C The mass will stay the same because the number of particles inside the bag stays the same.

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

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| **Diagnostic question** |
| **Predicting mass after changes of state** |

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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 particle model to explain conservation of mass during changes of state. |
| Question type: | simple multiple choice |
| Key words: | liquid, gas, state, particle, mass |

**What does the research say?**

A review of research by Hadenfeldt, Liu and Neumann (2014) organised student understanding of conservation of matter into different levels. At the most basic level students believe that a substance can disappear when it changes state. It is suggested that conservation of matter is beyond their everyday experience and therefore students have little exposure to the concept. An understanding of the particle model allows students to have a higher level of understanding as they realise that the number of particles stays the same during a change of state, so a substance cannot simply disappear. The next stage is to link this with the idea that mass too will remain unchanged.

**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*

Some students may benefit from a visual prompt (such as showing them a plastic bag) to ensure that they fully understand the experiment being described.

However, due to difficulties and risks in heating a plastic bag, the demonstration described in the response activity ‘water syringe’ is preferable.

**Expected answers**

C

**How to respond - what next?**

The selection of option A indicates that the student is still thinking at a macroscopic observable level. The liquid water is observed to ‘disappear’. Selection of option B shows that the student still has some misunderstandings about the particle model for the gas state.

If students still do not completely understand the particle model for the gas state, you may wish to discuss more carefully with students that only water was in the bag. The bag was sealed so the bag could only have contained water particles. The students need to infer from this that when water changes from the liquid to the gas state, the particles move further apart and there is empty space between them.

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

* Water in syringe

The discussion could be adapted to focus on the mass of the syringe.

**Acknowledgments**

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Images: None

**References**

Hadenfeldt, J.C., Liu, X., Neumann, K. (2014). Framing students’ progression in understanding matter: a review of previous research. *Studies in Science Education*. 50(2) 181-208