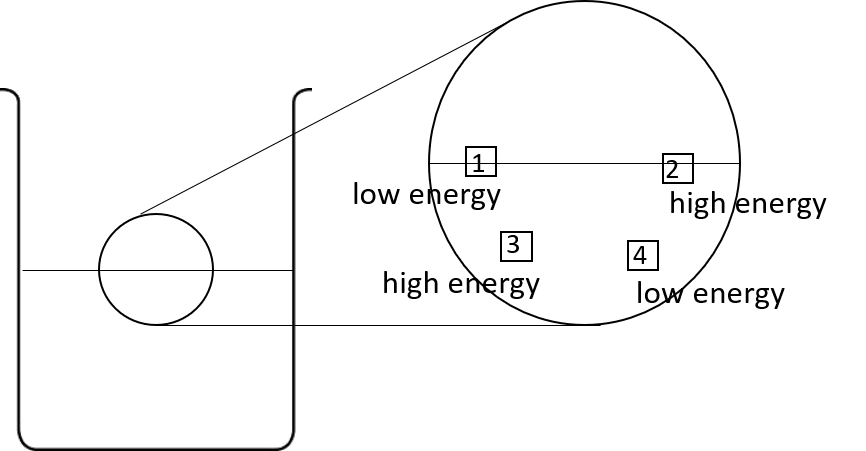
**Evaporating particles**

During evaporation particles leave the liquid and mix with the ‘air’ particles.



The diagram shows the location and energy of four particles.

Which particle is most likely to leave, and why?

Put a tick (✓) in the box next to the best answer.

|  |  |  |
| --- | --- | --- |
| **A** | 1 and 2 |  |
|  |  |  |
| **B** | 3 and 4 |  |
|  |  |  |
| **C** | 2 and 3 |  |
|  |  |  |
| **D** | 2 only |  |
|  |  |  |

*Chemistry > Big idea CPS: Particles and structure > Topic CPS5: Evaporation > Key concept CPS5.1: Explaining evaporation*

|  |
| --- |
| **Diagnostic question** |
| **Evaporating particles** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Evaporation takes place at any temperature between melting and boiling point |
| Observable learning outcome: | Use the idea that particles have a range of energies to explain how evaporation occurs below the boiling point of a substance. |
| Question type: | Diagnostic, simple multiple choice |
| Key words: | Energy, particle, evaporation |

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This diagnostic question probes understanding of ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

In the Association for Science Education publication “Teaching Secondary Chemistry” (Johnson, 2012), Phil Johnson writes that whilst the basic particle model can explain the overall ‘disappearance’ of water that is evaporating below boiling point in terms of mixing with the ‘air’ particles, it cannot explain *how* this can happen. It is likely that boiling has been explained to students in terms of water needing to be at the boiling point of 100°C in order for particles to have enough energy to escape.

This makes it very challenging for students to explain everyday observations of water evaporating below boiling point. In order to understand evaporation more fully, Johnson recommends that students should be introduced at a basic level to the idea that temperature is related to the average energy of particles but that any single particle could have a different temperature to another. Some particles therefore have sufficient energy to escape.

**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*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

D

**How to respond - what next?**

A student who selects option A may understand that evaporation occurs as particles leave the surface of the liquid but not that a particle must have sufficient energy to leave. Selection of option B suggests a misunderstanding about where the particles leave from, and a potential confusion with the boiling process in which bubbles of the substance in the gas state form within the liquid.

A student choosing option C may also still have misunderstandings about where the particles leave from but may have understood the need for a particle to have sufficient energy.

If students have misunderstandings about where particle leave a liquid from during evaporation, students may need to revisit ideas explored in the response activity “Observations”. Students could be encouraged to think further about the need for particles to have sufficient energy to evaporate by thinking about how temperature affects rate of reaction.

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

* Evaporation rate

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden and Alistair Moore (UYSEG)

**References**

Johnson, P. (2012). Introducing particle theory. In Taber, K. (ed.) *ASE Science Practice: Teaching Secondary Chemistry.* New edition ed. London, UK: Hodder Education.