**Boiling or evaporation?**

The following statements describe either **boiling** or **evaporation**.

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | Evaporation takes place at a specific temperature. |  |  |  |  |
| **B** | Boiling produces bubbles of the substance in the gas state. |  |  |  |  |
| **C** | During boiling, particles leave only from the surface. |  |  |  |  |
| **D** | During evaporation, the particles mix with particles in the air. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Boiling or evaporation** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Evaporation takes place at a temperature between melting and boiling point. |
| Observable learning outcome: | Distinguish boiling from evaporation. |
| Question type: | Diagnostic, confidence grid |
| Key words: | Boiling, evaporation, particles |

**What does the research say?**

In their research paper Johnson and Papageorgiou (2009) comment that if the concept of substance is absent, the standard “solids, liquids and gases” framework (in which different materials are described as *being* a solid, liquid or gas rather than a substance being in the solid, liquid or gas state) makes no distinction between boiling and evaporation. Both are regarded as changes of state. The difference between the formation of a pure sample of a substance (e.g. water) in the gas state (boiling) and evaporation in which a water mixes with other substances (in the air) is ignored. Without this idea it is difficult for students to reconcile the requirement of water to be at 100°C in order for water particles to have enough energy to move apart from each other during boiling with water particles “escaping” at room temperature during evaporation.

This may be why some students believe that evaporation requires a temperature gradient (Coştu and Ayas, 2005).

**Ways to use this question**

Students should complete the confidence grid 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.

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**

Evaporation does not take place at a specific temperature. Evaporation can take place at any temperature between melting and boiling point.

It is boiling that takes place at a specific temperature.

Boiling does produce bubbles of the substance in the gas state.

Particles do not leave only from the surface during boiling. This is what happens during evaporation.

During evaporation particles do mix with particles in the air.

**How to respond - what next?**

A student who agrees with the statement that “Evaporation takes place at a specific paper” may not fully understand that evaporation can take place at any temperature between melting point and boiling point.

Statement B is correct but if a student is not confident that this is right, they may need to revisit key concept CPS1.1: A particle model for the solid, liquid and gas state to better understand the formation of bubbles during boiling. Similar consolidation may be necessary if a student considers that C is correct.

Statement D is correct but a lack of confidence by a student about this statement suggests that they may not have understood the idea of individual particles leaving from the surface of the liquid.

If students have misunderstandings about the difference between boiling and evaporation, they may need further practice with some additional examples. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Observations

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: None

**References**

Coştu, B. and Ayas, A. ş. a. (2005). Evaporation in different liquids, secondary students' conceptions. *Research in Science and Technological Education,* 23(1)**,** 75-97.

Johnson, P. and Papageorgiou, G. (2009). Rethinking the introduction of particle theory: A subtance-based approach. *Journal of Research into Science Teaching,* 47(2)**,** 130-150.