**Melting point**

Ice is kept inside a freezer.

The temperature of the freezer is -10oC.

As soon as the ice is taken out of the freezer it is placed in a beaker and its temperature is measured.

Its temperature is measured each minute until ten minutes after all the ice has melted.

The melting point of ice is 0oC.

These statements are about the melting point of ice.

*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** | The temperature of ice taken out of the freezer is 0oC. |  |  |  |  |
| **B** | When it melts the temperature of ice is more than 0oC. |  |  |  |  |
| **C** | The temperature of water in the beaker is 0oC until after all the ice has melted. |  |  |  |  |

*Physics > Big idea PMA: Matter > Topic PMA3: Energy of moving particles > Key concept PMA3.3: Specific latent heat*

|  |
| --- |
| **Diagnostic question** |
| **Melting point** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Specific latent heat (of a particular change of state) is the amount of energy needed to change the state of 1 kg of a substance without changing its temperature. |
| Observable learning outcome: | Interpret a heating curve and explain physical changes to a substance that is heated from the solid state to the liquid state. |
| Question type: | Confidence grid |
| Key words: | Solid state, liquid state, melting point |

**What does the research say?**

Heating a substance without a change of state increases the motion of particles and the temperature of the substance. When melting or vaporising a substance, its particles are moved apart against their electrostatic attraction, a very small amount for melting and rather more for vaporisation (Millar, 2011). As particles move apart against the attractive force that holds them together, their movement slows and prevents the temperature of the substance from rising until the change of state is complete.

Adadan and Yavuzkaya (2018) found in a large study (n=656), that 29% of 15- to 16-year-olds thought that ice was always 0oC, and 32% that water cannot be 0oC. These students appear to be relying on recall of factual knowledge rather than on a clear understanding. In other studies, students believed that the temperature of ice cubes existing in a warm room must be above 0°C, and that water cannot exist at 0°C even if ice cubes remain in a puddle of water (Chu et al., 2012; Kacovsky, 2015).

**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**

Statements A and B are wrong; and statement C is right.

**How to respond - what next?**

When energy is transferred to ice by heating from its surroundings its temperature increases when it is not at its melting point because the average speed of its particles is caused to increase. At its melting point the energy transferred by heating from its surroundings enables water molecules to overcome electrostatic forces of attraction between them and loosen their connections to form a liquid. Overcoming the electrostatic forces of attraction slows the particles and so their average speed does not increase (temperature does not increase) whilst this is happening.

*Statement A*

Ice taken out of a freezer will initially be at the same temperature as the freezer, which is minus 10oC. It is common for students to think that ice is always at 0oC because they have learnt that it ‘freezes at 0oC’, but they may not fully understood what this means.

*Statements B and C*

Students that get these statements wrong typically think that water is always in its solid state at (or below) 0oC and in its liquid state above 0oC.

Those who think the temperature of ice rises above zero as it melts may hold the misunderstanding that temperature is some form of substance that flows into the ice with heating. Those who think that the temperature of water is greater than 0oC as the ice is melting are not applying an understanding of thermal equilibrium to the mixture.

If students have misunderstandings about interpreting a heating curve and explaining physical changes to a substance that is heated from the solid state to the liquid state, it can help to challenge their thinking with direct observation. Regular readings of temperature as ice melts, or a real-time plot using a temperature probe, clearly show a rise in temperature stops during melting and continues only after all the ice has melted.

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

* Response activity: Faster melting

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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