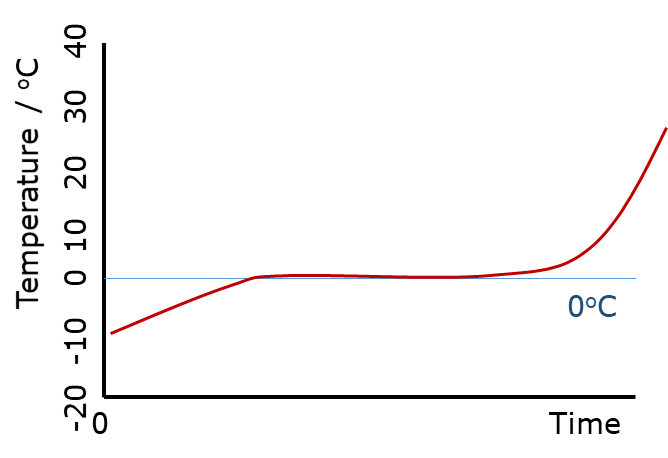
**Faster melting**



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.

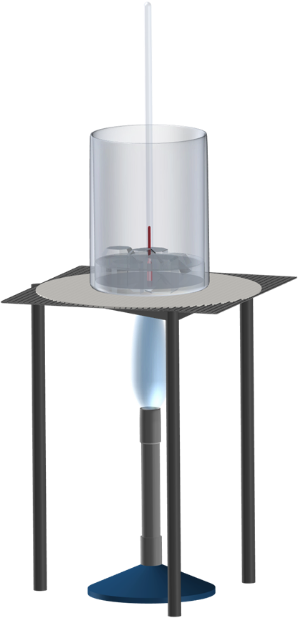
Its temperature is measured each minute until ten minutes after all the ice has melted.

**Predict**

Add a second line to the graph to show how you think temperature will change if the ice is heated with a Bunsen burner.

**Explain**

Why do you think the temperature will change like this?



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| --- |
| **Investigate how the temperature of ice changes as it is heated.** |

**Observe**

Record the measurements needed to plot both lines on a graph.

Plot a graph that shows both lines.

**Explain**

Were your prediction and explanation correct?

Try to improve your first explanation to explain what happens more clearly.

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

|  |
| --- |
| **Response activity** |
| **Faster melting** |

**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. |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | Solid state, liquid state, melting point |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Boiling point
* Diagnostic question: 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 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 activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

* For this investigation, the results only need to be approximate. If possible, it is helpful to set up a beaker of ice in advance of the lesson using a data logger with a temperature probe to record the temperature of ice each minute as it melts.
* Whilst heating ice with a Bunsen burner, the temperature needs to be taken more often than once each minute.
* If ice is placed in the laboratory at the start of the lesson, it is likely to have reached its melting point and be at 0oC when students begin their measurements.
* A data logger with a temperature probe could be used to plot the temperature changes in real time.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* Thermometer to measure from -10oC to 100oC
* Glass beaker (250 cm3)
* Bunsen burner, heat proof mat, gauze
* Clamp and stand to hold the thermometer
* Crushed ice, straight from the freezer (about 100 cm3)

For the class:

* As above, but replace the thermometer with a data logger and temperature probe.
* A means of projecting the results or the graph produced onto a whiteboard.

**Technician notes**

Crushed ice is needed as it makes better contact with the bulb of a thermometer or a temperature probe than cubes.

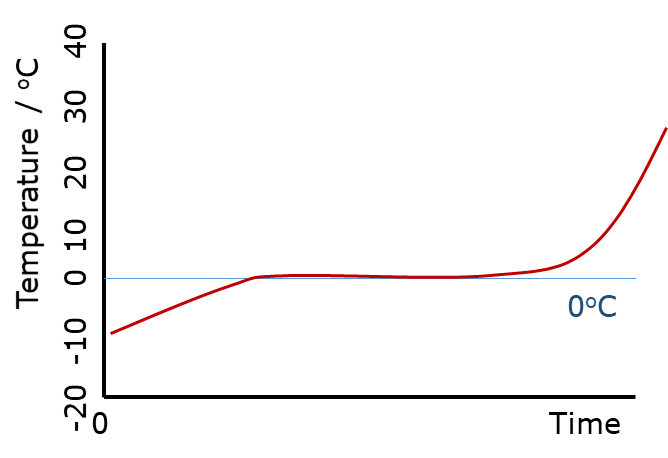
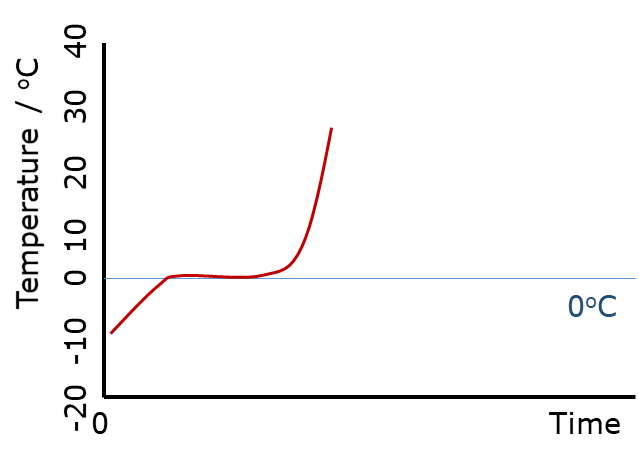
Measurements need to start when the temperature of ice is significantly below zero degrees C, so readings need to start as quickly as possible after it has been removed from the freezer.

**Health and safety**

Hot water and hot equipment can burn, glassware can break, and melting ice on the floor can cause a slip hazard.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

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*Placed at room temperature Heated with a Bunsen burner*

When heated more quickly the temperature still levels off at 0oC as the ice is melting. The increased heating transfers energy to the ice more quickly. Before and after melting the temperature increases more quickly. During melting more energy than before is transferred in any one time interval to move the particles apart and loosen the connections between them so the change of state happens more quickly.

Water molecules in ice need to vibrate with a particular amount of vigour to loosen the connections between them. The size of vibrations at which this happens always corresponds to a temperature of 0oC (at standard pressure).

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Adadan, E. and Yavuzkaya, M. N. (2018). Examining the progression and consistency of thermal concepts: a cross age study. *International Journal of Science Education,* 40 (4)**,** 371-396.

Chu, H.-E., et al. (2012). Evaluation of Students' Understanding of Thermal Concepts in Everyday Contexts. *International Journal of Science Education,* 34:10**,** 1509-1534.

Kacovsky, P. (2015). Grammar school students' misconceptions concerning thermal phenmomena. *Journal of Baltic Science Education,* 14(2)**,** 194-206.

Millar, R. (2011). Energy. In Sang, D. (ed.) *Teaching Secondary Physics.* London: Hodder Education.