

Objectives

- P14.6** Explain how heating a system will change the energy stored within the system and raise its temperature or produce changes of state.
- P14.7** Define the terms specific heat capacity and specific latent heat and explain the differences between them.
- P14.10** Explain ways of reducing unwanted energy transfer through thermal insulation.
- P14.11** *Core Practical: Investigate the properties of water by ~~determining the specific heat capacity of water and obtaining a temperature-time graph for melting ice.~~*

Maths requirements

- 4a** Translate information between graphic and numeric form.
- 4c** Plot two variables from experimental or other data.

Learning outcomes

-  **SP14.6** Explain how heating affects the particles in a substance or object, including changes of state.
-  **SP14.6** Describe how the temperature of an object changes with time while being heated or cooled to make it change state.
-  **SP14.7** Define the term specific heat capacity.
-  **SP14.7** Define the term specific latent heat.
-  **SP14.7** Explain the difference between specific heat capacity and specific latent heat.
-  **SP14.10** Explain ways of reducing unwanted energy transfer through thermal insulation.

Exploring

1. Melting ice

This practical forms part of the core practical requirement of the specification and is supported by *Students' sheet CP7b (Investigating properties of water - the construction of a temperature–time graph)* and *SP14c Core Practical – Investigating water* in the Student Book. See *Students' sheet CP7b (Investigating properties of water - the construction of a temperature–time graph)* for a full method for this practical. The full method for the other part of this core practical (the determination of specific heat capacity) can be found on *Students' sheet CP7a (Investigating properties of water - specific heat capacity)*. The two practicals could be run together after study of *SP14c Energy calculations*, if so desired. The evaluation questions on the worksheet ask about sources of error. Skills Sheet PI3 may be useful.

This practical can be extended by providing students with other substances to melt. Fatty acids are suitable, and it is best if students are provided with boiling tubes containing the solid substances with thermometers already in place. Warn students not to try to remove the thermometers from the solids as they may break. Students warm the substances in a water bath and take the temperature of the substance every minute until it has all melted and the temperature begins to rise. At this point the boiling tube can be carefully removed from the water bath and placed in an empty beaker to cool down again, with students continuing to record the temperature every minute until it has completely solidified. If there is any crushed ice left over, this could be put into the beaker to increase the cooling rate.

Support: Students do only the melting ice practical. They may need help with drawing the axes for their graph. Check they understand that the starting temperature of the ice should be recorded against time zero.

Stretch: Students produce melting and cooling curves for two of the suggested substances in addition to the melting ice practical, and compare the results. Alternatively, some groups could be given a mixture of two substances, asked to obtain melting and cooling curves and to compare the shape of these to the graphs obtained by groups using pure substances.



Safety

Wear eye protection. Warn students to take care with hot apparatus and hot liquids. Students should be warned not to try to remove thermometers from the solid substances, as this may break them. Mop up any spilled water straight away.

Expected results

Students produce a temperature-time graph for melting ice, and possibly also heating and cooling curves for other substances.

Course resources

Phys Students' sheet CP7b

Equipment

Melting ice: eye protection, boiling tube, beaker, thermometer, tripod and gauze, heat-resistant mat, Bunsen burner, stop clock, hot water from kettle, crushed ice

Optional: extra beaker, one or more of the following substances – stearic (octadecanoic) acid, salol (phenyl salicylate), lauric (dodecanoic) acid, or other fatty acids with melting points in the range 30 °C to 80 °C.