Teaching ideas for Topic 3: *Thermal properties of matter*, Core

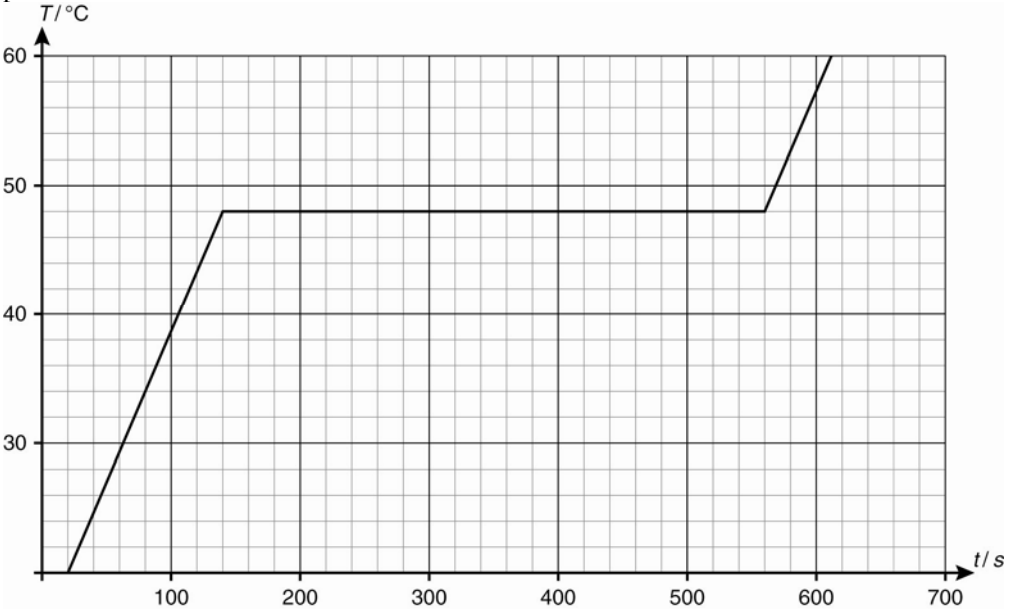
Questions

A number of worksheets are provided for this Topic:

- support questions examine the very basic concepts of the syllabus
- extended questions delve deeper and are equivalent to exam level questions.

Teaching ideas

- This topic offers good opportunities for 'easy' lab work for the students, with very good possibilities to do well in the conclusion/evaluation part of the report. Examples are measuring the specific heat capacity by the method of mixtures or an electrical method or measuring the specific latent heat of fusion of ice.
- Experience shows that students make terrible algebra/arithmetical mistakes when solving a problem in calorimetry. An easy way out is to make use of something they know well from their maths classes: just put the equation as is, without any manipulation, on their graphic display calculator 'Solver' and ask for the solution – it always works!
- A simple exercise that will teach them (almost) everything about this topic is the following: A sample of 120 g of solid paraffin initially at 20 °C is being heated by a heater of constant power. The specific heat capacity of solid paraffin is 2500 J kg^{-1} K^{-1}. The temperature of paraffin varies with time as shown.



1 Explain the difference between internal energy and thermal energy.

2 Identify the regions in the graph above where:

a paraffin is solid

b paraffin is liquid

c the solid and liquid phase co-exist.

3 Explain the presence of a region in the graph where the temperature remains constant.

4 Determine

a the power of the heater

b the melting temperature of paraffin

c the specific latent heat of fusion of paraffin

d the specific heat capacity of paraffin in the liquid phase.

5 The density of solid paraffin is 900 kg m^{-3} and its molar mass is 422 g mol^{-1}. Estimate the average separation of paraffin molecules in solid paraffin.

Practical activities/ICT

- A very simple and basic simulation of the behaviour of matter at different temperatures and pressures is provided at http://phet.colorado.edu/en/simulation/states-of-matter-basics
- An equally simple and basic simulation of the behaviour of matter at different temperatures, but also providing information on intermolecular potential energy, is provided at http://phet.colorado.edu/en/simulation/states-of-matter
- A simple student lab would be 'A study of a factor that affects the rate of evaporation from a liquid'. This could be just design or, better yet, a full lab.

Common problems

- Students often fail to understand why heating a substance at the melting or boiling point does not result in a temperature increase and this point needs to be explained well.

Theory of knowledge (TOK)

- A simple connection with TOK in this topic is the concept of 'heat', as this has an interesting history. Originally, heat was thought of as a liquid whose amount in the body determined the temperature; this idea was abandoned in favour of the modern 'heat as energy'. This transformation of the concept of heat is a good example of how models change and how experiments definitively decide an issue of (almost) ideological dimensions.
- This topic is also good in showing the connections between microscopic concepts (in this case the motion of molecules and their random kinetic energy) with a macroscopic concept such as absolute temperature.