Specific Latent Heat

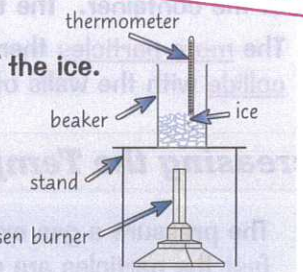
If you heat up a pan of water on the stove, the water never gets any hotter than 100 °C. You can carry on heating it up, but the temperature won't rise. How come, you say? It's all to do with latent heat...

You Need to Put In Energy to Break Intermolecular Bonds

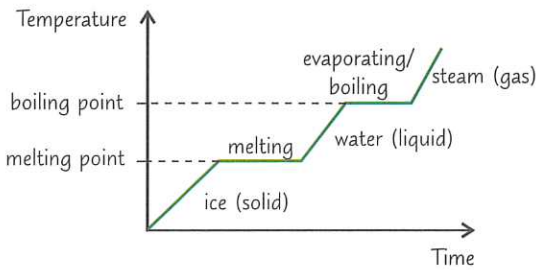
1) Remember, when you heat a solid or liquid, you're transferring energy to the kinetic energy stores of the particles in the substance, making the particles vibrate or move faster (p.156).
2) When a substance is melting or boiling, you're still putting in energy, but the energy's used for breaking intermolecular bonds rather than raising the temperature.
3) When a substance is condensing or freezing, bonds are forming between particles, which releases energy. This means the temperature doesn't go down until all the substance has turned into a liquid (condensing) or a solid (freezing).
4) You can see this by doing this simple experiment:

PRACTICAL

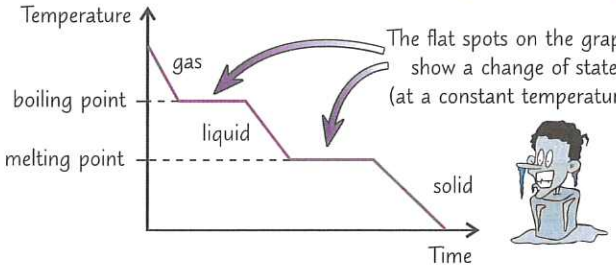
1) Fill a beaker with crushed ice.
2) Place a thermometer into the beaker and record the temperature of the ice.
3) Using the Bunsen burner, gradually heat the beaker full of ice.
4) Every twenty seconds, record the temperature and the current state of the ice (e.g. partially melted, completely melted).
5) Continue this process until the water begins to boil.
6) Plot a graph of temperature against time for your experiment.



Your graph should look like this:



You get a similar one for condensing and freezing:



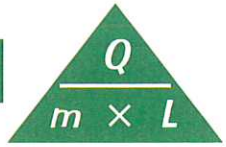
The flat spots on the graphs show a change of state (at a constant temperature).

Specific Latent Heat is the Energy Needed to Change State

Don't get confused with specific heat capacity, which relates to a temperature rise of 1 °C.

1) The specific latent heat (SLH) of a change of state of a substance is the amount of energy needed to change 1 kg of it from one state to another without changing its temperature.
2) For cooling, specific latent heat is the energy released by a change in state.
3) Specific latent heat is different for different materials, and for changing between different states.
4) The specific latent heat for changing between a solid and a liquid (melting or freezing) is called the specific latent heat of fusion. The specific latent heat for changing between a liquid and a gas (evaporating, boiling or condensing) is called the specific latent heat of vaporisation.
5) You can work out the energy needed (or released) when a substance of mass m changes state using this formula:

$$\text{Thermal Energy } (Q) = \text{Mass } (m) \times \text{Specific Latent Heat } (L)$$



Thermal energy is given in joules (J), mass is in kg and SLH is in J/kg.

Breaking Bonds — Blofeld never quite manages it...

Fun fact: this stuff explains how sweating cools you down — the energy that builds up in your body when you exercise is used to change liquid sweat into gas, rather than increasing your temperature. Nice...

Q1 Sketch a graph showing how the temperature of a sample of water will change over time as it's heated from –5 °C to 105 °C. [3 marks]

Specific Latent Heat

1 **Figure 1** shows the mass and specific latent heat of vaporisation (SLH) of substances A-D. Which substance requires the most amount of energy to completely boil it?

Grade 4-6

Figure 1

	Mass (kg)	SLH (J/kg)
☐ **A**	1	1.5
☐ **B**	1	1.0
☐ **C**	2	1.5
☐ **D**	3	2.0

[Total 1 mark]

2 A student uses a freezer to freeze 0.50 kg of brine.

Grade 6-7

a) Define the term 'specific latent heat'.

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[1]

b) Explain the difference between specific heat capacity and specific latent heat.

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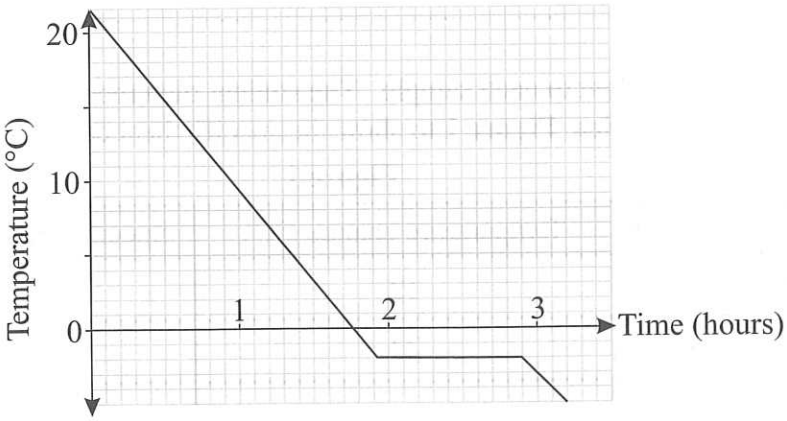
[1]

Figure 2 shows the temperature-time graph for brine as it was cooled.

Figure 2



c) State the freezing point of brine.

Freezing point = ... °C

[1]

[Total 3 marks]

PRACTICAL

3 A student investigates the specific latent heat of water. They place 500 g of ice into an insulated beaker and use an immersion heater to heat the ice. They record the temperature of the water every 10 seconds. Their results are shown in **Figure 3**.

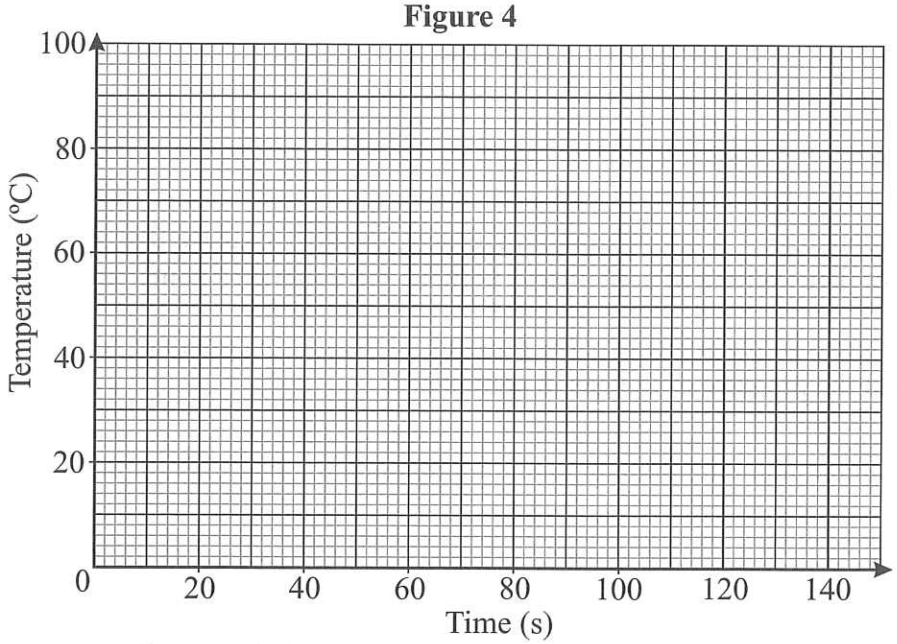
Grade 6-7

Figure 3

Time (s)	Temperature (°C)
0	0
10	0
20	0
30	0
40	0
50	0
60	7
70	21

Time (s)	Temperature (°C)
80	36
90	50
100	64
110	79
120	92
130	100
140	100
150	100

Figure 4



a) Draw the temperature-time graph for the student's results on **Figure 4**. *[2]*

b) The immersion heater transfers 1.13 MJ of energy to the water once it has reached its boiling point to completely boil all of the water. Calculate the specific latent heat of vaporisation of water. Give your answer in MJ/kg.

Specific latent heat = ... MJ/kg
[3]

c) Explain, in terms of particles, the shape of the graph between 0 and 50 seconds.

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[3]

[Total 8 marks]