

Exercise walk-through

4.1

Kinetic theory and latent heat

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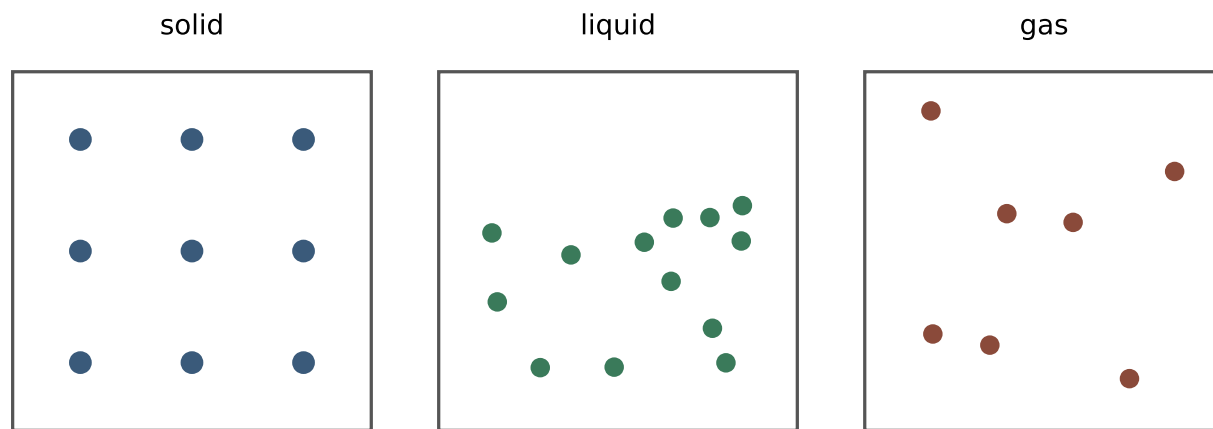
The method

Method — The model and its energies

$$E = mc\Delta\theta \quad (P) \quad E = mL_V \quad (P) \quad E = mL_F$$

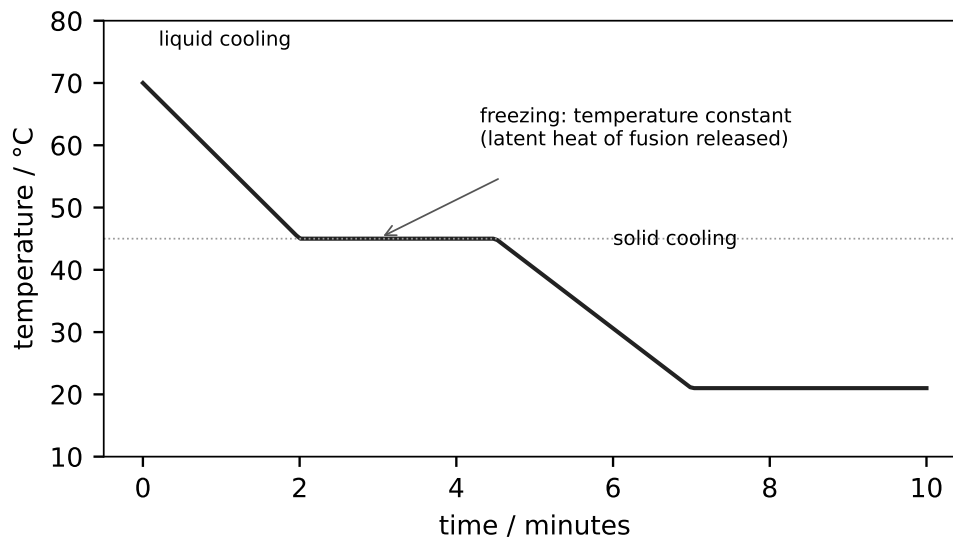
Worked check. Boiling away 0.2 kg of water ($L_V = 2\,260\,000 \text{ J/kg}$):

$$E = 0.2 \times 2.26 \times 10^6 = 452\,000 \text{ J}.$$



Solid, liquid and gas particle arrangements.

Method — (P) The cooling curve's flat shelf



Temperature constant while freezing: latent heat released at a fixed temperature.

Exercises 2.1·2.3

2.1 Describe the particle arrangement and motion in a gas. [2]

2.2 Define specific heat capacity. [1]

2.3 Calculate the energy to heat 0.8 kg of copper ($c = 390$) by $60\text{ }^{\circ}\text{C}$. [2]

Exercises 2.1·2.3

2.1 Describe the particle arrangement and motion in a gas. [2]

2.1 Far apart (mostly empty space), moving fast in random straight-line paths between collisions.

2.2 Define specific heat capacity. [1]

2.2 The energy needed to change the temperature of 1 kg of a substance by 1 °C.

2.3 Calculate the energy to heat 0.8 kg of copper ($c = 390$) by 60 °C. [2]

2.3 $E = 0.8 \times 390 \times 60 = 18\,720 \text{ J}.$

Exercises 2.4·3.1

2.4 (P) State what happens to temperature during boiling. [1]

2.5 (P) Calculate the energy to melt 1.2 kg of ice ($L_F = 334\,000\text{ J/kg}$). [2]

3.1 A 2.5 kg block of a mystery material absorbs 45 000 J and warms by 20 °C. Calculate its specific heat capacity. [3]

Exercises 2.4·3.1

2.4 (P) State what happens to temperature during boiling. [1]

2.4 (P) It stays constant.

2.5 (P) Calculate the energy to melt 1.2 kg of ice ($L_F = 334\,000\text{ J/kg}$). [2]

2.5 (P) $E = 1.2 \times 334\,000 = 400\,800\text{ J}$.

3.1 A 2.5 kg block of a mystery material absorbs 45 000 J and warms by 20 °C. Calculate its specific heat capacity. [3]

3.1 $c = E/(m\Delta\theta) = 45\,000/(2.5 \times 20) = 900\text{ J/(kg °C)}$.

Exercises 3.2·3.3

3.2 (P) Sketch or describe the temperature–time graph for stearic acid cooling from 80 °C to room temperature, labelling the plateau. [3]

3.3 (P) Explain, in particle terms, why burns from steam at 100 °C are worse than burns from water at 100 °C. [3]

Exercises 3.2·3.3

3.2 (P) Sketch or describe the temperature–time graph for stearic acid cooling from 80 °C to room temperature, labelling the plateau. [3]

3.2 (P) A falling line from 80 °C; a horizontal plateau at the freezing point while the liquid solidifies; then a falling line again down to room temperature.

3.3 (P) Explain, in particle terms, why burns from steam at 100 °C are worse than burns from water at 100 °C. [3]

3.3 (P) When steam condenses on skin it first releases its latent heat of vaporisation – a large extra energy transfer on top of the hot water’s cooling – so more energy enters the skin for the same mass.