Solutions

Each answer shows the steps, then the **result**.

2.1

- $T = 25 + 273 = \mathbf{298}$ K

2.2

- the fastest particles escape, lowering the average energy of those left

2.3

- condensation: the gas particles slow down and come close enough for the attractions between them to hold them as a liquid
- solidification: the liquid particles lose more energy and settle into fixed positions in a regular pattern

2.4

- the forces between gas particles are very weak, so they are free to spread much further apart
- in a solid strong forces hold the particles in a lattice, so they only vibrate a little more

2.5

- any two of: gaps left between railway rails; a bridge resting on rollers; a tight metal lid loosened in hot water; the liquid rising in a thermometer

3.1 B

- the temperature stays constant during a change of state

3.2

(a) $c = \Delta E/(m\Delta\theta)$

$$c = \frac{9000 \text{ J}}{(0.50 \text{ kg})(40 \text{ °C})} = \mathbf{450} \text{ J/(kg °C)}$$

(b) some energy is lost to the surroundings, so more than 9000 J was really needed

3.3

- the most energetic particles leave the surface
- so the average kinetic energy — and the temperature — of the remaining particles falls

3.4

(a) the mass of the sand

- the temperature before and after heating, giving the rise
- the time the heater is on together with its power, or the current and voltage, giving the energy

(b) $E = Pt$

$$E = (50\ \text{W})(4.0 \times 60\ \text{s}) = \mathbf{12\,000}\ \text{J}$$

(c) $\Delta\theta = 22.0\ ^\circ\text{C} - 7.0\ ^\circ\text{C} = 15.0\ ^\circ\text{C}$

- $c = E/(m\Delta\theta)$

$$c = \frac{12\,000\ \text{J}}{(0.80\ \text{kg})(15.0\ ^\circ\text{C})} = \mathbf{1000}\ \text{J/(kg}\,^\circ\text{C)}$$

(d) some supplied energy escapes to the surroundings instead of heating the sand, so the calculated c is too large

- add more insulation, or a lid

(e) the sand is losing energy to the surroundings as fast as the heater supplies it, so there is no net gain