

Solutions

2.1

$$E = mL = 0.030 \times 3.34 \times 10^5 = \mathbf{1.0 \times 10^4 \text{ J}}$$

(substitution 1, answer with unit 1.)

2.2

$$L = \frac{E}{m} = \frac{45\,000}{0.020} = \mathbf{2.25 \times 10^6 \text{ J/kg}}$$

(rearrangement 1, answer 1.)

2.3 Specific heat capacity is the energy to raise the temperature of one kilogram by one degree Celsius – a temperature **change**; specific latent heat is the energy to change the state of one kilogram with **no** temperature change.

3.1 (a) The supplied energy increases the particles' potential energy as they break free of the liquid; their average kinetic energy – and so the temperature – stays constant until all the water has boiled. (b)

$$E = mL_v = 0.030 \times 2.26 \times 10^6 = \mathbf{6.8 \times 10^4 \text{ J}}$$

(c) If water already left by evaporation, less than 0.030 kg actually boiled at 100 °C for the measured energy; with the full 0.030 kg in the calculation, L comes out too **small**.

3.2 (a) Convert: $L = 60 \text{ kJ/kg} = 60\,000 \text{ J/kg}$ (C1).

$$m = \frac{E}{L} = \frac{1.02}{60\,000} = \mathbf{1.7 \times 10^{-5} \text{ kg}}$$

(rearrangement C1, answer A1.) (b) More than 1.02 J was needed in total, some leaking to the surroundings; the true mass is **smaller** than calculated – $m = E/L$ with the true (larger) energy gives a smaller mass for the same delivered 1.02 J of melting.

3.3 (a)

$$E = mL_f = 1.5 \times 3.34 \times 10^5 = \mathbf{5.0 \times 10^5 \text{ J}}$$

(b) Convert: 50 min = 3000 s (C1).

$$P = \frac{E}{t} = \frac{5.01 \times 10^5}{3000} = \mathbf{170 \text{ W}} \text{ (2 s.f.)}$$

(C1, A1.) (c)

$$\Delta E = mc\Delta\theta = 1.5 \times 2100 \times 18 = \mathbf{56\,700 \text{ J}} \approx 5.7 \times 10^4 \text{ J}$$

(C1, A1.) (d) Cooling the ice needs only $5.7 \times 10^4 \text{ J}$ against $5.0 \times 10^5 \text{ J}$ for freezing – about a ninth of the energy; freezing must break-form particle arrangements with latent heat, while cooling only lowers kinetic energy per degree.