Solutions

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

2.1

- $T = 27 + 273 = \mathbf{300}$ K

2.2

- $\theta = 200 - 273 = \mathbf{-73}$ °C

2.3

- $-\mathbf{273}$ °C (-273.15)

2.4

- any two: density of a liquid; volume of a gas; resistance of a metal; e.m.f. of a thermocouple

3.1 B

- 100 °C $= 100 + 273 = \mathbf{373}$ K
- **A** is 0 °C; **C** is 100 without converting; **D** is absolute zero in kelvin

3.2

- the **lowest possible temperature**
- at which a system has its **minimum internal energy** (least particle motion)

3.3

- $\theta = 310 - 273 = \mathbf{37}$ °C

3.4

- a property-based scale depends on **how that property changes** (it may not be linear), so different thermometers can disagree
- the thermodynamic scale is defined independently of any substance, so it is consistent

3.5

(a)(i) $-\mathbf{273.15}$ °C

(a)(ii) **0** K — the unit is required

(b) the gas behaves as an **ideal gas**: $pV \propto T$ with no intercept, which is what $pV = NkT$ predicts

(c) $pV = NkT$

$$N = \frac{340 \text{ Pa m}^3}{(1.38 \times 10^{-23} \text{ J K}^{-1})(640 \text{ K})} = \mathbf{3.8 \times 10^{22}}$$

(d) $n = N/N_\text{A}$

$$n = \frac{3.8 \times 10^{22}}{6.02 \times 10^{23} \text{ mol}^{-1}} = \mathbf{0.064} \text{ mol}$$

(e) for an ideal gas $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$

$$m = \frac{3kT}{\langle c^2\rangle} = \frac{3 \times (1.38 \times 10^{-23} \text{ J K}^{-1})(640 \text{ K})}{(1400 \text{ m s}^{-1})^2} = 1.35 \times 10^{-26} \text{ kg}$$

$$\frac{1.35 \times 10^{-26} \text{ kg}}{1.66 \times 10^{-27} \text{ kg u}^{-1}} = \mathbf{8.1} \text{ u}$$