Solutions

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

2.1

- by **heating** it (transferring thermal energy to it)
- and by **doing work** on it

2.2

- $W = p\Delta V$

2.3

- $W = p\Delta V$

$$W = p\Delta V = (1.0 \times 10^5\ \text{Pa})(3.0 \times 10^{-3}\ \text{m}^3) = \mathbf{300}\ \text{J}$$

2.4

- **positive**

3.1 C

- work done **on** the gas is **positive** in this sign convention
- **A** would be work done *by* the gas; **B** would mean no volume change; **D** is not how the convention works

3.2

- $\Delta U = q + W$

$$\Delta U = q + W = 500\ \text{J} + 200\ \text{J} = \mathbf{700}\ \text{J}$$

3.3

- compressed → work done **on** the gas is positive: $W = p|\Delta V|$

$$W = p|\Delta V| = (2.0 \times 10^5\ \text{Pa})(3.0 \times 10^{-3}\ \text{m}^3) = 600\ \text{J}$$

- cooling removes energy, so $q = -800$ J

$$\Delta U = q + W = -800\ \text{J} + 600\ \text{J} = \mathbf{-200}\ \text{J}$$

3.4

- the air is compressed quickly, so little heat leaves ($q \approx 0$)
- work is done **on** the gas, so W is positive
- by $\Delta U = q + W$, $\Delta U > 0$, so the internal energy and temperature **rise**: the pump feels warm

3.5

(a) the pressure is constant, so the work done by the gas is $W_{\text{by}} = p\Delta V$

$$W_{\text{by}} = p\Delta V = 1.5 \times 10^5\ \text{Pa} \times 4.0 \times 10^{-3}\ \text{m}^3 = \mathbf{600}\ \text{J}$$

(b) the gas does work, so the work done **on** the gas is $W = -600$ J

$$\Delta U = q + W = 1500\ \text{J} + (-600\ \text{J}) = +\mathbf{900}\ \text{J}$$

(c) **zero**

- the volume does not change, so $p\Delta V = 0$

(d) an ideal gas has no intermolecular forces, so its internal energy is the total kinetic energy of its molecules

- pV rises from 300 J to 900 J, so the temperature and the mean kinetic energy of the molecules increase