



## Mark scheme for Topic 10

- 1 The molecules rebound off the piston with a higher average speed, so **C**.
- 2 The work is the area under the curve and so this is  $\frac{(12+4)\times 10^5}{2} \times 6.0 \times 10^{-4} = 480 \text{ J}$ , **D**.

Exam tip: Watch the numbers on the axes and the powers that go with them.

- 3  $Q = \Delta U + W$ ,  $\Delta U = 0$  and so  $W = Q = -500 \text{ J}$ . The magnitude of this is 500 J and so **D**.

- 4  $Q = \Delta U + W$ . At constant volume  $W = 0$  and so  $\Delta U_v = Q$ .

At constant pressure gas expands and so  $\Delta U_p = Q - W$ .

So  $\Delta U_v > \Delta U_p$  and hence temperature increases more in the constant volume case. **[3]**

Exam tip: To see what happens to temperature you must concentrate on what happens to the internal energy.

- 5 a  $n = \frac{pV}{RT} = \frac{9.8 \times 10^6 \times 3.3 \times 10^{-3}}{8.31 \times 580} = 6.7 \text{ moles}$ .

Hence  $N = n \times N_A = 6.7 \times 6.02 \times 10^{23} = 4.0 \times 10^{24}$ . **[2]**

- b i When the temperature is reduced the average speed of the molecules is decreased.

The pressure is related by how many collisions there are per second with the walls and with what speed these collisions take place.

Since the speed is reduced both factors affecting pressure decrease and so the pressure decreases. **[3]**

- ii  $\frac{p_1}{T_1} = \frac{p_2}{T_2} \Rightarrow \frac{9.8 \times 10^6}{580} = \frac{5.4 \times 10^6}{T_2}$

$T_2 = 320 \text{ K}$ . **[2]**

- c**    **i**     $\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{3.3 \times 10^6}{320} = \frac{V_2}{580}$
- $V_2 = 5.98 \times 10^{-3} \approx 6.0 \times 10^{-3} \text{ m}^3$     [1]
- ii**     $W = p\Delta V = 5.4 \times 10^6 \times (6.0 - 3.3) \times 10^{-3}$
- $W = 14580 \text{ J} \approx 15 \text{ kJ}$ .    [2]
- iii**     $Q = \Delta U + W = 22 + 15$
- $Q = 37 \text{ kJ}$ .    [2]
- d**    **i**    The internal energy change is zero since the process is isothermal.
- Work is being done on the gas and so energy must be removed.    [2]
- ii**     $Q = \Delta U + W = 0 - 15$
- Magnitude of  $Q$  is therefore 15 kJ.    [2]
- 6**    **a**    It is a measure of the disorder of a system.    [1]
- b**    **i**    Energy has been removed from the water/the water has turned into more ordered ice.
- And so the entropy of the water has decreased.    [2]
- ii**    The energy removed from the water went into the surroundings.
- And so the entropy of the surroundings increased.    [2]
- c**    The increase in the entropy of the surroundings is greater than the decrease in the entropy of the water,
- so that the overall change in the entropy of the universe is an increase as demanded by the second law of thermodynamics.    [2]