3 **(a)** Define the term entropy.

....

.... [1]

(b) **(i)** Place **one** tick (✓) in each row of Table 3.1 to show the sign of the entropy change, ΔS, for each process.

Table 3.1

process	ΔS is negative	ΔS is positive
steam condensing into water		
solid KC*l* dissolving in water		

[1]

(ii) Chlorine trifluoride, ClF_3, decomposes on heating into its elements, as shown.

reaction 1 $$2ClF_3(g) \rightarrow Cl_2(g) + 3F_2(g)$$

Standard entropies are shown in Table 3.2.

Table 3.2

substance	$ClF_3(g)$	$Cl_2(g)$	$F_2(g)$
$S^\ominus$ / $J K^{-1} mol^{-1}$	+281.6	+223.1	+203.0

Calculate the standard entropy change, $\Delta S^\ominus$, in $J K^{-1} mol^{-1}$, for reaction 1.

$\Delta S^\ominus$ for reaction 1 = ... $J K^{-1} mol^{-1}$ [2]

(c) Group 2 carbonates decompose on heating. The decomposition for one of the Group 2 carbonates, MCO_3, is shown in reaction 2.

reaction 2 $$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

(i) Predict the sign of the entropy change, ΔS, for reaction 2.

Explain your answer.

....

.... [1]

(ii) The Gibbs equation is shown.

$$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$$

Fig. 3.1 shows values of the Gibbs free energy change, $\Delta G^\ominus$, in $kJ mol^{-1}$, at different temperatures, T, in K, for reaction 2.

Assume $\Delta H^\ominus$ and $\Delta S^\ominus$ values for this reaction remain constant over this temperature range.

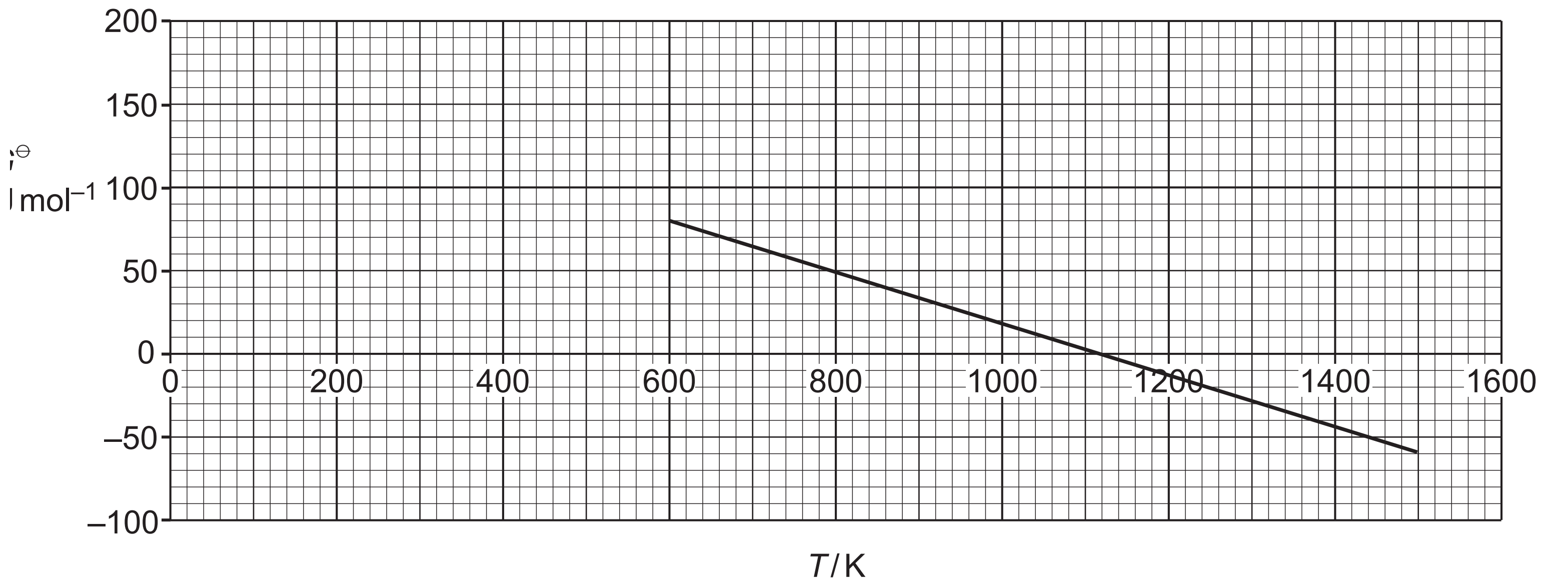

Fig. 3.1

Use the gradient and intercept on the y-axis in Fig. 3.1 and the Gibbs equation to determine:

- $\Delta S^\ominus$, in $J K^{-1} mol^{-1}$, for reaction 2
- the minimum temperature, T, in K, at which the reaction is feasible
- $\Delta H^\ominus$, in $kJ mol^{-1}$, for reaction 2.

$\Delta S^\ominus$ for reaction 2 = ... $J K^{-1} mol^{-1}$

minimum temperature, T = ... K

$\Delta H^\ominus$ for reaction 2 = ... $kJ mol^{-1}$

[4]

[Total: 9]