

3 (a) Define the term entropy.

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 [1]

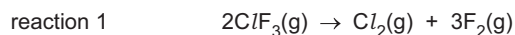
(b) (i) Place **one** tick (✓) in each row of Table 3.1 to show the sign of the entropy change, ΔS , for each process.

Table 3.1

process	ΔS is negative	ΔS is positive
steam condensing into water		
solid KCl dissolving in water		

[1]

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



Standard entropies are shown in Table 3.2.

Table 3.2

substance	$\text{ClF}_3(\text{g})$	$\text{Cl}_2(\text{g})$	$\text{F}_2(\text{g})$
$S^\ominus / \text{JK}^{-1} \text{mol}^{-1}$	+281.6	+223.1	+203.0

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

$\Delta S^\ominus$ for reaction 1 = $\text{JK}^{-1} \text{mol}^{-1}$ [2]

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



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

Explain your answer.

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 [1]
 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.

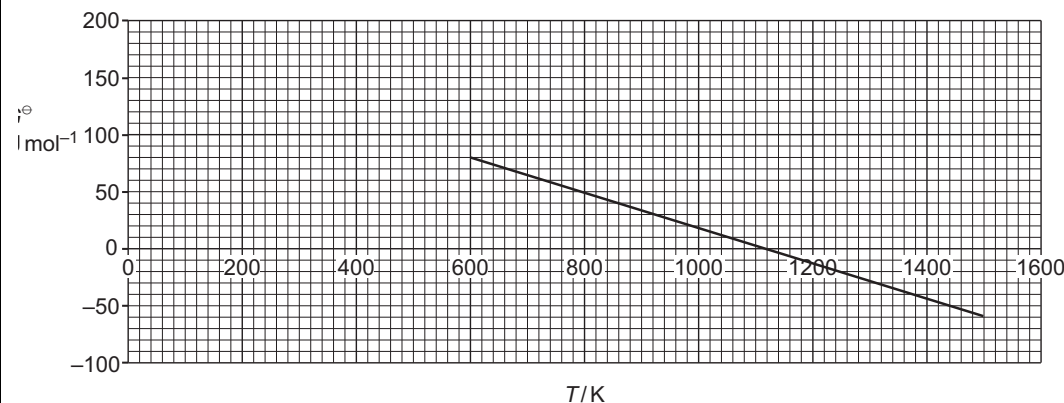


Fig. 3.1

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

- $\Delta S^\ominus$, in $\text{JK}^{-1} \text{mol}^{-1}$, 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 = $\text{JK}^{-1} \text{mol}^{-1}$

minimum temperature, T = K

$\Delta H^\ominus$ for reaction 2 = kJ mol^{-1}
 [4]

②