

Past-paper walk-through

Entropy change, ΔS ■ 23.3

eXercise

Questions in this set

- 9701/44 N25 Q3 ■ 9 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 3

9701/44 N25 ■ Q3 ■ 9 marks

3 (a) Define the term entropy.

Question 3

- (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.



Question 3

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.

Question 3

- (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.

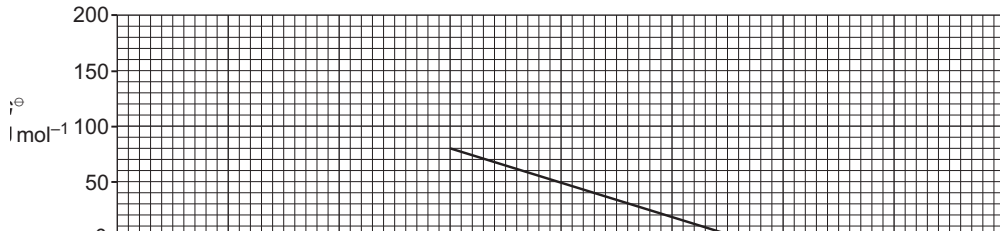
Question 3

(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.



Question 3



Question 3

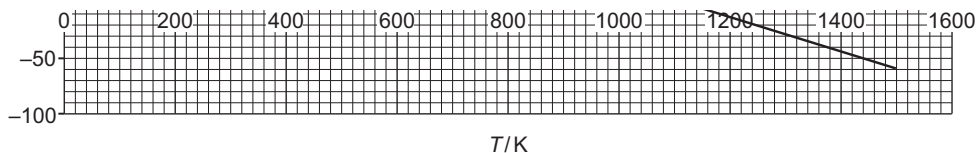


Fig. 3.1

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.

Question 3

Question 3

Question 3

[4]

Total: 91

Solution 3

(a)

Mark scheme

- number of possible arrangements of particles and energy in a system
- 1

Solution 3

(b)(i) Mark scheme

- process
- ΔS is negative
- ΔS is positive
- steam condensing into water
-
- solid KCl dissolving into water
-
- 1

Solution 3

(b)(ii)**Mark scheme**

- M1: three numbers and correct multipliers used
- M2: correct signs and evaluation
- $\Delta S_o = (3 \times 203.0) + (223.1) - (2 \times 281.6) = (+)268.9 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$
- 2

Solution 3

(c)(i)

Mark scheme

- positive
- AND
- gas produced / on the right OR less / no gas on left
- 1

Solution 3

(c)(ii) Mark scheme

- M1 and M2: calculation of gradient from the graph for ΔS
- gradient = $(-)\text{140} / \text{900} = (-)\text{0.1556}$
- $\Delta S_{\text{O}} = (-)\text{0.1556} \times \text{1000}$
- $= (+)\text{155.6} \pm 5 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$
- M3: $T = \text{1120} \pm 5 \text{ (K)}$
- M4: $\Delta H_{\text{O}} = (+)\text{172} \pm 10 \text{ (kJ mol}^{-1}\text{)}$
- 4
- 9701/44

Solution 3

- October/November 2025