

Exercise walk-through

4.2.1

Total entropy and feasibility

Pearson Edexcel · International A-Level · Chemistry

Find the temperature boundary

Your turn

$\Delta H = +36.0 \text{ kJ mol}^{-1}$; $\Delta S(\text{system}) = +120 \text{ J mol}^{-1} \text{ K}^{-1}$. Which condition gives positive total entropy?

- A. T below 300 K
- B. T above 300 K
- C. Every temperature
- D. No temperature

Buffer after neutralisation

Your turn

0.0100 mol HA receives 0.00400 mol OH^- . Which HA:A⁻ ratio enters the buffer expression?

- A. 10:4
- B. 6:4
- C. 4:6
- D. 10:6

Independent structural identification

Your turn

$\text{C}_3\text{H}_6\text{O}$ has two carbon-13 signals, gives iodoform and no Tollens' silver. Which structure fits?

- A. Propanal
- B. Propanone
- C. Propan-1-ol
- D. Ethanoic acid

Exercises 2.1·2.3

2.1 Predict the likely sign of system entropy for $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$, with a reason. [2]

2.2 For $\text{A}(\text{g}) \rightarrow 2\text{B}(\text{g})$, $S^\circ(\text{A}) = 200$ and $S^\circ(\text{B}) = 150 \text{ J mol}^{-1} \text{ K}^{-1}$. Calculate standard

2.3 At 300 K a reaction has $\Delta H = +18.0 \text{ kJ mol}^{-1}$ and $\Delta S(\text{system}) = +90.0 \text{ J mol}^{-1} \text{ K}^{-1}$. Calculate total entropy. [3]

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2.1 Positive: a gas is produced from solids, increasing dispersal/accessible arrangements.

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2.2 $\Delta S = 2(150) - 200 = +100 \text{ J mol}^{-1} \text{ K}^{-1}$.

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2.3 $\Delta S_{\text{surroundings}} = -18000/300 = -60.0 \text{ J mol}^{-1} \text{ K}^{-1}$. Total = $90.0 - 60.0 = +30.0 \text{ J}$

Exercises 3.1·3.2

3.1 A reaction has $\Delta H = +36.0 \text{ kJ mol}^{-1}$ and $\Delta S(\text{system}) = +120 \text{ J mol}^{-1} \text{ K}^{-1}$. Find

3.2 A reaction is exothermic and has negative system entropy. Explain why it may be favoured only at lower temperatures, and why thermodynamic favourability does not imply fast reaction. [3]

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3.1 At the boundary $0 = 120 - 36000/T$, so $T = 300 \text{ K}$. Above 300 K total entropy is positive. ΔH and system ΔS are treated as temperature-independent over the range.

3.2 A reaction is exothermic and has negative system entropy. Explain why it may be favoured only at lower temperatures, and why thermodynamic favourability does not imply fast reaction. [3]

3.2 The positive surroundings term $-\Delta H/T$ decreases as T rises, so it may cease to outweigh negative system entropy. Rate depends on activation energy/pathway rather than total entropy alone.

Exercise 3.3

3.3 (a) State the entropy of a perfect crystal at 0 K, then describe how its entropy changes as it warms within a phase and passes through melting and boiling. (b) Explain why dissolving an ionic crystal does not always give a positive system entropy change. (c) Explain spontaneous spreading of a gas through a sealed room in terms of arrangements and total entropy.

[7]

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3.3 (a) Zero at 0 K for a perfect crystal; entropy increases on warming within a phase; it increases on melting and again on boiling as particles/energy have more accessible arrangements. (b) Released ions disperse through the solvent, but hydration can order surrounding water, so the net system change need not be positive. (c) Dispersal through the larger volume permits more molecular arrangements; the spontaneous direction increases total entropy of the gas and surroundings, without requiring molecules to disappear.