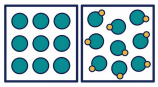
Enthalpy and Entropy Map

OCR A Level Chemistry A · 5.2.2 Enthalpy and entropy

1 Entropy, S

5.2.2(a), (d)

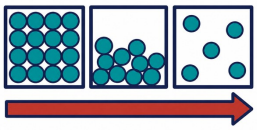
- Endothermic changes can happen: **ΔH alone does not decide**
- **Entropy**: disorder of a system
- Ways of arranging **molecules** and sharing **energy quanta**
- Units **J K^{-1} mol^{-1}** (joules)



2 State and temperature

5.2.2(b)

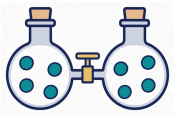
- **Solid < liquid < gas**
- Biggest jump at **boiling**
- S rises with **temperature**
- Perfect crystal at 0 K: **S = 0**

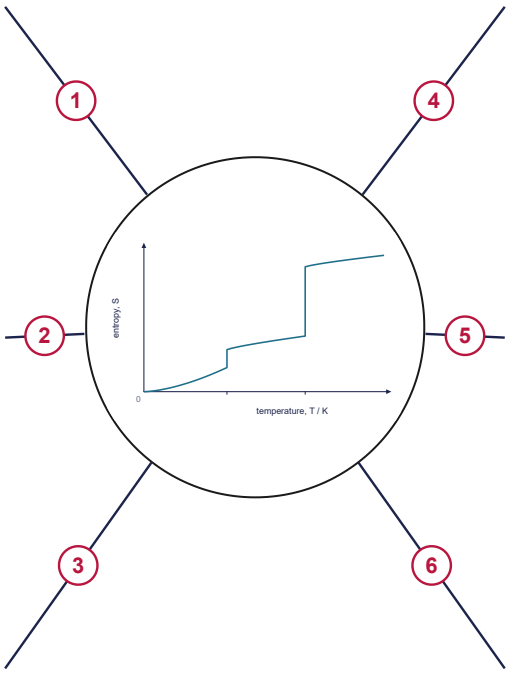


3 The sign of ΔS

5.2.2(b)

- Left alone, change goes the way **disorder increases**
- Gases spread; never gather back
- More moles of gas: **ΔS positive**
- Dissolving: ions freed (+), water ordered (−)





4 ΔS and ΔG

5.2.2(c), (e)

- ΔS = **ΣS(products) − ΣS(reactants)**
- Multiply by the **balancing numbers**
- **ΔG = ΔH − TΔS**: ΔS ÷ 1000 to kJ
- **ΔG ≤ 0**: feasible



5 Temperature and ΔG

5.2.2(d), (e)

- Mixed signs: **temperature decides**
- Turning point: **T = ΔH ÷ ΔS** (ΔG = 0)
- ΔG–T line: intercept **ΔH**, gradient **−ΔS**
- Assume ΔH and ΔS **constant**



6 The limits of ΔG

5.2.2(f)

- ΔG tells you **whether**, not **how fast**
- Feasible but slow: **high E_a**
- e.g. methane in air, H_2 + O_2
- Catalysts lower E_a; ΔG unchanged



Which way does temperature push feasibility?

ΔG = ΔH − TΔS: the −TΔS term grows as T rises

ΔH	ΔS	−TΔS	Feasible
negative	positive	negative	at all temperatures
positive	negative	positive	never
negative	negative	positive	below T = ΔH ÷ ΔS
positive	positive	negative	above T = ΔH ÷ ΔS

Worked examples

ΔS of a reaction

- $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
- 2(69.9) − (2(130.6) + 205.0)
- **−326.4 J K^{-1} mol^{-1}**

Feasibility temperature

- ΔH = +50 kJ mol^{-1}
- ΔS = +125 J K^{-1} mol^{-1}
- T = 50 000 ÷ 125 = **400 K**: feasible above

Methane in air

- ΔG = −818 kJ mol^{-1}: feasible
- but E_a is high: no reaction
- **feasible, yet too slow** until a spark

ΔG returns in 5.2.3 (electrode potentials and cells).

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