

Exercise walk-through

9.2

Absolute Entropy and Entropy Change

AP Chemistry

Entropy

Entropy S measures how spread out matter and energy are among **microstates**. $\Delta S > 0$ for more freedom:

- solid $\rightarrow$ liquid $\rightarrow$ gas
- dissolving a solid
- more gas molecules

Products minus reactants

$$\Delta S^\circ = \sum S^\circ(\text{prod}) - \sum S^\circ(\text{react})$$

Gases have the highest S° ; a reaction making a gas has $\Delta S > 0$.

When entropy increases

entropy S

measures the dispersal of energy and matter – loosely, the **number of ways** to arrange a system

phase

increases solid $\rightarrow$ liquid $\rightarrow$ gas, and the gas step is by far the largest

particle count

more moles of gas on the product side means $\Delta S > 0$

dissolving

usually increases entropy, as an ordered lattice disperses

temperature

raising it increases entropy, because more energy levels become accessible

volume

expanding a gas increases it

Count the **moles of gas** on each side first. That single comparison predicts the sign of ΔS for most reactions on the paper.

Exercises 2.1-2.3

2.1 Write the formula for ΔS° of a reaction.

[1]

2.2 Is S° of an element zero?

[1]

2.3 For products summing to 400 and reactants to 550 J/K, find ΔS° .

[2]

Exercises 2.1-2.3

2.1 Write the formula for ΔS° of a reaction. [1]

2.1

- $\Delta S^\circ = \Sigma S^\circ(\text{products}) - \Sigma S^\circ(\text{reactants})$
-

2.2 Is S° of an element zero? [1]

2.2

- No – it is a positive value
-

2.3 For products summing to 400 and reactants to 550 J/K, find ΔS° . [2]

2.3

- $400 - 550 = -150 \text{ J/K}$

Exercise 3.1

3.1 Unlike ΔH_f° , the standard entropy S° of an element is

[1]

☐

A zero

B a positive value

C negative

D undefined

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3.1 B

- a positive value

Exercise 3.2 (a)

3.2 For $2\text{SO}_2(g) + \text{O}_2(g) \rightarrow 2\text{SO}_3(g)$, with S° : $\text{SO}_2 = 248$, $\text{O}_2 = 205$, $\text{SO}_3 = 257 \text{ J mol}^{-1}\text{K}^{-1}$

(a) Calculate ΔS° .

[3]

Exercise 3.2 (a)

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(a) Calculate ΔS° . [3]

(a)

- $\Delta S^\circ = 2(257) - [2(248) + 205] = 514 - 701 = -187 \text{ J K}^{-1}$

Exercise 3.2 (b)

3.2 For $2\text{SO}_2(g) + \text{O}_2(g) \rightarrow 2\text{SO}_3(g)$, with S° : $\text{SO}_2 = 248$, $\text{O}_2 = 205$, $\text{SO}_3 = 257 \text{ J mol}^{-1}\text{K}^{-1}$

(b) Is the sign consistent with the change in gas moles? [1]

Exercise 3.2 (b)

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(b) Is the sign consistent with the change in gas moles? [1]

(b)

- Yes – 3 gas moles become 2, so a decrease is expected

Exercise 3.3

3.3 Explain why ΔS° is negative for a reaction that goes from 3 moles of gas to 2 moles of gas. [2]

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3.3

- Fewer gas molecules means fewer ways to arrange the particles, so the disorder (entropy) decreases, giving a negative ΔS°