9.2 Absolute Entropy and Entropy Change

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS entropy

Objective

Build the skills to answer exam questions on **absolute entropy and entropy change**.

You must be able to:

- use $\Delta S^\circ = \Sigma S^\circ(\text{products}) - \Sigma S^\circ(\text{reactants})$
- weight each S° by its coefficient
- interpret the sign of the result

1 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later – follow the steps and you can do the Practice and Exam-style questions yourself.

Standard molar entropy

Every substance has a positive **standard molar entropy** S° (unlike ΔH_f, elements are **not** zero). Gases have the largest S°.

The entropy-change formula

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

each weighted by its coefficient.

A worked calculation

For $N_2 + 3H_2 \rightarrow 2NH_3$, with S°: $N_2 = 192$, $H_2 = 131$, $NH_3 = 193$ J mol^{-1}K^{-1}:

$$\Delta S^\circ = 2(193) - [192 + 3(131)] = 386 - 585 = -199 \text{ J K}^{-1}.$$

Negative – consistent with 4 gas moles becoming 2.

■ **Sign check**

The calculated sign should match the qualitative prediction (fewer gas moles → negative). If not, recheck the coefficients.

2 Practice

Now apply the methods above.

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]

3 Exam-style questions

3.1 Unlike ΔH_f°, the standard entropy S° of an element is [1]

- ☐ **A** zero
- **B** a positive value
- **C** negative
- **D** undefined

3.2 For $2SO_2(g)+O_2(g) \rightarrow 2SO_3(g)$, with S°: $SO_2 = 248$, $O_2 = 205$, $SO_3 = 257$ J mol^{-1}K^{-1}.

(a) Calculate ΔS°. [3]

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

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