

6.8 Enthalpy of Formation

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS standard enthalpy of formation

Objective

Build the skills to answer exam questions on **enthalpy of formation**.

You must be able to:

- use standard enthalpies of formation ΔH_f°
- apply $\Delta H_{\text{rxn}} = \Sigma \Delta H_f^\circ(\text{products}) - \Sigma \Delta H_f^\circ(\text{reactants})$
- know that ΔH_f° of an element is zero

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 enthalpy of formation

ΔH_f° is the enthalpy change to make **1 mole** of a compound from its elements in their standard states. For an **element** in its standard state, $\Delta H_f^\circ = 0$.

■ The formula

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

weighting each by its coefficient.

■ A worked calculation

For $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$, with ΔH_f° : $\text{CH}_4 = -75$, $\text{CO}_2 = -394$, $\text{H}_2\text{O} = -286$, $\text{O}_2 = 0$:

$$\Delta H = [(-394) + 2(-286)] - [(-75) + 0] = -966 + 75 = -891 \text{ kJ.}$$

■ Don't forget coefficients

Multiply each ΔH_f° by the species' coefficient before summing – a common lost mark.

2 Practice

Now apply the methods above.

2.1 What is ΔH_f° of an element in its standard state? [1]

2.2 Write the formula for ΔH_{rxn} from formation enthalpies. [1]

2.3 For products summing to -500 and reactants to -200 kJ, find ΔH_{rxn} . [2]

3 Exam-style questions

3.1 The standard enthalpy of formation of $\text{O}_2(g)$ is [1]

- ☐ **A** -286 kJ/mol
B 0
C $+286$ kJ/mol
D unknown

3.2 For $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, $\Delta H_f(\text{H}_2\text{O}) = -286$ kJ/mol.

(a) State ΔH_f of H_2 and O_2 . [1]

(b) Find ΔH_{rxn} . [3]

3.3 For $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$, with ΔH_f : $\text{C}_2\text{H}_4 = +52$, $\text{CO}_2 = -394$, $\text{H}_2\text{O} = -286$, find ΔH_{rxn} . [4]

Solutions

Each answer shows the steps, then the **result**.

2.1

- Zero

2.2

- $\Delta H_{\text{rxn}} = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$

2.3

- $-500 - (-200) = -300 \text{ kJ}$

3.1 B

- an element in its standard state has $\Delta H_f^\circ = 0$

3.2

(a)

- Both 0 (elements)

(b)

- $\Delta H = 2(-286) - [2(0) + 0] = -572 \text{ kJ}$

3.3

- products = $2(-394) + 2(-286) = -1360$; reactants = $52 + 3(0) = 52$; $\Delta H = -1360 - 52 = -1412 \text{ kJ}$