

6.9 Hess's Law

Name: _____ Class: _____ Date: _____

Total: 11 marks**KEY WORDS** hess's law 盖斯定律 • state function 状态函数

Objective

Build the skills to answer exam questions on **Hess's law**.**You must be able to:**

- combine known reactions to find an unknown ΔH (**Hess's law** 盖斯定律)
- **reverse** a reaction (flip ΔH sign) and **scale** it (multiply ΔH)
- add the steps so intermediates cancel

1 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.

■ Hess's law

 ΔH depends only on the **start and end** states, not the path. So you can add known reactions to reach the target reaction, and add their ΔH values.

■ Two allowed moves

- **Reverse** a reaction $\rightarrow$ change the sign of its ΔH .
- **Multiply** a reaction by a factor $\rightarrow$ multiply its ΔH by the same factor.

■ A worked combination

Target: $\text{C} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}$. Given (1) $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$, $\Delta H = -394$; (2) $\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$, $\Delta H = -283$. Reverse (2): $\Delta H = +283$. Add (1) + reversed (2): CO_2 cancels, giving $\Delta H = -394 + 283 = -111$ kJ.

■ Cancel the intermediates

Arrange the steps so the species not in the target reaction cancel between the two sides. What remains must be the target equation.

2 Practice

Now apply the methods above.

2.1 State Hess's law in one sentence.

[1]

2.2 If reversing a reaction, what happens to ΔH ?

[1]

2.3 A reaction has $\Delta H = -100$ kJ. What is ΔH if you multiply the reaction by 2? [1]

3 Exam-style questions

3.1 Hess's law works because ΔH is a

[1]

- **A** state function (path-independent)
- **B** rate
- **C** catalyst
- **D** temperature

3.2 Find ΔH for $\text{N}_2 + 2\text{O}_2 \rightarrow 2\text{NO}_2$ using: (1) $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$, $\Delta H = +180$ kJ; (2) $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$, $\Delta H = -112$ kJ.

(a) State how to combine (1) and (2).

[1]

(b) Find the target ΔH .

[2]

3.3 Find ΔH for $\text{C} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}$ using $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ (-394 kJ) and $\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$ (-283 kJ). Show your reasoning. ^[4]

Solutions

2.1 The enthalpy change of a reaction is the same regardless of the path taken.

2.2 Its sign changes.

2.3 -200 kJ .

3.1 A — ΔH is a state function.

3.2 (a) Add (1) and (2) directly — the 2NO cancels. (b) $\Delta H = 180 + (-112) = +68 \text{ kJ}$.

3.3 Keep reaction 1 as is (-394); reverse reaction 2 ($\text{CO}_2 \rightarrow \text{CO} + \frac{1}{2}\text{O}_2$, $+283$); add — CO_2 cancels, leaving $\text{C} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}$; $\Delta H = -394 + 283 = -111 \text{ kJ}$.