AP CHEMISTRY • EXERCISE SHEET

6.9 Hess's Law

Name: ____________ Class: ________ Date: __________ **Total: 11 marks**

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 → change the sign of its ΔH.
- **Multiply** a reaction by a factor → multiply its ΔH by the same factor.

A worked combination

Target: $C+\frac{1}{2}O_2 \rightarrow CO$. Given (1) $C+O_2 \rightarrow CO_2$, $\Delta H = -394$; (2) $CO+\frac{1}{2}O_2 \rightarrow CO_2$, $\Delta H = -283$. 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 $N_2 + 2O_2 \rightarrow 2NO_2$ using: (1) $N_2 + O_2 \rightarrow 2NO$, $\Delta H = +180$ kJ; (2) $2NO + O_2 \rightarrow 2NO_2$, $\Delta H = -112$ kJ.

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

(b) Find the target ΔH. [2]

3.3 Find ΔH for $C + \frac{1}{2}O_2 \rightarrow CO$ using $C + O_2 \rightarrow CO_2$ (-394 kJ) and $CO + \frac{1}{2}O_2 \rightarrow CO_2$ (-283 kJ). Show your reasoning. [4]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **6.9 Hess's Law** lesson on the **Learn** page;
- read the **Hess's Law** section of the AP Chemistry handout on the **Know** page.

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) $\Delta H = 180 + (-112) = +68$ kJ.

3.3 Keep reaction 1 as is (-394); reverse reaction 2 ($CO_2 \rightarrow CO + \frac{1}{2}O_2$, $+283$); add — CO_2 cancels, leaving $C + \frac{1}{2}O_2 \rightarrow CO$; $\Delta H = -394 + 283 = -111$ kJ.