6 Finding enthalpy changes – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
enthalpy of reaction	反应焓			
enthalpy of formation	生成焓			
Hess's law	盖斯定律			

Recall

In Part A you measured reaction heat. Now **calculate** it from data:

- Breaking bonds takes in energy; making bonds gives energy out.
- You have used bond energies before to estimate a reaction's energy change.

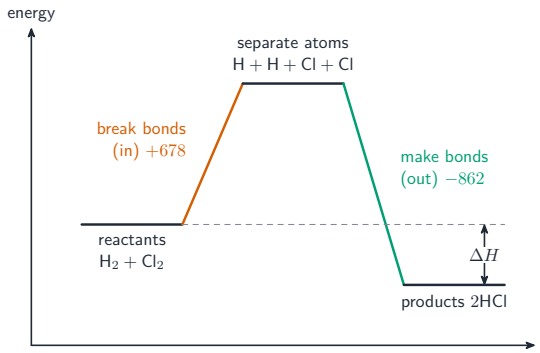
Each idea has a worked example before the Practice.

New ideas

1 Bond enthalpies

The **enthalpy of reaction** 反应焓 ΔH can be estimated from bond energies: add the energy to **break** all reactant bonds, then subtract the energy **released** forming the product bonds:

$$\Delta H \approx \sum(\text{bonds broken}) - \sum(\text{bonds formed}).$$



net: $\Delta H = 678 - 862 = -184$ kJ/mol (exothermic)

Worked example. For $H_2 + Cl_2 \rightarrow 2HCl$ (H–H = 436, Cl–Cl = 242, H–Cl = 431 kJ/mol): broken = 436 + 242 = 678; formed = $2 \times 431 = 862$; $\Delta H \approx 678 - 862 = -184$ kJ (exothermic).

2 Enthalpy of formation

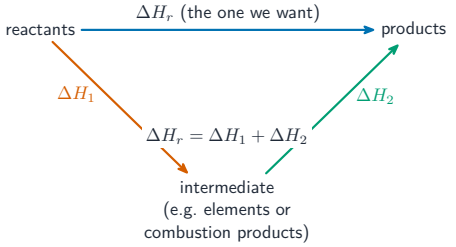
The **enthalpy of formation** 生成焓 ΔH_f is the energy to make one mole of a compound from its elements. A reaction's enthalpy is

$$\Delta H = \sum \Delta H_f(\text{products}) - \sum \Delta H_f(\text{reactants}).$$

Worked example. For $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ (ΔH_f: $CH_4 = -75$, $CO_2 = -394$, $H_2O = -286$, $O_2 = 0$): $\Delta H = [-394 + 2(-286)] - [-75] = -966 + 75 = -891$ kJ.

3 Hess's law

Hess's law 盖斯定律 says that if a reaction is the sum of several steps, its ΔH is the sum of the steps' ΔH values – no matter what route is taken.



Watch out: breaking a bond **takes in** energy (positive) and forming a bond **releases**

energy (negative). If the bonds formed are stronger than the bonds broken, the reaction is exothermic overall.

Practice

Try these in order. The methods are all above.

2.1 State whether breaking a bond takes in or gives out energy, and do the same for forming a bond. [2]

2.2 A reaction breaks bonds worth 500 kJ and forms bonds worth 650 kJ. Find ΔH and state whether it is exothermic. [3]

2.3 For $H_2 + Br_2 \rightarrow 2HBr$ (H–H = 436, Br–Br = 193, H–Br = 366 kJ/mol), estimate ΔH. [3]

2.4 State what Hess's law tells you about the enthalpy change of a reaction that goes in several steps. [1]