5 Enthalpy changes – Part 1

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)		
exothermic	放热			
endothermic	吸热			
enthalpy change	焓变			
activation energy	活化能			
bond energy	键能			

Recall

At IGCSE you learned that reactions can be **exothermic** 放热 (give out heat) or **endothermic** 吸热 (take in heat). Now we measure that energy and give it a symbol.

- The energy change at constant pressure is the **enthalpy change** 焓变, ΔH.
- We can read it off an energy diagram, or work it out from bonds.

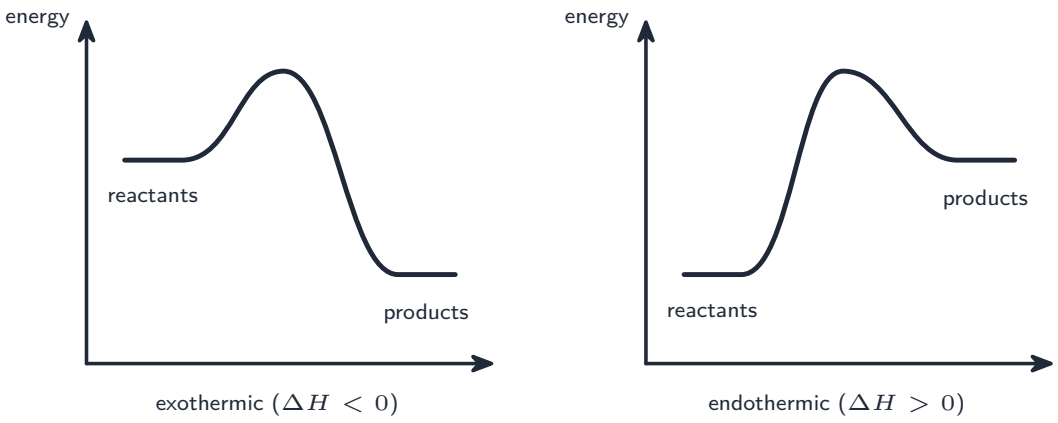
Nothing here is harder than IGCSE — it just adds the symbol ΔH and the bond method.

New ideas

Read these first, then do the Practice.

■ 1 Exothermic and endothermic

- **exothermic** 放热 — gives out heat; products **lower** than reactants; ΔH is **negative**.
- **endothermic** 吸热 — takes in heat; products **higher** than reactants; ΔH is **positive**.



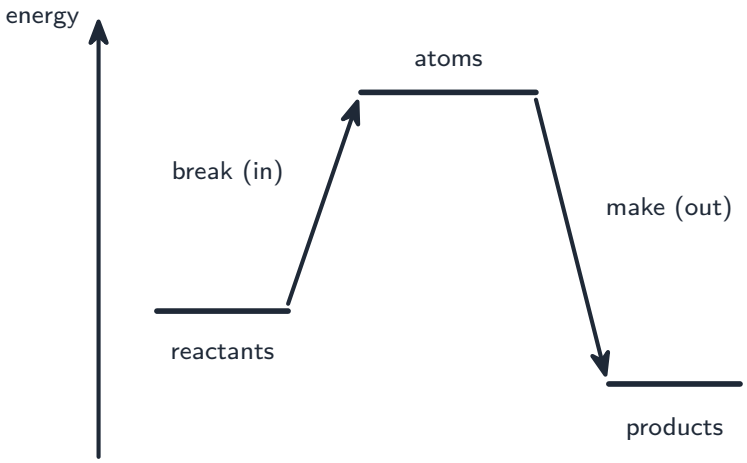
The height of the "hill" is the **activation energy** 活化能 — the least energy needed to start the reaction.

2 Energy from breaking and making bonds

- **breaking** a bond **takes in** energy.
- **making** a bond **gives out** energy.

$$\Delta H = \sum(\text{bonds broken}) - \sum(\text{bonds made})$$

The **bond energy** 键能 is the energy to break one mole of a bond (always positive).



Worked example. $H_2 + Cl_2 \rightarrow 2HCl$. Bond energies: H–H = 436, Cl–Cl = 242, H–Cl = 431.

$$\Delta H = (436 + 242) - (2 \times 431) = 678 - 862 = -184 \text{ kJ mol}^{-1}.$$

Watch out: use $\Delta H = \sum(\text{bonds broken}) - \sum(\text{bonds made})$ in that order. A *negative* answer means exothermic — more energy is released making bonds than is taken in

> breaking them.

Practice

Try these in order.

5.1 State the sign of ΔH for (a) an exothermic, (b) an endothermic reaction. [2]

5.2 In an exothermic reaction, are the products higher or lower in energy than the reactants? [1]

5.3 What is meant by the *activation energy*? [1]

5.4 State whether (a) breaking a bond, (b) making a bond takes in or gives out energy. [2]

5.5 Use bond energies to find ΔH for $H_2 + Br_2 \rightarrow 2HBr$. Bond energies: H–H = 436, Br–Br = 193, H–Br = 366. [3]

5.6 Challenge. A reaction is found to have a negative ΔH. Explain what this tells you about the energy released in making bonds compared with the energy taken in breaking bonds. [2]