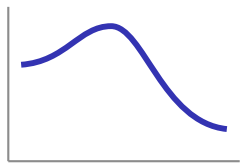
Chemical Energetics

A-Level Chemistry ▪ Topic 5

A-Level Chemistry

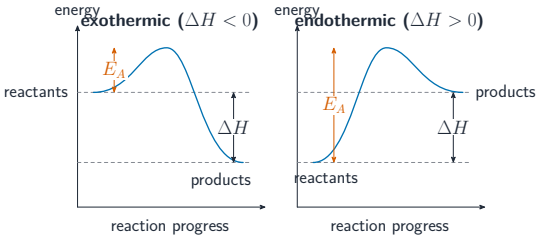


What we will cover

1. Enthalpy change ΔH
2. Types of enthalpy change
3. Bond energy
4. Measuring ΔH
5. Hess's law

burning fuel is exothermic

Enthalpy change ΔH



cold pack

Types of enthalpy change

$\Delta H_r^\ominus$ **reaction 反应焓变** – for the equation as written

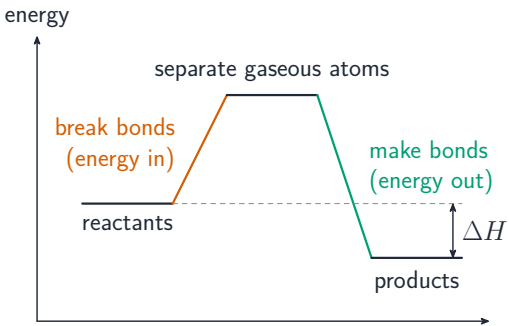
$\Delta H_c^\ominus$ **combustion 燃烧焓变** – 1 mol burnt in oxygen

$\Delta H_f^\ominus$ **formation 生成焓变** – 1 mol of compound from elements

$\Delta H_{\text{neut}}^\ominus$ **neutralisation 中和焓变** – 1 mol of water formed

Standard conditions 标准条件 ($^\ominus$): $298\,\text{K}$, $101\,\text{kPa}$, each substance in its normal state.

Bond energy



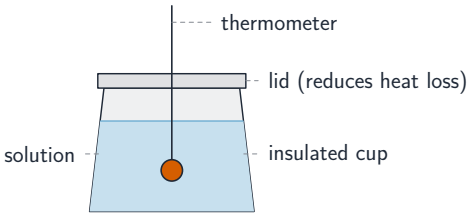
Breaking bonds takes energy in; making bonds gives it out:

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

$H_2 + Cl_2 \rightarrow 2HCl$

$(436 + 242) - (2 \times 431) = -184\,\text{kJ mol}^{-1}$

Measuring ΔH



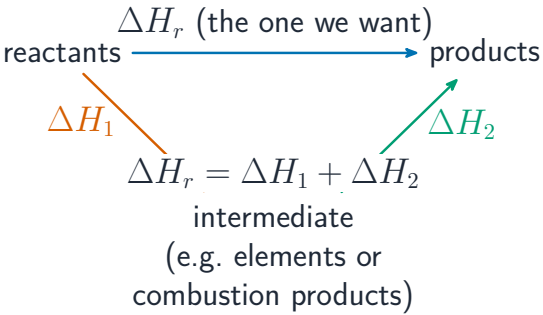
Heat transferred: $q = mc\Delta T$ (**specific heat capacity** 比热容 c).

$$\Delta H = -\frac{mc\Delta T}{n}$$

0.50 g methanol heats 100 g water by 18 °C

$q = 7520\,\text{J},\ n = 0.0156 \Rightarrow \Delta H_c \approx -480\,\text{kJ mol}^{-1}$

Hess's law



Hess's law 盖斯定律: the total enthalpy change is the same by any route (energy is conserved).

> An **energy cycle** 能量循环 finds a ΔH you cannot measure directly: $\Delta H_r = \Delta H_1 + \Delta H_2$.

Topic 5 – key takeaways

1 Enthalpy

exothermic $\Delta H < 0$; endothermic $\Delta H > 0$

2 Bond energy

ΔH = bonds broken − bonds made

3 Calorimetry

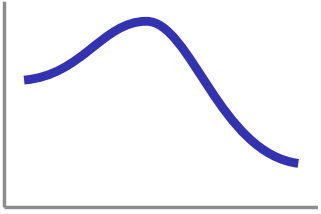
$q = mc\Delta T$; $\Delta H = -q/n$

4 Hess's law

ΔH is route-independent

Check yourself

1. Sign of ΔH for an exothermic reaction?
2. Does breaking a bond take in or give out energy?
3. Write the equation for heat transferred.
4. What does Hess's law say about the route?



Answers **1.** negative **2.** takes in energy **3.** $q = mc\Delta T$ **4.** it is the same by any route