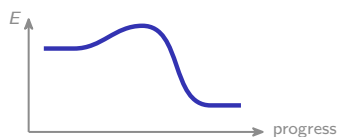


Thermochemistry

AP Chemistry ■ Unit 6

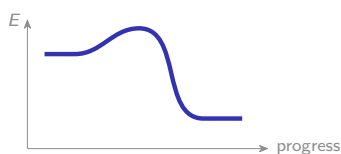
AP Chemistry



Thermochemistry

What we will cover

- 1 Endothermic and exothermic
- 2 Energy diagrams and ΔH
- 3 Calorimetry
- 4 Phase changes
- 5 Bond enthalpies
- 6 Enthalpy of formation
- 7 Hess's law



1

Endo/exo

Endothermic and exothermic

Energy flows between the **system** 系统 and its **surroundings** 环境:

exothermic 放热: releases energy (warms)

endothermic 吸热: absorbs energy (cools)



Endothermic packs absorb heat from surroundings

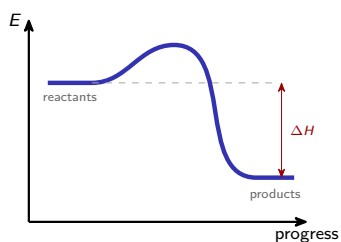
2 Energy diagrams

Energy diagrams and enthalpy

The **enthalpy change** 焓变 ΔH is the heat at constant pressure:

- products **lower** $\Rightarrow \Delta H < 0$ (exothermic)
- products **higher** $\Rightarrow \Delta H > 0$ (endothermic)

ΔH is **extensive** 广延量 – double the moles, double ΔH .



3 Calorimetry

Thermochemistry
└ Calorimetry

Calorimetry

Specific heat 比热容 c warms 1 g by 1°:

Heat transferred

$$q = mc\Delta T$$

Calorimetry 量热法: an isolated system, so

$$q_{\text{rxn}} = -q_{\text{water}}$$

Worked example

100 g water warms 5.0°:

$$q = 100(4.18)(5.0) = 2090 \text{ J}$$

The reaction released -2090 J – exothermic. For 0.010 mol: $\Delta H = -209 \text{ kJ/mol}$.

4 Phase changes

Energy of phase changes

A **phase change** 相变 overcomes **intermolecular forces** 分子间作用力, not bonds.

On a **heating curve** 加热曲线, temperature stays **constant** during a phase change – energy goes into breaking IMFs.

Heat of vaporization 汽化热 > **heat of fusion** 融化热 (boiling separates molecules fully).



Phase changes absorb or release latent heat

5 Bond enthalpies

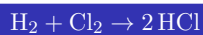
Bond enthalpies

Estimate ΔH from the bonds that change:

Broken minus formed

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

Breaking is endothermic (in), forming exothermic (out).



break H-H (436) + Cl-Cl (243); form 2 H-Cl (431 each):

$$(679) - (862) = -183 \text{ kJ}$$

6 Formation & Hess

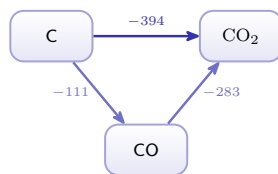
Enthalpy of formation and Hess's law

From a table of ΔH_f°

$$\Delta H_{rxn}^\circ = \sum \Delta H_f^\circ(\text{prod}) - \sum \Delta H_f^\circ(\text{react})$$

An element in its standard state has $\Delta H_f^\circ = 0$.

Hess's law 赫斯定律: ΔH is a **state function** 状态函数 – add steps. **Re-verse** flips the sign; **scale** multiplies it.



Same start
and end $\Rightarrow$ same ΔH .

7 Recap

Unit 6 – key takeaways

1 Enthalpy

$\Delta H < 0$ exothermic; break absorbs, form releases

2 Calorimetry

$$q = mc\Delta T; q_{rxn} = -q_{water}$$

3 Phase change

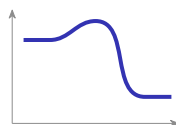
constant T ; vaporization $>$ fusion

4 Enthalpy paths

bond enthalpies; ΔH_f° ; Hess adds steps

Check yourself

- 1 If products sit lower than reactants, what is the sign of ΔH ?
- 2 Does breaking a bond absorb or release energy?
- 3 What happens to temperature during a phase change?
- 4 Reverse a reaction – what happens to its ΔH ?



Answers 1. negative 2. absorb 3. it stays constant 4. its sign flips