

5.1 Exothermic and endothermic reactions

Name: _____ Class: _____ Date: _____

Total: 8 marks

KEY WORDS reaction pathway diagram

• enthalpy change

• products

• reactants

• bond energy

Objective

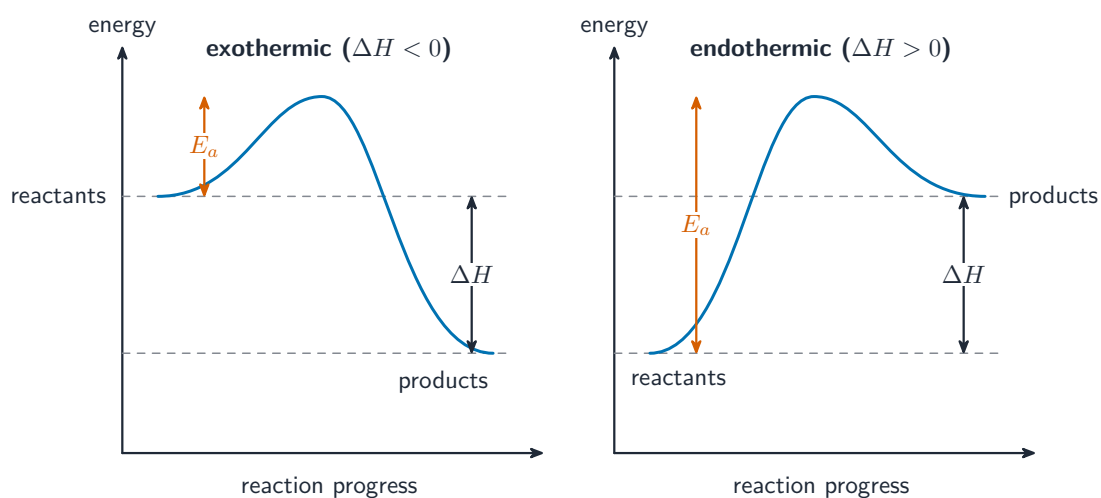
Build the skills to answer exam questions on **exothermic and endothermic reactions** – temperature changes, **enthalpy change** ΔH , **reaction pathway diagrams**, and **bond energy** calculations.

You must be able to:

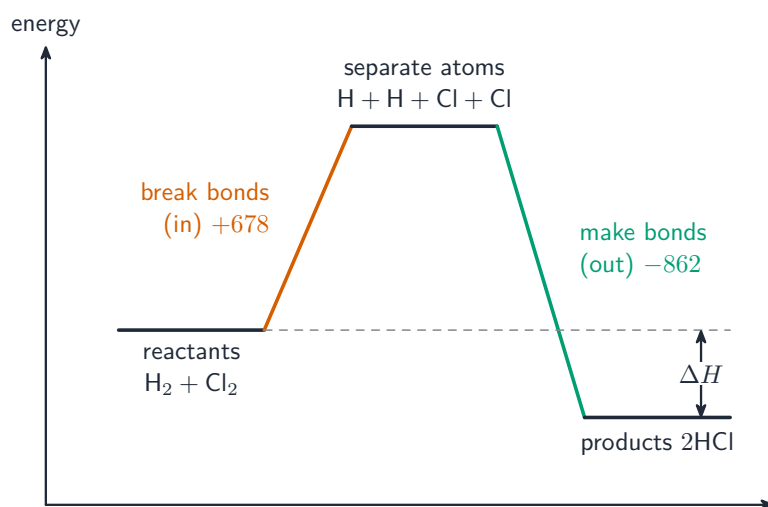
- classify reactions as exothermic ($\Delta H < 0$) or endothermic ($\Delta H > 0$)
- interpret a reaction pathway diagram (activation energy, ΔH)
- calculate ΔH from bond energies

1 Key knowledge and worked examples

■ Bond energy calculation



Exothermic: products lower ($\Delta H < 0$). Endothermic: products higher ($\Delta H > 0$)



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

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

$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$: broken $436 + 242 = 678$; made $2 \times 431 = 862$; $\Delta H = 678 - 862 = -184 \text{ kJ/mol}$.

2 Practice

2.1 State the sign of ΔH for an exothermic reaction.

[1]

2.2 State whether bond breaking takes in or gives out energy.

[1]

3 Exam-style questions

3.1 During an endothermic reaction, the temperature of the surroundings:

[1]

☐

A rises

B falls

C stays the same

D rises then falls

3.2 Consider $\text{H}_2 + \text{F}_2 \rightarrow 2\text{HF}$. Bond energies (kJ/mol): $\text{H-H} = 436$, $\text{F-F} = 158$, $\text{H-F} = 568$.

(a) Calculate ΔH . [3]

(b) State whether the reaction is exothermic or endothermic. [1]

3.3 On a reaction pathway diagram, state what the height of the 'hill' above the reactants represents. [1]

Solutions

Each answer shows the steps, then the **result**.

2.1

- an exothermic reaction gives out energy
- ΔH is **negative**

2.2

- bond breaking **takes in** energy (endothermic)

3.1 B

- an endothermic reaction takes in energy, so the surroundings **cool down**
- A is exothermic; C and D are wrong

3.2

(a)

- bonds broken = $436 + 158 = 594 \text{ kJ mol}^{-1}$
- bonds made = $2 \times 568 = 1136 \text{ kJ mol}^{-1}$

$$\Delta H = \text{bonds broken} - \text{bonds made} = 594 \text{ kJ mol}^{-1} - 1136 \text{ kJ mol}^{-1} = -\mathbf{542 \text{ kJ mol}^{-1}}$$

(b)

- ΔH is negative, so the reaction is **exothermic**

3.3

- the height of the hill above the reactants is the **activation energy**