5.1 Exothermic and endothermic reactions

Name: _____ Class: _____ Date: _____ **Total: 8 marks**

KEY WORDS reaction pathway diagram • reactants • bond energy • enthalpy change • products

Objective

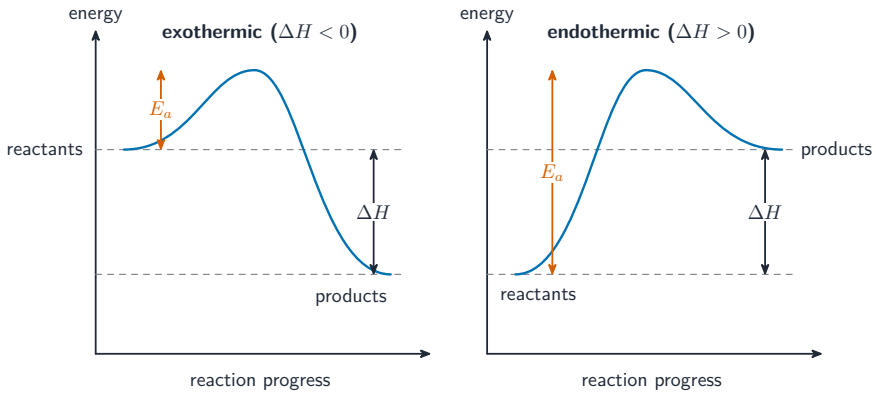
Build the skills to answer exam questions on **exothermic and endothermic reactions** – temperature changes, **enthalpy change** ΔH, **reaction pathway diagrams**, and **bond energy** calculations.

You must be able to:

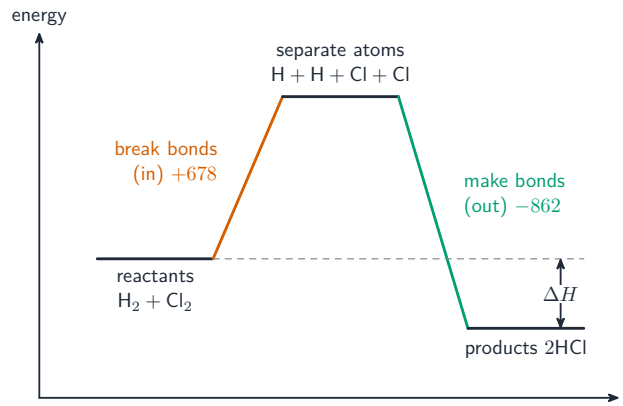
- classify reactions as exothermic ($\Delta H < 0$) or endothermic ($\Delta H > 0$)
- interpret a reaction pathway diagram (activation energy, ΔH)
- calculate ΔH from bond energies

1 Key knowledge and worked examples

■ Bond energy calculation



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



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

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

$H_2 + Cl_2 \rightarrow 2HCl$: broken $436 + 242 = 678$; made $2 \times 431 = 862$; $\Delta H = 678 - 862 = -184$ 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 $H_2 + F_2 \rightarrow 2HF$. Bond energies (kJ/mol): H–H = 436, F–F = 158, 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 $= 436 + 158 = 594$ kJ mol^{-1}
- bonds made $= 2 \times 568 = 1136$ kJ mol^{-1}

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

(b)

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

3.3

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