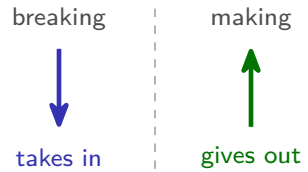
Exercise walk-through

5.1 Exothermic and endothermic reactions

IGCSE Chemistry

What we will cover

1. Exothermic vs endothermic
2. Enthalpy change ΔH
3. Activation energy
4. Reaction pathway diagrams
5. Bonds & energy



bonds and energy

Exothermic, endothermic, and activation energy

exothermic	gives out heat, so the surroundings warm and ΔH is negative
the examples	**combustion** – burning a fuel – and **neutralisation** , an acid reacting with an alkali
endothermic	takes in heat, so the surroundings cool and ΔH is positive
the examples	thermal **decomposition** , and photosynthesis
activation energy	E_a – the smallest energy **colliding** **particles** must have to react at all
bond energy	breaking bonds takes in energy, making them gives out energy – and the difference is ΔH

ΔH = energy in to break bonds − energy out from making them. Getting that subtraction the right way round decides the sign.

Exam tips

- **Exothermic** gives out heat, so the surroundings warm up and ΔH is *negative*; **endothermic** takes in heat, so the surroundings cool and ΔH is *positive*.
- **Bond breaking** takes energy in (endothermic); **bond making** gives energy out (exothermic). Use
  $\Delta H = (\text{energy to break bonds}) - (\text{energy released making bonds})$.
- If more energy is released making bonds than is used breaking them, the reaction is exothermic. Always check the sign of your final answer.
- On a **reaction pathway diagram**, an exothermic reaction ends *lower* than it starts; an endothermic one ends *higher*. The height of the hill is the **activation energy**.

Exercises 2.1·2.2

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]

Exercises 2.1·2.2

2.1 State the sign of ΔH for an exothermic reaction. [1]

2.1

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

2.2 State whether bond breaking takes in or gives out energy. [1]

2.2

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

Exercise 3.1

3.1 During an endothermic reaction, the temperature of the surroundings: [1]

- ☐ **A** rises
- **B** falls
- **C** stays the same
- **D** rises then falls

Exercise 3.1

3.1 During an endothermic reaction, the temperature of the surroundings: [1]

- ☐ **A** rises
- **B** falls
- **C** stays the same
- **D** rises then falls

3.1 B

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

Exercise 3.2 (a)

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]

Exercise 3.2 (a)

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]

(a)

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

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

Exercise 3.2 (b)

3.2 Consider $H_2 + F_2 \rightarrow 2HF$. Bond energies (kJ/mol): H–H = 436, F–F = 158, H–F = 568.

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

Exercise 3.2 (b)

3.2 Consider $H_2 + F_2 \rightarrow 2HF$. Bond energies (kJ/mol): H–H = 436, F–F = 158, H–F = 568.

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

(b)

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

Exercise 3.3

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

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

3.3

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