

Chemical energetics

IGCSE Chemistry 0620 · Topic 5 revision notes

Everything from the 3 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Exothermic and endothermic reactions

2. Reaction pathway diagrams

3. Bond breaking, bond making and bond energies

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1 Exothermic and endothermic reactions

Syllabus 5.1

An **exothermic** reaction transfers thermal energy **to** the surroundings, so the temperature of the surroundings increases. An **endothermic** reaction takes in thermal energy **from** the surroundings, so the temperature of the surroundings decreases. **Extended:** the transfer of thermal energy during a reaction is the enthalpy change, ΔH . ΔH is negative for exothermic reactions and positive for endothermic reactions.

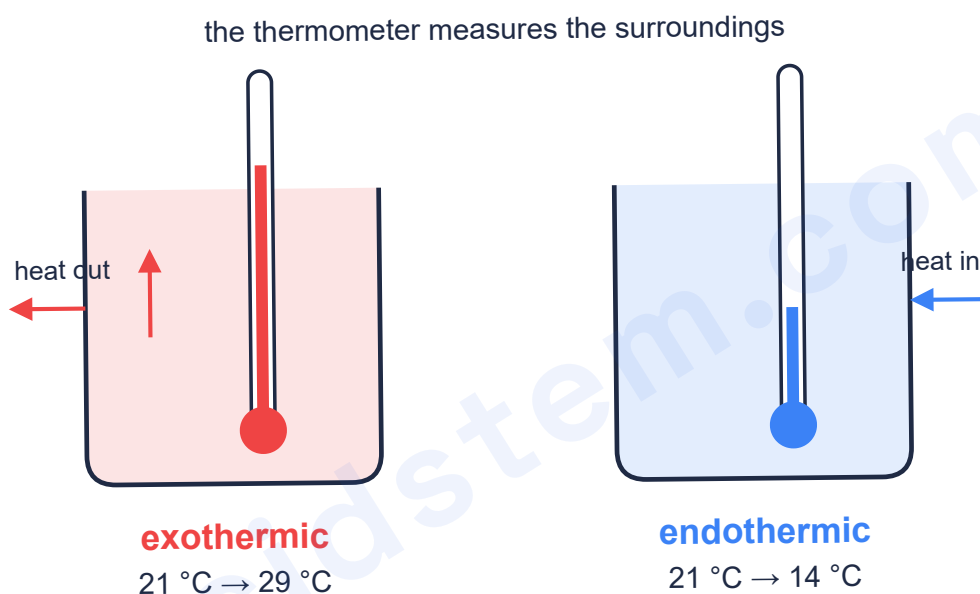


Fig. 1: the temperature of the surroundings tells you the direction of energy transfer

Exo out, endo in.

- ✓ **Exothermic:** energy to the surroundings; temperature rises.
- ✓ **Endothermic:** energy from the surroundings; temperature falls.
- ✓ **Extended:** ΔH negative for exothermic, positive for endothermic.
- ✓ **Reverse the reaction,** reverse the sign of ΔH .

Watch out!

In an endothermic reaction the **chemicals** gain energy, but the **thermometer** shows a fall, because it measures the surroundings, which have lost energy. Do not say an endothermic reaction "gives out cold": cold is not a form of energy.

2 Reaction pathway diagrams

Syllabus 5.1

On a reaction pathway diagram, if the products are **lower** in energy than the reactants the reaction is **exothermic**; if the products are **higher** it is **endothermic**. **Extended:** the enthalpy change ΔH is the difference in energy between reactants and products. The **activation energy**, E_a , is the minimum energy that colliding particles need in order to react; it is the height of the hill from the reactants to the top.

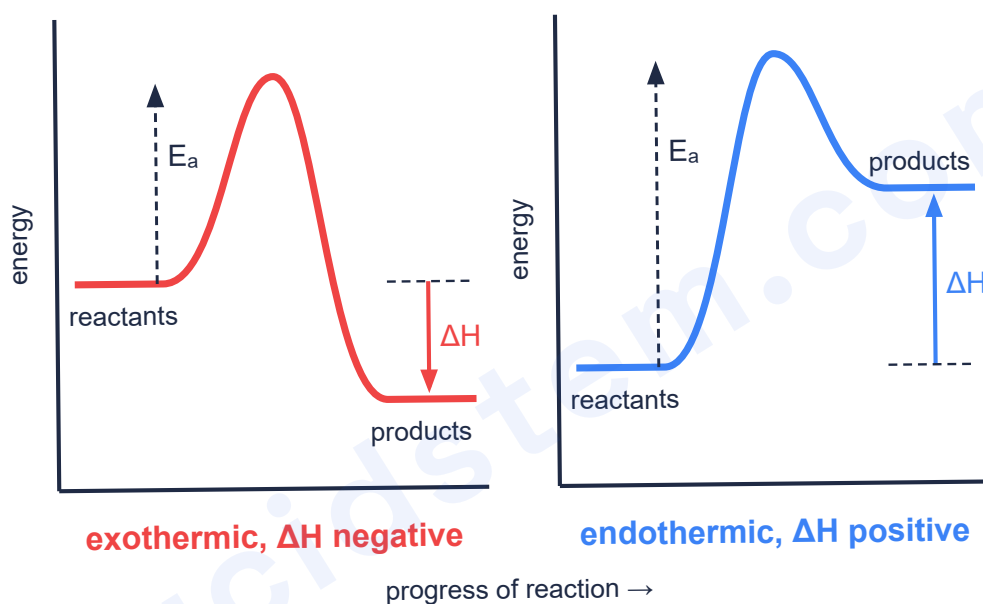


Fig. 1: reaction pathway diagrams for an exothermic and an endothermic reaction

Start every arrow at the reactants.

- ✓ **Products lower:** exothermic. **Products higher:** endothermic.
- ✓ **E_a :** reactants up to the top of the hill.
- ✓ **ΔH :** reactants to products; down is negative, up is positive.
- ✓ **Catalyst:** lower hill, same ΔH .

Watch out!

The activation energy arrow starts at the **reactants**, not at the bottom axis and not at the products. And ΔH is measured between the reactant and product levels, not from the top of the hill. Arrows drawn from the axis lose the mark.

3 Bond breaking, bond making and bond energies

Syllabus 5.1

Extended. **Bond breaking is endothermic**: energy must be taken in to separate atoms. **Bond making is exothermic**: energy is released when atoms join. ΔH = energy needed to break bonds – energy released making bonds. If more energy is released making the new bonds than is needed to break the old ones, ΔH is negative and the reaction is exothermic.

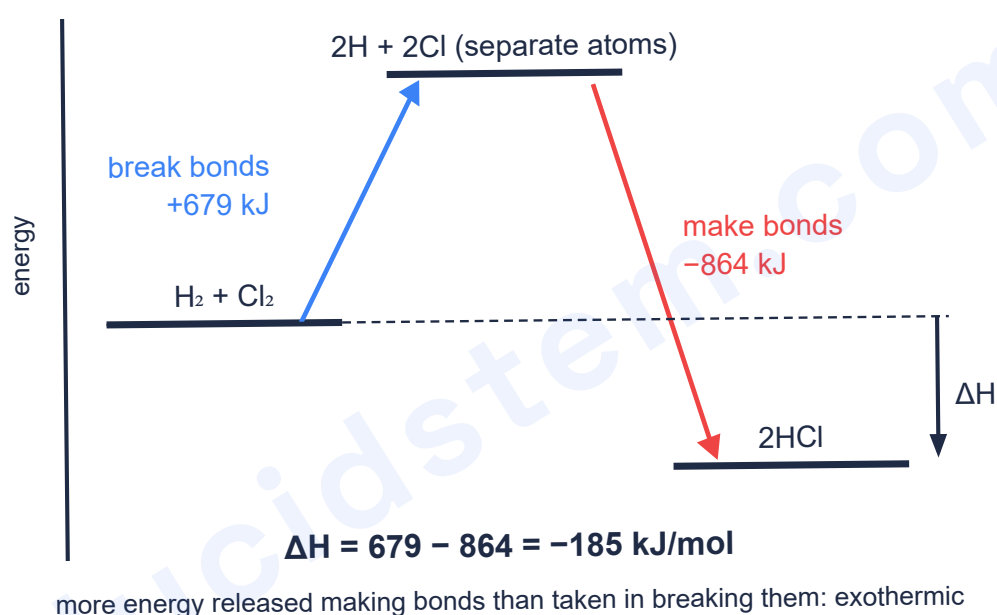


Fig. 1: breaking and making bonds in $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$

Broken minus made.

- ✓ **Draw displayed formulae** and count every bond.
- ✓ **Multiply** by the numbers in the equation.
- ✓ **ΔH = bonds broken – bonds made.**
- ✓ **Negative:** exothermic. **Positive:** endothermic.

Watch out!

Multiply each bond energy by the number of those bonds, including the big numbers in the equation: 2O_2 means two $\text{O}=\text{O}$ bonds, and CO_2 has **two** $\text{C}=\text{O}$ bonds. And always subtract in the order broken – made. Doing it the other way round gives the right number with the wrong sign.