Topic 3: Physical chemistry

Edexcel International GCSE Chemistry 4CH1 · Section 3 · statements 3.1–3.22C · sheet 3.1

Heat, speed and finish

Your turn

A factory makes ammonia from nitrogen and hydrogen.

A. Does the reaction give out or take in heat?

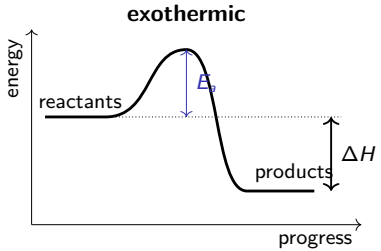
B. What could make it go faster?

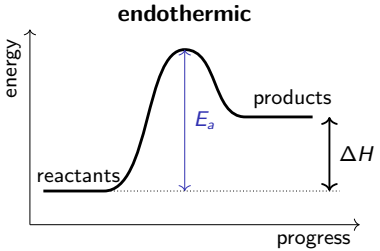
C. Why does it never turn all the reactants into ammonia?

Exothermic and endothermic

Exothermic: products below reactants. Endothermic: products above.

- Exothermic gives out heat; ΔH is negative.
- Endothermic takes heat in; the mixture cools.





Measuring heat with Q = mcΔT

1. **Known** 50 g of water rises 24 °C; 0.010 mol of fuel burns; c = 4.2 J/g °C.
2. **Equation** $Q = mc\Delta T$
3. **Substitute** $Q = 50 \times 4.2 \times 24 = 5040$ J
4. **Per mole** $\Delta H = -5040 / 0.010 = -504\,000$ J/mol

Decision

ΔH = −504 kJ/mol; negative because the burning gave out heat.

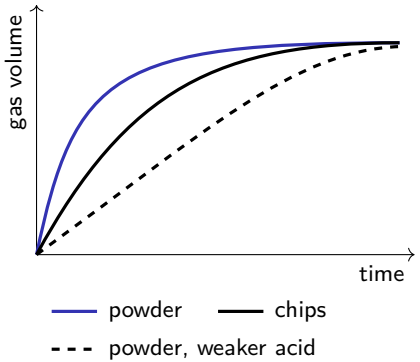
(C) Bond energies

1. **Reaction** $H_2 + Cl_2 \rightarrow 2HCl$
2. **Broken** $436 + 242 = 678$ kJ/mol
3. **Formed** $2 \times 431 = 862$ kJ/mol
4. **ΔH** $678 - 862 = -184$ kJ/mol

Decision

More energy is released making bonds than is taken in breaking them, so it is **exothermic**.

Following a rate



> The steeper the start, the faster; the level part means the reaction has finished.

- Measure gas volume, mass loss, or a disappearing cross.
- The steeper the curve, the faster the reaction.

Four levers and collision theory

Lever	Why the rate rises
surface area	more exposed particles, so more collisions per second
concentration or pressure	particles closer together, so more frequent collisions
temperature	faster particles collide more often and more energetically
catalyst	an alternative pathway with lower **activation energy**

Use the evidence

A catalyst is unchanged at the end and makes no extra product.

Reversible reactions

Examples

Hydrated copper(II) sulfate $\rightleftharpoons$ anhydrous copper(II) sulfate + water: heat drives it forward, water reverses it.

Ammonium chloride $\rightleftharpoons$ ammonia + hydrogen chloride on heating.

(C) Dynamic equilibrium

Forward and reverse rates are equal.

Concentrations stay constant, yet both reactions still run.

(C) Shifting the equilibrium

Change	**Shift**	**$N_2 + 3H_2 \rightleftharpoons 2NH_3$ (forward exothermic)**
temperature up	endothermic direction	left, less ammonia
pressure up	side with fewer moles of gas	right (4 moles $\rightarrow$ 2), more ammonia
catalyst added	no shift; both rates rise equally	equilibrium reached sooner

Check yourself

Your turn

Answer without notes, then check.

A. 100 g of water cools by 8.0 °C in a dissolving experiment. Calculate Q.

B. Why does powdered marble react faster than one large chip?

C. Define a catalyst.

D. (C) State the two features of dynamic equilibrium.

E. (C) What does raising the pressure do to $N_2 + 3H_2 \rightleftharpoons 2NH_3$?