

Endothermic	Energy is taken in from the surroundings so the temperature of the surroundings decreases	- Thermal decomposition - Sports injury packs
Exothermic	Energy is transferred to the surroundings so the temperature of the surroundings increases	- Combustion - Hand warmers - Neutralisation

Ionic half equations	Negative electrode: $2\text{H}_2(\text{g}) + 4\text{OH}^-(\text{aq}) \rightarrow 4\text{H}_2\text{O}(\text{l}) + 4\text{e}^-$	Positive electrode: $\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$
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Hydrogen fuel cells	Word equation: <i>hydrogen + oxygen → water</i>	Symbol equation: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
	Advantages: - No pollutants produced - Can be a range of sizes	Disadvantages: - Hydrogen is highly flammable - Hydrogen is difficult to store

Reaction profiles	Show the overall energy change of a reaction
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Breaking bonds in reactants	Endothermic process
Making bonds in products	Exothermic process

Overall energy change of a reaction	Exothermic	Energy released making new bonds is greater than the energy taken in breaking existing bonds.
	Endothermic	Energy needed to break existing bonds is greater than the energy released making new bonds.

Bond energy calculation	Calculate the overall energy change for the forward reaction $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$
	Bond energies (in kJ/mol): H-H 436, H-N 391, N≡N 945
	Bond breaking: $945 + (3 \times 436) = 945 + 1308 = 2253 \text{ kJ/mol}$
	Bond making: $6 \times 391 = 2346 \text{ kJ/mol}$ Overall energy change = $2253 - 2346 = -93 \text{ kJ/mol}$ Therefore reaction is exothermic overall.

Types of reaction

The energy change of reactions (HT only)

AQA Chemistry
C5: Energy Changes

Cells and batteries (Chemistry only)

Fuel cells (Chemistry only)

Reaction profiles

Activation energy	Chemical reactions only happen when particles collide with sufficient energy	The minimum amount of energy that colliding particles must have in order to react is called the activation energy.
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Simple cell	Make a simple cell by connecting two different metals in contact with an electrolyte	Increase the voltage by increasing the reactivity difference between the two metals.
Batteries	Consist of two or more cells connected together in series to provide a greater voltage.	

Non-rechargeable cells	Stop when one of the reactants has been used up	Alkaline batteries
Rechargeable cells	Can be recharged because the chemical reactions are reversed when an external electrical current is supplied	Rechargeable batteries

Endothermic		Products are at a higher energy level than the reactants. As the reactants form products, energy is transferred from the surroundings to the reaction mixture. The temperature of the surroundings decreases because energy is taken in during the reaction.
Exothermic		Products are at a lower energy level than the reactants. When the reactants form products, energy is transferred to the surroundings. The temperature of the surroundings increases because energy is released during the reaction.