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Topic 5 AQA Chemistry -Energy changes

- Triple Science Content only in purple
- Triple Science and Higher Content Only in blue

Exothermic and endothermic reactions:

The energy of a chemical reaction **is conserved**

Exothermic reactions	*Endothermic reactions*
• An exothermic reaction is one that **transfers energy to the surroundings** so the temperature of the surroundings increases. The product must have **less energy than the reactants**, as energy has been transferred to the surroundings. • Examples of exothermic reactions include; **combustion and neutralisation.** • Everyday examples of exothermic reactions include; self-heating cans, hand warmers.	An endothermic reaction is one that **takes in energy from the surroundings** so the temperature of the surroundings decreases. product must have **more energy than reactants** as energy has been taken in Examples of endothermic reactions are **thermal decomposition** and the reaction of citric acid and sodium hydrogen carbonate. • sports injury packs are based on endothermic reactions.

- Chemical reactions can occur only when reacting particles **collide with each other** and with sufficient energy (activation energy)

Activation energy = minimum amount of energy that particles must have to react

Reaction profiles show the relative energies of reactants and products, the activation energy and the energy change of a reaction:

Exothermic: heat released to the surroundings, so products have less energy than

reactants

Endothermic: heat taken in from surroundings, so products have more energy than reactants

The energy change of reactions

Breaking and Making Bonds

- During a **chemical reaction**, **energy** is involved in **bond breaking** and **bond making**.
- **Energy must be supplied (endothermic)** to **break bonds** in the **reactants**.
- **Energy is released (exothermic)** when **new bonds form** in the **products**.

Calculating Overall Energy Change

- The **overall energy change** can be calculated using:

Overall energy change=Energy needed to break bonds−Energy released when bonds form

Types of Reaction

- If **energy needed to break bonds** > **energy released when bonds form** → **Endothermic reaction** (energy taken in).
- If **energy needed to break bonds** < **energy released when bonds form** → **Exothermic reaction** (energy released).

Chemical cells and fuel cells

A **chemical cell** is a device that produces electricity through a **chemical reaction between two different substances**.

- In a cell, **chemical energy** is converted into **electrical energy**.
- When the reactants are used up, the reaction stops → no more electricity is produced

Batteries:

- A **battery** is made by **joining two or more cells in series** to increase the voltage.

Non-Rechargeable Cells:

- In some cells, the chemical reactions are **irreversible**.
- Once one of the reactants is used up, the cell **stops producing electricity**.
- Example: **Alkaline batteries** (zinc–manganese dioxide).

Rechargeable Cells:

- The reactions can be **reversed** by applying an **external electrical current**.
- This **reforms the original chemicals**, allowing the cell to be used again.
- Examples: Lithium-ion batteries (used in phones, laptops, electric cars).

Advantages of rechargeable cells:
✅ Can be reused many times
✅ Reduces waste and overall cost over time

Disadvantages:
❌ More expensive to manufacture
❌ Lose efficiency after repeated charging cycles
❌ May eventually stop recharging due to chemical degradation

Fuel Cells

A **fuel cell** is a device that produces electricity **by reacting a fuel with oxygen**, without burning it.

- The reaction happens **electrochemically** — meaning energy is released as electricity, not heat.
- The most common example: **Hydrogen fuel cell**.

The Hydrogen Fuel Cell

Fuel: Hydrogen gas (H_2)
Oxidant: Oxygen gas (O_2)

These gases react to produce **water** and **electricity**.

Overall reaction:

2H2+O2→2H2O2H_2 + O_2 → 2H_2O2H2+O2→2H2O

Advantages of Hydrogen Fuel Cells

Advantage	*Explanation*
No harmful emissions	*Only water is produced — no carbon dioxide if hydrogen is pure.*
Continuous energy supply	*Will keep producing electricity as long as fuel and oxygen are supplied.*
Efficient	*Converts chemical energy directly into electrical energy (less energy wasted as heat).*
Lightweight	*Suitable for vehicles like buses and spacecraft.*

Disadvantages of Hydrogen Fuel Cells

Disadvantage	*Explanation*
Hydrogen storage	*Hydrogen gas is flammable and must be stored under high pressure.*
Hydrogen production	*Most hydrogen today is made from natural gas (releases CO_2), so not fully carbon-neutral.*

Infrastructure	*Hydrogen refuelling stations are not widely available.*
High cost	*Platinum catalysts are expensive.*