5 Energy

Endothermic and Exothermic reactions

- Energy is conserved in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the **same** as before the reaction takes place.
- If a reaction transfers energy to the surroundings the **product** molecules must have **less energy** than the reactants, by **the amount transferred.**
- **Exothermic** reactions include combustion, many oxidation reactions and neutralisation.
- Everyday uses of exothermic reactions include self-heating cans and hand warmers.
- **Endothermic** reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate. Some sports injury packs are based on endothermic reactions.

Definitions

Exothermic – a reaction that transfers energy to the surroundings so the temperature of the surroundings increases.
Endothermic – a reaction that takes in energy from the surroundings so the temperature of the surroundings decreases.
Activation energy - The minimum amount of energy that particles must have to react.
Reaction profile - used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.

Higher tier only

During a chemical reaction:

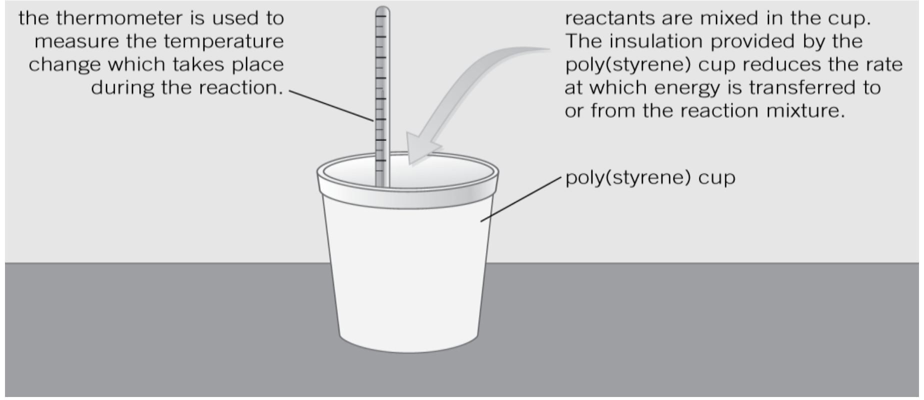
- energy must be **supplied** to **break bonds** in the reactants
- energy is **released** when bonds in the **products are formed**.

The energy needed to break bonds and the energy released when bonds are formed can be calculated from **bond energies**.

The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction.

In an exothermic reaction, the energy released from **forming new bonds** is **greater** than the energy needed to **break** existing bonds.
In an endothermic reaction, the energy needed to **break** existing bonds is **greater** than the energy released from **forming** new bonds.

Required practical



- Displacement (e.g. Copper Sulfate + Iron → Iron Sulfate + Copper)
- Neutralisation (e.g. Hydrochloric Acid + Sodium Hydroxide → Sodium Chloride + Water)

Chemical cells and fuel cells TRIPLE ONLY

Cells contain chemicals which react to produce electricity.

The **voltage** (potential difference) produced by a cell is dependent upon a number of factors including the **type of electrode** and **electrolyte**.

A simple cell can be made by connecting **two different metals** in contact with an electrolyte.

In **non-rechargeable** cells and batteries the chemical reactions stop when one of the reactants has been used up. Alkaline batteries are non-rechargeable.
Rechargeable cells and batteries can be recharged because the chemical reactions are **reversed** when an external electrical current is supplied.
Fuel cells are supplied by an external source of fuel (eg hydrogen) and oxygen or air. The fuel is **oxidised** electrochemically within the fuel cell to produce a potential difference.

The overall reaction in a hydrogen fuel cell involves the **oxidation of hydrogen** to produce **water**.

Hydrogen fuel cells offer a potential alternative to rechargeable cells and batteries.

Half equations in a hydrogen fuel cell: **(HT only)**

$2H_2$ -> $4H_+$ $+4e^-$ (negative electrode)
$0_2 + 4H^+ + 4e^-$ -> $2H_2O$ (positive electrode)

$2H_2 + O_2$ -> $2H_20$ (overall)