WJEC Wales Chemistry GCSE

2.4: Chemical reactions and energy

Detailed notes

Energy transfer during exothermic and endothermic reactions

When chemical reactions occur, energy is transferred to or from its surroundings – it is conserved.

- The amount of energy at the beginning is the same as at the end.

Exothermic reactions

- An exothermic reaction is one that transfers energy to the surroundings so the temperature of the surroundings increases.
- Examples of exothermic reactions include combustion, many oxidation reactions and neutralisation.
- Everyday examples of exothermic reactions include self-heating cans (e.g for coffee) and hand warmers.

Endothermic reactions

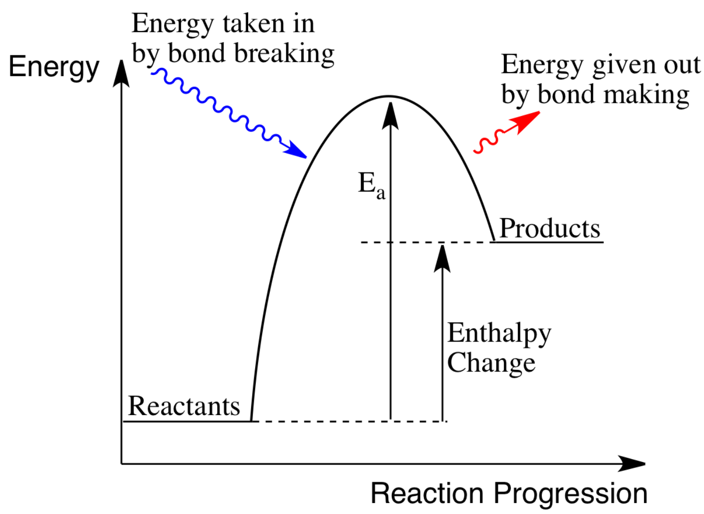
- An endothermic reaction is one that takes in energy from the surroundings so the temperature of the surroundings decreases.
- Examples of endothermic reactions are thermal decomposition and the reaction of citric acid and sodium hydrogencarbonate.
- Some sports injury packs are based on endothermic reactions.

Reaction profiles

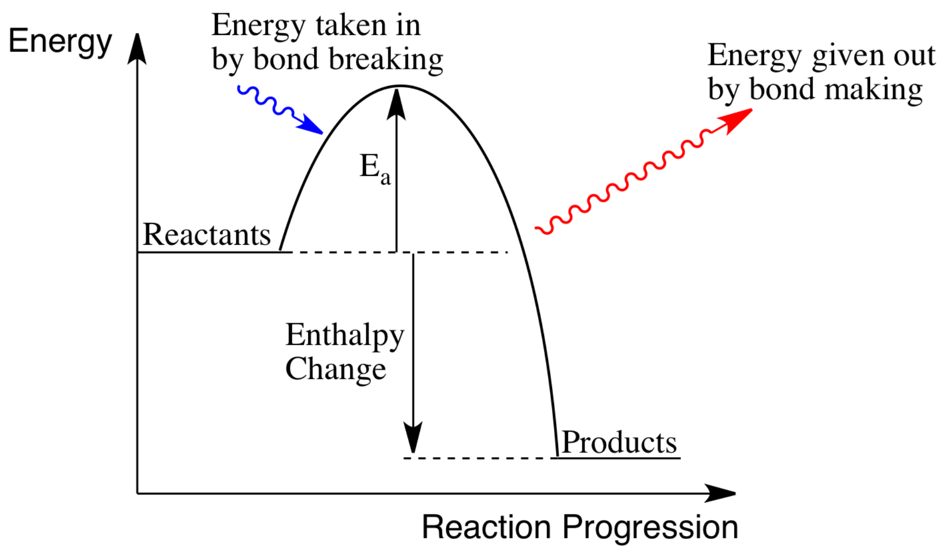
Basics

- Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy.
  - Activation energy is the minimum amount of energy that particles must have to react
- Reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.

Endothermic reaction energy profile



Exothermic reaction energy profile



Bond energies

The energy change of reactions

- During a chemical reaction:
  - Energy must be supplied to break bonds in the reactants
  - Energy is released when bonds in the products are formed
  - Energy needed to break bonds and energy released when bonds are formed can both be calculated from bond energies
  - Sum of energy to break bonds – sum of energy released when bonds form = overall energy change
    - If the overall energy change is negative the reaction is exothermic
    - If the overall energy change is positive the reaction is endothermic
- Energy needed to break > energy released ENDOTHERMIC
- Energy needed to break < energy released EXOTHERMIC

Using bond energy data - example

Bond energies

Bond	Energy (kJ/mol)
N≡N	946
H-H	436
N-H	389

Overall equation: $N_2 + 3H_2 \rightarrow 2NH_3$

- Energy in the reactants/bonds broken
  - 1 x N≡N (1 x 946) = 946

    - 3 x H-H (3 x 436) = 1,308
- Energy in the products/bonds formed
    - 6 x N-H (6 x 389) = 2,334

Overall energy change = ∑(bonds broken) - ∑(bonds formed)

(946 + 1,308) - (2,334) = -80 kJ/mol

- This is a negative overall energy change, therefore the reaction is exothermic.