Edexcel IGCSE Chemistry

Topic 3: Physical chemistry

Energetics

Notes

3.1 know that chemical reactions in which heat energy is given out are described as exothermic, and those in which heat energy is taken in are described as endothermic

- 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 oxidisation reactions and neutralisation.
- Everyday examples of exothermic reactions include; self-heating cans (e.g for coffee) and hand warmers.

- 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.

3.2 describe simple calorimetry experiments for reactions such as combustion, displacement, dissolving and neutralization

- Salts dissolving in water can be either exothermic or endothermic
- Neutralisation reaction is exothermic
- Displacement is an exothermic or endothermic reaction
- Combustion is an exothermic reaction

3.3 calculate the heat energy change from a measured temperature change using the expression Q = mc∆T

It is possible to measure the enthalpy change by using a reaction to heat or cool a known mass of water. The enthalpy change can be measured by using the formula:

$$\Delta E = m\ c\ \Delta T$$

- **ΔE** = energy supplied by water (joules)
- **m** = mass of water (grams)
- **c** = specific heat capacity of water (4.2 J/g/°C)
- **ΔT** = the change in temperature of the water (°C).

Since an increase in the temperature of the water means a decrease in the energy of the chemicals, to find the enthalpy change of the reaction, use:

$$\Delta H = -\ m\ c\ \Delta T$$

If the reaction occurs in solution, the mass of the solution is used.

Enthalpy change is commonly given per mole, and the molar enthalpy change is given in kilojoules per mole.

e.g. 100g of water were placed in a copper calorimeter above a fuel burner containing hexane, C_6H_{14}. Burning the hexane caused the temperature of the water to rise from 18 to 44°C. The mass of the burner decreased from 98.30g to 97.87g. What is the enthalpy of combustion of 1 mole of hexane?

- Formula mass of hexane = (6 x 12) + (14 x 1) = 86
- Temperature rise = 44 – 18 = 26°C
- Mass of hexane burned = 98.30 – 97.87 = 0.43 g
- Moles of hexane burned = mass / molar mass = 0.43 / 86 = 0.005 mol
- Energy supplied to water = m c ΔT = 100g x 4.2 J/g/°C x 26°C= 10920 J
- Enthalpy change = - m c ΔT= -10920 J
- Enthalpy change per mol= -10920J / 0.005 mol= -2184000 J/mol

$$\frac{\Delta H}{} = \underline{\textbf{= -2184 kJ/mol}}$$

3.4 calculate the molar enthalpy change (ΔH) from the heat energy change, Q

- Q/ J divide by 1,000 to get Q/ kJ
- Find moles of fuel used using moles = mass / molar mass
- Then do Q/ kJ divided by mol to get ΔH/ kJ/mol.

3.5 (chemistry only) draw and explain energy level diagrams to represent exothermic and endothermic reactions

- energy level diagrams can be used to show the energy of the reactants compared to the products of a reaction
- exothermic reaction: energy is released to surroundings, so reactants have more energy than products
- endothermic reactions: energy is taken in from surroundings, so reactants have less energy than products

3.6 (chemistry only) know that bond-breaking is an endothermic process and that bond-making is an exothermic process

- During a chemical reaction:
  - Energy must be taken in to break bonds in the reactants
  - Energy is released when bonds in the products are formed
- Energy needed to BREAK > energy RELEASED ENDOTHERMIC
- Energy needed to BREAK < energy RELEASED EXOTHERMIC

3.7 (chemistry only) use bond energies to calculate the enthalpy change during a chemical reaction

1. Add together all the bond energies for all the bonds in the reactants – this is the 'energy in'
2. Add together the bond energies for all the bonds in the products – this is the 'energy out'
3. Calculate the energy change: energy in – energy out

3.8 practical: investigate temperature changes accompanying some of the following types of change: salts dissolving in water, neutralisation reactions, displacement reactions, combustion reactions