

ENTHALPY CHANGES PART 1

412 Term 2

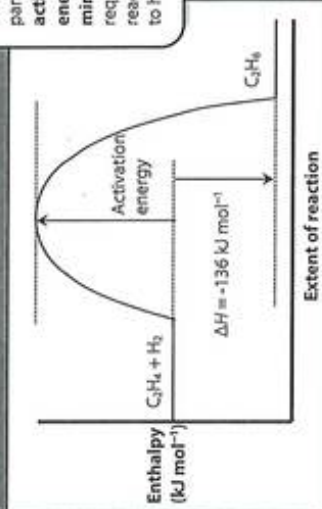
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ENTHALPY CHANGES AND ENTHALPY PROFILE DIAGRAM

EXOTHERMIC REACTIONS

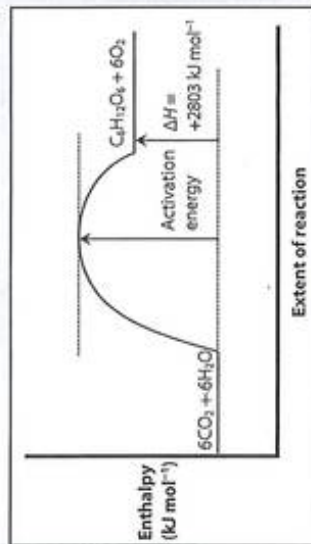
- Products have **less** energy than reactants
 - Energy given out (usually as heat)
- e.g. $\text{C}_2\text{H}_4 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6$ $\Delta H = -136 \text{ kJ mol}^{-1}$

In a collision between reactant particles, the **activation energy** is the minimum energy required for a reaction to happen.



ENDOTHERMIC REACTIONS

- Products have **more** energy than reactants
 - Energy taken in (usually as heat – reaction gets colder)
- e.g. $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ $\Delta H = +2803 \text{ kJ mol}^{-1}$



CALORIMETRY

Enthalpy changes can be calculated by measuring the temperature change of water when reactions happen in aqueous solution.

Solutions are mixed in an insulated container. Temperature of solutions before reaction is recorded and subtracted from the maximum temperature reached to find ΔT .

Energy absorbed by water is calculated using:

$$q = mc\Delta T$$

q = energy (J); m = mass of water (g);

c = $4.18 \text{ (J K}^{-1} \text{ g}^{-1})$; ΔT = temperature change (K)

e.g. 50 cm^3 of NaOH(aq) and 50 cm^3 of HCl(aq) (both 1.0 mol dm^{-3} and 21.0°C) are mixed, causing the temperature to reach 26.5°C .



$$q = 100 \times 4.18 \times 5.5 = 2299 \text{ J}$$

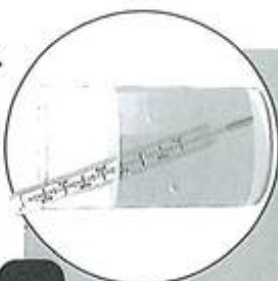
no. moles of water formed = 0.050 mol

$$\Delta H = -2299 / 0.050 = -45980 \text{ J mol}^{-1} = -45.98 \text{ kJ mol}^{-1}$$

For water $100 \text{ cm}^3 = 100 \text{ g}$

-ve because energy given out (gets hotter)

EXAM TIP
You will be given the value of c in exam questions



DEFINITIONS

When asked to define 'standard enthalpy of ...', add 'under standard conditions, with all reactants and products in their 'standard states' to the regular definition.

These are the quantities in the balanced equation – if the equation is balanced differently, the enthalpy change will be different, e.g. if all the molar quantities are doubled, the enthalpy of reaction will double.

Standard conditions

- Pressure = 100 kPa
- Temperature = $298 \text{ K (} 25^\circ\text{C)}$
- Concentration of any solutions = 1 mol dm^{-3}

Standard state

The physical state that a substance is normally in under standard conditions, e.g. at standard conditions water is a liquid, nitrogen is a gas and calcium carbonate is a solid.

Enthalpy change of reaction ΔH

The change in enthalpy when a reaction occurs in the quantities specified by a balanced equation, e.g. for $\text{Pb(NO}_3)_2(\text{aq}) + 2\text{KI(aq)} \rightarrow \text{PbI}_2(\text{s}) + 2\text{KNO}_3(\text{aq})$

ΔH is the enthalpy change when **one mole** of $\text{Pb(NO}_3)_2$ reacts with exactly **two moles** of KI

Enthalpy change of formation $\Delta_f H$

The change in enthalpy when **one mole** of a compound is formed from its elements, e.g. formation of ethene: $2\text{C(s)} + 2\text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_4(\text{g})$

$\Delta_f H$ is the enthalpy change when **one mole** of C_2H_4 is formed by the reaction of two moles of carbon with two moles of hydrogen

Enthalpy change of combustion $\Delta_c H$

The change in enthalpy when **one mole** of a substance is **completely** combusted (reacted with oxygen), e.g. for combustion of ethene: $\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O(l)}$

$\Delta_c H$ is the enthalpy change when one mole of C_2H_4 reacts with **three moles** of O_2