12 Measuring enthalpy changes

Teaching plan

Sub-chapter	Approximate number of learning hours	Learning content	Resources
12.1 Heat and temperature 12.2 Exothermic and endothermic reactions	1–2	Chemical reactions involve a transfer of energy between the system and the surroundings, while total energy is conserved. Understanding of the difference between heat and temperature. Reactions are described as endothermic or exothermic, depending on the direction of energy transfer. Understanding of the temperature change (decrease or increase) that accompanies endothermic and exothermic reactions. The relative stability of reactants and products determines whether reactions are endothermic or exothermic. Sketching and interpretation of potential energy profiles for endothermic and exothermic reactions.	**Coursebook** Sections 12.1–12.2 Test your understanding questions **Workbook** Exercises 12.1–12.2 **Teacher's resource** PowerPoint 12, slides 2–6 End of Chapter 12 test
12.3 Enthalpy changes and standard conditions 12.4 Measuring enthalpy changes	2–3	The standard enthalpy change for a chemical reaction, $\Delta H^{\ominus}$, refers to the heat transferred at constant pressure under standard conditions and states. It can be determined from the change in temperature. Application of the equations $Q = mc\Delta T$ and $\Delta H = -\frac{Q}{n}$ in the calculation of the enthalpy change of a reaction.	**Coursebook** Sections 12.3–12.4 Test your understanding questions **Workbook** Exercises 12.3–12.4 **Teacher's resource** PowerPoint 12, slides 7–8 Worksheet 12.1

BACKGROUND KNOWLEDGE

- Students should have an understanding of some chemical reactions from previous learning. They may have encountered the topic of energetics in their previous learning (IGCSE / MYP programmes). This may include some of the content in this unit, including exothermic and endothermic reactions and enthalpy changes of reaction.

Syllabus overview

- Students will understand the difference between heat and temperature.
- They will gain an understanding of the difference between exothermic and endothermic reactions.
- They will be able to interpret and draw energy level diagrams, linking these to exothermic or endothermic processes.
- Students will also be able to calculate enthalpy changes of simple reactions.

12.1 Heat and temperature and 12.2 Exothermic and endothermic reactions

LEARNING PLAN

Learning objectives	Success criteria
Understand the difference between heat and temperature	Students can explain the difference between heat and temperature.
Understand the difference between exothermic and endothermic reactions	Students can explain the difference between exothermic and endothermic reactions.
Understand what is meant by the term stability	Students can explain the term stability.
Sketch and interpret potential energy profiles	Students can draw and interpret potential energy profiles for exothermic and endothermic reactions.

Common misconceptions

Misconceptions	How to identify	How to overcome
Students confuse the terms exothermic and endothermic.	Throughout the lesson and during the plenary activity.	Highlight the differences between the two terms. Exothermic is giving out heat, so it gets hotter; endothermic is taking in heat, so it gets colder.
Students assume the + sign is exothermic and the − sign is endothermic for enthalpy changes.	When going through the energy level diagrams.	Highlight misconceptions to students at the start of the lesson and check work and get students to correct their own mistakes.

Misconceptions	How to identify	How to overcome
Draw energy level diagrams the wrong way, e.g., exothermic reaction products are higher than reactants.	When students are drawing energy level diagrams	Highlight the correct way to draw energy level diagrams – for exothermic explain that energy is being lost to the surroundings, so it is getting hotter, meaning the products are at a lower energy than reactants, and it is the opposite for endothermic reactions.

Starter ideas

1 Exothermic and endothermic reactions (10 minutes)

Resources: Ice pack.

Description and purpose: Show students an ice pack and ask them what is happening when they are being used. Explain the difference between heat and energy. Explain the terms exothermic and endothermic.

What to do next: Students can think of other reactions that give out energy or take in energy.

2 Definitions for the topic (10 minutes)

Resources: Definitions required for the topic – exothermic, endothermic, stability. There could be a mix and match with the definitions and explanations on the board.

Description and purpose: Students will recap what they know from prior learning and reinforce their understanding of the topic so far.

› **Language focus:** Students should correct their own work and read through the correct definitions to make sure they understand them.

Main teaching ideas

1 Exothermic and endothermic reactions practical (40 minutes)

Resources: Chemicals and apparatus for the practical (a risk assessment will need to be carried out by the teacher supervising the practical). See the links to digital resources section on how to get to the website (you will need to register for free the first time you use this website). Other examples are Mg / HCl, decomposition of H_2O_2, $BaCl_2$ / NH_4SCN.

Description and purpose: Students will get to see how different reactions either produce heat or take in heat from the surroundings. This will give them a better understanding of exothermic and endothermic reactions.

› **Differentiation ideas:**

Support: The teacher can go around the classroom during the practical and work with those who need more support or help with the practical and understanding of the content covered.

Stretch and challenge: Students can be given questions on enthalpy changes to work out which ones are exothermic and which ones are endothermic and the overall enthalpy change of a reaction.

2 Energy level diagrams (30 minutes)

Resources: Energy level diagrams for exothermic and endothermic reactions.

Description and purpose: The teacher should explain the energy level diagrams for exothermic and endothermic reactions. The students will then be given some reactions and asked to draw the energy level diagrams for these.

› **Differentiation ideas:**

Support: Students can work together (the teacher could pick groups) and then the teacher can spend time with students that require more help with this topic.

Stretch and challenge: Students could be given experimental data and then asked to draw out the energy level diagrams for the reactions.

Plenary ideas

1 Share results of the practical (10 minutes)

Resources: Online Excel spreadsheet

Description and purpose: Students share their results with the class to check that they all get similar results. These results should be discussed and the terms exothermic and endothermic should be revisited to ensure students have a full understanding of these terms. The teacher could show the students how to use Excel to process their data.

2 Exothermic or endothermic (10 minutes)

Resources: Different exothermic and endothermic reactions and energy level diagrams.

Description and purpose: Students will answer exothermic or endothermic by voting (could use coloured cards, blue and red, or by putting one hand up for exothermic and two hands up for endothermic). This will allow the teacher to assess the students' understanding of exothermic and endothermic reactions and energy level diagrams.

12.3 Enthalpy changes and standard conditions and 12.4 Measuring enthalpy changes

LEARNING PLAN

Learning objectives	Success criteria
Understand the term standard enthalpy change for a reaction	Students can explain the term standard enthalpy change for a reaction.
Calculate standard enthalpy changes from experimental data	Students can calculate standard enthalpy changes from experimental data.

Common misconceptions

Misconception	How to identify	How to overcome
Energy (Q) is enthalpy of combustion.	Look through the calculations that the students are doing during their data processing.	Make sure that students are aware of the difference and, when going through the example calculation on the board, explain the differences. Give them a step-by-step guide to the calculation, so it is very clear.

Starter ideas

1 Students design their own experiment (20 minutes)

Resources: Chemicals and apparatus for the practical work.

Description and purpose: In pairs, students think about how they could work out the enthalpy of combustion with the equipment and chemicals available. This will make students think more about the practical work and have a greater understanding of the experiment.

What to do next: The teacher should speak to all the groups and combine their best ideas to come up with a suitable practical method that they could all use. This is an appropriate time to speak to the students about practical work, including random and systematic errors.

Main teaching ideas

1 Practical on burning alcohols to work out the enthalpy change of a reaction (35 minutes)

Resources: Chemicals and apparatus for the practical work (for any practical work, the teacher must write out a risk assessment).

Description and purpose: Students do the practical on burning alcohols to work out the enthalpy change for the reaction.

› **Differentiation ideas:**

Support: A worked example on the board to help students understand the calculations involved.

Stretch and challenge: Students could try the experiment with different alcohols and see if they can work out why some alcohols have a higher enthalpy change than others (could get them to think about bonding). Students could calculate the enthalpy change of a reaction for other reactions, dissolving salts, for example.

Plenary ideas

1 Questions on enthalpy changes of a reaction (20 minutes)

Resources: Questions on enthalpy changes of a reaction.

Description and purpose: Students will practice answering questions on enthalpy changes of a reaction to ensure that they understand how to calculate them.

Assessment ideas

- Assessed practical on working out an enthalpy change of reaction.
- Past paper questions on this topic.

Homework ideas

› **Language focus:** Create a structured revision sheet to explain all the syllabus points. Highlight the key definitions to avoid any misconceptions.

- The teacher can use this to revise any syllabus points that the students have not understood fully.
- Students should go through the syllabus points and use a traffic light system to highlight the points and show how much they understand.

Links to digital resources

- In this class experiment, students measure the temperature changes in four reactions, and classify the reactions as exothermic or endothermic
- A practical on the enthalpy of combustion of alcohols. The purpose of this experiment is to determine the heats of combustion of the alcohol butan-1-ol
- A practical to investigate the amounts of heat energy produced by the combustion of different alcohols

CROSS-CURRICULAR LINKS

- Physics: There are experiments in physics that look at the specific heat capacity of different materials.
- Maths: Manipulating data and processing data.