14 Energy from fuels

Teaching plan

Sub-chapter	Approximate number of learning hours	Learning content	Resources
14.1 Combustion reactions	1–2	Reactive metals, non-metals and organic compounds undergo combustion reactions when heated in a supply of oxygen. Construction of equations for reactions of combustion, including hydrocarbons and alcohols. Incomplete combustion of organic compounds, especially hydrocarbons, leads to the production of CO and C. Construction of equations for the incomplete combustion of hydrocarbons and alcohols.	**Coursebook** Section 14.1 Test your understanding Questions 1–4 **Workbook** Exercise 14.1 **Teacher's resource** PowerPoint 14, slides 3–4 End of Chapter 14 test
14.2 Fuels	2–3	Fossil fuels include coal, crude oil and natural gas, which have different advantages and disadvantages. Evaluation of the amount of carbon dioxide added to the atmosphere when different fuels burn. Understanding of the link between CO_2 levels and climate change.	**Coursebook** Sections 14.2–14.3 **Workbook** Exercises 14.2–14.3 **Teacher's resource** End of Chapter 14 test
14.3 Renewable and non-renewable energy sources 14.4 Fuel cells	1–2	Biofuels are produced from the biological fixation of carbon over a short period of time, through photosynthesis. Understanding of the difference between renewable and non-renewable energy sources. Consideration of the advantages and disadvantages of biofuels. A fuel cell can be used to convert chemical energy from a fuel that is consumed, directly to electrical energy.	**Coursebook** Section 14.4 Exam-style questions **Workbook** Exercise 14.4 **Teacher's resource** PowerPoint 14, slides 5–7 End of Chapter 14 test Worksheet 14.1

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BACKGROUND KNOWLEDGE

- Students should have an understanding of the shape and composition of organic molecules, including alkanes and alkenes.
- From the stoichiometry topic, students should be able to balance chemical equations.
- Students should be able to calculate the amount of product formed from the reactants using moles calculations.
- Students should understand reduction and oxidation from pre-IB learning.

Syllabus overview

- Students will understand what combustion is and which reactions are combustion reactions. They should also be aware of the difference between complete and incomplete combustion and the dangers of incomplete combustion.
- Students will then look at renewable and non-renewable energy sources and be able to link the use of fossil fuels to the change in CO_2 levels in the atmosphere and the rise in global warming.
- The students will then explore biofuels and fuel cells, as alternative fuels, and be able to consider the advantages and disadvantages of these.

14.1 Combustion reactions

LEARNING PLAN

Learning objectives	Success criteria
Understand that reactive metals, non-metals and organic compounds undergo combustion reactions Discuss combustion reactions in terms of oxidation and reduction Deduce equations for incomplete combustion of organic compounds	Students can write equations for combustion reactions. Students can discuss combustion reactions in terms of oxidation and reduction. Students can deduce equations for incomplete combustion of organic compounds.

Common misconceptions

Misconceptions	How to identify	How to overcome
Students confuse incomplete and complete combustion.	Questions in class; the teacher going around and assessing students' knowledge.	Highlight misconceptions in class and get students to practice.
Students don't balance the equations correctly, often forgetting about the oxygen in alcohols, for example.	Practice questions in lessons and during plenary lessons will help highlight any errors.	Balance the equations alphabetically (C then H then O). Highlight the oxygen in alcohols and give students lots of practice.
Students get confused between oxidation and reduction and oxidising agents and reducing agents.	When going through equations, ask students which reagents are oxidised / reduced / oxidising agents / reducing agents.	Clearly write out definitions on the board and go through how to work these out.

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Starter ideas

1 What is combustion? (20 minutes)

Resources: Oxygen, magnesium ribbon, sulfur powder, carbon powder, fume cupboard.

Description and purpose: Explain what is needed for combustion to occur using the fire triangle. Demonstrate burning different elements, such as sulfur, magnesium and carbon, in oxygen (a risk assessment will be needed for this).

What to do next: Ask the students if there are any issues with burning things. This could provide a link to environmental issues and could link to incomplete combustion.

Main teaching ideas

1 Combustion reactions (30 minutes)

Resources: Bunsen burner, glass beaker.

Description and purpose: Demonstation: Heating up a glass beaker with a Bunsen burner. When the air hole is open, there is sufficient oxygen, so complete oxidation occurs. Close the airhole and the beaker will start to get covered in soot, showing incomplete combustion is occurring as insufficient oxygen is present (a risk assessment should be completed). Explain how a combustion reaction works and what the products are for complete combustion and incomplete combustion. Explain how to balance these equations and explain why these are redox reactions.

Differentiation ideas:

Support: Worksheet to deduce equations for complete and incomplete combustion. The teacher could create these to be scaffolded to start with word equations and simple combustion equations.

Challenge: Students are given harder equations to balance, and they should label which substances are getting reduced and which are getting oxidised and also label the oxidising agents and the reducing agents.

Plenary ideas

1 Mini quiz (10 minutes)

Resources: Mini-whiteboards.

Description and purpose: Ten questions on the work done. The students show their answers on the mini-whiteboards, so the teacher can assess their understanding of the topic.

14.2 Fuels

LEARNING PLAN

Learning objectives	Success criteria
Discuss the advantages and disadvantages of fossil fuels	Students can discuss the advantages and disadvantages of fossil fuels.
Calculate the carbon dioxide formed when fossil fuels burn	Students can calculate the carbon dioxide formed when fossil fuels burn.

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Common misconceptions

Misconception	How to identify	How to overcome
Students get confused with how to calculate the amount of CO_2 formed when fuels burn.	Through the project work, the teacher can assess different groups' knowledge on this. When they are presenting their projects, the teacher will understand if they have made any mistakes.	A step-by-step method could be given to the students to show how to do the calculation. The teacher could work with weaker students during the project to make sure they understand how to do this.

Starter ideas

1 Project starter (15 minutes)

Description and purpose: Explain to the students the research project on the advantages and disadvantages of fossil fuels. Include calculations of the amount of carbon dioxide formed when fossil fuels burn. Give them some questions or points that you would like the students to research specifically.

Main teaching ideas

1 Research project on fossil fuels (60–120 minutes)

Resources: Computers.

Description and purpose: Students research the advantages and disadvantages of fossil fuels. This is an opportunity for students to collaborate. The task could be split so that some groups look at the advantages and others look at disadvantages of fossil fuels (language focus).

Differentiation ideas:

Support: Students can be given questions they could research to break down the task. Websites could be given to students to help them find the information.

Stretch and challenge: Students could be given some harder topics to research, looking at the chemistry in more depth.

Plenary ideas

1 Student presentations (30 minutes)

Resources: None.

Description and purpose: Students present their work to the rest of the class and take questions about their research. This gives students a chance to improve their presentation skills and public speaking. It will also show their knowledge of the subject, so the teacher can assess their knowledge.

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14.3 Renewable and non-renewable energy sources
14.4 Fuel cells

LEARNING PLAN

Learning objectives	Success criteria
Understand what biofuels are	Student can explain what biofuels are.
Explain the difference between renewable and non-renewable energy sources	Students can explain the difference between renewable and non-renewable energy sources.
Explain how fuel cells work	Students can explain how fuel cells work.
Deduce half-equations for the reactions occurring in fuel cells	Students can deduce half-equations for the reactions occurring in fuel cells.

Common misconceptions

Misconception	How to identify	How to overcome
Students get the half-equations the wrong way round (are confused by which ones are reduced and which ones are oxidised).	Add questions to the plenary lesson to test the students' knowledge of this. Homework could be tailored to ask questions on this topic.	Go over how to construct half-equations again. Students can use the electrode potentials from the data booklet to help them understand which equation will be reduction and which will be oxidation.

Starter ideas

1 Renewable or non-renewable (20mins)

Resources: Pictures of different energy sources.

Description and purpose: Show students pictures of different energy sources; go through which ones are renewable and which ones are non-renewable.

What to do next: Explain what biofuels are and how they are made.

Main teaching ideas

1 Fuel cells (40 minutes)

Resources: Diagrams of different fuel cells. Worksheet with questions on fuel cells and half-equations.

Description and purpose: Explain how different fuel cells work, giving the advantages and disadvantages of fuel cells, and show students the different half-equations that occur in a fuel cell.

› **Differentiation ideas:**

Support: Students can have a diagram of a fuel cell to label.

Stretch and challenge: Students are given different types of fuel cells and asked to work out the half-equations for these fuel cells as well. This could be an independent project or homework and allow the students to add extra details to their work. They could look at how fuel cells are used in everyday life, giving context to this topic.

› **Language focus:** Students can have half-equation questions with blanks to fill in.

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Plenary ideas

1 Traffic lights (25 minutes)

Resources: Green, yellow and red cards for every student.

Description and purpose: Go through each learning objective from the chapter, and get the students to think about how much they understand each one (hold up green for complete understanding, yellow for some understanding or red for no understanding). This will help the teacher assess the students' knowledge of the topic.

Assessment ideas

- Students can assess each other's research projects on fossil fuels, adding in content or details they feel would be relevant. The teacher can also assess the projects, and award marks for their presentations, and make notes of improvements that need to be made for each group and any misconceptions that the students may have.

Homework ideas

- Students can work on their presentations for homework.
- Questions from the Coursebook.

› **Language focus:** Students can read articles in the news about different fuels, e.g., looking at electric cars or hydrogen-powered cars versus petrol cars, to get them to think about their understanding of the topic.

› **Language focus:** Students could create exam-style questions on the topic with model answers to help them with their understanding of the content.

Links to digital resources

- How to write and balance combustion equations
- An explanation of the chemistry of combustion reactions
- The advantages and disadvantages of fossil fuels
- Pros and cons of fossil fuels
- Looking at the differences between renewable and non-renewable energy
- Data for renewable energy
- The chemistry of biofuels
- Explanation of three fuel cells

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