Cracking

This resource is part of the **Structure strips** series of resources, designed to support literacy in science teaching. More resources in this series can be found at: rsc.li/4aXYgzt.

Learning objectives

1. Define the term cracking.
2. Interpret and write equations for cracking processes.
3. Explain why cracking is carried out.
4. Describe how to test the products of cracking for unsaturation (C=C double bonds).

Introduction

Crude oil is a mixture of compounds, with long-chain hydrocarbons making up most of this mixture. However, the demand for long-chain hydrocarbons is low, whereas the high demand for short-chain molecules is not met by their supply. The long-chain molecules can be 'cracked' to give shorter chains to meet this demand.

How to use structure strips

Structure strips are a type of scaffolding you can use to support learners to retrieve information independently. Use them to take an overview at the start of a topic, to activate prior knowledge, or to summarise learning at the end of a teaching topic. For more ideas on how to use structure strips with your learners, visit rsc.li/3EszCfr.

Structure strips have sections containing prompts, sized to suggest the amount that learners must write. Learners glue the strips into the margin of an exercise book and write their answers next to the sections, in full sentences or in bullet points. When learners have finished using the structure strip, they will have an A4 page set of notes and examples.

Scaffolding

- Encourage learners to use the suggested keywords in their answers. These link with our key terms support resources for **hydrocarbons and crude oil** (available from rsc.li/3Ys0jYi).
- To further support learners, include additional prompts in the structure strip. If learners are struggling to engage with the task, supply them with sentence starters created from the example answers.

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- As learners grow in confidence, ask them to attempt the extension question first and then use the structure strip to improve or self-assess their answers.

Metacognition

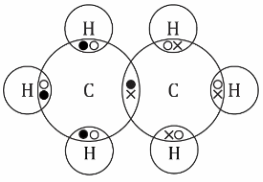
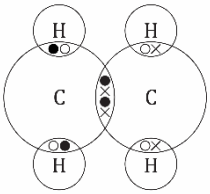
This resource supports learners to develop their metacognitive skills in three key areas.

- **Planning**: the strips provide scaffolding to plan the written response. Learners need to decide where to gather information from (textbooks, own notes, revision websites). Ask learners: is the source of information you are using reliable?
- **Monitoring**: learners are prompted by the questions in the structure strip and can check their own answers against the prompts. Ask learners: have you covered all the prompts in the space provided? Do you need to change anything to complete the task?
- **Evaluation**: learners can self-assess or ask a peer to check their work against the answers. Ask learners: did you achieve what you meant to achieve? What will you do differently another time?

Example answers

Example answers for the structure strip are on page 3. Learners can write the answers as bullet points or prose.

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Structure strip Cracking	Example answer
Compare the supply in crude oil and economic demand for: • short-chain hydrocarbons • long-chain hydrocarbons	Crude oil contains lots of long-chain hydrocarbons. These are not particularly useful and are not commercially in demand. Short-chain hydrocarbons are in high demand as they are very useful. Therefore, cracking is carried out so that more money can be made from crude oil, as it increases the supply of short-chain hydrocarbons to meet the high demand.
Describe the process of cracking.	Cracking is a process which breaks up long-chain hydrocarbons into short-chain hydrocarbons. long-chain alkane → short-chain alkane + alkene
Give an example of cracking using hexane as the reactant. Use word and symbol equations.	$C_6H_{14} \rightarrow C_4H_{10} + C_2H_4$ hexane → butane + ethene (alkane) → (alkane) + (alkene) *Guidance: check that the number of atoms forming the molecules on the left and right of the equation are equal. This is only possible if there is an alkane and an alkene product.*
Name the two types of cracking and give the conditions for each.	Catalytic cracking: • temperature ~550°C • catalyst (zeolite containing aluminium oxide and silicon oxide) Steam cracking: • temperature of over 800°C • H_2O • no catalyst
State the general formulas of alkanes and alkenes. Draw dot and cross diagrams for ethane and for ethene. Explain how the structures are different.	Alkanes have a general formula of C_nH_{2n+2} and alkenes have a general formula of C_nH_{2n}.  ethane  ethene Alkanes contain no double bonds (they are saturated), and alkenes contain a C=C double bond (they are unsaturated).

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Describe a test for the alkene functional group.	Test for alkenes – add aqueous bromine (bromine water). If a double bond is present the bromine water decolourises (goes from orange to colourless). If no double bond is present, there is no visible change.

Extended answer question

Get learners to answer the question after they have attempted the structure strip. The structure strip activates the required knowledge which learners can then apply to the question.

Consider reframing the context of this question to one that your learners are more familiar with, to empower them to unlock their existing science capital. Read our article about targeting science capital: rsc.li/40FAMLP.

Example answer to extended answer question

1. A saturated hydrocarbon is a compound made of only carbon and hydrogen atoms which contains only single bonds.
2. Octane can be cracked to make many products as it has seven C–C bonds which can be broken.
3. *Guidance: look for balanced symbol equations with octane on the left and the named alkane and alkene on the right.*

- hexane: octane → hexane + ethene
- $C_8H_{18} \rightarrow C_6H_{14} + C_2H_4$
- pentane: octane → pentane + propene
- $C_8H_{18} \rightarrow C_5H_{12} + C_3H_6$
- butane: octane → butane + butene
- $C_8H_{18} \rightarrow C_4H_{10} + C_4H_8$

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