

Cracking: teacher guidance

This resource forms part of the **Review my learning** series from the Royal Society of Chemistry. The worksheets assess learner's understanding of content from common 11–14 and 14–16 curriculums. They can be used to identify knowledge gaps and misconceptions once that part of the curriculum has been taught.

The Cracking worksheets cover the following topics:

- the supply and demand of the different fractions from the fractional distillation of crude oil
- reasons for cracking
- producing smaller alkane molecules and alkenes from cracking
- writing equations to represent cracking
- catalytic and steam cracking.

If learners successfully answer questions on these topics, they can attempt the extension question. This requires learners to compare the formulas and bonding in ethane and ethene, and to use information to write equations for steam cracking reactions at different temperatures.

Scaffolding

Level 1 (*) is a scaffolded worksheet which supports learners in a variety of ways, such as selecting words from a word bank, providing answer options to choose from or completed examples. Level 2 (**) is a partially scaffolded worksheet with a reduced level of support, such as partially completed sentences or a wider range of answer options to select from. Level 3 (***) is an unscaffolded worksheet in which most of the tasks involve answering questions with a minimum of prompts.

Metacognition

The 'What do I understand?' page is common to all levels of worksheet and can be used both to identify areas needing whole class attention and as an indicator for learners to help guide their revision.

Below you will find model answers for each level and guidance on learners' misconceptions. Learners can use the model answers to self- or peer assess.

When to use

The worksheets can be used in a variety of ways:

- To assess learners' knowledge at the beginning or end of a period of teaching. Match the level of the worksheet to the support needs of the learners.
- To assess knowledge during a period of teaching and after learners have completed the relevant topic.

- As part of revision.
- As a refresher exercise for teachers or non-subject specialists.

There is also scope for the level of the worksheets used to be increased as learners progress through their curriculum.

Further support

For more resources to support teaching of this topic and address any misconceptions identified, go to rsc.li/3PmRw5E.

For more assessment questions on this topic use our Knowledge check and In context worksheets on Cracking hydrocarbons rsc.li/2SCxbLL.

Answers

Cracking: knowledge check

1.1 (Level 1, 2 and 3)

- (a) Demand is higher than supply for **gases, petrol, kerosene** and **diesel**.
(b) Supply is higher than demand for **bitumen** and **fuel oil**.

Guidance: Learners need to understand the meanings of the terms 'supply' and 'demand'.

1.2 (Level 1)

- (a) True
(b) False
(c) False
(d) False
(e) True
(f) False

(Level 2 and 3)

- (a) True
(b) False – Smaller hydrocarbon molecules are generally more useful than larger hydrocarbon molecules.
(c) False – Unsaturated hydrocarbons contain at least one double covalent bond between carbon atoms.
(d) False – Alkenes are unsaturated compounds.
(e) True
(f) False – Alkanes and alkenes are two different homologous series.

Guidance: Common misconceptions include:

- Confusing the process and changes that occur during cracking with the process and changes that occur during fractional distillation. Cracking involves breaking covalent bonds, whereas fractional distillation involves separation by boiling point (which depends on breaking weak intermolecular forces).
- Confusing alkanes and alkenes. Sloppy handwriting may add to this problem as an 'a' can easily be confused with an 'e'. Learners need to understand the terminology, including the meaning of the terms 'saturated', 'unsaturated' and 'homologous series'.

1.3 (Level 1, 2 and 3)

demand; alkanes; fuels; diesel; alkenes; polymers

Guidance: See guidance for questions 1.1 and 1.2.

1.4 (Level 1, 2 and 3)

covalent; smaller; 550°C; catalyst; speed up; 800°C; steam

Guidance: Learners may find 'steam cracking' referred to as 'thermal cracking' in other sources.

Cracking: test myself

2.1 (Level 1, 2 and 3)

thermal decomposition/decomposition

Guidance: Learners need to be familiar with the meaning of the term 'decomposition' in relation to chemical changes.

2.2 (Level 1, 2 and 3)

C_nH_{2n}

Guidance: Misconceptions include:

- not understanding the nature of a general molecular formula
- confusing general molecular formulas with molecular formulas and empirical formulas.

2.3 (Level 1, 2 and 3)

two pairs of electrons

Guidance: A common misconception is confusing the number of pairs of electrons shared with the number of electrons shared.

2.4 (Level 1, 2 and 3)

ethene

Guidance: Learners may confuse the meanings of the terms 'saturated' and 'unsaturated'.

2.5 (Level 1)

C_2H_4

(Level 2 and 3)

$C_{11}H_{24} \rightarrow C_9H_{20} + C_2H_4$

Guidance: Learners can check accuracy by adding up the numbers of 'H's and 'C's on either side of the equation.

Common errors include not using upper case letters and subscripts correctly in formulas and not balancing the equation correctly.

2.6 (Level 1, 2 and 3)

C_7H_{16}

Guidance: Misconceptions include:

- not correctly calculating the number of carbon atoms in the alkane produced
- not using the correct molecular formula for heptane.

2.7 (Level 1, 2 and 3)

$C_{16}H_{34} \rightarrow C_{12}H_{26} + C_4H_8$

Guidance: Misconceptions include:

- not correctly calculating the number of carbon atoms in the alkene produced
- writing the incorrect molecular formula for the alkene.

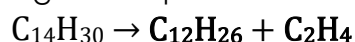
2.8 (Level 1, 2 and 3)Reason 1: **it uses less energy.**Reason 2: **the catalyst can be reused.****Guidance:** This is a synoptic question and requires learners to link cracking methods to climate change strategies and the advantages of using catalysts.**Cracking: feeling confident?****3.1 (Level 1, 2 and 3)**

Compound	Homologous series	Molecular formula	Displayed structural formula	Number of single covalent bonds	Number of double covalent bonds
ethane	alkanes	C_2H_6	$ \begin{array}{c} H & H \\ & \\ H-C & -C-H \\ & \\ H & H \end{array} $	7	0
ethene	alkenes	C_2H_4	$ \begin{array}{c} H & & H \\ & \diagdown & / \\ & C = C & \\ & / & \diagdown \\ H & & H \end{array} $	4	1

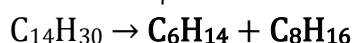
Guidance: Misunderstandings arise from not recognising the notation used to represent single and double covalent bonds.**3.2 (Level 1, 2 and 3)**

Learners' answers may vary but examples include:

(a) Higher temperature



(b) Lower temperature

**Guidance:** There are alternative answers to this question. The products from cracking are not exact or predictable, and several different reactions are possible. Completing this question may help learners to appreciate that.

Cracking: what do I understand?

Mini-topic	Assessed via:
I can compare the supply and demand of fractions produced from the fractional distillation of crude oil.	1.1
I can describe the reasons for cracking.	1.2, 1.3
I can describe the production of smaller alkane molecules and alkene molecules from cracking.	1.4, 2.1, 2.2, 2.3
I can write equations to represent cracking.	2.4, 2.5, 2.6, 2.7
I can compare catalytic and steam cracking.	2.8
Feeling confident? topics	Assessed via:
I can describe the difference between ethane and ethene.	3.1
I can predict products formed during steam cracking.	3.2