AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.7.1.4

Cracking and alkenes

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**6**
Available paper years	**2020–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.7.1.4 Cracking and alkenes

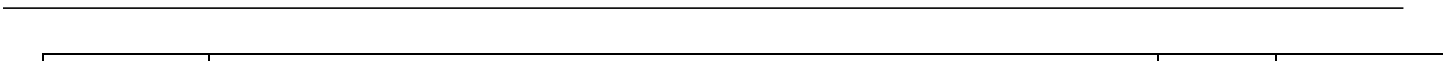
Answer 01 · Mark scheme November 2020 | 8464/C/2H | Original Q1

01.1	$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$	allow multiples	1	AO2 5.1.1.1 5.7.1.3
01.2	(bubble gas through) lime water turns milky / cloudy / white **or** white precipitate forms	MP2 is dependent upon correct response in MP1 allow (bubble gas through) calcium hydroxide (solution)	 1 1	AO1.2 5.8.2.3
01.3	C_3H_6		1	AO2 5.1.1.1 5.7.1.4
01.4	burning / lit splint burns with a (squeaky) pop sound	MP2 is dependent upon correct response in MP1 allow flame do **not** accept glowing splint allow pops	 1 1	AO1 5.8.2.1
01.5	bromine (water) (colour change) orange (to) colourless	do **not** accept bromide allow 1 mark for colourless (to) orange ignore clear	1 1 1	AO1 5.7.1.4
Total			**9**	

5.7.1.4 Cracking and alkenes

Answer 01 · Mark scheme

November 2020 | 8464/C/2H | Original Q1



5.7.1.4 Cracking and alkenes

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	plankton **or** (ancient) biomass	allow microscopic plants / animals	1	AO1 5.7.1.1
02.2	propane	allow C_3H_8	1	AO1 5.7.1.1

5.7.1.4 Cracking and alkenes

Answer 02 · Mark scheme

November 2021 | 8464/C/2H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	4–6	AO3
	Level 1: Relevant features are identified and differences noted.	1–3	AO1 AO2
	No relevant content	0	
	Indicative content • methane has 1 carbon atom, hexane has 6 • methane has 4 hydrogen atoms, hexane has 14 • both contain C – H bonds • only hexane contains C – C bonds • both are hydrocarbons • hexane has a higher melting point than methane (or converse) • hexane has a higher boiling point than methane (or converse) • methane is a gas at room temperature • hexane is a liquid at room temperature • both are small molecules • hexane has larger molecules than methane • weak forces between molecules • forces between hexane molecules stronger than between methane molecules • hexane is more viscous than methane • both are flammable • methane is more flammable than hexane (or converse) • possible products of combustion from both are: carbon, carbon monoxide, carbon dioxide, water • neither conduct electricity		5.2.2.4 5.7.1.1 5.7.1.3

5.7.1.4 Cracking and alkenes

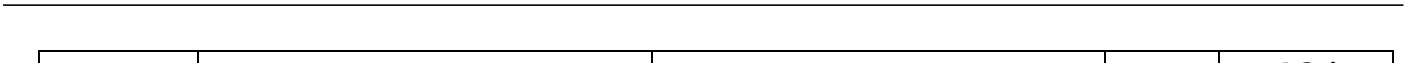
Answer 02 · Mark scheme

02.4	C_8H_{18}		1	AO2 5.3.1.1 5.7.1.4
02.5	bromine (water) turns (from orange / brown) to colourless	 MP2 is dependent on MP1 allow decolourises ignore clear	1 1	AO1 5.7.1.4
Total			**11**	

5.7.1.4 Cracking and alkenes

Answer 02 · Mark scheme

November 2021 | 8464/C/2H | Original Q2



5.7.1.4 Cracking and alkenes

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	butane		1	AO2 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(molecule) made up of carbon and hydrogen (atoms) only		1	AO1 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	$C_{11}H_{24} \rightarrow C_5H_{10} + 2\,C_2H_4 + C_2H_6$ **OR** $C_{11}H_{24} \rightarrow C_5H_{10} + 2\,C_3H_6 + H_2$ (2) **OR** $C_{11}H_{24} \rightarrow C_5H_{10} + 2\,C_2H_6 + C_2H_2$ (2)	allow **1** mark for $2\,C_2H_4$ allow **1** mark for C_2H_6 allow **1** mark for $2\,C_3H_6$ allow **1** mark for H_2 allow **1** mark for $2\,C_2H_6$ allow **1** mark for C_2H_2	2	AO2 5.1.1.1 5.3.1.1 5.7.1.4

5.7.1.4 Cracking and alkenes

Answer 03 · Mark scheme

June 2022 | 8464/C/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	C_2H_6 is useful as a fuel	allow smaller molecule so useful as a fuel	1	AO1 5.7.1.3 5.7.1.4
	(because more) flammable (than larger molecules)		1	
	OR			
	C_2H_4 / C_3H_6 / C_5H_{10} is used to make polymers (1)	allow C_2H_4 / C_3H_6 / C_5H_{10} is used to make plastics allow C_2H_4 / C_3H_6 / C_5H_{10} is used to make other chemicals		
	(because more) reactive (than alkanes) (1)			
		if a named product is given, allow **1** mark for a correct use and **1** mark for a correct linked reason		

Question	Answers	Mark	AO / Spec. Ref.
04.5	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons is given.	5–6	AO3 5.9.2.2 5.10.1.1 5.10.2.1
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • production of plastic uses more hydrocarbons which are from non-renewable crude oil • production of plastic produces more greenhouse gases in the atmosphere which contributes to global warming • production of plastic produces more sulfur dioxide which causes acid rain • production of plastic produces more oxides of nitrogen which cause acid rain and respiratory problems • disposal of plastic produces more waste which increases landfill • burning plastic produces fumes which are toxic so cause respiratory problems • lifetime cost of plastic frames is less • plastic frames have lower costs for maintaining • the total energy consumption for plastic frames is greater than for wooden frames • judgement		

Total Question 4		**12**

5.7.1.4 Cracking and alkenes

Answer 04 · Mark scheme

June 2023 | 8464/C/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(crude oil is a mixture but) not a useful product	allow (crude oil is) not designed for a specific purpose	1	AO2 5.7.1.1 5.8.1.2
	(and) not mixed in carefully measured quantities	allow not the same composition all the time	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(crude oil) is heated to vaporise (the hydrocarbons)	allow (crude oil) is heated to evaporate the hydrocarbons	1	AO1 5.7.1.2
	temperature (of column) decreases from bottom to top	allow the column gets cooler going up	1	
	(so) the fractions / hydrocarbons condense at different heights (in the column)		1	
	(because) the fractions / hydrocarbons have different boiling points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(to make) smaller (hydrocarbon) molecules		1	AO1 5.7.1.4
	any **one** from: (which are) • more useful molecules • useful as fuels • starting materials	allow (which are) in higher demand allow (which are) alkenes for the production of other chemicals	1	

5.7.1.4 Cracking and alkenes

Answer 04 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(test) burning / lit splint	MP2 is dependent upon MP1 being awarded allow flame do **not** accept glowing splint	1	AO2
	(result) burns with a (squeaky) pop sound	allow pops	1	AO1 5.8.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	C_2H_4		1	AO2 5.7.1.1 5.7.1.4

Total Question 3	11

5.7.1.4 Cracking and alkenes

Answer 05 · Mark scheme

June 2024 | 8464/C/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(molecules) made up of carbon and hydrogen (atoms only)		1	AO1 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	$C_{10}H_{22}$		1	AO2 5.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	(crude oil) is heated		1	AO1 5.7.1.2
	(so some of the hydrocarbons) vaporise		1	
	the column has a temperature gradient	allow the column gets cooler going up	1	
	(so) the hydrocarbons / fractions condense at different heights / temperatures in the column **or** (and) the hydrocarbons / fractions condense at their boiling points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$C_{14}H_{30} \rightarrow C_8H_{18} + \mathbf{2}\,C_3H_6$		1	AO2 5.1.1.1 5.7.1.4

5.7.1.4 Cracking and alkenes

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	add bromine (water) (bromine water) changes (from orange) to colourless	 allow (bromine water) decolourises ignore clear MP2 is dependent on MP1 being awarded	1 1	AO1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	polymer	allow plastic allow hydrocarbon	1	AO1 5.2.1.4 5.7.1.4

Total Question 1	10

5.7.1.4 Cracking and alkenes

Answer 06 · Mark scheme

June 2025 | 8464/C/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(a resource that) will run out	allow (a resource that) is non-renewable	1	AO1 5.7.1.1 5.10.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(a compound / molecule) made up of carbon and hydrogen (atoms) only		1	AO1 5.7.1.1

5.7.1.4 Cracking and alkenes

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(volume of petrol =) $90 \times 159 \times \frac{31.3}{100}$ **or** (volume of petrol =) $14310 \times \frac{31.3}{100}$ **or** (volume of petrol =) 90×49.767 **or** (volume of petrol =) 28.17×159	allow **1** mark for 90×159 **or** $159 \times \frac{31.3}{100}$ **or** $90 \times \frac{31.3}{100}$	2	AO2 5.7.1.1 5.7.1.2
	= 4479.03		1	
	= 4480 (dm^3)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses 90 barrels, 159 dm^3 and a fraction percentage	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	lubricants		1	AO1 5.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	steam cracking		1	AO1 5.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(test) add bromine water (result) (bromine) changes (from orange) to colourless	 allow (bromine) is decolourised	 1 1	AO2 5.7.1.4

Total Question 3	**10**

5.7.1.4 Cracking and alkenes

Answer 02 · Examiner comments

November 2021 | 8464/C/2H | Original Q2

Question 2 (standard demand)

Very few were able to correctly identify what is decomposed to form crude oil, many appeared to confuse “decomposition” with “composition” and gave hydrocarbons as their answer. However, the naming of alkanes was well known.

In the comparision of methane and hexane most students focused their attention on the comparison of the boiling points and the relative numbers of atoms in each molecule, using only the information provided. There was some confusion evident around the negative values of the melting points. A significant number of students stated that methane has a higher melting point than hexane. Better answers linked the information to the physical states of the hydrocarbons. Some excellent answers were seen where the students expanded upon the data, for example, to

Answer 02 · Examiner comments

November 2021 | 8464/C/2H | Original Q2

explain why the molecules had different melting and boiling points in terms of the strength of their intermolecular forces or they deduced their physical states.

5.7.1.4 Cracking and alkenes

Answer 03 · Examiner comments June 2022 | 8464/C/2H | Original Q4

Question 4

There is only a small section on organic chemistry in this specification. However in responses students do not appear to have consolidated the ideas of organic chemistry.

04.1 Just over half of the students were able to identify butane from the picture.

04.2 There were only 2 in 5 students who were able to correctly quote this definition.

04.3 Students found balancing the cracking equation quite challenging, often making up molecules that fitted rather than working out possible molecules from prior knowledge.

04.4 It was anticipated that students would choose one of their products or identify one as an alkane or an alkene and quote a use. This was very rare, and students were given some leeway in identifying a use. Explanations as to why the molecule was used were even rarer.

04.5 Students found the start of this question very accessible, comparing the data supplied. Direct comparisons only allowed access to level 1, however, and links to the problems caused were required to make further progress. Nearly 10% of students were able to reach level 3. A judgement (which many students gave) and comparisons of both economic and environmental factors was required to do this. On evaluate questions, students need to bring in some of their own knowledge to access the higher levels.

Answer 04 · Examiner comments June 2023 | 8464/C/2H | Original Q3

Question 3

03.1 This question required an application of the definition of a formulation, which students found difficulty with. Only a quarter of students gained at least one mark, usually for the idea that a formulation is made for a specific purpose. Few went on to give the idea that crude oil has a variable composition.

03.2 The steps in fractional distillation were not well known and often produced muddled sequencing. Two thirds of students gained at least one mark, usually for the idea that fractions have different boiling points (though some referred to melting points). Fewer than two in five went on with further descriptions, and one in five gained either three or four marks.

03.3 About one third of students gained two marks, with a further one in five getting one mark. This was usually for the idea that cracking produces smaller molecules. A specific use such as fuels or as a starting material for making polymers was credited for the second mark, whilst many students said that smaller molecules were more useful, were more in demand, or had more uses, all of which were creditworthy.

03.4 About half of students were able to describe the test for hydrogen, which had to be identified from the given equation. The gas tests are not well known and need to be learnt, so that they are expressed clearly.

03.5 Four in five students correctly identified the alkene.

Answer 05 · Examiner comments

Question 1 (standard demand)

01.1 About two thirds of students knew the definition of a hydrocarbon. Those who did not achieve the mark often used words such as 'atom' or 'mixture' instead of compound so were not credited. Similarly, students who gave answers in terms of carbon or hydrogen molecules (instead of atoms) were not given any marks.

01.2 Three-quarters of students achieved the mark for correctly determining the formula of decane. The most common incorrect response was $C_{10}H_{20+2}$.

01.3 This question has typically been targeted at high demand in previous years. However, this year it was set at standard demand, with the diagram containing more detail and the mark scheme for loosened a little to separate the first two marking points. Nearly all students on this tier were able to start the explanation of fractional distillation.

Four marks were available for this question. Most students who gained 1 mark did so for correctly identifying that the crude oil is heated. Some students indicated that the crude oil was heated once it was in the fractional distillation column itself, which was not creditworthy. Fewer students were able to explain that some of the hydrocarbons were vaporised/evaporated/boiled or turned into a gas for marking point 2. A third of students explained that there was a temperature gradient in the column. This could have been explained as a comparative statement, for example, the column is cooler at the top or by using sensible temperature values. Some students were able to explain that the hydrocarbons/fractions condensed or were able to give a clear description of condensation at different heights in the column or at different temperatures.

The most common responses that gained no marks referred to the different sizes and boiling points of the hydrocarbons/fractions.

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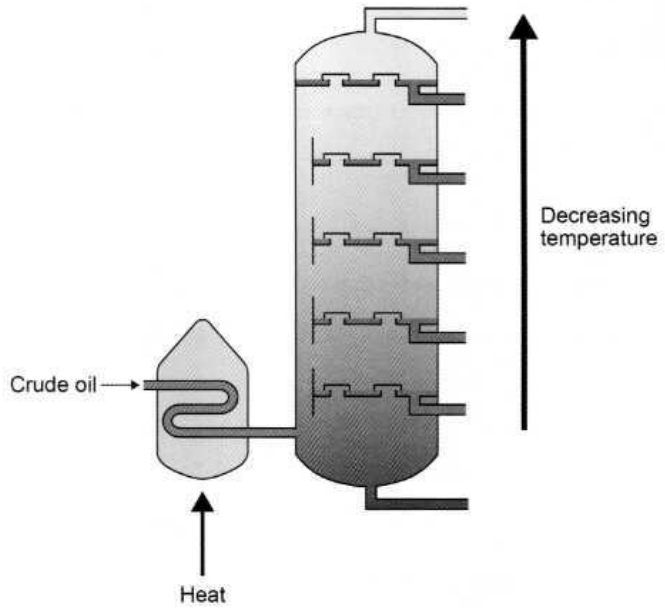
5.7.1.4 Cracking and alkenes

Answer 05 · Examiner comments June 2024 | 8464/C/2H | Original Q1

0 1 . 3 Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

[4 marks]

firstly, crude oil is heated until evaporated. Each fractions has different boiling points. The longer hydrocarbons reaches to the bottom fractions as they have very high boiling points, so the small hydrocarbons reaches the top fractions as they have low boiling points, so then at each fraction these condense.

This response gains the first two marking points in the first line. The student then describes the lengths of the hydrocarbons but the language used is very muddled, and is suggesting that the different heights in the column are the fractions. Because of this the mention of 'condense' is insufficient as it is linked to an incorrect interpretation of fraction. No further marks are gained.

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5.7.1.4 Cracking and alkenes

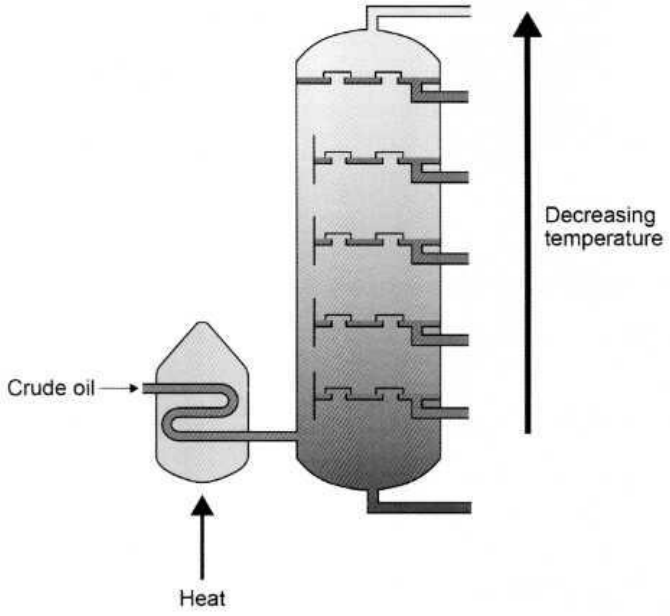
Answer 05 · Examiner comments

June 2024 | 8464/C/2H | Original Q1

0 1 . 3 Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

[4 marks]

Crude oil is a mixture of different hydrocarbons with different boiling points. First the crude oil is heated to a very high temperature to ~~evaporate~~ completely vaporise it, then its passed into a fractionating column which is hottest at the bottom, and coolest at the top. This means ~~hydrocarbons will continue~~ the gaseous hydrocarbons will rise until the temperature reaches their boiling points, causing them to ~~do~~ condense and collect in the trays. This means ~~crude~~ boiling point is used to seperate Crude oil into fractions

There is nothing creditworthy in the first sentence. Marking points 1 and 2 are gained in the second sentence. The student then goes on to describe the temperature gradient on line 5: '… hottest at the bottom, and coolest at the top' for marking point 3. The description of the gaseous hydrocarbons condensing their boiling points is sufficient for marking point 4.

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5.7.1.4 Cracking and alkenes

Answer 05 · Examiner comments June 2024 | 8464/C/2H | Original Q1

01.4 Most students correctly balanced the cracking equation.

01.5 Students find the recall of chemical tests challenging, with fewer than half of students gaining both marks on the test for an alkene.

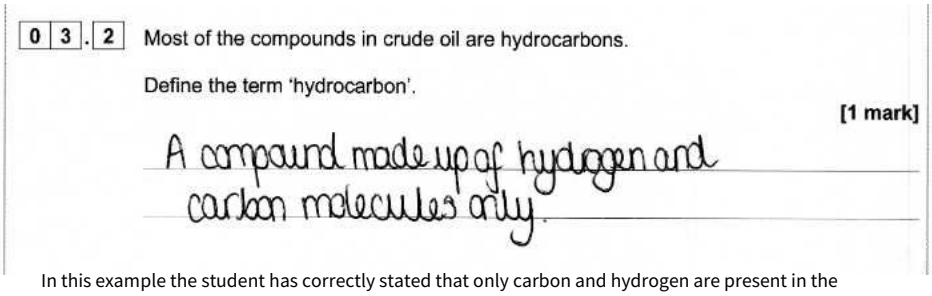
01.6 Fewer than 20% of students applied their knowledge from paper 1 and the scaffolding provided to correctly identify the structure as a polymer, with the mark scheme also allowing hydrocarbon as an answer.

Answer 06 · Examiner comments June 2025 | 8464/C/2H | Original Q3

Question 3 (Standard and Standard /High demand)

03.1 The majority of students could explain that a finite resource is one that will run out. The most common incorrect responses were linked to either it 'taking a long time to make more' or 'using it up too fast', neither being sufficient for the mark.

03.2 While the majority of students correctly identified hydrogen and carbon, the mark could often not be credited because it was not made clear that these were the *only* atoms present. A significant number of students used the incorrect terminology for describing a compound/molecule or an atom. Subsequently only half of all students were credited the mark.


0 3 . 2 Most of the compounds in crude oil are hydrocarbons.

Define the term 'hydrocarbon'.

[1 mark]

A compound made up of hydrogen and carbon molecules only.

In this example the student has correctly stated that only carbon and hydrogen are present in the compound but have incorrectly called the particles 'molecules' rather than 'atoms', so the mark cannot be awarded.

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5.7.1.4 Cracking and alkenes

Answer 06 · Examiner comments

June 2025 | 8464/C/2H | Original Q3

0 3 . 2 Most of the compounds in crude oil are hydrocarbons.

Define the term 'hydrocarbon'.

[1 mark]

A mixture of hydrogen and carbon atoms

In this example the student has incorrectly used the terminology 'mixture' rather than 'compound' and have failed to state that hydrogen and carbon are the **only** atoms there, no marks were awarded.

03.3 The large majority of students attempted this question, and a variety of different approaches were seen, with over half of students gaining all four marks. Students not gaining full marks, were often able to identify which values they needed to use but were not so confident in using them correctly. A significant number failed to give their answer correctly rounded to 3 significant figures.

0 3 . 3 Crude oil found in different areas has different compositions.

Table 2 shows the percentage (%) composition of crude oil from one area.

Table 2

Fraction	Percentage (%) of fraction
Petrol	31.3
Kerosene	13.4
Diesel oil	14.4
Heavy fuel oil	40.9

The volume of crude oil is measured in a unit called 'barrels'.

1 barrel = 159 dm^3

Calculate the volume of **petrol** in dm^3 in 90 barrels of crude oil.

Give your answer to 3 significant figures.

[4 marks]

159 × 90 = 14310 dm^3

0·313 × 14310 = 4479·03

Volume of petrol (3 significant figures) = 4480 dm^3

This example shows the most commonly used approach. Students generally showed good mathematical skills in this question. The total volume of oil in 90 barrels is first calculated, followed by then working out 31.3% of this value. The answer is then correctly rounded to 3 significant figures. 4 marks awarded.

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5.7.1.4 Cracking and alkenes

Answer 06 · Examiner comments June 2025 | 8464/C/2H | Original Q3

03.4 By selecting lubricants, over half of students answered correctly. The most common incorrect response was fertilisers.

03.5 Less than half of students could recall the correct method. Students who did not gain credit generally confused other processes involving hydrocarbons and often referred to fractional distillation. A significant number just wrote 'steam' which is not a method and therefore did not gain credit.

03.6 Only half of all students gained credit in this question. The majority of students who could recall bromine water as the required test then went on to successfully state the correct colour change, to colourless. Bromine alone was insufficient for the mark, although students were allowed a mark for the correct result if they went down this path. A significant number of students were not able to recall the test and often confused it with limewater leading to a cloudy solution.