

2(a). The table shows the names, number of carbon atoms and molecular formula of some alkanes.

Name of alkane	Number of carbon atoms	Molecular formula
methane	1	CH ₄
ethane	2	C ₂ H ₆
propane	3	C ₃ H ₈
butane	4	C ₄ H ₁₀
pentane	5	

Complete the table to show the molecular formula of the missing alkane.

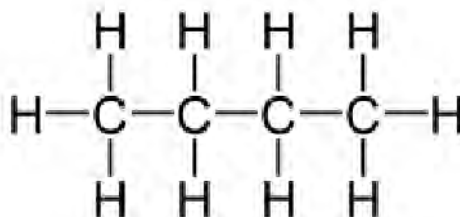
[1]

(b). The diagrams show a ball and stick model for one alkane and a displayed formula of another.

Complete the diagrams by filling in the missing names.



Name of alkane.....



Name of alkane.....

[2]

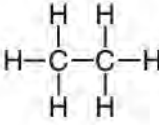
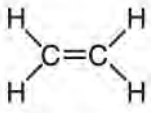
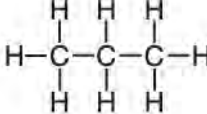
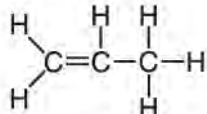
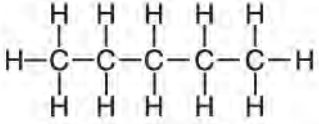
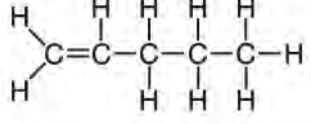
(c). The alkanes have the general formula C_nH_(2n + 2).

What is the molecular formula of an alkane with 8 carbon atoms?

[1]

3. Alkenes are a family of hydrocarbons.



The table shows the structures of some alkanes and alkenes that have the same number of carbon atoms.

Number of carbon atoms	Structure of alkane	Structure of alkene
2		
3		
5		

(i) What are the **similarities** and **differences** between the structures of alkanes and alkenes?

----- [3]

(ii) Draw the structure of an alkane and an alkene that contain 6 carbon atoms.

	
alkane	alkene

[2]

4.

The general formula for all of the alkenes is C_nH_{2n} .

The empirical formula for all of the alkenes is CH_2 .

(i) Use examples from **Table 4.2** to explain why all of the alkenes have the same general formula, C_nH_{2n} .

----- [2]

(ii) Explain why the empirical formula of all of the alkenes is CH_2 .

----- [1]

5. Methane is an alkane.

Which statements about methane are true?

Put ticks (✓) in the boxes next to the **two** correct answers.

Methane is a carboxylic acid.

Methane contains single covalent bonds.

Methane is in the same family of compounds as ethane and propane.

Methane is an ionic compound.

Methane has a melting point above room temperature.

[2]

6. Which of the statements about alkanes are true?

Put ticks (✓) in the boxes next to the **two** correct answers.

All alkanes are hydrocarbons.

Alkanes have double bonds between their carbon atoms.

The alkanes are a homologous series.

Alkanes are all solids at room temperature.

[2]

7. The table shows some information about the first four alkanes.

Name	Formula
methane	-----
-----	C_2H_6
-----	C_3H_8
butane	-----

Complete the table by filling in the missing boxes. Use names and formulae from these lists.

ethanol
 C_2H_4

propane
 CH_4

butanol
 C_2H_5OH

ethane
 CH_3COOH

methanol
 C_4H_{10}

[3]

8. Some fractions from crude oil are cracked to give ethene, C_2H_4 .

Which homologous series is ethene a member of?

Tick (✓) one box.

Alcohols

Alkanes

Alkenes

Carboxylic acids

[1]

9(a). The **alkanes** and the **alkenes** are both examples of homologous series.

Table 4.1 shows the names and chemical formulae of some alkanes.

Alkanes	
methane	CH ₄
ethane	C ₂ H ₆
propane	C ₃ H ₈
butane	C ₄ H ₁₀

Table 4.1

(i) Down the series, the number of carbon atoms and hydrogen atoms increases by the same amount each time.

Use examples from **Table 4.1** to show that this statement is true.

----- [2]

(ii) Pentane is an alkane with five carbon atoms.

Predict the formula of pentane.

----- [1]

(b). Table 4.2 shows the names and formulae of some alkenes.

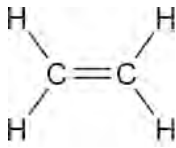
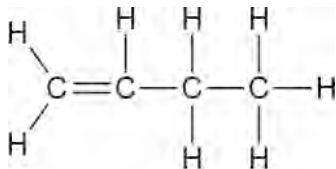
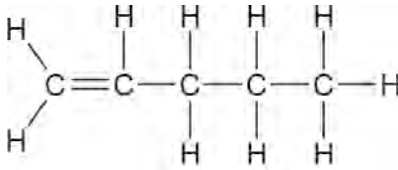
Alkene	Number of carbon atoms	Formula	Displayed formula
methene	does not exist		
ethene	2	C ₂ H ₄	
propene	3	C ₃ H ₆	
butene	4	C ₄ H ₈	
pentene	5	C ₅ H ₁₀	

Table 4.2

(i) Complete Table 4.2 by drawing the displayed formula for propene.

[2]

(ii) There is no alkene called 'methene'.

Which statement explains why 'methene' cannot exist?

Tick (✓) one box.

Methene cannot be a gas at room temperature.

Alkenes contain all single bonds.

Alkenes need to contain at least two carbon atoms.

Methene would be too flammable.

[1]

10(a) Crude oil is a mixture of hydrocarbons.

Information about some of these hydrocarbons is given in the table.

Hydrocarbon	Formula	Melting point in °C	Boiling point in °C
methane	CH ₄	?182	?164
ethane	C ₂ H ₆	?183	?89
propane	C ₃ H ₈	?188	?42
butane	C ₄ H ₁₀	?138	?0.5
pentane	C ₅ H ₁₂	?130	36

Which of these hydrocarbons is a liquid at 25 °C?

----- [1]

(b).

(i) Finish this sentence to describe the trend shown in the table.

The ----- the hydrocarbon molecule, the ----- its boiling point.

[1]

(ii) Use ideas about energy and the forces between molecules to explain your answer.

----- [2]

11(a) Crude oil is a mixture of hydrocarbons.

Some hydrocarbons boil at higher temperatures than others.

Explain why.

Use ideas about the length of molecules and the forces between them.

[2]

(b). Some of the chemicals from crude oil are polymerised to make polymers.

Which of these statements describe polymerisation?

Put ticks (?) in the boxes next to the **two** correct statements.

Large molecules are broken down to make smaller ones.

Hydrocarbons are burned to release energy.

Many small monomer molecules join together.

Monomer molecules are separated.

Large molecules with long chains of atoms are made.

12. This question is about fuels that burn in car engines.

These fuels are hydrocarbons.

(i) Hydrocarbons burn in plenty of air to make two products.

One product is carbon dioxide.

What is the **other** product?

Put a **ring** around the correct answer.

chlorine

nitrogen

oxygen

water

[1]

(ii) Which diagram shows a molecule of carbon dioxide, CO₂?

Put a **ring** around the correct answer.



[1]

13. Synthetic materials are often made from the hydrocarbons in crude oil.

How many different elements are there in hydrocarbons?

Put a **ring** around the correct answer.

1

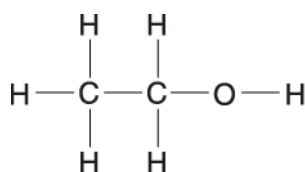
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3

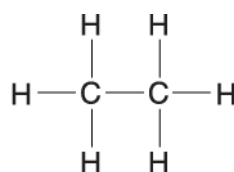
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[1]

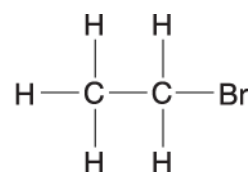
14(a) Look at the formulae of these five organic compounds.



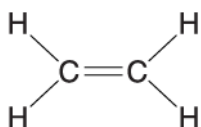
A



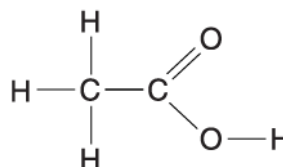
B



C



D



E

Use the letters A, B, C, D and E to answer the questions.

Which compound is a saturated hydrocarbon?

answer [1]

(b). Which compound is an unsaturated hydrocarbon?

answer [1]

15. Crude oil is a mixture of hydrocarbons.

Crude oil is refined to make chemicals that are used in different ways.

One way they are used is as raw materials, for example to make polymers.

Write down **two other** ways that chemicals from refined crude oil are used.

1

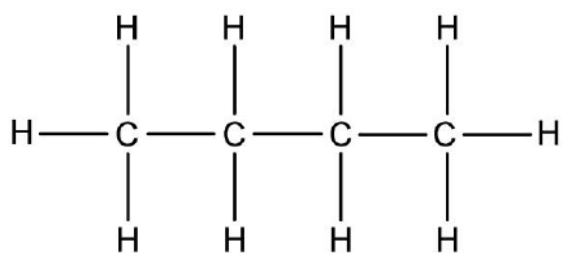
2

[2]

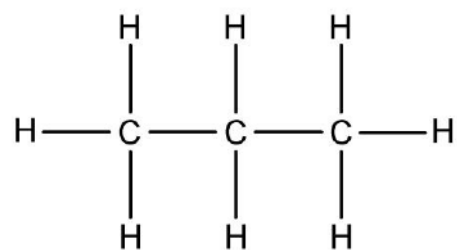
16. Crude oil is divided into fractions to make useful products.

One of the fractions in crude oil is LPG.

LPG contains propane and butane.



butane



propane

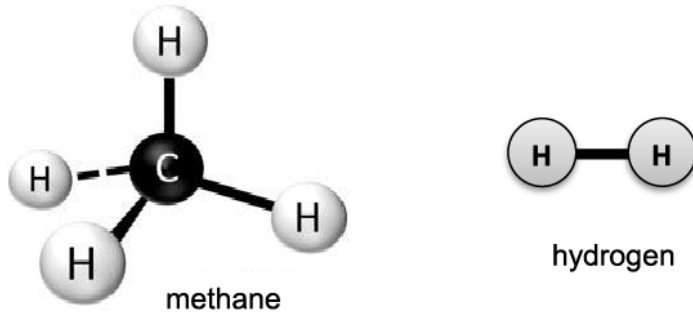
Write down the molecular formula of butane.

answer [1]

17. The surface of the planet Neptune is covered with clouds.

The clouds contain methane and hydrogen.

The diagrams show the arrangement of atoms in methane and hydrogen.



Compare the structures of methane and hydrogen.

Explain **one** similarity and **one** difference between them.

Similarity _____

Difference _____

_____ [2]

18. When ethyne burns completely in oxygen **two** substances are made.

What are these **two** substances?

Put **rings** around the **two** correct answers.

argon

carbon
dioxide

chlorine

nitrogen

sulfur
dioxide

water

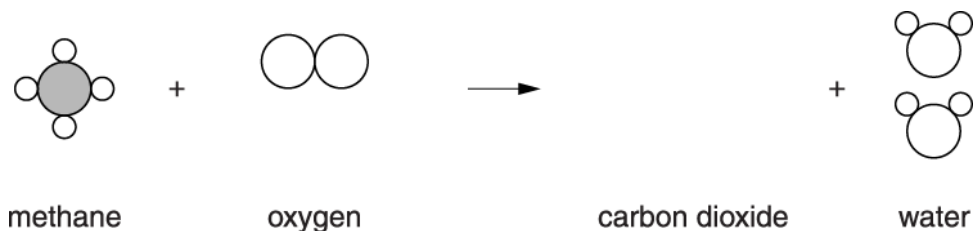
[2]

19. Methane, CH₄, is a chemical in natural gas.

When methane burns in a plentiful supply of air, **complete combustion** takes place.

The products are carbon dioxide and water.

(i) Finish this diagram to show the complete combustion of one molecule of methane.



[2]

(ii) When methane, CH₄, burns in a limited supply of oxygen, **incomplete combustion** takes place.

Which of these statements about this incomplete combustion are true?

Put ticks (✓) in the boxes next to the **two** correct statements.

Not all of the carbon reacts with oxygen.

None of the hydrogen reacts with oxygen.

Water is not one of the products.

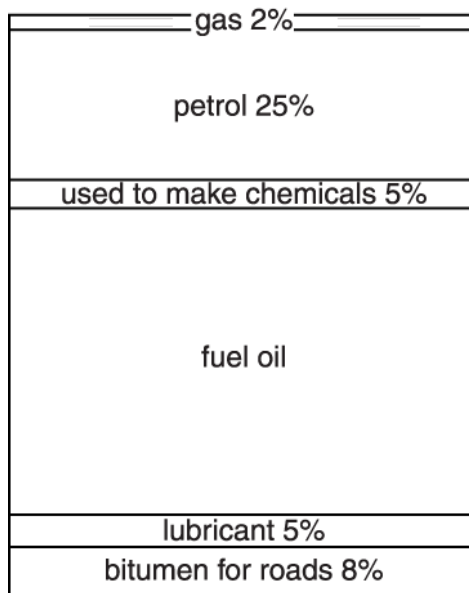
Carbon monoxide is one of the products.

Carbon is the only product.

[2]

20. An oil refinery separates crude oil into different fractions.

This Diagram shows the amount of each fraction made from a barrel of crude oil.



(i) Here are some statements about the fractions in crude oil.

Use the diagram to find out if the statements are true or false.

Put a tick (✓) in the correct box for each statement.

	true	false
The smallest fraction of crude oil is gas.		
There is more lubricant than petrol.		
The amount of crude oil used to make chemicals is the same as the amount of lubricant.		

[2]

(ii) Show that more than half of the crude oil is used as fuel oil.

21. Some fractions from crude oil are used as fuels.

Some fractions are used as a feedstock to make chemicals like ethene.

In the future, more crude oil will be used as a feedstock and less will be used as a fuel.

Give **two** reasons for this.

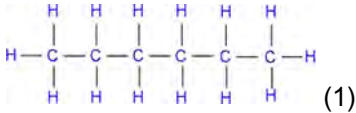
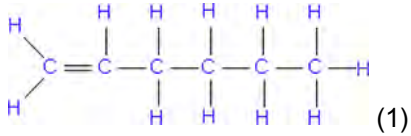
1 -----

2 -----

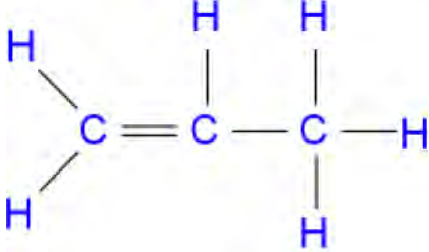
[2]

END OF QUESTION PAPER


Question		Answer/Indicative content	Marks	Guidance
1		<p>propane and butane contain carbon and hydrogen (atoms) ✓ only ✓</p> <p>has (carbon to carbon) single bonds only / contains single (covalent) bonds only ✓</p>	3	<p>DO NOT ALLOW is a mixture of carbon and hydrogen (only)</p> <p>DO NOT ALLOW contains carbon and hydrogen molecules</p> <p>'only' must be linked to first marking point and is not independent</p> <p>ALLOW has no (carbon to carbon) double bonds (1)</p> <p>ALLOW they are saturated compounds (1)</p> <p>ALLOW has general formula $C_nH_{(2n+2)}$ (1)</p> <p>IGNORE has the maximum amount of hydrogen atoms</p>
		Total	3	
2	a	C_5H_{12} ✓	1	
	b	<p>methane ✓</p> <p>butane ✓</p>	2	
	c	C_8H_{18} ✓	1	
		Total	4	

Question		Answer/Indicative content	Marks	Guidance
3	i	<p>2 max from: Similarities all contain C;</p> <p>each carbon atom forms 4 bonds;</p> <p>All contain H;</p> <p>each hydrogen atom forms 1 bond;</p> <p>difference alkanes only single bonds / are saturated;</p> <p>alkenes contain double bonds / are unsaturated;</p>	any 3	<p>Can only score 3 marks by giving 2 similarities and identifying that alkenes contain a double bond.</p> <p>Accept alkenes contain fewer hydrogen atoms / compares general formulae; Ignore 'different numbers of hydrogen atoms'</p> <p>Examiner's Comments</p> <p>Again, most candidates gave clear comparisons of the alkanes and alkenes to gain at least one mark. Many correctly discussed the presence of double bonds or compared saturation or unsaturation.</p>
	ii	 <p>(1)</p>  <p>(1)</p>	2	<p>Examiner's Comments</p> <p>Most gained at least one mark, usually for a correct structure for hexane. Common errors included omitting hydrogen atoms, usually from hexane, or putting too many hydrogen atoms on the carbons closest to the double bond in hexane.</p>
		Total	5	

Question			Answer/Indicative content	Marks	Guidance
4		i	alkenes have twice as many hydrogen atoms as carbon atoms ✓ shows working using values of 'n' for <u>at least two</u> alkenes: ethene n=2, 2n=4, propene n=3, 2n=6, butene n=4, 2n=8, pentene n=5, 2n=10✓	2 (AO 2× 2.1)	Examiner's Comments This question was not well answered with many candidates seeming to find it difficult to explain this concept.
		ii	All alkenes have twice as many hydrogen atoms as carbon atoms. ✓	1 (AO 2.1)	ALLOW explanation of ratio
			Total	3	
5			methane contains single covalent bonds ✓ methane is in the same family _ _ _ _ _ _ _ _ ✓	2	
			Total	2	
6			✓ all alkanes are hydrocarbons. ✓ the alkanes are a homologous series.	2	
			Total	2	
7			CH ₄ ethane propane C ₄ H ₁₀	3	All 4 correct (3) 2 or 3 correct (2) 1 correct (1) Examiner's Comments Most candidates gained at least one mark, and about half gained all three for selecting the correct names and formulae for the alkanes.
			Total	3	
8			Alkene ✓	1 (AO 1.1)	Examiner's Comments The majority of candidates knew that ethene is an alkene.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
9	a	i	<p>increases by one carbon and two hydrogen atoms / increases by CH₂ ✓</p> <p>gives number of C and H atoms in at least two pairs of compounds as evidence: methane has one carbon atom and four hydrogen atoms, ethane has two carbon atoms and six hydrogen atoms, propane has three carbon atoms and eight hydrogen atoms, butane has four carbon atoms and ten hydrogen atoms ✓</p>	2 (AO 2 × 2.1)	<p>Examiner's Comments</p> <p>Full marks required the use of examples, but most candidates only identified the pattern.</p>
		ii	C ₅ H ₁₂ ✓	1 (AO 2.1)	<p>DO NOT ALLOW C₅H₁₂ or C⁵H¹²</p> <p>Examiner's Comments</p> <p>Most candidates were able to extend the series to give this formula.</p>
	b	i	 <p>One double bond shown / 3 carbons and 6 hydrogens shown in a molecule ✓</p> <p>molecule shown fully correct ✓</p>	2 (AO 2 × 2.1)	<p>Fully correct structure (2) marks</p> <p>Examiner's Comments</p> <p>A correct diagram for propene was worth two marks. Most candidates were credited 1 mark for either a structure with one double bond or with three carbon atoms and six hydrogen atoms. The requirement for each carbon atom to have exactly four bonds was not widely appreciated.</p>
		ii	Alkenes need to contain at least two carbon atoms ✓	1 (AO 2.1)	<p>Examiner's Comments</p> <p>Most answers were limited to 1 mark as candidates did not use examples in their answers.</p>
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
10	a		pentane	1	<p>allow C₅H₁₂ do not allow ?130 or 36</p> <p>Examiner' Comments</p> <p>A reasonable number of candidates correctly chose pentane, but where an incorrect choice was made it appeared to be random.</p>
	b	i	larger ... higher	1	<p>allow alternative words with same meaning allow reverse argument</p> <p>Examiner' Comments</p> <p>This was poorly answered, with only the stronger candidates accessing the mark. The problem was the understanding of an alternative word for 'larger'. The word 'higher' was frequently used incorrectly as an alternative. This was not suitable as the first space referred to the size of the molecule and then compared this to its boiling point.</p>
		ii	<p>larger molecules have more / larger forces between them (1)</p> <p>the higher the forces between the molecules the more energy is needed to separate them (1)</p>	2	<p>Examiner' Comments</p> <p>Almost all candidates failed to score on this question. This area of the specification is not easily accessed by foundation candidates as linking the ideas between intermolecular forces and energy appears to be conceptually difficult. This question would have been more easily accessed if it Q4bi had been answered more successfully. A common misconception was to link 'force' to the 'time' taken to boil. Ideas about energy required to separate molecules was not seen.</p>
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
11	a		longer molecules have more / stronger forces between them (1) more energy needed to separate longer molecules (1)	2	allow longer chain have higher boiling points for 1 mark Examiner's Comments Some candidates could link the length of the hydrocarbon chain with boiling point but there was very poor use of scientific terminology. Many candidates wrote about having longer molecules in the hydrocarbon rather than longer chains and also breaking the 'chains' rather than breaking the 'forces' between the chains. Very few candidates discussed 'energy' and the increased amount of energy needed to separate longer chains. Only a small number of candidates scored two marks.
	b		<p>Many small monomer molecules join together. <input type="checkbox"/></p> <p>Large molecules with long chains of atoms are made. <input checked="" type="checkbox"/></p>	2	Examiner's Comments Candidates could identify that 'monomers' and 'large molecules' were part of the correct responses, but often chose the distracter statements rather than linking the correct statements.
			Total	4	
12		i	water	1	Examiner's Comments Whilst almost all students attempted the question, there were few correct answers. The candidates may not have completely read the question before choosing their answer as the common incorrect response was 'oxygen'. This would be a reagent rather than the other product of the reaction.
		ii		1	Examiner's Comments This was generally well answered with candidates most able to identify carbon dioxide
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
13			2	1	<p>Examiner's Comments</p> <p>Most Candidates could recognise that there are just 2 elements in a hydrocarbon.</p>
			Total	1	
14	a		B	1	<p>Examiner's Comments</p> <p>Candidates struggled to correctly identify the formulae of the appropriate organic compound from the list given. Many understood the meaning of hydrocarbon but gave the alkene as saturated and the alkane as unsaturated.</p>
	b		D	1	<p>Examiner's Comments</p> <p>A significant number thought that the carboxylic acid was a saturated hydrocarbon and the alcohol was an unsaturated one.</p>
			Total	2	
15			as fuels (1) as lubricants (1)	2	<p>ignore named examples of fractions e.g. diesel, bitumen</p> <p>ignore references to monomers / polymers / plastics / named polymers / making pharmaceuticals etc</p> <p>allow making roads</p> <p>Examiner's Comments</p> <p>Candidates struggled with this question because they gave the name of a product rather than the use. For example a frequent response was 'petrol', rather than 'fuel'. A large number of candidates mentioned a huge variety of materials with no link to oil at all. Another common response that didn't score was 'polymers', which was given in the question.</p>
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
16			C ₄ H ₁₀	1	DO NOT ALLOW C ₄ H ₁₀ / C ⁴ H ¹⁰ ALLOW H ₁₀ C ₄
			Total	1	
17			hydrogen is an element / only contains hydrogen atoms / contains all the same type of element / contains 2 atoms per molecule whereas methane is a compound / contains carbon and hydrogen atoms / contains two types of atoms / contains 5 atoms per molecule / contains more atoms per molecule ✓ both contain hydrogen atoms / both are simple molecules / both covalently bonded ✓	2	
			Total	2	
18			carbon dioxide; (1) water;(1)	2	Examiner's Comments Few candidates selected both correct answers, however the majority of Candidates could correctly identify 'carbon dioxide' as one of the 2 substances formed when a hydrocarbon burns.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
19		i	<p>one additional oxygen molecule on left / 2 in front of the one oxygen molecule on left (1)</p> <p>one carbon dioxide molecule on right (1)</p>	2	<p>do not allow if there is a visible gap between the oxygens allow slightly overlapping circles Any shape but no gaps between carbon and oxygens and the two oxygens must not touch allow circle with C for carbon / O for oxygen do not allow oxygen circles same size as hydrogen unless labelled with O</p> <p>Examiner's Comments</p> <p>The majority of candidates failed to score either of the 2 marks here. Where they did score, it was only 1 mark for most candidates. The mark scored was for correctly drawing a molecule of carbon dioxide using one black circle, with 2 white circles, one on either side, which touched the back circle but not each other (linear shape). Other common mistakes included using small circles that were representative of hydrogen atoms and a lack of shading. Only the stronger candidates realised they needed to add an oxygen molecule to the left hand side of the diagram to balance the equation.</p>
		ii	<p>tick in box 1 (1) tick in box 4 (1)</p>	2	<p>Examiner's Comments</p> <p>This was answered well with most candidates scoring at least 1 mark. Candidates were more able to demonstrate they understood that carbon monoxide was a product of incomplete combustion.</p>
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
20		i	TFT	2	All correct (2) 1 or 2 correct (1) Almost all candidates scored at least one mark, most scoring both marks. Where candidates did miss the second mark it was generally the idea that 'the amount of crude oil used to make chemicals is the same as the amount of lubricant' that was thought to be false. The barrel showing this information to be true was at the top of the page.
		ii	fuel oil is 100 ? $(2 + 25 + 5 + 5 + 8) = 55\%$; (2)	2	Correct answer of 55% scores 2 marks If final answer incorrect look at working to score max 1 mark Examiner's Comments Very few candidates scored just 1 mark. Either 2 marks for correctly carrying out the two stage calculation or no marks. Common errors included incorrect addition and failure to subtract 45 from 100 to get the final answer of 55%
			Total	4	
21			Any two from: fossil fuels running out / not sustainable ✓ burning fossil fuels produces pollutants ✓ alternatives to fossil fuels are increasingly used ✓	2 (AO 1.1 × 2)	IGNORE green / environmentally friendly arguments Examiner's Comments Many candidates knew that crude oil is not a sustainable resource, and some were able to give a second reason that went beyond 'it's good for the environment'.
			Total	2	