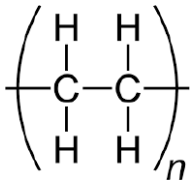
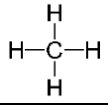
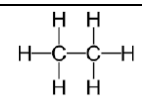
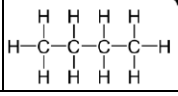
Mark scheme – Organic Chemistry (F)

Question			Answer/Indicative content	Marks	Guidance
1			**B** ✓	1 (AO2.1)	
			Total	**1**	
2			**B** ✓	1 (AO2.2)	
			Total	**1**	
3			**A** ✓	1 (AO1.1)	
			Total	**1**	
4			**C** ✓	1 (AO1.1)	
			Total	**1**	
5			**C** ✓	1 (AO1.1)	
			Total	**1**	
6			**C** ✓	1(AO 2.1)	**Examiner's Comments** Higher ability candidates tended to recognise that option C was the only option to consist solely of hydrocarbons. For the others, choices were fairly evenly split between options A, B and D although, interestingly, far fewer went for option D.
			Total	**1**	
7			**C** ✓	1(AO 1.1)	**Examiner's Comments** Higher ability candidates realised that gases would have the weakest intermolecular forces, with the most popular alternative being bitumen.
			Total	**1**	
8			**A** ✓	1(AO 1.2)	**Examiner's Comments** Addition reactions were not well known. Most candidates assumed that the reaction would be a neutralisation.
			Total	**1**	
9	a	i	High temperature / catalyst ✓	1 (AO1.1)	**ALLOW** stated temperature above 500°C **IGNORE** temperature / heat without

					qualification **ALLOW** named catalyst eg zeolite / aluminium oxide / silicon oxide
		ii	product of cracking more in demand / makes up the shortfall / more useful ✓ gives examples from the table ✓	2 (AO2.1)	
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 124.49(%) award 3 marks** 11,000,000 – 4,900,000 = 6.1×10^6 ✓ 6,100,000 ÷ 4,900,000 = 1.244897959 ✓ 1.244897959 × 100 = 124.49(%) ✓	3 (AO2×2.2) (AO1.2)	**ALLOW** ECF from calculation
	c	i	Waxes and tar ✓	1 (AO2.1)	
		ii	Waxes and tar ✓	1 (AO2.1)	
			Total	**8**	
10	a		**Any two from:** Have the same general formula / both have the formula C_nH_{2n+2} ✓ Idea that they differ from each other by CH_2 ✓ They are both saturated / idea that their carbon atoms are joined to each other by (only) single (covalent) bonds ✓	2 (AO1.1)	**ALLOW** have similar chemical properties **ALLOW** show trends in physical properties
	b	i	(Ethene) molecules have a (carbon to carbon) double bond / (Ethane) molecules do not have a (carbon to carbon) double bond or only have single bonds ✓	1 (AO2.2)	
		ii	 Single bond between the carbon atoms ✓ Single bonds to the side of each carbon atom ✓	2 (AO2.1)	
	c		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.	6 (AO2 × 1.1)	**AO1.1 Knowledge and understanding of why incomplete combustion happens** • Insufficient oxygen / air

			Level 3 (5–6 marks) Describes how incomplete combustion of hydrocarbons such as propane happens. **AND** Describe the problems of incomplete combustion for campers, including a correct balanced symbol equation. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes how incomplete combustion of hydrocarbons such as propane happens. **AND** Attempts to describe the problems of incomplete combustion for campers. **OR** Includes a correct balanced symbol equation. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes how incomplete combustion of hydrocarbons such as propane happens. **OR** Attempts to describe the problems of incomplete combustion for campers. **OR** Attempts a correct balanced symbol equation. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	(AO4 × 2.1)	• This can happen if there is not enough ventilation, such as in a caravan • Not enough oxygen / air for complete combustion **AO2.1 Application of knowledge and understanding of sources of CO and the associated problems** • Carbon monoxide gas is produced, which is toxic • Carbon monoxide combines with haemoglobin / red blood cells • So less oxygen can be carried / there is a lack of oxygen to cells • Can cause unconsciousness / death • Carbon particles / soot produced • Cause blackening of the inside of the caravan • Less energy produced so wastes camping gas / fuel • • Takes longer to heat the caravan / to cook food **AO2.1 Application of knowledge and understanding to produce a balanced symbol equation** Eg $C_3H_8 + 3½O_2 \rightarrow 3CO + 4H_2O$ OR $C_3H_8 + 3O_2 \rightarrow 2CO + C + 4H_2O$ Other balanced equations are possible
			Total	**11**	
11			(Condensation) polymer ✓	1(AO 1.1)	**ALLOW** polyamide / polypeptide **DO NOT ALLOW** addition polymer **DO NOT ALLOW** chain **Examiner's Comments** Candidates found this question challenging with only some of the higher ability candidates appreciating that Kevlar is a polymer molecule. Some others were heading more in the right direction when they suggested that it might be a giant

					structure. There was a wide variety of incorrect answers to this question with 'nanoparticle' being one of the more commonly seen responses.
			Total	**1**	
12	a		**Z** ✓	1(AO 2.1)	**Examiner's Comments** Higher ability candidates often realised that well Z had the lowest boiling point fraction but most candidates saw the largest number in the table and went for X.
	b		**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 40.31(kg) award 2 marks** $\frac{29}{100} \times 139$ ✓ = 40.31(kg) ✓	2(AO 2.2)	**ALLOW** 40.3 / 40 ✓✓ **ALLOW** ecf for one mark if 26% or 28% used (=36.14 or 38.92) ✓ **Examiner's Comments** Marks gained tended to be 2 or 0. Higher ability candidates answered correctly, many others added all the figures in the 'Oil Y' column to get, unsurprisingly, 100, then either calculated 139/100 or 139-100.
	c		$C_{16}H_{34}$ ✓	1(AO 2.1)	**ALLOW** $H_{34}C_{16}$ **Examiner's Comments** Higher ability candidates handled the formula with ease. Other candidates showed clear partial understanding with answers such as $C_{16}H_{2n+2}$ or $C_{16}H_{32+2}$.
	d	i	**Any two from:** idea that decane boils / evaporates / turns into gaseous decane ✓ Idea that decane (vapour or gas) reacts / breaks down as it comes into contact with the porcelain chips ✓ Idea that large molecules of decane produce smaller molecules like ethene ✓	2(AO 1.2)	**ALLOW** passed over hot catalyst **ALLOW** liquid decane reacts with chips BOD **Examiner's Comments** This is another question where candidates were expected to explain a practical application, and few appeared comfortable with the task. The most common incorrect responses included 'decane reacts with the water and makes ethene', 'the porcelain

					turns into ethene', and 'the chips melt / give off a gas'.
		ii	C_6H_{14} ✓	1(AO 2.2)	**ALLOW** $H_{14}C_6$ **ALLOW** if the candidate tries to write an (erroneous) equation for cracking and gives it as a product **Examiner's Comments** Again, higher ability candidates handled this formula with ease. Others got most of the way there and gave answers such as C_6H_{18} or C_8H_{18}.
			Total	**7**	
13	a		<table><tr><th>Name of alkane</th><th>Molecular formula</th><th>Structure</th></tr><tr><td>Methane</td><td>CH_4</td><td>  </td></tr><tr><td>Ethane</td><td>**C_2H_6** ✓</td><td>  </td></tr><tr><td>**Butane** ✓</td><td>C_4H_{10}</td><td>  ✓</td></tr></table>	3(AO 1.1)	**Examiner's Comments** Molecular formula and structure were both exceptionally well done, with the most common mistake being to write the structure as an incorrect version of cyclobutane. Naming was much more problematic. Most candidates assumed that alkane would be propane. A few realised that it would start with 'b' but wrote bromine. There was the usual crop of minor misspellings.
	b		**Hydrocarbon because** contains only carbon and hydrogen ✓ **Saturated because** contains single (covalent) bonds <u>only</u> / AW ✓	2(AO 2.1)	**ALLOW** fits the general formula C_nH_{2n+2} **ALLOW** has only H and C ✓ **DO NOT ALLOW** contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen **ALLOW** does not have a double bond **IGNORE** 'saturated because not an alkene / because all its carbons have 4 bonds **Examiner's Comments** Almost all candidates saw that there were two parts to this question and tried to answer both. Hydrogen and carbon were quoted by many, and a small minority went on to say 'only' and so gained credit. Very, very few could explain what 'saturated' meant. Sometimes candidates got part way there with 'it contains single bonds' but again did not add the word 'only' which would have made it complete.

					'Because it only contains two carbons' was not an uncommon incorrect response.
	c		Ethane – bromine water remains orange / orange-brown ✓ Ethene – bromine water is decolourised / turns colourless ✓	2(AO 2.2)	**IGNORE** No change **IGNORE** turns clear / disappears **Examiner's Comments** Very few candidates knew what happens when bromine water is added. 'Water fizzes and bubbles with ethene' was a common incorrect response
	d		Alkene(s) ✓	1(AO 1.1)	**Examiner's Comments** The term alkenes was well known.
			Total	**8**	
14			A	1	
			Total	**1**	
15	a		Tall column with condensers coming off at different heights (1) Column heated at the bottom so hot at the bottom and cool at the top (1) Substances with high boiling points condense at the bottom (1) Substances with low boiling points condense at the top (1)	4	
	b		$C_{15}H_{32} \rightarrow 2C_6H_{12} + C_3H_8$ (1)	1	**ALLOW** any correct multiple
			Total	**5**	
16			C	1	
			Total	**1**	
17			C	1	
			Total	**1**	
18			D	1	
			Total	**1**	
19			C	1	
			Total	**1**	