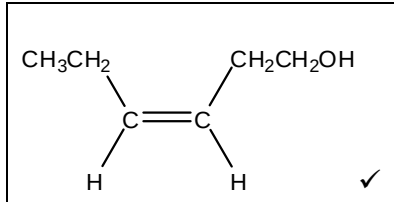
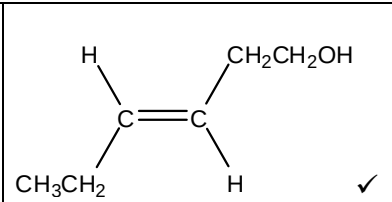
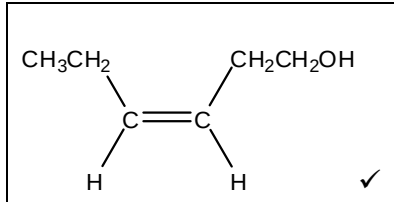
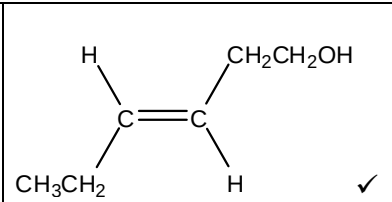
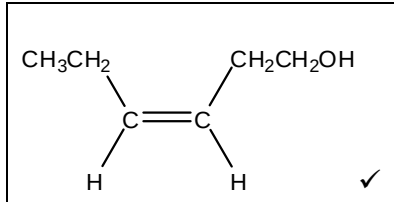
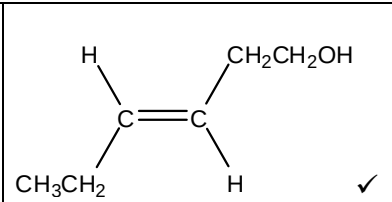
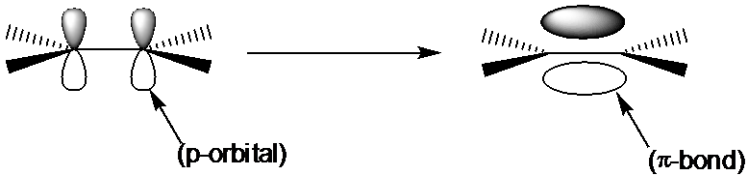
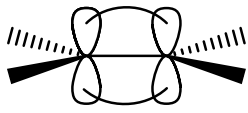
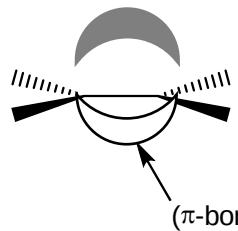
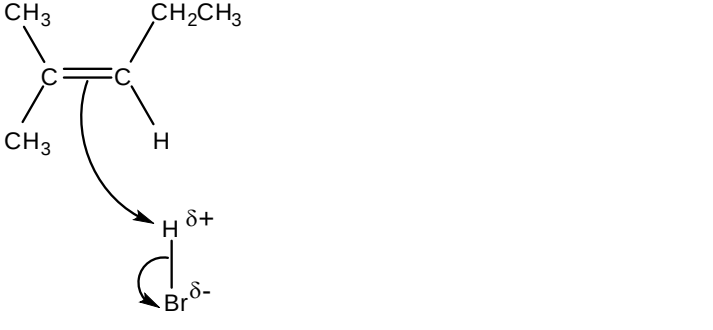
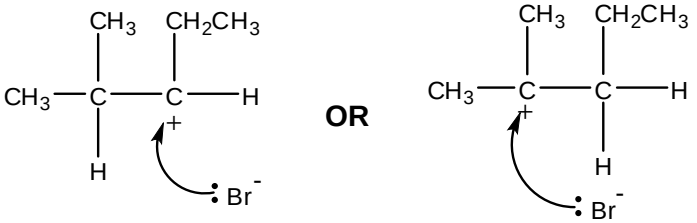


Question			Answer	Marks	Guidance
1	(a)		Compound A (is branched so) has less points of contact / less surface interaction between molecules ✓ Induced dipole–dipole interactions / London (dispersion) forces are weaker. AND Require less energy to break (these interactions / forces) ✓	2	Both answers need to be comparisons ALLOW ORA throughout DO NOT ALLOW ‘more contact between atoms’ IGNORE van der Waals’ forces/VDW for induced dipole–dipole interactions (ambiguous as this term refers to both permanent dipole – dipole and induced dipole–dipole forces) ALLOW fewer induced dipole-dipole interactions. IGNORE it is easier to break the induced dipole-dipole / London forces. (reference to energy required) IGNORE less energy required to separate molecules IGNORE less energy is needed to break the bonds.
	(b)	(i)	Hex-3-en-1-ol ✓	1	ALLOW Hex-3-ene-1-ol ALLOW 1-hydroxyhex-3-ene as this is unambiguous Hex-3-enol is not sufficient IGNORE lack of hyphens, or addition of commas

Question		Answer	Marks	Guidance				
	(ii)	Same structural formula AND Different arrangement (of atoms) in space OR different spatial arrangement (of atoms) ✓	1	ALLOW have the same structure/displayed formula/skeletal formula DO NOT ALLOW same empirical formula OR same general formula IGNORE same molecular formula Reference to <i>E/Z</i> isomerism or optical isomerism is not sufficient				
	(iii)	<table border="1"><tr><td></td><td></td></tr><tr><td><i>cis</i></td><td><i>trans</i></td></tr></table>			<i>cis</i>	<i>trans</i>	2	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous ALLOW one mark if both stereoisomers of compound C are shown but in the incorrect columns ALLOW one mark for correct stereoisomers of compound C in correct columns where –CH ₂ CH ₂ OH is represented as –C ₂ H ₅ O or –C ₂ H ₄ OH DO NOT ALLOW incorrect connectivity e.g. –CH ₃ CH ₂ on first occasion but allow ECF in second structure.
								
<i>cis</i>	<i>trans</i>							

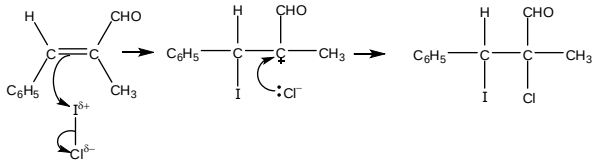
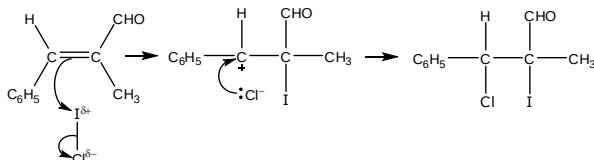
Question	Answer	Marks	Guidance
(c)	 Two p-orbitals shown as a “dumb-bell” added to structure on left. AND π-bond on structure on right ✓	1	DO NOT ALLOW C=C in diagram DO NOT ALLOW overlapping p orbitals on left hand side in the diagram. DO NOT ALLOW a diagram that contains four lobes on the right hand side. e.g.  IGNORE any atoms joined to the bonds Note: labels are not required ALLOW the following diagram to show the π-bond 
(d)	(i)	1	(The H atom of HBr) accepts a pair of electrons ✓
	(ii)	2	ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous ALLOW in either order

Question	Answer	Marks	Guidance
(iii)	Curly arrow from C=C bond to H of H-Br ✓ Correct dipole shown on H-Br AND curly arrow showing the breaking of H-Br bond ✓  Correct carbocation AND curly arrow from Br⁻ to C⁺ of carbocation ✓ 	3	ANNOTATE ANSWER WITH TICKS AND CROSSES ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous DO NOT ALLOW partial charges shown on C=C double bond (the second marking point) DO NOT ALLOW $\delta+$ on C of carbocation Curly arrow must come from a lone pair on Br⁻ OR from the negative sign of Br⁻ ion (then lone pair on Br⁻ ion does not need to be shown)

Question	Answer	Marks	Guidance
(iv)	$ \begin{array}{c} \text{CH}_3 \quad \text{CH}_2\text{CH}_3 \\ \quad \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{Br} \quad \text{H} \end{array} $ 2-bromo-2-methylpentane AND (the) carbocation intermediate (in the formation of 2-bromo-2-methylpentane) is more stable (than the carbocation in the formation of the other product) ✓	1	Note: the correct product and explanation are both required for the mark The major product may be identified by its • corresponding letter (E or F) from the table in (d)(ii) • correct structure • correct name DO NOT ALLOW product comes from the more stable secondary or primary carbocation IGNORE explanations based on Markownikoff's rule.
(e) (i)	$n(\text{myrcene}) = \frac{204 \times 10^{-3}}{136.0} = 1.5(0) \times 10^{-3} \text{ (mol)} \checkmark$ $ \begin{aligned} \text{Volume of H}_2 &= 3 \times 1.5(0) \times 10^{-3} \times 24000 \\ &= 108 \text{ (cm}^3\text{)} \checkmark \end{aligned} $	2	Correct working required for the first marking point. ALLOW ECF from incorrect moles of myrcene i.e. $n(\text{myrcene}) \times 3 \times 24000$ Common incorrect answers 108000 cm³ = 1 mark (not converted to g) 12cm³ = 1 mark (divided by 3) 36 cm³ = 1 mark (not multiplied by 3) IGNORE Calculations based on $pV = nRT$

Question			Answer	Marks	Guidance
		(ii)	Amount of hydrogen $n(\text{H}_2) = \frac{5.28}{24.0} = 0.22(0) \text{ (mol)} \quad \checkmark$ Number of double bonds $= \frac{0.220}{0.0200} = 11 \quad \checkmark$ Formula of saturated product $\text{C}_{40}\text{H}_{78} \quad \checkmark$ Equation $\text{C}_{40}\text{H}_{56} + 11\text{H}_2 \longrightarrow \text{C}_{40}\text{H}_{78} \quad \checkmark$	4	ALLOW Evidence of $n(\text{H}_2) = \frac{5.28}{24.0}$ if 0.22 is not seen Evidence for 11 double bonds could come from 11H_2 in equation Formula could be shown as the product of an equation ALLOW ECF from $\text{C}_{40}\text{H}_{82}$ and $\text{C}_{40}\text{H}_{80}$ only i.e. $\text{C}_{40}\text{H}_{60} + 11\text{H}_2 \longrightarrow \text{C}_{40}\text{H}_{82}$ $\text{C}_{40}\text{H}_{58} + 11\text{H}_2 \longrightarrow \text{C}_{40}\text{H}_{80}$
			Total	20	

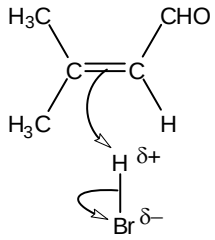
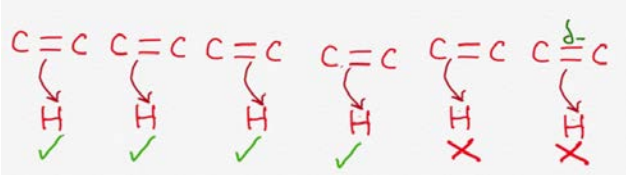
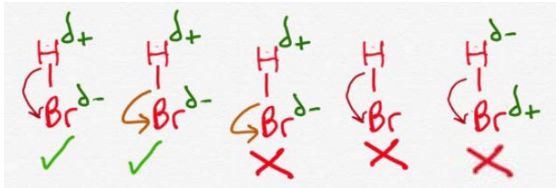
	Question		Answer	Marks	Guidance
2	(a)		priority groups/atoms are on different/opposite sides ✓ High(est) priority groups are C₆H₅ AND CHO OR Lowest priority groups are H and CH₃ ✓	2	ALLOW suitable alternatives to 'priority' e.g. groups with highest atomic number or more important groups etc. ALLOW high priority groups are diagonal(ly across) IGNORE references to relative mass of groups, A_r, M_r, ALLOW identification by name e.g aldehyde for CHO phenyl/benzene group for C₆H₅ alkyl for CH₃ ALLOW response in terms that O has higher priority than H in context of –CH₃ and –CHO IF 'priority' is not mentioned ALLOW 1 mark for 'C₆H₅ and CHO are on different sides' OR H and CH₃ are on different sides
	(b)	(i)	Bromine/ Br₂ AND goes colourless/decolourised ✓	1	Note: both reagent and observation are required ALLOW bromine water/ Br₂(aq)

Q	Answer	Marks	Guidance
2 (c)*	<i>Please refer to marking instructions on page 5 of mark scheme for guidance on how to mark this question.</i> Level 3 (5–6 marks) An outline of the mechanism for the formation of either product which is mostly correct. AND Major and minor products identified with a correct explanation of which product is most/least likely to be formed. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) An outline of the mechanism for the formation of either product but with a few omissions/errors. AND Identifies major/minor product correctly OR Explanation of which product is most/least likely to be formed. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A basic outline of the mechanism for the formation of either product is attempted. OR Basic explanation of which of the products is most/least likely to be formed. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i>	6	Please check all of page 23 which is included with this response. If this page is blank please annotate with SEEN Throughout: ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above if unambiguous Indicative scientific points: <u>Mechanism for formation of either product.</u> • Curly arrow from C=C to attack the I atom of the I-Cl • Correct dipole on I-Cl • Curly arrow from I-Cl bond to Cl • Carbocation with full positive charge on carbon atom • Curly arrow from negative charge on Cl⁻ or lone pair on Cl⁻ to carbon atom with positive charge  OR 

Question	Answer	Marks	AO	Guidance
3	C	1	AO1.2	

Question	Answer	Marks	AO	Guidance
4	C	1	AO1.2	ALLOW E (This is the correct term)

Question	Answer	Marks	AO	Guidance
5	D	1	AO2.5	

	Question	Answer	Marks	AO element	Guidance
6	(a) (i)	ANNOTATE ANSWER WITH TICKS AND CROSSES  Curly arrow from C=C bond to H of H-Br ✓ DO NOT ALLOW partial charge on C=C Correct dipole shown on H-Br AND curly arrow showing breaking of H-Br bond ✓	4	AO1.2 AO1.2	NOTE: curly arrows can be straight, snake-like, etc. but NOT double headed or half headed arrows 1st curly arrow must - go to the H atom of H-Br AND - start from, OR be traced back to any point across width of C=C  2nd curly arrow must - start from, OR be traced back to any part of $\delta^+ \text{H}-\text{Br}^{\delta-}$ bond AND - go to $\text{Br}^{\delta-}$ 

IGNORE connectivity of CHO and CH₃ groups in carbocation and product
e.g. **ALLOW**

$\begin{array}{c} \text{CHO} \\ | \\ \text{---} \end{array} \quad \text{OR} \quad \begin{array}{c} \text{CHO} \\ | \\ \text{---} \end{array}$

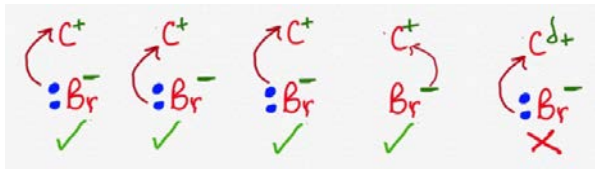
ALLOW COH for CHO (reaction does not involve this group)

3rd curly arrow must

- go to the C⁺ of carbocation

AND

- start from, **OR** be traced back to **any point across width** of lone pair on :Br⁻
- OR** start from – charge of Br⁻ ion

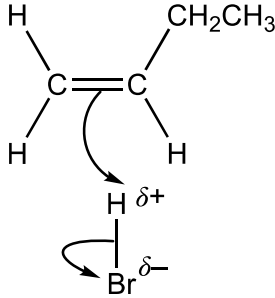
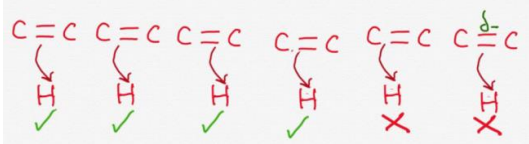
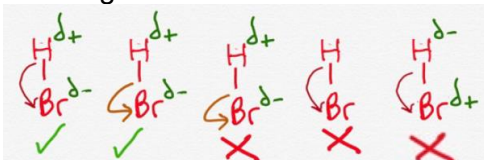


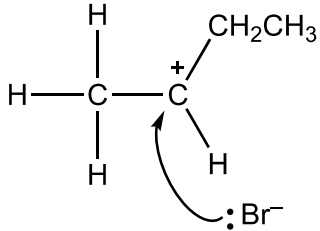
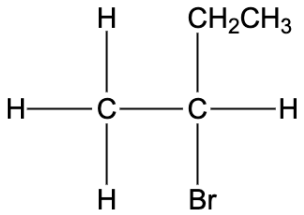
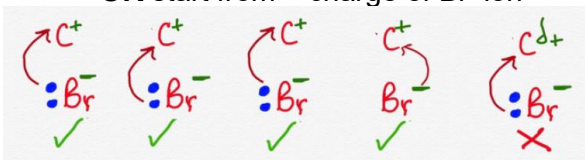
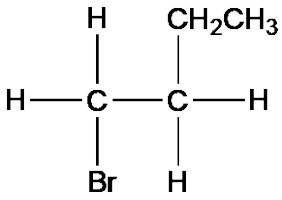
(Lone pair **NOT** needed if curly arrow shown from – charge of Br⁻ ion)

IF Br₂ is used instead of HBr contact your Team Leader

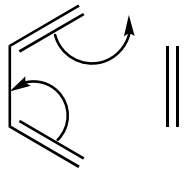
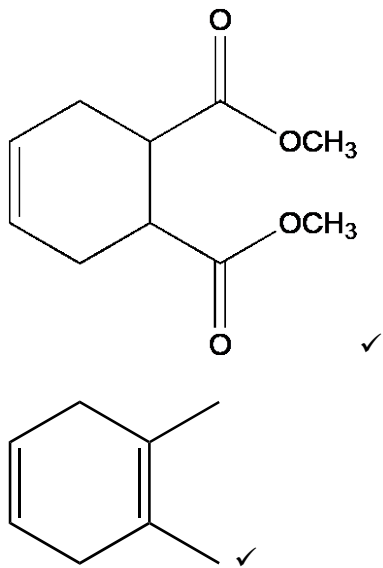
Question			Answer	Marks	AO element	Guidance
			intermediate/carbocation ✓ (major product forms from a) tertiary carbocation OR carbocation bonded to more C atoms / more alkyl groups OR carbocation bonded to no H atoms ✓		AO1.1 AO1.2	ALLOW carbonium ion or cation IGNORE descriptions of the major/minor product in terms of Markownikoff's rule e.g. H atom joins to C with most H IGNORE references to stability of the product ----- ALLOW ORA, i.e. (minor product forms from) least/less stable intermediate/carbocation ✓ (minor product forms from a) secondary carbocation OR carbocation bonded to fewer C atoms / more alkyl groups OR carbocation bonded to H atoms ✓ -----

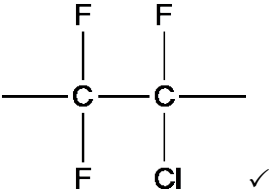
Question	Answer	Marks	AO	Guidance
7	B	1	1.1	

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	σ -bond: Overlap of orbitals between (bonding) atoms ✓ π -bond: Sideways overlap of (adjacent) p-orbitals ✓	2	AO1.1 ×2	ALLOW labelled diagrams IGNORE the type of orbital for σ -bond DO NOT ALLOW pi-orbital
		(ii)	σ -bonds: 9 ✓ π -bonds: 2 ✓	2	AO1.2 ×2	
	(b)	(i)	 Curly arrow from C=C bond to H of H-Br ✓ DO NOT ALLOW partial charge on C=C Correct dipole shown on H-Br AND curly arrow showing breaking of H-Br bond ✓	4	AO1.2 ×2 AO2.5 ×2	NOTE: curly arrows can be straight, snake like, etc. but NOT double headed or half headed arrows 1st curly arrow must - go to the H atom of H-Br AND - start from, OR be traced back to any point across width of C=C  2nd curly arrow must - start from, OR be traced back to any part of $\delta^+ \text{H}-\text{Br}^{\delta-}$ bond AND - go to $\text{Br}^{\delta-}$ 

Question	Answer	Marks	AO element	Guidance
	Correct carbocation AND curly arrow from Br⁻ to C⁺ of carbocation ✓ DO NOT ALLOW δ⁺ on C of carbocation  Correct product ✓ 			3rd curly arrow must - go to the C⁺ of carbocation AND - start from, OR be traced back to any point across width of lone pair on :Br⁻ OR start from – charge of Br⁻ ion  (Lone pair NOT needed if curly arrow shown from – charge of Br⁻ ion) ALLOW ECF for product from incorrect carbocation, i.e.  IF Br₂ is used instead of HBr contact your Team Leader

Question			Answer	Marks	AO element	Guidance
		(ii)	(major product forms from) most/more stable intermediate/carbocation ✓ (major product forms from a) secondary carbocation OR carbocation bonded to more C atoms / more alkyl groups OR carbocation bonded to fewer H atoms ✓	2	AO1.1 AO1.2	For carbocation, ALLOW carbonium ion or cation IGNORE descriptions of the major/minor product in terms of Markownikoff's rule e.g. H atom joins to C with most H IGNORE references to stability of the product ----- ALLOW ORA, i.e. (minor product forms from) least/less stable intermediate/carbocation ✓ (minor product forms from a) primary carbocation OR carbocation bonded to less C atoms / less alkyl groups OR carbocation bonded to more H atoms ✓
		(iii)	3 ✓	1	AO1.2	
	(c)	(i)	Same structural formula AND Different arrangement (of atoms) in space OR different spatial arrangement (of atoms) ✓	1	AO1.1	ALLOW structure/displayed/skeletal formula DO NOT ALLOW same empirical formula OR same general formula IGNORE same molecular formula Reference to <i>E/Z</i> isomerism or optical isomerism is not sufficient
		(ii)	Student is not correct AND 2 groups on one carbon atom (of C=C) are the same OR C–C bond can rotate ✓	1	AO3.1	DO NOT ALLOW one side of C=C

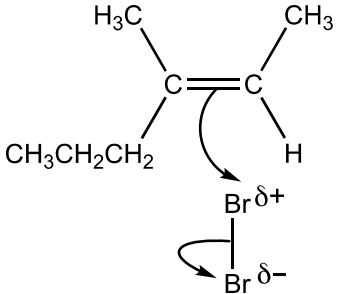
Question			Answer	Marks	AO element	Guidance
	(d)	(i)	 1 mark for each curly arrow ✓✓	2	AO2.5 ×2	IGNORE any dipoles shown NOTE: curly arrows can be straight, snake-like, etc. but NOT half headed or double headed arrows Curly arrow from C=C bond must start from, OR be traced back to, Lower left: any part of C=C bond and go to C—C Upper left: any part of C=C bond and go to gap between C=C and C=C
		(ii)	 ✓ ✓	2	AO3.2 ×2	
			Total	17		

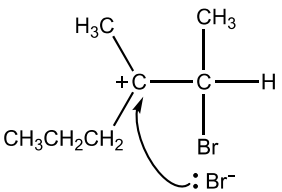
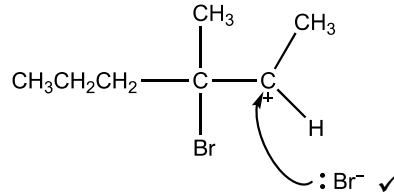
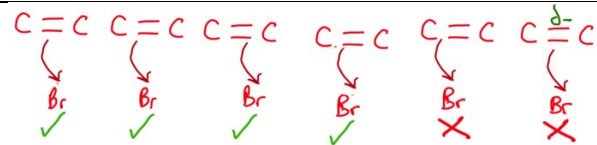
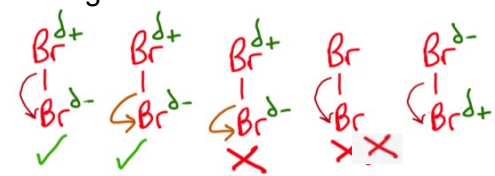
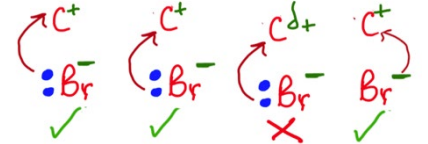
Question			Answer	Marks	AO	Guidance
9	(a)	(i)		1	AO2.5	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous 'End bonds' MUST be shown DO NOT ALLOW more than 1 repeat unit IGNORE brackets IGNORE <i>n</i>
		(ii)	More points of contact / more surface interaction (between molecules) AND Stronger/more dipole(–dipole) interactions ✓ More energy needed to break the intermolecular forces ✓	2	AO2.1 ×2	Both answers need to be a comparison IGNORE surface area ALLOW more electrons ALLOW induced/permanent dipole interactions ALLOW London forces ALLOW van der Waals' forces (as permanent dipole-dipole and induced dipole-dipole interactions are present within this polymer) IGNORE IDID

Question	Answer	Marks	AO	Guidance
10	B	1	AO1.1	

Question	Answer	Marks	AO	Guidance
11	C	1	AO2.6	ALLOW 4.8 (This is the correct volume)

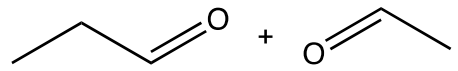
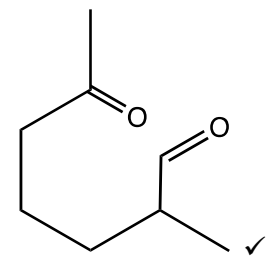
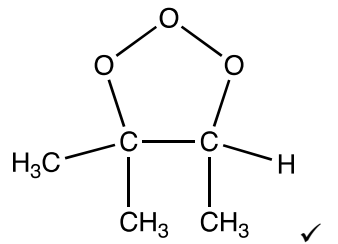
SECTION B

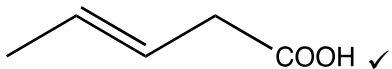
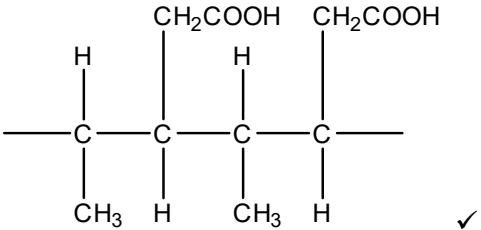
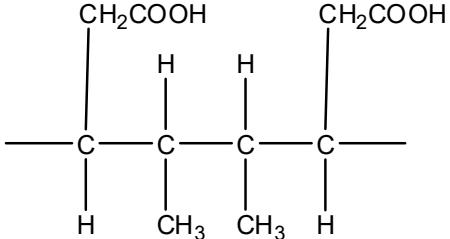
Question	Answer	Marks	AO element	Guidance
12 (a) (i)	3-methylhex-2-ene ✓	1	AO1.2	IGNORE lack of hyphens, or addition of commas DO NOT ALLOW 3-methyhex-2-ene OR 3-methhex-2-ene OR 3-methlyhex-2-ene OR 3-methylhexan-2-ene IGNORE references to <i>E/Z</i> or <i>cis/trans</i>
12 (a) (ii)	ANNOTATE ANSWER WITH TICKS AND CROSSES  Curly arrow from C=C bond to Br^{δ+} of Br–Br AND Correct dipole on Br–Br AND curly arrow for breaking of Br–Br bond ✓	3	AO1.2 ×1 AO2.5 ×2	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous IGNORE connectivity of CH₃CH₂CH₂ and CH₃ groups in carbocation and product ALLOW C₃H₇ for CH₃CH₂CH₂ DO NOT ALLOW half headed or double headed arrows but allow ECF if seen more than once DO NOT ALLOW use of HBr but ECF for subsequent use For curly arrows, ALLOW straight or snake-like arrows and small gaps (see examples): ----- DO NOT ALLOW partial charge on C=C 1st curly arrow must go to a Br atom of Br–Br AND start from, OR be traced back to any point across width of C=C

Question	Answer	Marks	AO element	Guidance
	Correct carbocation to match mechanism AND curly arrow from Br⁻ to C⁺ of carbocation  OR  <i>i.e. ALLOW carbonium + on either C atom</i> -----			 2nd curly arrow must - start from, OR be traced back to, any part of $\delta^+ \text{Br}-\text{Br}^{\delta-}$ bond AND go to Br$^{\delta-}$  3rd curly arrow must - go to the C⁺ of carbocation AND - start from, OR be traced back to any point across width of lone pair on :Br⁻ OR start from – charge on Br⁻ ion  <i>(Lone pair NOT needed if curly arrow shown from – charge on Br⁻)</i> ALLOW bromonium ion (Contact TL)

Question			Answer	Marks	AO element	Guidance
			<u>Correct product to match mechanism</u> ✓ <pre> CH₃ CH₃ CH₃CH₂CH₂—C—C—H Br Br </pre>			
12	(b)	(i)	Same molecular formula AND Different structural formulae ✓ OR Both have the molecular formula C₆H₁₂ AND Different structural formulae ✓	1	AO1.1	Same formula is not sufficient <i>(no reference to molecular)</i> Different arrangement of atoms is not sufficient <i>(no reference to structure/structural)</i> For 'structural formulae', ALLOW structure/displayed/skeletal formulae/ functional groups DO NOT ALLOW any reference to spatial/space
12	(b)	(ii)	Same structural formula AND Different arrangement (of atoms) in space OR different spatial arrangement (of atoms) ✓	1	AO1.1	ALLOW structure/displayed/skeletal formula DO NOT ALLOW same empirical formula OR same general formula IGNORE same molecular formula Reference to <i>E/Z</i> isomerism or optical isomerism is not sufficient

Question	Answer		Marks	AO element	Guidance
12	(b)	(iii)	2	AO1.2 AO2.5	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous
		H H C=C H₃C CH(CH₃)₂ <i>cis</i> isomer H₃C H C=C H CH(CH₃)₂ <i>trans</i> isomer			C ₃ H ₇ is not sufficient (could be unbranched)
		OR Identification of 3-methylpent-2-ene as <i>cis</i> AND <i>trans</i> isomers ✓✓ H CH₂CH₃ C=C H₃C CH₃ <i>cis</i> isomer H₃C H C=C CH₂CH₃ CH₃ <i>trans</i> isomer			ALLOW one mark if <i>cis</i> AND <i>trans</i> isomers of 4-methylpent-2-ene are in the wrong boxes
			ALLOW the isomers of 3-methylpent-2-ene in either box H₃C CH₂CH₃ C=C H CH₃ <i>cis</i> isomer H CH₂CH₃ C=C H₃C CH₃ <i>trans</i> isomer	ALLOW one mark for correct identification of <i>cis</i> AND <i>trans</i> isomers of unbranched C₆H₁₂ e.g. H H C=C CH₃CH₂ CH₂CH₃ <i>cis</i> isomer CH₃CH₂ H C=C H CH₂CH₃ <i>trans</i> isomer	

Question			Answer	Marks	AO element	Guidance
12	(c)	(i)	 BOTH structures required for ✓ 	2	AO3.1 ×1 AO3.2 ×1	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous
12	(c)	(ii)		1	AO3.2	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous
			Total	17		

			Answer	Marks	AO element	Guidance
13	(a)		Pent-3-enoic acid  2 repeat units of polymer 	2	AO1.2 AO2.5	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous ALLOW either the <i>E</i> or <i>Z</i> isomer ALLOW ECF from pent-2-enoic acid OR pent-4-enoic acid ONLY For repeat unit, • 'side bonds' required on either side of repeat unit from C atoms • 2 repeat units required IGNORE connectivity of CH₂COOH in polymer IGNORE brackets IGNORE <i>n</i> ALLOW any consistent repeat unit: CH₂COOH and CH₃ groups can alternate or be on opposite sides of chain e.g. 

Question		Answer	Marks	AO	Guidance
14		A	1	AO1.2	

Question	Answer	Marks	Guidance
15	C	1	

Question	Answer	Marks	Guidance
16	There was an issue with this question which affected candidates' ability to answer it. To make sure all candidates were treated fairly, we have awarded the mark to all candidates for this question.		
	Total	15	

SECTION B

Question		Answer	Marks	Guidance
17	(a)	B, C, D AND E only ✓	1	ALLOW letters in any order
17	(b)	A AND B only ✓	1	ALLOW letters in any order
17	(c)	A AND D only ✓	1	ALLOW letters in any order
17	(d)	1-ethyl-2,4-dimethylbenzene ✓	1	ALLOW other unambiguous names using smallest numbering. e.g. ALLOW 1,3-dimethyl-4-ethylbenzene 2,4-dimethylethylbenzene ethyl-2,4-dimethylbenzene 2,4-dimethyl-1-ethylbenzene IGNORE alphabetical order of methyl and ethyl IGNORE lack of hyphens, extra hyphens, full stops instead of commas, extra spaces DO NOT ALLOW 1,5-dimethyl-2-ethylbenzene OR 1,3-dimethyl-6-ethylbenzene <i>Needs smallest numbers</i> DO NOT ALLOW the following for dimethyl: dimethy, dimeth, dimethly, dimethanyl DO NOT ALLOW the following for ethyl: ethy, eth, ethly, ethanyl

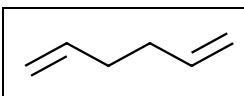
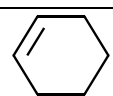
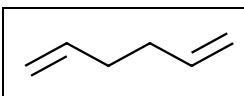
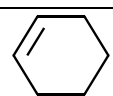
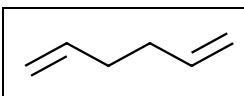
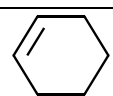
Question			Answer	Marks	Guidance
17	(e)		Priority groups are on the same side (Highest) priority groups are CH₃ AND C₂H₅ OR Low(est) priority groups CH₃ AND H	2	ALLOW suitable alternatives to 'priority' e.g. Groups with highest atomic number or more important groups or major groups etc. IGNORE references to (relative) mass of groups including Ar or Mr ALLOW suitable alternatives to 'same side' e.g. priority groups are both on the top OR above the C=C IGNORE priority groups in same plane OR adjacent IGNORE Use of 'molecules' instead of groups ALLOW identification by name e.g. ethyl and methyl IF 'priority' is not mentioned ALLOW one mark for 'CH₃CH₂ and CH₃ are on same side' OR 'H and CH₃ are on same side'

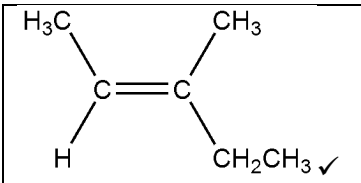
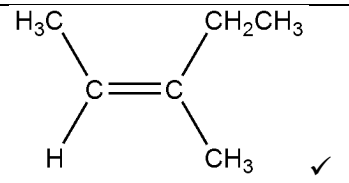
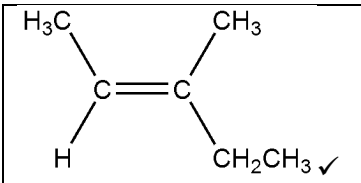
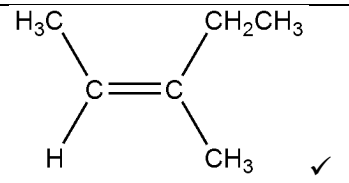
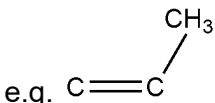
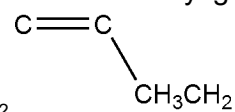
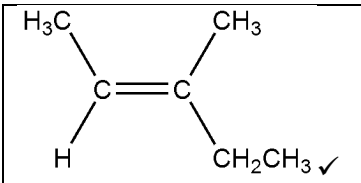
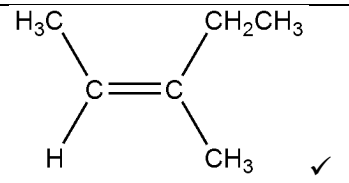
Question		Answer	Marks	Guidance
18		C	1	

Question		Answer	Marks	Guidance
19		B	1	

Question		Answer	Marks	Guidance
20		C	1	

SECTION B

Question			Answer	Mark	Guidance												
21	(a)		2-methylpent-2-ene ✓	1	IGNORE lack of hyphens, or addition of commas DO NOT ALLOW the following for methyl: methy, meth, methly, methyle, methanyl DO NOT ALLOW 2-methylpentan-2-ene												
21	(b)		<table><tr><td></td><td></td><td></td></tr><tr><td>Molecular formula</td><td>C₆H₁₀</td><td>C₆H₁₀</td></tr><tr><td>Number of σ bonds</td><td>15</td><td>16</td></tr><tr><td>Number of π bonds</td><td>2</td><td>1</td></tr></table> One row correct ✓ Two rows correct ✓✓ Three rows correct ✓✓✓				Molecular formula	C ₆ H ₁₀	C ₆ H ₁₀	Number of σ bonds	15	16	Number of π bonds	2	1	3	One mark per row If no other marks awarded, ALLOW 1 mark for a correct column
																	
Molecular formula	C ₆ H ₁₀	C ₆ H ₁₀															
Number of σ bonds	15	16															
Number of π bonds	2	1															

Question			Answer	Mark	Guidance				
21	(c)	(i)	<table><tr><td></td><td></td></tr><tr><td>E</td><td>Z</td></tr></table>			E	Z	2	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous ALLOW one mark if both stereoisomers of compound A are shown but in the incorrect columns ALLOW –C₂H₅ for ethyl group ALLOW connectivity to any part of methyl or CH₂ in ethyl e.g.  BUT DO NOT ALLOW ethyl group bonded via CH₃ e.g. 
									
E	Z								

Question			Answer	Mark	Guidance
21	(c)	(ii)	C=C / double bond does not rotate OR restricted rotation of the C=C/double bond ✓ Each carbon atom in C=C/double bond has (two) different groups/atoms (bonded) ✓	2	ALLOW π/pi bond does not rotate ALLOW C=C / double bond does not twist IGNORE groups are fixed in position IGNORE 'bond does not move' OR 'bond has restricted movement' ALLOW each end of the π/pi -bond is bonded to different groups/atoms DO NOT ALLOW 'functional groups' OR 'molecules' OR 'compounds' OR 'species' for 'groups' IGNORE C=C bond has two different groups IGNORE two different groups either side of the double bond <i>(could be above or below must be clear it is on each C)</i> IGNORE references to 'priority' (even if incorrect) IGNORE attempts to give definition of stereoisomerism e.g. same structural formula but different arrangement of atoms in space
21	(d)		$\text{C}_6\text{H}_{14} + 6\text{O}_2 \rightarrow 5\text{CO} + \text{C} + 7\text{H}_2\text{O} \quad \checkmark$	1	DO NOT ALLOW any equations which show H_2 as a product ALLOW $\text{C}_6\text{H}_{14} + 6\text{O}_2 \rightarrow 2\text{CO}_2 + \text{CO} + 3\text{C} + 7\text{H}_2\text{O}$ ALLOW $\text{C}_6\text{H}_{14} + 6\text{O}_2 \rightarrow \text{CO}_2 + 3\text{CO} + 2\text{C} + 7\text{H}_2\text{O}$ ALLOW multiples that show a 1:6 ratio e.g. $2\text{C}_6\text{H}_{14} + 12\text{O}_2 \rightarrow 10\text{CO} + 2\text{C} + 14\text{H}_2\text{O}$ OR $2\text{C}_6\text{H}_{14} + 12\text{O}_2 \rightarrow 5\text{CO}_2 + 7\text{C} + 14\text{H}_2\text{O}$

Question	Answer	Mark	Guidance
21 (e)	reagent: H_2 AND catalyst: Ni ✓	3	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous ALLOW names for reagents e.g. hydrogen, if no formulae given DO NOT ALLOW minor product, i.e. ALLOW reagent and catalyst on either answer line For catalyst ALLOW Pt / Pd or any suitable non-specification alternative IGNORE state symbols IGNORE conditions i.e. temp and pressure

Question			Answer	Mark	Guidance
22	(a)		(Chlorine containing polymers) produces toxic (products when incinerated) ✓	1	ALLOW suitable alternatives for 'produces' e.g. forms, releases (<i>must be clear that it is a product</i>) ALLOW produces HCl /hydrogen chloride/ hydrochloric acid ALLOW 'poisonous' for toxic IGNORE harmful / pollutant / dangerous