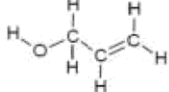
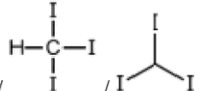
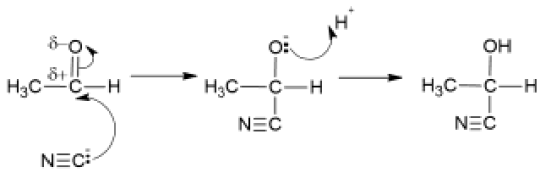
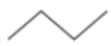
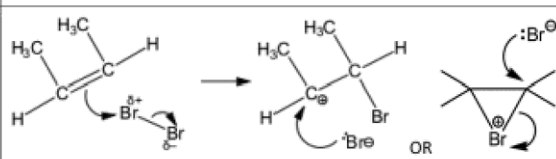


4(a)(i)	(molecules / isomers with) the same molecular formula / same number of atoms of each element	1
	different structural / displayed formulae / arrangement of bonds	1
4(a)(ii)	sp ² overlap of (2)s with two (2)p (atomic) orbitals	1
	sp ³ overlap of (2)s with all three (2)p (atomic) orbitals	1
4(b)(i)		1
4(b)(iv)	CO ₂ / carbon dioxide	1
4(c)(ii)	 tr(i)iodomethane / CHI ₃ /	1
4(d)(i)	(molecules / isomers with) the same (molecular and) structural formula	1
	Any two of: chiral centre / C attached to four different groups / atoms non-super(im)posable mirror images different spatial / 3D arrangement of atoms (owtte) different rotation of plane-polarised light	1
4(d)(ii)		
	curly arrow from lone pair on :C≡N to C ^(δ+)	1
	correct dipole on carbonyl ^{δ+} C=O ^{δ-} AND curly arrow from bond to O ^(δ-)	1
	correct intermediate, including C–O ⁻ AND curly arrow from lone pair to H ⁺	1
Total:		19

4(a)(i)	(A =) 	1
4(a)(iii)	CH ₃ CHCHCH ₃ OR CH ₃ CH=CHCH ₃	1
4(a)(iv)	No rotation / restricted / limited rotation of C=C / (carbon) double bond	1
	One (of the two) methyl groups / one (of the two) H (atoms) is on each C (of C=C)	1
4(a)(v)	 arrow from the C=C double bond drawn to the bromine dipole on Br₂ in correct orientation AND arrow from the Br-Br bond to the Br^{δ-} correct carbocation / bromonium ion from the structure with C=C drawn Br⁻ with lone pair, negative charge AND arrow from lone pair to the carbon atom of intermediate OR using both arrows shown (in alternative diagram)	1
4(a)(vi)	electrons in pi bond induce it (the dipole) OR (high) electron density in pi bond / double bond / C=C repels electrons (away from nearest Br) OR polarised by (high) electron density in pi bond / double bond / C=C	1

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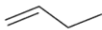
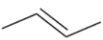
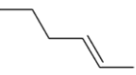
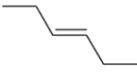
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Question	Answer	Marks
4(b)(ii)	$2\text{C}_4\text{H}_8\text{O}_2 + \text{Na}_2\text{CO}_3 \rightarrow 2\text{C}_4\text{H}_7\text{O}_2\text{Na} + \text{H}_2\text{O} + \text{CO}_2$	1
4(c)(ii)	F = CH ₃ CH ₂ CH ₂ COCH ₃	1
	G = C ₂ H ₅ CH(CH ₃)CHO	1
4(c)(iii)	a (tetrahedral) atom with four different groups / atoms / substituents attached OR a carbon (atom) with four different groups / atoms / substituents attached	1
4(d)(ii)	H = ethanoic acid	1
	I = methyl methanoate	1
	Total:	23

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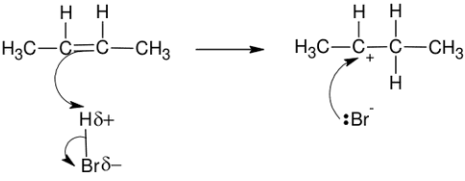
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May/June 2017 9701/22 · Q4 (a)(i), (a)(iii), (a)(iv), (a)(v), (a)(vi), (b)(ii), (c)(ii), (c)(iii), (d)(ii)

1(a)	(molecules / isomers with) the same molecular formula / same number of atoms of each element	1
	different structural / displayed formulae / different arrangement of bonds	1
1(b)(i)	4	1
1(b)(ii)	6	1
1(b)(iv)		1
	 alternative using supplied data: any two   	1
1(b)(v)	correct conversions of data to SI / consistent units $P = 100\,000$; $V = 25 \times 10^{-6}$; $T = 310$	1
	calculation of n ($= pV / RT$) $n = \frac{100 \times 10^3 \times 25 \times 10^{-6}}{8.31 \times 310}$	1
	calculation of mass m ($= n \times M_r$) AND answer correct to 3sf $m = 9.705 \times 10^{-4} \times 56 = 0.0543$ (g)	1
	Alternative answer for using C_6H_{12} : $m = 9.705 \times 10^{-4} \times 84 = 0.0815$ (g)	
Total:		11

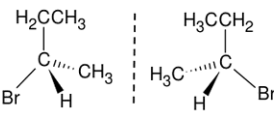
Question	Answer	Marks
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May/June 2017 9701/23 · Q1 (a), (b)(i), (b)(ii), (b)(iv), (b)(v)

4(b)	In any order $\text{CH}_2=\text{CHCH}_2\text{CH}_3$ / $\text{CH}_2\text{CHCH}_2\text{CH}_3$ / $\text{CH}_2\text{CHC}_2\text{H}_5$ AND $\text{CH}_3\text{CH}=\text{CHCH}_3$ / $\text{CH}_3\text{CHCHCH}_3$ AND $(\text{CH}_3)_2\text{C}=\text{CH}_2$ / $(\text{CH}_3)_2\text{CCH}_2$	1
4(c)(ii)	 arrow from the C=C double bond drawn to the H dipole on H-Br in correct orientation AND arrow from the H-Br bond to the $\text{Br}^{\delta-}$ correct carbocation from the structure with C=C drawn Br^- with lone pair, negative charge AND arrow from lone pair to the positively charged carbon atom of intermediate	1 1 1 1

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Question	Answer	Marks
4(d)(i)	a (tetrahedral) atom with four different groups / atoms / substituents attached OR a carbon (atom) with four different groups / atoms / substituents attached	1
4(d)(iii)	 One 3D structure of 2-bromobutane which must have 2 bonds shown the same and two different, i.e. three bond types altogether, e.g. two solid lines, one wedge and one dash. If two bonds are drawn in the plane of the paper, i.e. single solid lines, they must not be at 180 degrees to each other. Second structure either mirror of first OR all bonds drawn the same with position of two groups swapped.	1 1
4(e)(i)	(2-)methylpropene / (2-)methylprop-1-ene	1

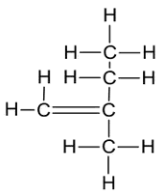
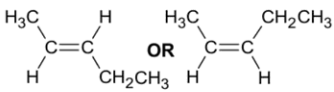
May/June 2017 9701/23 · Q4 (b), (c)(ii), (d)(i), (d)(iii), (e)(i)

4(b)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ $(\text{CH}_3)_3\text{COH}$ $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$	2
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May/June 2018 9701/21 · Q4 (b)

4(b)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$	1
	$(\text{CH}_3)_2\text{CHCHO}$	1

May/June 2018 9701/22 · Q4 (b)

2(a)(i)	(molecules / isomers with) the same molecular formula / same number of atoms of each element	1
	different structural formulae / different structures	1
2(a)(ii)	(Molecules / isomers) with the same (molecular and) structural formula	1
	different arrangement of atoms in space / different spatial arrangement of atoms.	1
2(b)(i)	two Hs on one of the C=C carbons / terminal C / C-1	1
	no chiral C / no C with 4 different groups / atoms / chains attached has a super(im)posable mirror image	1
2(b)(ii)		1
	2-methylbut-1-ene	1
2(b)(iii)	structure 	1
	trans-pent-2-ene or E- or cis-pent-2-ene or Z-	1

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Question	Answer	Marks
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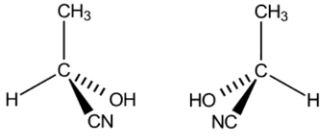
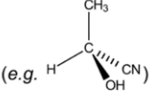
May/June 2018 9701/23 · Q2 (a)(i), (a)(ii), (b)(i), (b)(ii), (b)(iii)

4(b)	<table><tr><td>$(\text{CH}_3)_3\text{CBr}$</td><td>$(\text{CH}_3)_2\text{CHCH}_2\text{Br}$</td><td>$\text{CH}_2\text{BrCH}_2\text{CH}_2\text{CH}_3$</td></tr></table>	$(\text{CH}_3)_3\text{CBr}$	$(\text{CH}_3)_2\text{CHCH}_2\text{Br}$	$\text{CH}_2\text{BrCH}_2\text{CH}_2\text{CH}_3$	2
$(\text{CH}_3)_3\text{CBr}$	$(\text{CH}_3)_2\text{CHCH}_2\text{Br}$	$\text{CH}_2\text{BrCH}_2\text{CH}_2\text{CH}_3$			
	3 correct = 2 marks 2 correct = 1 mark				

May/June 2018 9701/23 · Q4 (b)

4(c)(iii)	nucleophilic substitution / S _N 2	1
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March 2019 9701/22 · Q4 (c)(iii)

5(a)	M1 a lone pair / electron pair donor	1
	M2 $(:)\text{CN}^-$ / $-(:)\text{CN}$ / cyanide ion	1
5(b)(i)	optical	1
5(b)(ii)	 M1 one 3-D structure of correct molecule shown.	1
	M2 a mirror image of the molecule drawn in M1 OR same profile with two groups swapped  (e.g. $\text{H}-\text{C}(\text{CH}_3)(\text{OH})(\text{CN})$)	1
	M3 central chiral C shown as *	1
5(c)	$\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$ OR $\text{HO}_2\text{CCH}(\text{OH})\text{CH}_3$	1

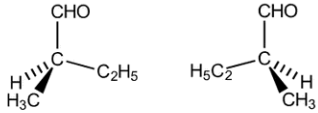
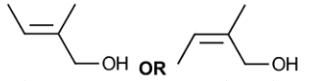
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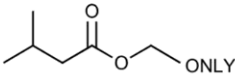
May/June 2019 9701/21 · Q5 (a), (b)(i), (b)(ii), (c)

4(d)(iii)	propagation	1
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May/June 2019 9701/22 · Q4 (d)(iii)

4(c)(ii)	Aldehyde	1
4(c)(iii)	has a carbon / atom attached / bonded to four different atoms / groups / groups of atoms / chains	1
4(c)(iv)	 M1: Correct 3D representation M2: Correct 3D representation of drawn enantiomer	2
4(c)(vi)	 M1: skeletal alkene group AND C5 structure M2: one alcohol group M3: branched chain AND capable of geometrical isomerism	3

Oct/Nov 2019 9701/21 · Q4 (c)(ii), (c)(iii), (c)(iv), (c)(vi)

4(b)(iii)	optical (isomerism)	1
4(c)(i)	Add bromine water / Br ₂ (aq) AND turns (from orange / brown to) colourless	1
4(d)(i)	3-methylbutan-1-ol	1
4(d)(iii)	M1: skeletal formula of Q  M2: one commercial use of Q (ethyl isovalerate / ethyl 3methylbutyrate) solvents / perfumes / flavourings	2

Oct/Nov 2019 9701/22 · Q4 (b)(iii), (c)(i), (d)(i), (d)(iii)

3(a)(ii)	nucleophilic addition	1
3(a)(iv)	it does not have four different (groups of) atoms attached to (central) carbon OR it does not have a chiral carbon / centre OR it has two identical / COOH groups attached to (central) carbon OR mirror image is super(im)posable	1

March 2020 9701/22 · Q3 (a)(ii), (a)(iv)

5(c)(i)	carbonyl / aldehyde / ketone	1
5(c)(ii)	tertiary halogenoalkane	1

May/June 2020 9701/21 · Q5 (c)(i), (c)(ii)

6(a)		1
6(b)(i)	hot AND concentrated	1
6(b)(ii)	oxidation	1

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Question	Answer	Marks
6(c)	Structural formula of X: HCO ₂ H OR HCOOH	1
6(d)	M1 reagent (2,4-) DNPH / (2,4)-dinitrophenylhydrazine M2 observation yellow / orange / red precipitate	2
6(f)(ii)	propan-1-ol ALLOW propan-2-ol as error carried forward from 6f(i)	1

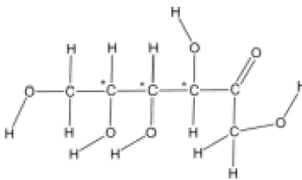
May/June 2020 9701/21 · Q6 (a), (b)(i), (b)(ii), (c), (d), (f)(ii)

3(b)	M1 both have molecular formula - C₆H₁₂O₆ M2 idea that in glucose and fructose there are the same number and type of atoms present but the atoms are arranged in a different order ie one has a carbonyl group at the end of the chain/molecule and the other has a carbonyl group in the middle of the chain/molecule	2
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May/June 2020 9701/22 · Q3 (b)

5(a)	Rxn.	name of mechanism	Name of reagents and conditions	6
	1	M1 electrophilic addition	M2 steam AND concentrated phosphoric acid (catalyst)	
	2		M3 & M4 Two marks for name of reagent and both conditions. One mark for name of reagent and one conditions acidified potassium dichromate ((VI)) condition 1 warm condition 2 distil NOT reflux	
	6	M5 nucleophilic substitution	M6 ammonia (alcoholic) AND heat in a sealed tube / heat under pressure	
5(b)(ii)	ALLOW in any order M1 nitrile M2 (secondary) alcohol			2

May/June 2020 9701/22 · Q5 (a), (b)(ii), (c)

3(b)(i)	an atom which is bonded to four different substituents / groups / atoms	1
3(b)(ii)	ALL three chiral carbons need to be shown by * 	1

May/June 2020 9701/23 · Q3 (b)(i), (b)(ii)

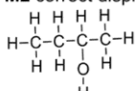
4(b)(i)	free-radical substitution	1
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Question	Answer	Marks
4(c)(i)	CH ₃ (CH ₂) ₃ CH=CH ₂	1

May/June 2020 9701/23 · Q4 (b)(i), (c)(i)

5(a)(ii)	M1 correct identification of butan-2-ol M2 correct displayed formula including correct connectivity of C–O–H 	2
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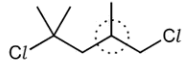
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Question	Answer		Marks
5(a)(iii)	isomer	name	2
	C	cis but-2-ene	
	D	trans but-2-ene	
	E	but -1-ene	
	2 marks for 3 correct names 1 mark for 2 correct names		
5(b)(i)		Functional group	3
	F	M1 Ester / RCOOR ⁽¹⁾ / RCO ₂ R ⁽¹⁾	
	G	M2 Carboxyl / carboxylic acid / RCOOH	
	H	M3 Alcohol / hydroxy / R-OH	

May/June 2020 9701/23 · Q5 (a)(ii), (a)(iii), (b)(i)

4(c)(ii)	Nucleophilic substitution / S_{N}	1
4(c)(iv)	(L has) two identical / two methyl groups attached to one end / one carbon of the $\text{C}=\text{C}$ / double bond	1

Oct/Nov 2020 9701/21 · Q4 (c)(ii), (c)(iv)

3(c)(ii)	M1: molecule with a non super-(im)posable mirror image M2: 	2
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Oct/Nov 2020 9701/22 · Q3 (c)(ii)

4(b)(i)	positional (isomerism) / regioisomerism	1
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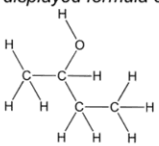
Oct/Nov 2020 9701/22 · Q4 (b)(i)

5(c)(i)	CO_2H / carboxylic acid	1
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May/June 2021 9701/21 · Q5 (c)(i)

4(a)(ii)	(molecules with the) same structural formula (and same molecular formula) with different arrangement of atoms / groups in space	1
4(b)(ii)	M1  skeletal formula only M2 explanation in terms of increased / greater stability of intermediate / carbocation intermediate / (secondary) carbocation / $\text{CH}_3\text{C}^+(\text{H})(\text{CH}_2\text{CH}_3)$ is (more) stable M3 reason for increased stability of intermediate in terms of greater number of alkyl groups showing largest inductive (electron releasing) effect greater (positive) inductive effect due to two alkyl groups OR greater electron donation of two alkyl groups	1 1 1

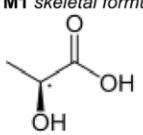
May/June 2021 9701/22 · Q4 (a)(ii), (b)(ii)

5(a)	displayed formula of butan-2-ol structure with O—H shown 	1
5(b)(ii)	substitution	1
5(b)(iii)	reagent M1 NaCN or KCN	1
	conditions M2 ethanolic AND heat (under reflux)	1
5(b)(iv)	(1) $C_4H_9CN + (1)H^+ + 2H_2O \rightarrow (1)C_4H_9CO_2H + (1)NH_4^+$ ✓✓ correct organic product showing carboxylic acid functional group M1 $C_4H_9CO_2H$ / C_4H_9COOH	1
	M2 balanced equation with a $C_5H_{10}O_2$ or equivalent structure as product	1

May/June 2021 9701/22 · Q5 (a), (b)(ii), (b)(iii), (b)(iv)

4(a)(ii)	carbonyl / ketone	1
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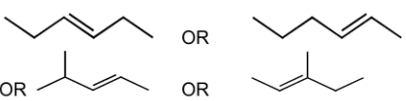
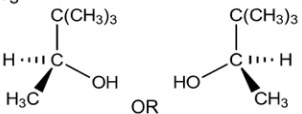
May/June 2021 9701/23 · Q4 (a)(ii)

5(b)(i)	M1 skeletal formula of 2-hydroxypropanoic acid / similar chiral isomer that meet the criteria in table 	1
	M2 chiral carbon marked with *	1
5(c)	M1 chiral centre / non superimposable mirror image / has a C attached to 4 different groups	1
	M2 C=C where each C is attached to (two) different groups	1
5(d)	(molecules / isomers with) the same molecular formula / same number of atoms of each element AND different structural formulae / different structures	1

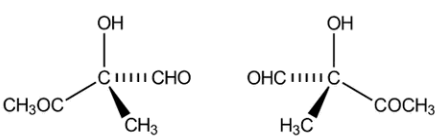
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May/June 2021 9701/23 · Q5 (b)(i), (c), (d)

3(b)		1
3(d)(i)	cold dilute acidified potassium manganate(VII)	1
3(e)(iv)	Draw two optical isomers of X. eg 	1
	M1 One correct 3-dimensional representation of X M2 3-d structure which represents the enantiomer of their X	1
3(e)(v)	heat AND concentrated H_2SO_4 / concentrated H_3PO_4 / concentrated sulfuric [(VI)] acid / concentrated phosphoric[(V)] acid	1

Oct/Nov 2021 9701/22 · Q3 (b), (d)(i), (e)(iv), (e)(v)

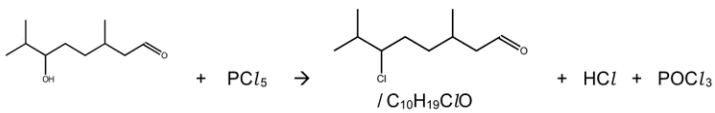
4(a)(ii)		2
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March 2022 9701/22 · Q4 (a)(ii)

3(a)	M1 optical M2 one of the C atoms has 4 different groups / atoms attached	2
3(c)(i)	NaBH ₄ / sodium borohydride / LiAlH ₄ / lithium tetrahydridoaluminate	1
3(c)(ii)	M1 H ₂ O(g) / steam M2 phosphoric acid (catalyst) / H ₃ PO ₄ (catalyst)	2
3(c)(iii)	M1 Q AND intermediate / cation is (more) stable M2 (as the) C ⁺ has 3 / more alkyl groups attached M3 (so) greater (positive) inductive effect	3
3(d)(i)	M1 Q orange → green M2 R orange → green M3 –CHO / aldehyde (in both) (and 2° / secondary alcohol in R) reacts / oxidised	3

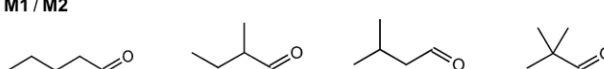
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Question	Answer	Marks
3(d)(ii)	 M1 correct formula of organic product M2 correct inorganic products	2
3(d)(iii)	M1 water reacts with / hydrolyses PCl ₅ M2 H ₂ O + PCl ₅ → POCl ₃ + 2HCl OR 4H ₂ O + PCl ₅ → H ₃ PO ₄ + 5HCl	2

Question	Answer	Marks
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May/June 2022 9701/21 · Q3 (a), (c)(i), (c)(ii), (c)(iii), (d)(i), (d)(ii), (d)(iii)

4(b)(ii)	3.196 g Br ₂ = 3.196 / 159.8 (= 0.02 mol Br ₂) AND 2.8(00) / 280 (= 0.01 mol V) 2 alkene / 2 C=C (groups)	1
4(c)(iii)	M1 / M2  M3 chain (isomerism)	3

May/June 2022 9701/21 · Q4 (b)(ii), (c)(iii)

4(a)(i)	$\text{CH}_3(\text{CH}_2)_2\text{CH}_2\text{Br}$ OR name: 1-bromobutane $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{CH}_3$ OR name: 2-bromobutane M1 structure of isomer 1 AND name M2 structure of isomer 2 AND name (in any order)	2
4(a)(ii)	positional	1
4(b)(i)		1

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Question	Answer	Marks
4(b)(ii)	$\text{CF}_3\text{CBrClH} \rightarrow \text{CF}_3\text{CHCl}\cdot + \text{Br}\cdot$	1
4(b)(iii)	[Ar] 	1
4(c)(ii)	non-biodegradable OR poisonous / harmful HCl made when burnt	1

Question	Answer	Marks
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May/June 2022 9701/22 · Q4 (a)(i), (a)(ii), (b)(i), (b)(ii), (b)(iii), (c)(ii)

3(b)(i)	functional group	1
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May/June 2022 9701/23 · Q3 (b)(i)

3(a)(ii)	molecules with the same molecular formula AND different structural formulae <i>owtte</i>	1
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Oct/Nov 2022 9701/22 · Q3 (a)(ii)

3(d)(iii)	equilibrium moves to left AND more moles / molecules of gas on LHS	1
3(d)(iv)	(molecules / isomers with) the same molecular formula	1
	but different structural formulae	1

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Question	Answer	Marks
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Oct/Nov 2022 9701/23 · Q3 (d)(iii), (d)(iv)

3(d)(ii)	name of stage	equation	3
	initiation	$\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$	
	propagation	$\text{CH}_2\text{Cl}_2 + \text{Cl}\cdot \rightarrow \text{CHCl}_2\cdot + \text{HCl}$	
	termination	$\text{CHCl}_2\cdot + \text{Cl}\cdot \rightarrow \text{CHCl}_3$	

May/June 2023 9701/21 · Q3 (d)(ii)

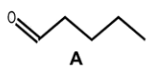
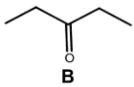
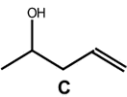
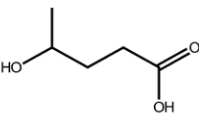
4(c)(i)	acid AND it donates a proton / H^+	1
4(c)(ii)	$(CH_3CH_2)^+$ OR $CH_3C^+H_2$ AND accepts a pair of electrons	1

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Question	Answer	Marks
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May/June 2023 9701/22 · Q4 (c)(i), (c)(ii)

5(a)	molecules / isomers with the same molecular formula / same number of atoms of each element AND different structural formulae / different structures	1
5(b)(ii)	 	2
5(c)(i)	 M1 $CH_3CH(OH)$ present M2 five carbons in a straight chain AND molecular formula $C_5H_{10}O$ AND 1 $C=C$ structure which shows only one type of stereoisomerism	2
5(c)(ii)	optical	1
5(d)(i)	ester	1
5(d)(ii)	condensation	1
5(d)(iii)		1

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Question	Answer	Marks
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May/June 2023 9701/22 · Q5 (a), (b)(ii), (c)(i), (c)(ii), (d)(i), (d)(ii), (d)(iii)

4(a)	<table><tr><td>molecule</td><td>P</td><td>Q</td><td>R</td><td>S</td></tr><tr><td>geometrical</td><td>✓</td><td>(x)</td><td>(x)</td><td>(x)</td></tr><tr><td>optical</td><td>(x)</td><td>✓</td><td>✓</td><td>✓</td></tr></table>	molecule	P	Q	R	S	geometrical	✓	(x)	(x)	(x)	optical	(x)	✓	✓	✓	1
	molecule	P	Q	R	S												
geometrical	✓	(x)	(x)	(x)													
optical	(x)	✓	✓	✓													
	<table><tr><td>molecule</td><td>P</td><td>Q</td><td>R</td><td>S</td></tr><tr><td>geometrical</td><td>✓</td><td>(x)</td><td>(x)</td><td>(x)</td></tr><tr><td>optical</td><td>(x)</td><td>✓</td><td>✓</td><td>✓</td></tr></table> CH ₃ CHBrCH ₂ CH ₃	molecule	P	Q	R	S	geometrical	✓	(x)	(x)	(x)	optical	(x)	✓	✓	✓	1
molecule	P	Q	R	S													
geometrical	✓	(x)	(x)	(x)													
optical	(x)	✓	✓	✓													
4(b)(ii)	<table><tr><td>geometrical</td><td>✓</td><td>(x)</td><td>(x)</td><td>(x)</td></tr><tr><td>optical</td><td>(x)</td><td>✓</td><td>✓</td><td>✓</td></tr></table> CH ₃ CHBrCH ₂ CH ₃ nucleophilic substitution	geometrical	✓	(x)	(x)	(x)	optical	(x)	✓	✓	✓	1					
geometrical	✓	(x)	(x)	(x)													
optical	(x)	✓	✓	✓													
4(b)(iii)	C ₄ H ₉ CN + 2H ₂ O + H ⁺ → C ₄ H ₉ COOH + NH ₄ ⁺	1															

March 2024 9701/22 · Q4 (a), (b)(ii), (b)(iii), (c)(iii)

6(a)(i)	(molecules with the) same structural formula (and same molecular formula) with different arrangement of atoms / groups in space	1
6(a)(ii)	M1 number of stereoisomers = 8 M2 reasoning: 2 chiral centres AND 1 C=C (producing a cis-and trans or geometrical pair)	2
6(a)(iv)	ester AND carbonyl / ketone AND C=C (bond) / alkene	1
6(b)(i)	reducing agent for C=O AND C=C	1
6(b)(ii)	sodium borohydride / NaBH ₄	1

May/June 2024 9701/21 · Q6 (a)(i), (a)(ii), (a)(iv), (b)(i), (b)(ii)

4(a)	Three-dimensional stereoisomers of CH ₃ (CH ₂) ₅ CHBrCH ₃ Br H₃C — C — H R Br H — C — CH₃ R M1 correct representation of left-hand answer as 3d structure of one of the enantiomers of CH ₃ (CH ₂) ₅ CHBrCH ₃ M2 correct representation of 3d structure of the second enantiomer of CH ₃ (CH ₂) ₅ CHBrCH ₃	2
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Question	Answer	Marks
4(d)(i)	elimination	1
4(d)(ii)	NaOH / sodium hydroxide in ethanol	1

May/June 2024 9701/22 · Q4 (a), (d)(i), (d)(ii)

5(c)(i)	hydroxyl	1
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May/June 2024 9701/22 · Q5 (c)(i)

5(b)(ii)	electrophilic addition	1
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May/June 2024 9701/23 · Q5 (b)(ii)

1(d)(i)	M1 $\frac{79.5}{209.4} : \frac{20.5}{18.0} = 0.380 : 1.14 = 1:3$ OR $18x / (102.9 + 3(35.5) + 18x) = 0.205$ $x = 3$ OR $(102.9 + 3(35.5)) / (209.4 + 18x) = 0.795$ $x = 3$ M2 $x = 3$	1
1(d)(ii)	molecules with the same structural formula and same molecular formula with different 3D / different spatial arrangement of atoms / groups	1
1(d)(iv)		1
		1

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Question	Answer	Marks
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Oct/Nov 2024 9701/21 · Q1 (d)(i), (d)(ii), (d)(iv)

4(a)(ii)	A's central carbon atom is not bonded to four different atoms/groups of atoms A 	1
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Oct/Nov 2024 9701/21 · Q4 (a)(ii)

4(d)(ii)	aldehyde	1
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Question	Answer	Marks
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Oct/Nov 2024 9701/22 · Q4 (d)(ii)

1(d)(iv)		1
		1

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Question	Answer	Marks
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Oct/Nov 2024 9701/23 · Q1 (d)(iv)

3(d)(ii)	electrophilic addition	1
3(d)(iii)		2
3(d)(iv)	position(al) / regio- (isomerism)	1

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Question	Answer	Marks
3(d)(v)	- secondary (carbo)(cat)ion/intermediate is more stable / $[\text{CH}_3\text{CHCH}_2\text{I}]^+$ is preferred - electrophile approaches with I nearest / $\text{I}^{\delta+}$ / I^+ attacks first - I and Br have different electronegativities / IBr is a polar molecule	2

Question	Answer	Marks
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March 2025 9701/22 · Q3 (d)(ii), (d)(iii), (d)(iv), (d)(v)

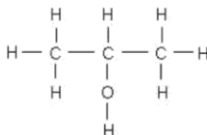
4(c)(i)	sp^3	1
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Question	Answer	Marks
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May/June 2025 9701/22 · Q4 (c)(i)

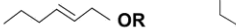
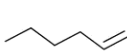
4(d)(ii)		2
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Question	Answer	Marks
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May/June 2025 9701/24 · Q4 (d)(ii)

5(a)	M1  M2  OR 	2
5(b)(ii)	(W / it has two) different groups bonded to each C of the double bond	1
5(c)		1
5(d)(ii)	hot concentrated acidified KMnO_4	1

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Question	Answer	Marks
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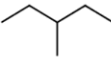
May/June 2025 9701/24 · Q5 (a), (b)(ii), (c), (d)(ii)

3(b)	two of: 	2
3(c)(i)	homolytic	1

Oct/Nov 2025 9701/21 · Q3 (b), (c)(i)

4(b)(ii)	M1 (molecules that have the) same structural formula (and same molecular formula) M2 but different 3D / spatial arrangement of atoms / groups	2
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Oct/Nov 2025 9701/21 · Q4 (b)(ii)

3(a)	M1 (family of molecules / compounds / series with) same general formula OR (family of molecules where) molecular formula differs (only) by (units of) $\text{CH}_2(n)$. M2 similar chemical properties / reactions	2
3(b)	M1 strong C—H (bonds) M2 non-polar (C—H / molecule / bonds)	2
3(d)(i)	M1  M2 	2
3(d)(ii)	M1 $\text{B} < \text{A} < \text{hexane}$. M2 hexane / unbranched has stronger / more IMFs M3 hexane / unbranched requires most / more energy	3
3(e)(i)	H_2 (g) OR hydrogen (gas)	1

Oct/Nov 2025 9701/22 · Q3 (a), (b), (d)(i), (d)(ii), (e)(i)

4(a)(i)	free-radical substitution	1
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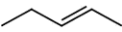
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Question	Answer	Marks
4(a)(ii)	M1 $\text{C}_3\text{H}_8 + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{HCl}$ OR $\text{C}_3\text{H}_8 + \text{Cl}^\bullet \rightarrow \text{C}_3\text{H}_7^\bullet + \text{HCl}$ M2 $\text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + \text{Cl}^\bullet$ OR $\text{C}_3\text{H}_7^\bullet + \text{Cl}_2 \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{Cl}^\bullet$ etc M3 $\text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ OR $\text{C}_3\text{H}_7^\bullet + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$	3
4(a)(iii)	homolytic	1
4(a)(iv)	1,2-dichloropropane	1
4(a)(v)	M1 (type of structural isomerism) positional M2 (type of stereoisomerism) optical	2
4(b)	sodium hydroxide AND water	1

Oct/Nov 2025 9701/22 · Q4 (a)(i), (a)(ii), (a)(iii), (a)(iv), (a)(v), (b)

4(b)(ii)	M1 (molecules that have the) same structural formula (and same molecular formula) M2 but different 3D / spatial arrangement of atoms / groups	2
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Oct/Nov 2025 9701/23 · Q4 (b)(ii)

4(a)(ii)	M1  M2 restricted / lack of / no rotation about C=C	2
4(a)(iii)	electrophilic addition	1

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Question	Answer	Marks
4(a)(v)	M1 (reaction proceeds via a) more stable intermediate / carbocation M2 because of greater positive inductive effect of more alkyl groups	2
4(b)(ii)	$(\text{C}_2\text{H}_5)_2\text{CHCN} + 2\text{H}_2\text{O} + \text{HCl} \rightarrow (\text{C}_2\text{H}_5)_2\text{CHCOOH} + \text{NH}_4\text{Cl}$	1

Oct/Nov 2025 9701/24 · Q4 (a)(ii), (a)(iii), (a)(v), (b)(ii)