

2(d)(i)	AgI (and AgCl solid) / silver ions reacting with iodide ions	1
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May/June 2017 9701/23 · Q2 (d)(i)

4(c)(i)	S = substitution N = nucleophilic	1
4(c)(ii)	M1 = dipole and curly arrow M2 = intermediate carbocation IGNORE CH₂CH₃ shown as C₂H₅ M3 = OH⁻ with lone pair and curly arrow from lone pair to the 'C'	3
4(d)	• C₄H₉Cl slower (than C₄H₉Br) • C₄H₉I faster (than C₄H₉Br) • C–Cl bond stronger than C–Br OR C–Cl 340 C–Br 280 • C–I bond weaker than C–Br OR C–Br 280 C–I 240 1 mark for each point, max 3	3

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Question	Answer	Marks
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May/June 2018 9701/23 · Q4 (c)(i), (c)(ii), (d)

4(d)	M1 major product formed from more stable intermediate / carbocation OR (intermediate has) 2° carbocation which is (more) stable M2 (positive) inductive effect / (+)I of alkyl groups (on the intermediate)	2
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March 2019 9701/22 · Q4 (d)

5(a)(i)	pentanenitrile	1
5(a)(ii)	a lone pair / electron pair donor	1
5(a)(iii)	$(\cdot\cdot)\text{CN}^- / \cdot\cdot\text{CN}$ / cyanide ion	1
5(a)(iv)	Br (atom) is replaced (with / by CN / nitrile)	1
5(b)	M1 reagent Ammonia M2 conditions heat with under pressure / heat in a sealed tube	2
5(c)(i)	M1 Increasing reactivity from $\text{Cl} \rightarrow \text{Br} \rightarrow \text{I}$ M2 Due to decreasing strength of C-X bond (from C-Cl to C-Br to C-I) OR Less energy needed to break C-X (from C-Cl to C-Br to C-I)	2
5(c)(ii)	M1 tertiary / 3° halogenoalkane M2 (carbo)cation / intermediate is stable M3 due to (3) electron releasing/donating methyl groups / + I groups (attached to central C) OR (positive) inductive effect of the (three) methyl groups /	3
5(c)(iii)	Any formula / name for any primary halogenoalkane i.e. 1-chlorobutane / 1-bromobutane / 1-iodobutane	1

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Question	Answer	Marks
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May/June 2019 9701/23 · Q5 (a)(i), (a)(ii), (a)(iii), (a)(iv), (b), (c)(i), (c)(ii), (c)(iii)

3(c)(i)	$\text{C}_2\text{H}_5\text{OH} + \text{PCl}_5 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{POCl}_3 + \text{HCl}$	1
3(c)(iii)	EITHER M1: HI / I^- is a strong(er) reducing agent (than HCl / Cl^-) M2: HI / I^- is oxidised (to iodine but the chloride is not) OR M1: H_2SO_4 is a (strong enough) oxidising agent (to react with HI / I^- here) M2: HI / I^- forms iodine OR M1: phosphoric acid is a weak / not an oxidising agent M2: (so) does not react with iodide (where M2 is dependent on M1 here)	2
3(c)(iv)	M1: $\text{C}_2\text{H}_5\text{I}$ reacts fastest AND $\text{C}_2\text{H}_5\text{Cl}$ reacts slowest OR $\text{C}_2\text{H}_5\text{Cl} < \text{C}_2\text{H}_5\text{Br} < \text{C}_2\text{H}_5\text{I}$ M2: C—I bond is the weak(est) AND C—Cl bond strong(est)	2

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Question	Answer	Marks
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Oct/Nov 2019 9701/22 · Q3 (c)(i), (c)(iii), (c)(iv)

2(e)(ii)	$\text{C}_2\text{H}_5\text{CH}(\text{OH})\text{C}_2\text{H}_5 + \text{HCl} \rightarrow \text{C}_2\text{H}_5\text{CH}(\text{Cl})\text{C}_2\text{H}_5 + \text{H}_2\text{O}$	1
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March 2020 9701/22 · Q2 (e)(ii)

1(c)(ii)	amphoteric	1
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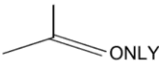
Question	Answer	Marks
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May/June 2020 9701/21 · Q1 (c)(ii)

4(a)(i)	Bromine / Br	1
4(a)(ii)	$\text{Ag}^+(\text{aq}) + \text{X}^-(\text{aq}) \rightarrow \text{AgX}(\text{s})$ OR $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$	1
4(a)(iii)	M1 reagent Add (aqueous) ammonia M2 expected result EITHER (Dilute ammonia) – partial amount precipitate dissolves OR not much precipitate dissolves OR add concentrated ammonia – precipitate dissolves	2

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Question	Answer	Marks
4(b)(i)	M1 primary/ 1° (carbo)cation formed is not very stable M2 EITHER (as) only one alkyl group exerting an inductive effect OR only one alkyl group so the charge is (more) localised on the C+	2
4(c)(i)	elimination	1
4(c)(ii)	$\text{C}_4\text{H}_9\text{Cl} + \text{NaOH} \rightarrow \text{C}_4\text{H}_8 + \text{NaCl} + \text{H}_2\text{O}$	1
4(c)(iii)		1
4(c)(iv)	M1 2-chloro(-2-)methylpropane M2 1-chloro(-2-)methylpropane ALLOW in any order	2

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Question	Answer	Marks
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May/June 2020 9701/22 · Q4 (a)(i), (a)(ii), (a)(iii), (b)(i), (b)(ii), (c)(i), (c)(ii), (c)(iii), (c)(iv)

4(b)(iii)	$(\cdot)\text{C}_6\text{H}_{13} + \text{Br}_2 \rightarrow \text{C}_6\text{H}_{13}\text{Br} + (\cdot)\text{Br}$	1
4(b)(iv)	$(\cdot)\text{C}_6\text{H}_{13} + (\cdot)\text{Br} \rightarrow \text{C}_6\text{H}_{13}\text{Br}$	1

May/June 2020 9701/23 · Q4 (b)(iii), (b)(iv)

2(e)(i)	M1: ionic M2: ions only able / free to move / free to conduct (when liquid / molten)	2
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Oct/Nov 2020 9701/21 · Q2 (e)(i)

4(a)(iv)	$3\text{I}_2 + 6\text{NaOH} \rightarrow 5\text{NaI} + \text{NaIO}_3 + 3\text{H}_2\text{O}$	1
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Question	Answer	Marks
4(b)(ii)	Electrophilic addition	1

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

2(e)(ii)	$\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4$	1
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Oct/Nov 2020 9701/22 · Q2 (e)(ii)

2(d)(ii)	$\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$	1
2(g)(i)	(free-)radical substitution	1

March 2021 9701/22 · Q2 (d)(ii), (g)(i)

6(e)(i)	elimination	1
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May/June 2021 9701/21 · Q6 (e)(i)

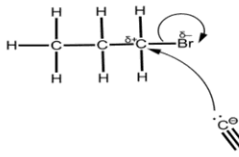
4(a)(i)	1,3-dichloropropan(-2-)one	1															
4(a)(iii)	NaBH_4 OR LiAlH_4	1															
4(c)	<table border="1"> <thead> <tr> <th>step</th><th>reagent and conditions</th><th>type of rxn</th></tr> </thead> <tbody> <tr> <td>1</td><td>M1 HCN and (trace) KCN / NaCN</td><td>M3 Addition</td></tr> <tr> <td>2</td><td>dilute sulfuric acid</td><td>Hydrolysis</td></tr> <tr> <td>3</td><td>M2 KCN/NaCN in ethanol / alcohol</td><td>M4 Substitution</td></tr> <tr> <td>4</td><td>dilute sulfuric acid</td><td>Hydrolysis</td></tr> </tbody> </table> M5 type of reaction for step 2 AND step 4	step	reagent and conditions	type of rxn	1	M1 HCN and (trace) KCN / NaCN	M3 Addition	2	dilute sulfuric acid	Hydrolysis	3	M2 KCN/NaCN in ethanol / alcohol	M4 Substitution	4	dilute sulfuric acid	Hydrolysis	5
step	reagent and conditions	type of rxn															
1	M1 HCN and (trace) KCN / NaCN	M3 Addition															
2	dilute sulfuric acid	Hydrolysis															
3	M2 KCN/NaCN in ethanol / alcohol	M4 Substitution															
4	dilute sulfuric acid	Hydrolysis															

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Question	Answer	Marks
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May/June 2021 9701/23 · Q4 (a)(i), (a)(iii), (c)

5(b)	M1 C–I (covalent bond) is weaker or a M2 lower activation energy / lower E_a (with 2-iodopropane) OR M2 explain in terms of the S_N1 mechanism (that is dominant / preferred / occurring with 2-iodopropane is fast(er)) (identical) carbocation is made (more) quickly (with 2-iodopropane) OR low / less energy is required to make the (same) carbocation / intermediate (from 2-iodopropane) OR M2 iodine / I (of C–I) has weaker attraction of nucleus to bonding / shared pair (of electrons) due to any one of: - more / high shielding (of electrons from inner shells) - more / 5 electron shells in iodine - C–I greater distance from nuclei (to bonding pair of electrons)	2
5(c)(i)	 M1 dipole $C^{\delta+}-Br^{\delta-}$ AND curly arrow from C–Br bond to $Br^{\delta-}$ M2 lone pair on C of ^-CN AND curly arrow from lone pair to C (on C-1 of bromopropane)	2

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Question	Answer	Marks
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May/June 2022 9701/22 · Q5 (b), (c)(i)

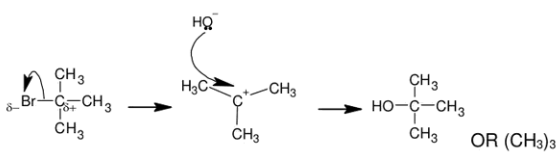
4(b)(i)	M1 hydroxy(l) M2 substitution	2
4(b)(v)	$CH_3CH_2CHICH_3$ M1 correct identification of I on 4C molecule M2 unambiguous structure of M – unbranched with 4C and I on 2C	2

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Question	Answer	Marks
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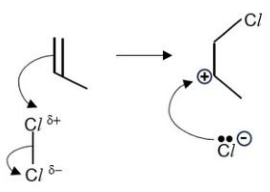
May/June 2022 9701/23 · Q4 (b)(i), (b)(v)

1(e)(i)	 M1 correct dipole in on $\delta^+C-Br^{\delta-}$ (in tBuBr) AND curly arrow from C–Br to Br M2 curly arrow from electron pair on O of $^-OH / :OH^-$ to C^+ in carbocation M3 tBuOH product	1
		1
		1

Oct/Nov 2022 9701/22 · Q1 (e)(i)

3(b)	$NaClO$ / sodium hypochlorite / chlorate(I) AND H_2O / water	1
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Oct/Nov 2022 9701/23 · Q3 (b)

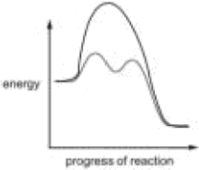
2(d)(i)	 • curly arrow from C=C bond to Cl(δ^+) • correct dipole on Cl₂ AND curly arrow from Cl–Cl bond to Clδ^- • correct carbocation intermediate • curly arrow from lone pair on Cl[–] to C⁺	1
		1
		1
		1

March 2024 9701/22 · Q2 (d)(i)

4(b)	$\delta^- \text{Br} \quad \text{C}_{\delta^+}(\text{CH}_2)_5\text{CH}_3$ CH_3 $\text{H} \quad \text{C}^+(\text{CH}_2)_5\text{CH}_3$ CH_3 HO^- (+ NaBr OR Br[–]) $\text{H} \quad \text{C}(\text{CH}_2)_5\text{CH}_3$ $\text{HO} \quad \text{CH}_3$ M1 correct dipole ($\delta^+\text{C}—\text{Br}\delta^-$) AND curly arrow from bond of C—Br to Br (or just beyond) M2 correct intermediate ALLOW R for $-(\text{CH}_2)_5\text{CH}_3$ M3 curly arrow from lone pair on OH[–] to the C of intermediate (or suitable position where C—OH bond is made) <i>If S_N2 mechanism shown:</i> Apply S_N2 mechanism mark scheme only if mechanism shows OH / NaOH species attacking the reactant and no OH M1 correct dipole ($\delta^+\text{C}—\text{Br}\delta^-$) AND curly arrow from bond of C—Br to Br of reactant (or just beyond) NOT M2 M3 curly arrow from lone pair on :OH[–] to the appropriate C of the reactant	3
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Question	Answer	Marks
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May/June 2024 9701/22 · Q4 (b)

4(c)(i)	nucleophile	1
4(d)	 M1 same start energy and finishing energy AND single hump M2 transition state / activation energy shown in answer is higher than both transition state energies shown in reaction profile (as the reaction is slower)	2
4(e)(ii)	NH ₄ Br / ammonium bromide	1
4(f)(i)		1
4(f)(ii)	M1 2-bromo-2-methylpropane AND more stable carbocation / C⁺ M2 alkyl groups have an inductive effect (of alkyl groups) AND 2-bromo-2-methylpropane has more / most alkyl groups attached (to C⁺) / carbocation contains more alkyl groups	2

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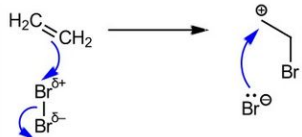
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Question	Answer	Marks
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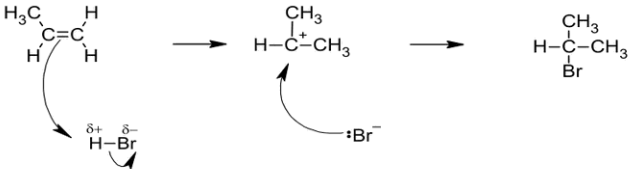
May/June 2024 9701/23 · Q4 (c)(i), (d), (e)(ii), (f)(i), (f)(ii)

2(c)(i)	cold NaOH(aq)	1
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Oct/Nov 2024 9701/21 · Q2 (c)(i)

4(a)	 pt 1 dipole on Br₂ pt 2 curly arrow from C=C bond to a Br^{δ+} pt 3 curly arrow from Br-Br bond to the other Br pt 4 correct intermediate pt 5 curly arrow from lone pair on Br⁻ to C⁺ 5• = 3 marks. 4• = 2 marks. 3• = 2 marks. 2• = 1 marks. 1• = 0 marks.	3
4(c)(iii)	C ₂ H ₂	1
4(d)(i)	structural / positional	1

Oct/Nov 2024 9701/22 · Q4 (a), (c)(iii), (d)(i)

3(a)(ii)	 M1 curly arrow from = of C=C to H (of HBr) M2 curly arrow from bond of H^{δ+}-Br^{δ-} to Br^{δ-} (dipole is essential) M3 correct intermediate M4 curly arrow from lone pair of Br⁻ to C⁺ of intermediate drawn	4
3(a)(iii)	M1(2-bromopropane is made from the) more stable intermediate / carbocation M2 (due to positive) inductive effect of more alkyl groups (attached to the C⁺ / central carbon atom) OR (due to) greater (positive) inductive effect of 2 methyl groups (rather than 1 ethyl group)	2

May/June 2025 9701/22 · Q3 (a)(ii), (a)(iii)

1(d)(ii)	$\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4$	1
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Question	Answer	Marks
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May/June 2025 9701/24 · Q1 (d)(ii)

3(b)(i)	$(\text{CH}_3)_2\text{CHOH} + \text{Na} \rightarrow (\text{CH}_3)_2\text{CHO}^-\text{Na}^+ + \frac{1}{2} \text{H}_2$	1
3(b)(ii)	M1 correct dipole on $\delta^+\text{C}-\text{Br}^{\delta-}$ AND curly arrow from $\text{C}-\text{Br}$ bond to Br M2 intermediate  M3 curly arrow from lone pair of $(\text{CH}_3)_2\text{CHO}^-$ to C^+	3
3(b)(iii)	M1 rate would decrease M2 $\text{C}-\text{Br}$ is weaker (than $\text{C}-\text{Cl}$, so breaks more easily)	2

Oct/Nov 2025 9701/24 · Q3 (b)(i), (b)(ii), (b)(iii)