

4(d)(i)	H C=O (group / bond) AND O—H (group / bond)	1
	I C=O (group / bond) AND C—H (group / bond)	1

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Question	Answer	Marks
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May/June 2017 9701/22 · Q4 (d)(i)

3(d)	M1 compound P	3
	M2 (absorption at) 2250 cm ⁻¹ AND C≡N (stretch)	
	M3 (absorption at) 3100–3700 cm ⁻¹ AND O—H (stretch)	

Question	Answer	Marks
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March 2019 9701/22 · Q3 (d)

4(c)(v)	principal absorptions in the infra-red spectrum	bond responsible	1
	3200–3600 cm ⁻¹	RO-H / O-H	
	1630 cm ⁻¹	C=C	
	1050 cm ⁻¹	C—O	

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Question	Answer	Marks
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Oct/Nov 2019 9701/21 · Q4 (c)(v)

4(e)(i)	1500–1680 (cm ⁻¹) AND C=C	1
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Oct/Nov 2019 9701/22 · Q4 (e)(i)

3(d)(iii)	M1 / M2 absorptions seen in both spectra (any two): (same) both show an absorption at 1680–1730 (cm ⁻¹) because of C=O (same) both show an absorption at 1040–1300 (cm ⁻¹) because of C—O (same) both show an absorption at 2500–3000 (cm ⁻¹) because of RCO ₂ H / O—H in RCO ₂ H / carboxyl(ic acid)	3
	M3 absorption only seen in spectrum of T : (different) T shows an absorption at 1500–1680 (cm ⁻¹) because of C=C (different) T shows an absorption at 3000–3100 (cm ⁻¹) because of (C=)C—H	

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March 2020 9701/22 · Q3 (d)(iii)

6(e)	Predict two differences, with reasons, between spectra of Y, $\text{CH}_3\text{CH}_2\text{COCH}_3$ and 2-methylbut-1-ene (shown) <i>first difference</i> M1 absence of peak/ absorption at 3100 cm^{-1} as no longer any =C-H present (in Y) <i>second difference</i> M2 peak at 1650 cm^{-1} moves to the left to any value / range of values between 1670 and 1740 due to disappearance of C=C (in Y) and appearance of C=O (in Y) OR absence of peak at 1650 cm^{-1} as no longer any C=C present (in Y) AND appearance of peak (in Y) at (any value / range of values) between $1670\text{--}1740\text{ cm}^{-1}$ due to C=O	2
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May/June 2020 9701/21 · Q6 (e)

3(c)(v)	Any two of three absorption references: - absorption $2200\text{--}2250\text{ cm}^{-1}$ shows presence of $\text{C}\equiv\text{N}$ - lack of absorption at $1680\text{--}1730\text{ cm}^{-1}$ shows lack of C=O - lack of absorption at $2500\text{--}3000\text{ cm}^{-1}$ shows lack of RCO_2H / O-H in RCO_2H	2
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Question	Answer	Marks
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Oct/Nov 2020 9701/21 · Q3 (c)(v)

4(d)(i)	X is C=O AND Z is C-O	1
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Oct/Nov 2020 9701/22 · Q4 (d)(i)

3(c)	M1: $2150\text{--}2250\text{ cm}^{-1}$ AND $\text{C}\equiv\text{C}$ M2: $2200\text{--}2250\text{ cm}^{-1}$ AND $\text{C}\equiv\text{N}$	2
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Question	Answer	Marks
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March 2021 9701/22 · Q3 (c)

5(b)(v)	$2200\text{--}2250\text{ cm}^{-1}$ due to $\text{C}\equiv\text{N}$ / triple bond between C and N.	1
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May/June 2021 9701/22 · Q5 (b)(v)

4(b)	M1 ester M2 1100 cm^{-1} linked to C-O AND 1720 cm^{-1} linked to C=O M3 No COOH / carboxylic acid and No OH / alcohol in D (but present in C) OR COOH / carboxylic acid and OH / alcohol reacted /lost (in C to form D)	3
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Oct/Nov 2021 9701/21 · Q4 (b)

3(d)(iii)	M1 C—O in range 1040–1300 (cm ⁻¹) M2 C=O in range 1670–1740 (cm ⁻¹)	2
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Oct/Nov 2021 9701/22 · Q3 (d)(iii)

4(b)(iii)	Perspex® would not have absorption 1500–1680 cm ⁻¹ AND Perspex® does not have C=C	1
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March 2022 9701/22 · Q4 (b)(iii)

4(d)	29 57 identity of Z	C_2H_5^+ $\text{COCH}_2\text{CH}_3^+$ OR $\text{C}_3\text{H}_5\text{O}^+$ OR $\text{CH}_2\text{COCH}_3^+$ pentan-3-one / $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$ pentan-2-one / $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_3$	3
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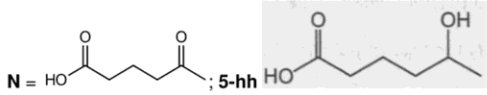
May/June 2022 9701/21 · Q4 (d)

6(c)(i)	Look for some reference to 116 as the mass of the molecular ion AND mass of $\text{C}_{(1)}\text{H}_{(1)}\text{O}_{(1)} = 29$ to conclude molecular formula is $\text{C}_4\text{H}_4\text{O}_4$ $116 / 29 = 4$ so $\text{C}_4\text{H}_4\text{O}_4$	1
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May/June 2022 9701/22 · Q6 (c)(i)

5(b)(i)	$100 \times 2.2 / 1.1 \times 100 = \underline{2}$	1
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May/June 2022 9701/23 · Q5 (b)(i)

5(b)	 N = HO-C(=O)-CH₂-CH₂-CH₂-C(=O)-OH; 5-hh HO-C(=O)-CH₂-CH₂-CH₂-CH₂-CH₂-OH M1 absorptions will overlap / be similar / the same / indistinguishable M2 both have some bonds in similar environments owtte	1
5(c)	100 / 1.1 ÷ 95.5 / 3.15 = 3 carbon atoms	1
		1

Oct/Nov 2022 9701/21 · Q5 (b), (c)

1(b)	NH ₄ ⁺ 11 p ⁺ AND 10 e ⁻	1
	CO ₃ ²⁻ 30 p ⁺ AND 32 e ⁻	1
	PO ₄ ³⁻ 47 p ⁺ AND 50 e ⁻	1

Oct/Nov 2022 9701/22 · Q1 (b)

3(c)(i)	C=C (bond) / alkene AND (absorption within) 1500–1680 cm ⁻¹ (present in E 's IR spectrum only)	1
3(c)(ii)	hydroxyl / alcohol AND (broad absorption within) 3200–3650 cm ⁻¹ (present in F 's IR spectrum only)	1
3(c)(iii)	120.9 / 121	1

Oct/Nov 2022 9701/22 · Q3 (c)(i), (c)(ii), (c)(iii)

5(c)	100 / 1.1 ÷ 95.5 / 3.15 = 3 carbon atoms	1
		1

Oct/Nov 2022 9701/23 · Q5 (c)

3(f)	M1 <i>m/e</i> 164 (CF ₂ ³⁵ Cl ⁷⁹ Br) ⁺ M2 <i>m/e</i> 166 (CF ₂ ³⁷ Cl ⁷⁹ Br) ⁺ AND (CF ₂ ³⁵ Cl ⁸¹ Br) ⁺	2
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Question	Answer	Marks
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May/June 2023 9701/21 · Q3 (f)

5(d)(iv)

Any two of the following differences in spectra **D** compared to **E**:

2

	bond	functional group	value or range of values of absorbance inclusive (cm ⁻¹)
E	C=O / C double bond to O	(ester)	1710–1750
D	C=O	(carboxy(l))	1670–1740
D	O-H OR OH bond	(carboxy(l))	2500–3000
D	O-H OR OH bond	(hydroxy(l) OR alcohol)	3200–3600

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May/June 2023 9701/22 · Q5 (d)(iv)

1(c)	⁶³ Cu ²⁺	1
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May/June 2023 9701/23 · Q1 (c)

4(c)(i)	$n = 100 / 1.1 \times 0.55 / 7.2$	1
	= 6.94 (so 7 carbon atoms)	1
4(c)(ii)	FG = ester / (R)COOR(')	1
	(absorption at) 1040–1300 cm ⁻¹ indicates C—O (stretch) AND (absorption at) 1710–1750 cm ⁻¹ indicates (C=O stretch)	1

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Question	Answer	Marks
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March 2024 9701/22 · Q4 (c)(i), (c)(ii)

6(c)(i)	M1 deduce $n = 12$ (from Y – 1C (in methanol)) M2 $(100 \times x) \div (1.1 \times 100) = 12$ (so) $x = 13.2$	2
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Question	Answer	Marks
6(c)(iv)	M1 Y will have absorption / peak / trough between 1670–1740 due to C=O (Q will not) M2 Q will have absorption / peak / trough between 3200–3600 due to O–H (Y will not)	2

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May/June 2024 9701/21 · Q6 (c)(i), (c)(iv)

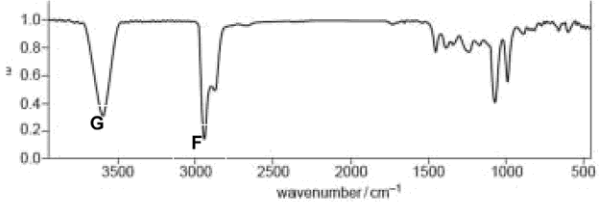
5(a)(i)	$4 = \frac{100 \times x}{1.1 \times 50} = 2.2$	1									
5(a)(ii)	M1 $m/e = 29$ $C_2H_5^+$ M2 $m/e = 59$ $C_3H_7O^+$	2									
5(b)(i)	<table border="1"> <thead> <tr> <th>absorption</th><th>bond</th><th>functional group containing the bond</th></tr> </thead> <tbody> <tr> <td>A</td><td>O–H</td><td>hydroxy(l) / alcohol</td></tr> <tr> <td>B</td><td>C=O</td><td>carbonyl</td></tr> </tbody> </table>	absorption	bond	functional group containing the bond	A	O–H	hydroxy(l) / alcohol	B	C=O	carbonyl	1
absorption	bond	functional group containing the bond									
A	O–H	hydroxy(l) / alcohol									
B	C=O	carbonyl									
5(c)(ii)	$(1) C_4H_9O + (1) Na \rightarrow C_4H_9ONa + \frac{1}{2} H_2$	1									

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Question	Answer	Marks
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May/June 2024 9701/22 · Q5 (a)(i), (a)(ii), (b)(i), (c)(ii)

5(c)	 M1 peak shown around 2850–2950 labelled F AND (corresponds to) C–H M2 peak shown around 3200–3600 labelled G AND (corresponds to) O–H (in hydroxy(l) / alcohol)	2
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May/June 2024 9701/23 · Q5 (c)

4(f)(i)	All three have a C—H OR CH bond	1
4(f)(ii)	compound A AND absorption at 2200–2250 cm ⁻¹ indicates C≡N	1

Oct/Nov 2024 9701/21 · Q4 (f)(i), (f)(ii)

4(e)(i)	 M1 identify H = M2 (broad) absorption within the range 3600–2500 cm⁻¹ so O-H (bond) O-H (bond) is equivalent to OH <u>bond</u> M3 pt 1 and pt 2 •✓ OR pt 1 and pt 3 •✓ •pt 1 absorption within the range 1670–1750 cm⁻¹ so C=O (bond) •pt 2 absorption within the range 1040–1300 cm⁻¹ so C-O (bond) •pt 3 (M⁺ at <i>m/e</i> = 60 so it has) molecular mass / Mr = 60	
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Oct/Nov 2024 9701/22 · Q4 (e)(i)

4(f)(i)	All three have a C—H OR CH bond	1
4(f)(ii)	compound A AND absorption at 2200–2250 cm ⁻¹ indicates C≡N	1

Oct/Nov 2024 9701/23 · Q4 (f)(i), (f)(ii)

1(d)(i)	(relative) abundance is 3:1 / 100:33 AND link to two isotopes of Cl	1
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March 2025 9701/22 · Q1 (d)(i)

4(c)	Any two complete rows from:	2															
	<table> <tr> <th>wavenumber</th><th>bond</th><th>functional group</th></tr> <tr> <td>1040 – 1300</td><td>C–O</td><td>ester / hydroxy</td></tr> <tr> <td>3200 – 3650</td><td>O–H</td><td>hydroxy / alcohols</td></tr> <tr> <td>2850 – 2950</td><td>C–H</td><td>alkane</td></tr> <tr> <td>1710 – 1750</td><td>C=O</td><td>ester</td></tr> </table>	wavenumber	bond	functional group	1040 – 1300	C–O	ester / hydroxy	3200 – 3650	O–H	hydroxy / alcohols	2850 – 2950	C–H	alkane	1710 – 1750	C=O	ester	
wavenumber	bond	functional group															
1040 – 1300	C–O	ester / hydroxy															
3200 – 3650	O–H	hydroxy / alcohols															
2850 – 2950	C–H	alkane															
1710 – 1750	C=O	ester															

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Question	Answer	Marks
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May/June 2025 9701/21 · Q4 (c)

5(b)(iii)	<table> <tr> <th>absorption / cm⁻¹</th><th>present in spectrum of vitamin C</th><th>present in spectrum of M</th></tr> <tr> <td>1500–1680</td><td>✓</td><td>✗ / – / blank</td></tr> <tr> <td>2850–2950</td><td>✓</td><td>✓</td></tr> <tr> <td>3200–3650</td><td>✓</td><td>✓</td></tr> </table>	absorption / cm ⁻¹	present in spectrum of vitamin C	present in spectrum of M	1500–1680	✓	✗ / – / blank	2850–2950	✓	✓	3200–3650	✓	✓	1
absorption / cm ⁻¹	present in spectrum of vitamin C	present in spectrum of M												
1500–1680	✓	✗ / – / blank												
2850–2950	✓	✓												
3200–3650	✓	✓												

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May/June 2025 9701/22 · Q5 (b)(iii)

5(b)(v)	- A C–H alkane - B C=O ester - C C=C alkene - D C–O ester 2 points = 1 mark, all 4 points = 2 marks	2
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May/June 2025 9701/23 · Q5 (b)(v)

6(c)(i)	M1 $\frac{100}{1.1} \times \frac{11}{100}$ M2 10	2
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May/June 2025 9701/24 · Q6 (c)(i)

1(a)(iii)	(relative) abundance (of each isotope)	1
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Oct/Nov 2025 9701/21 · Q1 (a)(iii)

3(e)(ii)	M1 absorption labelled at approx. 3000 cm ⁻¹ identified as O—H M2 absorption labelled at approx. 1720 cm ⁻¹ identified as C=O	2
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Question	Answer	Marks
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Oct/Nov 2025 9701/21 · Q3 (e)(ii)

4(c)(ii)	(The spectrum is of) X AND 41 is [CH ₂ =CCH ₃] ⁺ / 41 is C ₃ H ₅ ⁺ OR 43 is [CH ₃ CHCH ₃] ⁺ / 43 is C ₃ H ₇ ⁺ OR X would NOT have significant peak at 54 / [(CH ₃) ₂ C=C ⁺] / C ₄ H ₆ ⁺ OR X would NOT have significant peak at 42 due to [(CH ₃) ₂ C ⁺] / C ₃ H ₆ ⁺	1
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Oct/Nov 2025 9701/21 · Q4 (c)(ii)

4(d)(ii)	M1 absorption labelled at approx. 1750 cm ⁻¹ identified as C=O M2 absorption labelled at approx. 1650 cm ⁻¹ identified as C=C M3 absorption labelled at approx. 1170 cm ⁻¹ identified as C—O	3
4(d)(iii)	(0.31 / 4.7 × 100 / 1.1) = 6 carbon atoms	1

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Oct/Nov 2025 9701/22 · Q4 (d)(ii), (d)(iii)

3(e)(ii)	M1 absorption labelled at approx. 3000 cm ⁻¹ identified as O—H M2 absorption labelled at approx. 1720 cm ⁻¹ identified as C=O	2
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Question	Answer	Marks
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Oct/Nov 2025 9701/23 · Q3 (e)(ii)

4(a)(vi)	M1 M2	2
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Oct/Nov 2025 9701/24 · Q4 (a)(vi)