

|         |               |   |
|---------|---------------|---|
| 4(c)(i) | P = propanal  | 1 |
|         | Q = propanone | 1 |

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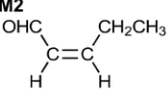
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| Question | Answer | Marks |
|----------|--------|-------|
|----------|--------|-------|

May/June 2017 9701/21 · Q4 (c)(i)

|         |                |   |
|---------|----------------|---|
| 4(c)(i) | triiodomethane | 1 |
|---------|----------------|---|

May/June 2017 9701/22 · Q4 (c)(i)

|      |                                                                                                                                   |   |
|------|-----------------------------------------------------------------------------------------------------------------------------------|---|
| 3(b) | $C_5H_{10}O + 2[H] \rightarrow C_5H_{12}O$                                                                                        | 1 |
| 3(c) | <p><b>M1</b> geometric(al)</p> <p><b>M2</b></p>  | 2 |

March 2019 9701/22 · Q3 (a), (b), (c)

|         |                                                                                                                                |   |
|---------|--------------------------------------------------------------------------------------------------------------------------------|---|
| 4(c)(i) | <ul style="list-style-type: none"> <li>orange / red / yellow precipitate</li> <li>orange / red / yellow precipitate</li> </ul> | 1 |
|---------|--------------------------------------------------------------------------------------------------------------------------------|---|

Oct/Nov 2019 9701/21 · Q4 (c)(i)

|           |                                   |   |
|-----------|-----------------------------------|---|
| 3(a)(iii) | yellow / orange / red ppt / solid | 1 |
|-----------|-----------------------------------|---|

March 2020 9701/22 · Q3 (a)(iii)

|          |                                                                                                                                                                                                                                                                                                                                                                                                                  |   |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 3(c)(ii) | <p><b>(M1: correct identity of R and statement re: reaction 3 ONLY ketone reduced)</b></p> <p>R (is 2-hydroxybutanoic acid) <b>AND</b> as (only) C=O / ketone reduced</p> <p><b>(M2: correct explanation re: strength of reducing agents)</b></p> <p>NaBH<sub>4</sub> cannot reduce the COOH / <b>carboxylic acid</b></p> <p><b>OR</b></p> <p>LiAlH<sub>4</sub> can reduce the COOH / <b>carboxylic acid</b></p> | 2 |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

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| Question  | Answer                                                                                                                                                                                                                                                                                                                                                                        | Marks |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 3(c)(iii) |  <p><b>M1:</b> Presence of :CN (if bonding shown, must be unambiguous triple bond)</p> <p><b>M2:</b> curly arrow from :CN lone pair to carbonyl carbon</p> <p><b>M3:</b> correct dipole <b>AND</b> curly arrow from double bond to oxygen</p> <p><b>M4:</b> correct intermediate drawn</p> | 4     |

Oct/Nov 2020 9701/21 · Q3 (c)(ii), (c)(iii)

|          |                                                                                                                                                            |   |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 4(c)(vi) | $CH_3COCH_3 + 3I_2 + 4OH^- \rightarrow (1)CH_3COO^- + 3H_2O + 3I^- + CHI_3$ <p><b>M1:</b> correctly balanced</p> <p><b>M2:</b> CHI<sub>3</sub> product</p> | 2 |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

Oct/Nov 2020 9701/21 · Q4 (c)(vi)

| 4(c)                            | <table border="1"> <tr> <th>reagent</th><th>result with P</th><th>result with Q</th></tr> <tr> <td>Br<sub>2</sub>(aq)</td><td>no change / stays orange</td><td>no change / stays orange</td></tr> <tr> <td>2,4-DNPH</td><td>no change</td><td>orange ppt</td></tr> <tr> <td>Na<sub>2</sub>CO<sub>3</sub></td><td>effervescence</td><td>no change</td></tr> </table> <p>Award one mark for every two correct observations.</p> | reagent                  | result with P | result with Q | Br <sub>2</sub> (aq) | no change / stays orange | no change / stays orange | 2,4-DNPH | no change | orange ppt | Na <sub>2</sub> CO <sub>3</sub> | effervescence | no change | 3 |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|---------------|---------------|----------------------|--------------------------|--------------------------|----------|-----------|------------|---------------------------------|---------------|-----------|---|
| reagent                         | result with P                                                                                                                                                                                                                                                                                                                                                                                                                 | result with Q            |               |               |                      |                          |                          |          |           |            |                                 |               |           |   |
| Br <sub>2</sub> (aq)            | no change / stays orange                                                                                                                                                                                                                                                                                                                                                                                                      | no change / stays orange |               |               |                      |                          |                          |          |           |            |                                 |               |           |   |
| 2,4-DNPH                        | no change                                                                                                                                                                                                                                                                                                                                                                                                                     | orange ppt               |               |               |                      |                          |                          |          |           |            |                                 |               |           |   |
| Na <sub>2</sub> CO <sub>3</sub> | effervescence                                                                                                                                                                                                                                                                                                                                                                                                                 | no change                |               |               |                      |                          |                          |          |           |            |                                 |               |           |   |

Oct/Nov 2020 9701/22 · Q4 (c)

|      |                                                                                                                              |   |
|------|------------------------------------------------------------------------------------------------------------------------------|---|
| 4(b) | <b>M1:</b> red / orange / yellow ppt / solid<br><b>M2:</b> silver mirror <b>OR</b> silver / grey / black / brown ppt / solid | 2 |
|------|------------------------------------------------------------------------------------------------------------------------------|---|

March 2021 9701/22 · Q4 (b)

|          |                  |                     |   |
|----------|------------------|---------------------|---|
| 4(d)(i)  | oxidation        |                     | 1 |
| 4(d)(ii) | functional group | present in <b>Z</b> | 1 |
|          | aldehyde         | ✓                   |   |
|          | ketone           |                     |   |
|          | carboxylic acid  |                     |   |

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| Question | Answer | Mark |
|----------|--------|------|
|----------|--------|------|

May/June 2021 9701/22 · Q4 (d)(i), (d)(ii)

| 4(b)                                 | <table border="1"> <tr> <th>reagent</th><th>observation with Q</th><th>observation with R</th></tr> <tr> <td>2,4-DNPH</td><td><b>M1</b> red / orange / yellow AND precipitate / solid / crystals</td><td><b>M2</b> red / orange / yellow AND precipitate / solid / crystals</td></tr> <tr> <td>Na<sub>2</sub>CO<sub>3</sub>(aq)</td><td><b>M3</b> no visible change</td><td><b>M4</b> fizz / effervescence</td></tr> </table> | reagent                                                            | observation with Q | observation with R | 2,4-DNPH | <b>M1</b> red / orange / yellow AND precipitate / solid / crystals | <b>M2</b> red / orange / yellow AND precipitate / solid / crystals | Na <sub>2</sub> CO <sub>3</sub> (aq) | <b>M3</b> no visible change | <b>M4</b> fizz / effervescence | 4 |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------|--------------------|----------|--------------------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------|-----------------------------|--------------------------------|---|
| reagent                              | observation with Q                                                                                                                                                                                                                                                                                                                                                                                                            | observation with R                                                 |                    |                    |          |                                                                    |                                                                    |                                      |                             |                                |   |
| 2,4-DNPH                             | <b>M1</b> red / orange / yellow AND precipitate / solid / crystals                                                                                                                                                                                                                                                                                                                                                            | <b>M2</b> red / orange / yellow AND precipitate / solid / crystals |                    |                    |          |                                                                    |                                                                    |                                      |                             |                                |   |
| Na <sub>2</sub> CO <sub>3</sub> (aq) | <b>M3</b> no visible change                                                                                                                                                                                                                                                                                                                                                                                                   | <b>M4</b> fizz / effervescence                                     |                    |                    |          |                                                                    |                                                                    |                                      |                             |                                |   |

May/June 2021 9701/23 · Q4 (b)

|         |                                   |   |
|---------|-----------------------------------|---|
| 3(c)(i) | C <sub>18</sub> H <sub>15</sub> P | 1 |
|---------|-----------------------------------|---|

Oct/Nov 2021 9701/21 · Q3 (c)(i)

|          |                                                                                                           |   |
|----------|-----------------------------------------------------------------------------------------------------------|---|
| 3(d)(ii) | <b>M1</b> (2,4-DNPH will produce a) red / orange / yellow precipitate<br><b>M2 V</b> has a carbonyl group | 2 |
|----------|-----------------------------------------------------------------------------------------------------------|---|

Oct/Nov 2021 9701/22 · Q3 (d)(ii)

|          |                                                                                                                                                                                                                                     |   |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 4(a)(i)  | red / orange / yellow precipitate / ppt / solid [1]<br>silver mirror / silver / grey solid / precipitate / ppt [1]<br>effervescence / bubbling / fizzing [1]                                                                        | 3 |
| 4(b)(iv) | step 1 KCN / HCN <b>OR</b> NaCN / H <sub>2</sub> SO <sub>4</sub> [1]<br>step 2 H <sup>+</sup> / H <sub>2</sub> SO <sub>4</sub> (aq) [1]<br>step 3<br>addition [1]<br>hydrolysis / substitution [1]<br>elimination / dehydration [1] | 5 |

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March 2022 9701/22 · Q4 (a)(i), (b)(iv)

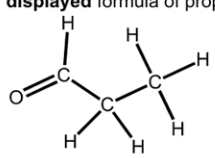
|         |          |   |
|---------|----------|---|
| 4(c)(i) | carbonyl | 1 |
|---------|----------|---|

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| Question | Answer | Marks |
|----------|--------|-------|
|----------|--------|-------|

May/June 2022 9701/21 · Q4 (c)(i)

|      |                                                                                                                                                                                                                                                     |   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 3(c) | <p><b>displayed</b> formula of propanal</p>  <p><b>M1</b> identification of propanal<br/><b>M2</b> correct use of displayed formula and correct formula used</p> | 2 |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

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| Question | Answer | Marks |
|----------|--------|-------|
|----------|--------|-------|

May/June 2022 9701/23 · Q3 (c)

|         |                  |   |
|---------|------------------|---|
| 5(b)(i) | carbonyl (group) | 1 |
|---------|------------------|---|

May/June 2023 9701/22 · Q5 (b)(i)

|           |                                      |                             |                             |   |
|-----------|--------------------------------------|-----------------------------|-----------------------------|---|
| 1(d)(iii) | reagent                              | observation with Y          | observation with Z          | 4 |
|           | Na <sub>2</sub> CO <sub>3</sub> (aq) | no reaction                 | • no reaction               |   |
|           | alkaline I <sub>2</sub> (aq)         | • yellow precipitate (ppt)  | • yellow ppt                |   |
|           | 2,4-DNPH                             | • red / orange / yellow ppt | • red / orange / yellow ppt |   |
|           | Tollens' reagent                     | • no reaction               | • silver mirror             |   |

March 2024 9701/22 · Q1 (d)(iii)

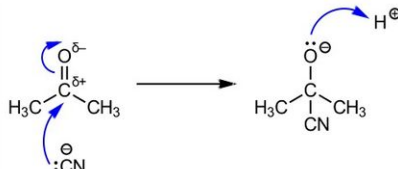
|          |   |                                     |   |
|----------|---|-------------------------------------|---|
| 6(c)(ii) |   | observation on addition of 2,4-DNPH | 1 |
|          | Y | orange precipitate                  |   |
|          | Q | no precipitate                      |   |

Both correct for one mark

May/June 2024 9701/21 · Q6 (c)(ii)

|           |                                                                                                                 |   |
|-----------|-----------------------------------------------------------------------------------------------------------------|---|
| 2(c)(iii) | $\text{CH}_3\text{COCH}_3 + 3\text{NaClO} \rightarrow 1\text{CHCl}_3 + 1\text{CH}_3\text{COONa} + 2\text{NaOH}$ | 1 |
|-----------|-----------------------------------------------------------------------------------------------------------------|---|

Oct/Nov 2024 9701/21 · Q2 (c)(iii)

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 4(a)(i)  |  <ul style="list-style-type: none"> <li>• curly arrow from lone pair on C of CN<sup>-</sup> to carbonyl C</li> <li>• correct dipole on C=O</li> <li>• curly arrow from C=O bond to O</li> <li>• correct intermediate (the lone pair(s) not needed for this bullet point)</li> <li>• curly arrow from lone pair on —O<sup>-</sup> to (source of) H<sup>+</sup></li> </ul> | 1 |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 |
|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 |
| 4(b)     | H <sub>2</sub> SO <sub>4</sub> (aq) or HCl(aq)                                                                                                                                                                                                                                                                                                                                                                                                            | 1 |
| 4(c)(ii) | propan-2-ol                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1 |

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| Question | Answer                                                                                           | Marks |
|----------|--------------------------------------------------------------------------------------------------|-------|
| 4(d)     | red / orange / yellow ppt                                                                        | 1     |
| 4(e)     | Fehling's solution cannot <b>oxidise</b> ketones<br>OR<br>ketones are not easily <b>oxidised</b> | 1     |

Oct/Nov 2024 9701/21 · Q4 (a)(i), (b), (c)(ii), (d), (e)

|           |                              |                                        |   |
|-----------|------------------------------|----------------------------------------|---|
| 4(d)(iii) | reagent                      | observation with F                     | 3 |
|           | 2,4-DNPH                     | red / orange / yellow ppt              |   |
|           | Tollens' reagent             | silver mirror OR grey ppt OR black ppt |   |
|           | alkaline I <sub>2</sub> (aq) | yellow ppt                             |   |

Oct/Nov 2024 9701/22 · Q4 (d)(iii)

|      |                                                                                                  |   |
|------|--------------------------------------------------------------------------------------------------|---|
| 4(b) | H <sub>2</sub> SO <sub>4</sub> (aq) or HCl(aq)                                                   | 1 |
| 4(e) | Fehling's solution cannot <b>oxidise</b> ketones<br>OR<br>ketones are not easily <b>oxidised</b> | 1 |

Oct/Nov 2024 9701/23 · Q4 (b), (e)

|      |                                                                                                    |   |
|------|----------------------------------------------------------------------------------------------------|---|
| 6(a) | carbonyl                                                                                           | 1 |
| 6(b) | <b>M1</b> (2,4)-dinitrophenylhydrazine / (2,4)-DNPH<br><b>M2</b> orange / red / yellow precipitate | 2 |

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| Question | Answer                                                            | Marks |
|----------|-------------------------------------------------------------------|-------|
| 6(c)(i)  | <b>F</b> = propanone<br><b>G</b> = ethanal<br><b>H</b> = propanal | 2     |
| 6(c)(ii) | tri-iodomethane <b>OR</b> $\text{CHI}_3$                          | 1     |

May/June 2025 9701/21 · Q6 (a), (b), (c)(i), (c)(ii)

|           |                                                                                                                                                                                                                                                     |     |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1(c)(iii) | <i>Due to an issue with question 1(c)(iii), the question has been removed from the question paper.</i>                                                                                                                                              | N/A |
| 1(c)(iv)  | <b>M1</b> $\text{CO}_2$ has only instantaneous / temporary dipole–induced dipole forces<br><b>AND</b> methanal has permanent dipole–permanent dipole (and id-id) forces<br><br><b>M2</b> IMF's in methanal are stronger than IMF's in $\text{CO}_2$ | 2   |

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| Question | Answer | Marks |
|----------|--------|-------|
|----------|--------|-------|

Oct/Nov 2025 9701/21 · Q1 (c)(iii), (c)(iv)

|           |                                                                                                        |     |
|-----------|--------------------------------------------------------------------------------------------------------|-----|
| 1(c)(iii) | <i>Due to an issue with question 1(c)(iii), the question has been removed from the question paper.</i> | N/A |
|-----------|--------------------------------------------------------------------------------------------------------|-----|

| Question | Answer | Marks |
|----------|--------|-------|
|----------|--------|-------|

Oct/Nov 2025 9701/22 · Q1 (c)(iii)

|          |                                                                                                                                                                                                                                                     |   |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 1(c)(iv) | <b>M1</b> $\text{CO}_2$ has only instantaneous / temporary dipole–induced dipole forces<br><b>AND</b> methanal has permanent dipole–permanent dipole (and id-id) forces<br><br><b>M2</b> IMF's in methanal are stronger than IMF's in $\text{CO}_2$ | 2 |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|

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| Question | Answer | Marks |
|----------|--------|-------|
|----------|--------|-------|

Oct/Nov 2025 9701/23 · Q1 (c)(iv)