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**CHEMISTRY**

**9701/33**

Paper 3 Advanced Practical Skills 1

**October/November 2017**

MARK SCHEME

Maximum Mark: 40

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**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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This document consists of **7** printed pages.

| Question | Answer   | Marks    |
|----------|--|----------|
| 1(a)     | <p><b>I</b> The following data is shown</p> <ul style="list-style-type: none"> <li>• two burette readings for the rough titration</li> <li>• titre for rough titration</li> <li>• initial <b>and</b> final burette readings for <b>two</b> (or more) accurate titrations (<i>i.e.</i> <math>2 \times 2</math> “box”)</li> </ul>  | <b>1</b> |
|          | <p><b>II</b> Appropriate headings and units for accurate titration.<br/><b>and</b> volume <b>FA 1</b> added recorded for each accurate titre.<br/><i>Headings should match readings.</i></p> <ul style="list-style-type: none"> <li>• initial / start <b>and</b> (burette) reading / volume (<i>allow vol but not V</i>)</li> <li>• final / end <b>and</b> (burette) reading / volume</li> <li>• titre <b>or</b> volume / <b>FA 1 and</b> used/added (<i>but not “difference” or “total” or “change”</i>)</li> </ul> <p>unit: / cm<sup>3</sup> <b>or</b> (cm<sup>3</sup>) <b>or</b> in cm<sup>3</sup> <b>or</b> cm<sup>3</sup> for <b>each</b> entry</p> | <b>1</b> |
|          | <p><b>III</b> All accurate burette readings are to the nearest 0.05 cm<sup>3</sup>.<br/><i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm<sup>3</sup> (if this was the initial reading), but it does not apply to the titre.</i><br/><i>Do not award this mark if:</i></p> <ul style="list-style-type: none"> <li>• 50(.00) is used as an initial burette reading</li> <li>• more than one final burette reading is 50.(00)</li> <li>• any burette reading is greater than 50.(00)</li> </ul>  | <b>1</b> |
|          | <p><b>IV</b> The final accurate titre recorded is within 0.10 cm<sup>3</sup> of any other accurate titre.</p>  | <b>1</b> |
|          | <p>Examiner rounds any accurate burette readings to the nearest 0.05 cm<sup>3</sup> and then selects the ‘best’ titres using the hierarchy:</p> <ul style="list-style-type: none"> <li>• two (or more) accurate identical titres, then</li> <li>• two (or more) accurate titres within 0.05 cm<sup>3</sup>, then</li> <li>• two (or more) accurate titres within 0.10 cm<sup>3</sup> etc.</li> </ul> <p>These best titres should be used to calculate the mean corrected titre to the nearest 0.01 cm<sup>3</sup>.<br/>Examiner compares candidate’s titre value with that of the Supervisor:</p>  |          |

| Question | Answer   | Marks |
|----------|--|-------|
| 1(a)     | Award <b>V</b> , <b>VI</b> and <b>VII</b> if $\delta \leq 0.30$ (cm <sup>3</sup> )   | 1     |
|          | Award <b>V</b> and <b>VI</b> if $0.30 < \delta \leq 0.60$  | 1     |
|          | Award <b>V</b> , only, if $0.60 < \delta \leq 1.00$  | 1     |
| 1(b)     | <p>Candidate calculates the mean correctly.</p> <ul style="list-style-type: none"> <li>• Candidate averages two (or more) titres where the total spread is <math>\leq 0.20</math> cm<sup>3</sup>.</li> <li>• Working must be shown <b>or</b> ticks must be put next to the two (or more) accurate readings selected.</li> <li>• The mean should be quoted to 2 dp, and be rounded to nearest 0.01 cm<sup>3</sup>.<br/>(e.g. <math>26.666</math> cm<sup>3</sup> must be rounded to <math>26.67</math> cm<sup>3</sup>)</li> </ul> <p>Two special cases, where the mean need not be to 2 dp:</p> <ul style="list-style-type: none"> <li>• Allow mean to 3 dp <b>only</b> for 0.025 or 0.075 (e.g. <math>26.325</math> cm<sup>3</sup>)</li> <li>• Allow mean to 1 dp, if <b>all</b> accurate burette readings were given to 1 dp <b>and</b> the mean is <b>exactly</b> correct.<br/>(e.g. <math>26.0</math> and <math>26.2 = 26.1</math> is allowed)<br/>(e.g. <math>26.0</math> and <math>26.1 = 26.1</math> is wrong – should be <math>26.05</math>)</li> </ul> <p>Do <b>not</b> award this mark if:</p> <ul style="list-style-type: none"> <li>• The rough titre was used to calculate the mean.</li> <li>• The candidate performed only one accurate titration.</li> <li>• Burette readings were incorrectly subtracted to obtain any of the accurate titre values.</li> <li>• <b>All</b> burette readings (resulting in titre values used in calculation of mean) are integers.</li> </ul> <p><b>Note:</b> the candidate's mean will sometimes be marked correct even if it was different from the mean calculated by the Examiner for the purpose of assessing accuracy.</p> | 1     |
| 1(c)(i)  | <p>Correctly calculates</p> $\text{Number of moles of } \text{S}_2\text{O}_3^{2-} \text{ used} = 0.150 \times \frac{\text{(b)}}{1000}$ <p>Answer given to 3 or 4 sf</p>  | 1     |
| 1(c)(ii) | <p>Correctly calculates<br/>ans(ii) = ans(i)</p> <p>Answer given to 3 or 4 sf</p>  | 1     |

| Question  | Answer   | Marks |
|-----------|--|-------|
| 1(c)(iii) | Correct use<br>ans(ii) / 0.0250 (or equivalent)<br>Answer given to 3 or 4 sf           | 1     |
| 1(c)(iv)  | Correct expression<br>32.5 / ans(iii) – 159.6  | 1     |
|           | Correct answer<br>x = nearest integer to $\frac{[32.5 / \text{ans(iii)} - 159.6]}{18}$ | 1     |
| 1(d)(i)   | Correct expression<br>Use of $\frac{0.1(0)}{\text{any accurate titre}} \times 100$     | 1     |
| 1(d)(ii)  | The volume from the burette has a smaller error / more precise                         | 1     |
|           | <b>FA 3</b> is in excess   | 1     |

| Question  | Answer   | Marks    |
|-----------|--|----------|
| 2(a)      | <b>I</b> Table of data<br>Must show all of the following: <ul style="list-style-type: none"> <li>• mass of crucible (+ lid)</li> <li>• mass of crucible (+ lid) + <b>FA 5</b></li> <li>• mass of crucible (+ lid) + residue</li> <li>• mass of <b>FA 5</b></li> <li>• mass of residue</li> <li>• mass of water lost</li> </ul> | <b>1</b> |
|           | <b>II</b> Recording of data <ul style="list-style-type: none"> <li>• Unit / g, (g) or in grams for all data recorded</li> <li>• all three balance readings recorded to same number of dp</li> </ul>  | <b>1</b> |
|           | <b>III</b> Correctly calculates <ul style="list-style-type: none"> <li>• mass of <b>FA 5</b>,</li> <li>• mass of residue,</li> <li>• mass of water lost</li> </ul>   | <b>1</b> |
|           | Examiner checks supervisor's subtraction for mass of <b>FA 5</b> and mass of residue and calculates the ratio mass of <b>FA 5</b> ÷ mass of residue to 2 dp.<br>Examiner compares candidate's value with that of Supervisor.   |          |
|           | Award <b>IV</b> if $\delta \leq 0.10$  | <b>1</b> |
|           | Award <b>V</b> if $\delta \leq 0.05$   | <b>1</b> |
| 2(b)(i)   | Correctly uses<br><b>(i)</b> = mass of residue / 208.3<br>Answer given to 2–4 sf   | <b>1</b> |
| 2(b)(ii)  | Correctly calculates<br><b>(ii)</b> = mass of water lost / 18<br>Answer given to 2–4 sf  | <b>1</b> |
| 2(b)(iii) | Correctly calculates<br><b>(ii) ÷ (i) and y</b> as an integer  | <b>1</b> |

| Question | Answer  | Marks |
|----------|---|-------|
| 2(c)(i)  | Greater mass lost / smaller mass of residue / fewer moles of residue / greater mass of water (appears to be lost) | 1     |
|          | so <b>y</b> would be greater  | 1     |
| 2(c)(ii) | heat to constant mass OWTTE / cooling in a desiccator   | 1     |

| Question  | Answer   | Marks |
|---|--|-------|
| <b>FA 6</b> is $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ; <b>FA 7</b> is $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ |  |       |
| 3(a)(i)   | <b>FA 6</b> (Heating) produces water vapour / steam / moisture or condensation / solution / liquid forms / melts / dissolves<br><b>AND</b><br><b>FA 7</b> (Heating) produces water vapour / steam / moisture or condensation / solution / liquid forms / melts | 1     |
|   | <b>FA 6</b> (stronger heating) gives a white solid/ residue<br><b>AND</b><br><b>FA 7</b> a yellow / green / brown / black solid/ residue   | 1     |
|   | Gas / chlorine / $\text{Cl}_2$ from heating <b>FA 7</b> bleaches damp litmus paper<br><b>or</b><br>Gas / hydrogen chloride / $\text{HCl}$ from heating <b>FA 7</b> turns litmus red.   | 1     |
| 3(a)(ii)  | water  | 1     |

| Question                               | Answer   | Marks   |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
|--|--|---|---------------------|------|------|---|---|-----------------|---|---|-----------|----------------------------------|------------------------|----------------------------------|-----------|---|
| 3(b)(i)                                | Clear presentation of results to show <b>FA 6</b> and <b>FA 7</b> and two or more reagents.  | 1   |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
|  | Uses NaOH(aq) <b>and</b> NH <sub>3</sub> (aq).   | 1   |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
|  | <table border="1"> <thead> <tr> <th></th> <th>FA 6</th> <th>FA 7</th> </tr> </thead> <tbody> <tr> <td>NaOH</td> <td>white ppt <b>and</b><br/>no change / insoluble with excess</td> <td>(pale / light) blue ppt <b>and</b><br/>no change / insoluble with excess</td> </tr> <tr> <td>NH<sub>3</sub></td> <td>white ppt <b>and</b><br/>no change / insoluble with excess</td> <td>(pale) blue ppt <b>and</b><br/>dark / deep blue solution with excess</td> </tr> </tbody> </table> <p>Two boxes correct for each mark.</p>  |   | FA 6                | FA 7 | NaOH | white ppt <b>and</b><br>no change / insoluble with excess | (pale / light) blue ppt <b>and</b><br>no change / insoluble with excess | NH <sub>3</sub> | white ppt <b>and</b><br>no change / insoluble with excess | (pale) blue ppt <b>and</b><br>dark / deep blue solution with excess | 2         |                                  |                        |                                  |           |   |
|  |  | FA 6  | FA 7                |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| NaOH                                   | white ppt <b>and</b><br>no change / insoluble with excess  | (pale / light) blue ppt <b>and</b><br>no change / insoluble with excess |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| NH <sub>3</sub>                        | white ppt <b>and</b><br>no change / insoluble with excess  | (pale) blue ppt <b>and</b><br>dark / deep blue solution with excess     |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| 3(b)(ii)                               | <table border="1"> <thead> <tr> <th rowspan="2"><i>test</i></th> <th colspan="2"><i>observations</i></th> </tr> <tr> <th>FA 6</th> <th>FA 7</th> </tr> </thead> <tbody> <tr> <td>+ Ba<sup>2+</sup>(aq)</td> <td>white ppt</td> <td>no reaction / no ppt / no change</td> </tr> <tr> <td>+ excess of HCl<br/>or HNO<sub>3</sub></td> <td>insoluble</td> <td>no reaction / no ppt / no change</td> </tr> <tr> <td>+ Ag<sup>+</sup>(aq)</td> <td>no reaction / no ppt / no change</td> <td>white ppt</td> </tr> </tbody> </table> <p>Two boxes correct for each mark.</p> | <i>test</i>   | <i>observations</i> |      | FA 6 | FA 7  | + Ba <sup>2+</sup> (aq)   | white ppt       | no reaction / no ppt / no change                          | + excess of HCl<br>or HNO <sub>3</sub>                              | insoluble | no reaction / no ppt / no change | + Ag <sup>+</sup> (aq) | no reaction / no ppt / no change | white ppt | 3 |
| <i>test</i>                            | <i>observations</i>  |   |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
|  | FA 6   | FA 7  |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| + Ba <sup>2+</sup> (aq)                | white ppt  | no reaction / no ppt / no change  |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| + excess of HCl<br>or HNO <sub>3</sub> | insoluble  | no reaction / no ppt / no change  |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| + Ag <sup>+</sup> (aq)                 | no reaction / no ppt / no change   | white ppt   |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |
| 3(b)(iii)                              | <p><b>FA 6</b> contains Mg<sup>2+</sup> / magnesium and SO<sub>4</sub><sup>2-</sup> / sulfate<br/> <b>FA 7</b> contains Cu<sup>2+</sup> / copper(II) and Cl<sup>-</sup> / chloride<br/>           1 mark for 2 correct ions</p>  | 2   |                     |      |      |   |   |                 |   |   |           |                                  |                        |                                  |           |   |