

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9701 CHEMISTRY

9701/31

Paper 3 (Advanced Practical Skills 1),
maximum raw mark 40

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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|--------|--|----------|-------|
| Page 2 | Mark Scheme | Syllabus | Paper |
| | Cambridge International AS/A Level – October/November 2015 | 9701 | 31 |

| Question | Indicative material | Mark | Total |
|----------|--|------|-------|
| 1 (a) | I Initial and final readings and titre value given for rough titre and initial and final readings for two (or more) accurate titrations (<i>minimum of 2 × 2 box</i>) | 1 | |
| | II Titre values recorded for accurate titrations and Appropriate headings for the accurate titration table and cm ³ units. <ul style="list-style-type: none"> initial / start burette reading / volume / value final / end burette reading / volume / value (<i>not amount</i>) titre or volume / FA 4 and used / added unit: /cm³ or (cm³) or in cm³ (for each heading) | 1 | |
| | III All accurate burette readings are to the nearest 0.05 cm ³ . Do not award this mark if: <ul style="list-style-type: none"> 50(.00) is used as an initial burette reading more than one final burette reading is 50.(00) any burette reading is greater than 50.(00) there is only one accurate titration. | 1 | |
| | IV There are two uncorrected accurate titres within 0.10 cm ³ <ul style="list-style-type: none"> Do not award this mark if, having performed two titres within 0.10 cm³, a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a further titration, within 0.10 cm³ of any other, has also been carried out. Do not award the mark if any “accurate” burette readings (apart from initial 0 cm³) are given to zero dp | 1 | |
| | <p>Examiner rounds any burette readings to the nearest 0.05 cm³, checks subtractions and then selects the “best” titres using the hierarchy:</p> <ul style="list-style-type: none"> two (or more) accurate identical titres, <i>then</i> two (or more) accurate titres within 0.05 cm³, <i>then</i> two (or more) accurate titres within 0.10 cm³, <i>etc</i> <p>These best titres are used to calculate the mean titre, expressed to nearest 0.01 cm³.</p> <p>Examiner calculates the difference (δ) between the mean titres obtained by the candidate and the Supervisor. Accuracy marks are awarded as shown.</p> <p>Award V, VI and VII if $\delta \leq 0.20$ (cm³) Award V and VI if $0.20 < \delta \leq 0.30$ Award V, only, if $0.30 < \delta \leq 0.50$</p> <p>Spread penalty: if the two “best” (corrected) titres used by the Examiner were ≥ 0.50 cm³ apart, cancel one accuracy mark.</p> | 3 | [7] |

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| | Cambridge International AS/A Level – October/November 2015 | 9701 | 31 |

| Question | Indicative material | Mark | Total |
|------------|--|------|-------|
| (b) | <p>Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. Working/explanation must be shown or ticks must be put next to the two (or more) accurate readings selected. The mean should be quoted to 2 dp, and be rounded to nearest 0.01 cm³.</p> <p>Two special cases, where the mean need not be to 2 dp:</p> <ul style="list-style-type: none"> • Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325 cm³) • Allow mean if expressed to 1 dp, if all accurate burette readings were given to 1 dp and the mean is exactly correct. (e.g. 26.0 and 26.2 = 26.1 is allowed) (e.g. 26.0 and 26.1 = 26.1 is wrong – should be 26.05) <p>Note: 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)(ii) | <p>Correctly calculates</p> <ul style="list-style-type: none"> • $n(\text{thio}) = 0.10 \times \text{(b)}/1000$ • $n(\text{I}_2) = 0.5 \times \text{(i)}$ <p>Both answers must be given to 3 or 4 significant figures</p> | 1 | [5] |
| (iii) | <p>Correctly calculates $n(\text{KMnO}_4) = 0.025 \times 0.018 = 0.00045$ or 0.000450 or 0.0004500</p> | 1 | |
| (iv) | <p>Correct expression, with answer given to 2, 3 or 4 sig fig $n(\text{I}_2) = \text{(ii)}/\text{(iii)} \times 2$ Theoretical answer = 5.0 (for 2.0 mol KMnO₄)</p> | 1 | |
| (v) | <p>Correct equation ticked, corresponding to (iv)</p> | 1 | |
| (vi) | <p>Allow any one of the following answers:</p> <ul style="list-style-type: none"> • An iodide ion loses one electron • $2\text{I}^- - 2\text{e}^- \rightarrow \text{I}_2$ (ionic equation must be correctly balanced) • Oxidation number of iodine increases from -1/ 1- (in iodide ion) to 0 (in iodine) | 1 | |
| (d) (i) | <p>% error = $0.06/25 \times 100 = 0.24 \%$</p> | 1 | |
| (ii) | <p>The student is wrong, since KI / FA 3 is in excess.</p> | 1 | [2] |
| Qn 1 | [Total: 15] | | |
| 2 (a) | <p>I Table for readings, headings and correct units: Headings:</p> <ul style="list-style-type: none"> • volume of FA 5 / acid • (volume of water – if included must be correct) • Time <p>Units allow Vol or /cm³ etc.</p> | 1 | |

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| Page 4 | Mark Scheme | Syllabus | Paper |
| | Cambridge International AS/A Level – October/November 2015 | 9701 | 31 |

| Question | Indicative material | Mark | Total |
|---|--|------|-------|
| | II Three reaction times all recorded to nearest second | 1 | [4] |
| | III and IV Examiner to calculate the time differences between Expt 1 and Expt 2 ($t_2 - t_1$). Then calculate 10% of the time for Expt 1 to 1dp (x). If $(t_2 - t_1) > x$ award III . Examiner to calculate the time differences between Expt 2 and Expt 3 ($t_3 - t_2$). Then calculate 20% of the time for Expt 2 to 1dp (y). If $(t_3 - t_2) > y$ award IV . | 2 | |
| (b) (i) | <ul style="list-style-type: none"> Rates correctly calculated All answers expressed to same sig fig (but not 1 sf) Unit given.... /s⁻¹ or (s⁻¹) | 1 | [5] |
| (ii) | Correctly calculates <ul style="list-style-type: none"> Expt 1, conc = 0.08571 (or 0.0857 or 0.086) mol dm⁻³ and <ul style="list-style-type: none"> Expt 3, conc = 0.02857 (or 0.0286 or 0.029) mol dm⁻³ <i>Both answers must be given to 2, 3 or 4 sig figs</i> | 1 | |
| (iii) | Rate increases with (increase of) concentration | 1 | |
| (iv) | <ul style="list-style-type: none"> Time is shorter for sulfuric acid Sulfuric acid has a greater / doubled concentration of H⁺ ions. | 1 | |
| (v) | <ul style="list-style-type: none"> time (for reaction) will be greater less depth (of solution) in the 250 cm³ | 1 | |
| Qn 2 | [Total: 9] | | |
| FA 6 is Na ₂ SO ₃ ; FA 7 is CaCl ₂ ; FA 8 is MgSO ₄ ; FA 9 is Al ₂ (SO ₄) ₃ ; FA 10 is MnSO ₄ | | | |
| 3 (a) (i) | Both observations required <ul style="list-style-type: none"> white precipitate with Ba²⁺ ion Precipitate dissolves / partially dissolves in (excess) HCl | 1 | |
| (ii) | Both observations required <ul style="list-style-type: none"> white precipitate with Ba²⁺ ion precipitate insoluble / no change with HCl | 1 | |
| (iii) | When heated, gas produced decolourises KMnO ₄ paper. | 1 | |
| (iv) | No change (when NaOH added) / no ppt / no reaction and green (solution) formed when KMnO ₄ added | 1 | |
| | Colourless solution (with acid) | 1 | |

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| Page 5 | Mark Scheme | Syllabus | Paper |
| | Cambridge International AS/A Level – October/November 2015 | 9701 | 31 |

| Question | Indicative material | Mark | Total | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------|--|---|---|--|------|-------|------|-----------|-----------|-----------|--|-------------|---|---|---|--|-----------------|------------------------------|-----------|-----------|--|------------------------|-----------------|---|---|--|---|--|
| (v) | Anion is sulfite and <u>one</u> piece of evidence <ul style="list-style-type: none"> FA 6 with acid – SO₂/gas which decolourises KMnO₄ is formed or FA 6 with Ba²⁺ – white precipitate / BaSO₃ formed which dissolves in acid / partially soluble in acid | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (vi) | Na ₂ SO ₃ + H ₂ O ₂ → Na ₂ SO ₄ + H ₂ O | 1 | [7] | | | | | | | | | | | | | | | | | | | | | | | | | |
| (b) (i) | <table border="1"> <thead> <tr> <th></th> <th>FA 7</th> <th>FA 8</th> <th>FA 9</th> <th>FA 10</th> </tr> </thead> <tbody> <tr> <td>NaOH</td> <td>white ppt</td> <td>white ppt</td> <td>white ppt</td> <td>off-white / buff / beige / light brown ppt</td> </tr> <tr> <td>excess NaOH</td> <td>no change or insoluble in excess</td> <td>no change or insoluble in excess</td> <td>(ppt) dissolves or soluble in excess</td> <td>insoluble in excess or ppt darkens (<i>owtte</i>)</td> </tr> <tr> <td>NH₃</td> <td>no ppt or no reaction</td> <td>white ppt</td> <td>white ppt</td> <td>off-white / buff / beige / light brown ppt</td> </tr> <tr> <td>excess NH₃</td> <td><i>(ignore)</i></td> <td>no change or insoluble in excess</td> <td>no change or insoluble in excess</td> <td>insoluble in excess or ppt darkens (<i>owtte</i>)</td> </tr> </tbody> </table> | | FA 7 | FA 8 | FA 9 | FA 10 | NaOH | white ppt | white ppt | white ppt | off-white / buff / beige / light brown ppt | excess NaOH | no change or insoluble in excess | no change or insoluble in excess | (ppt) dissolves or soluble in excess | insoluble in excess or ppt darkens (<i>owtte</i>) | NH ₃ | no ppt or no reaction | white ppt | white ppt | off-white / buff / beige / light brown ppt | excess NH ₃ | <i>(ignore)</i> | no change or insoluble in excess | no change or insoluble in excess | insoluble in excess or ppt darkens (<i>owtte</i>) | 5 | |
| | FA 7 | FA 8 | FA 9 | FA 10 | | | | | | | | | | | | | | | | | | | | | | | | |
| NaOH | white ppt | white ppt | white ppt | off-white / buff / beige / light brown ppt | | | | | | | | | | | | | | | | | | | | | | | | |
| excess NaOH | no change or insoluble in excess | no change or insoluble in excess | (ppt) dissolves or soluble in excess | insoluble in excess or ppt darkens (<i>owtte</i>) | | | | | | | | | | | | | | | | | | | | | | | | |
| NH ₃ | no ppt or no reaction | white ppt | white ppt | off-white / buff / beige / light brown ppt | | | | | | | | | | | | | | | | | | | | | | | | |
| excess NH ₃ | <i>(ignore)</i> | no change or insoluble in excess | no change or insoluble in excess | insoluble in excess or ppt darkens (<i>owtte</i>) | | | | | | | | | | | | | | | | | | | | | | | | |
| (ii) | Conclusions <ul style="list-style-type: none"> FA 7 – calcium / Ca²⁺ or barium / Ba²⁺ FA 8 – magnesium / Mg²⁺ FA 9 – aluminium / Al³⁺ FA 10 – manganese(II) / Mn²⁺ <p><i>Four correct = 2 marks</i> <i>Two or three correct = 1 mark</i></p> | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (iii) | M ²⁺ + 2OH ⁻ → M(OH) ₂ (for any divalent cation) or M ³⁺ + 3OH ⁻ → M(OH) ₃ (for any trivalent cation) | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (iv) | Use higher concentration | 1 | [9] | | | | | | | | | | | | | | | | | | | | | | | | | |
| Qn 3 | [Total: 16] | | | | | | | | | | | | | | | | | | | | | | | | | | | |