

CAMBRIDGE INTERNATIONAL EXAMINATIONS
GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/36

Paper 3 (Advanced Practical Skills 2),
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.

Cambridge will not enter into discussions about these mark schemes.

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| | | | |
|--------|-------------------------------------|----------|-------|
| Page 2 | Mark Scheme | Syllabus | Paper |
| | GCE A LEVEL – October/November 2013 | 9701 | 36 |

| Question | Sections | Indicative material | Mark | Total |
|----------|---------------|--|-------------|-------|
| 1 (a) | PDO layout | <p>I The following data are given</p> <ul style="list-style-type: none"> • mass of solid used (or both weighings) • volume used in rough titre (or both readings) • initial and final readings for two (or more) accurate titrations | 1 | |
| | PDO recording | <p>II Acceptable/appropriate headings for all data given in weighing and accurate titration tables and g and cm³ units.</p> <ul style="list-style-type: none"> • mass/weight of beaker (empty) • mass of beaker + FB 1/solid • mass solid/FB1 • initial/start/first (burette) reading/volume • final/end/second (burette) reading/volume • titre or volume used/added/FB 5 added (<i>but not difference or change in volume</i>) • unit:/cm³ or (cm³) or in cm³ or cm³ <p><i>If g/cm³ units are not given in the heading, every entry in the table must have the correct unit.</i></p> | 1 | |
| | PDO recording | <p>III All accurate burette readings are to the nearest 0.05 cm³.</p> <p><i>The need to record to 0.05 only applies to the burette readings, including 0.00 cm³ (if this was the initial reading), but it does not apply to the titre.</i></p> <p><i>Do not award this mark if:</i></p> <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). | 1 | |
| | MMO decision | <p>IV There are two uncorrected accurate titres within 0.10 cm³.</p> <p><i>Do not include a reading if it is labelled “rough”.</i></p> <p><i>Do not award this mark if, having performed two titres within 0.1 cm³, a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless further titrations, within 0.1 cm³ of any other, has also been carried out.</i></p> <p><i>Do not award the mark if any accurate burette readings (apart from initial zero) are given as integers.</i></p> | 1 | |
| | MMO quality | <p>Examiner calculates mean titre × mass FB 1 for candidate and Supervisor.</p> <p>Award V, VI and VII if $\delta \leq 2$ (g cm³)</p> <p>Award V and VI if $2 < \delta \leq 3$</p> <p>Award V, only, if $3 < \delta \leq 5$.</p> <p><i>Spread penalty: if two best titres used by the Examiner are ≥ 0.50 cm³ apart, cancel one Q mark.</i></p> | 1 1 1 | [7] |

| Page 3 | Mark Scheme | Syllabus | Paper |
|--------|-------------------------------------|----------|-------|
| | GCE A LEVEL – October/November 2013 | 9701 | 36 |

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|-------|--------------------|---|---|-----|
| 1 (b) | MMO decision | Candidate calculates the mean correctly. | 1 | |
| | | Candidate must take the average two (or more) titres where the total spread is $\leq 0.2 \text{ cm}^3$. | | |
| | | Working must be shown or ticks must be put next to the accurate titres selected. | | |
| | | The mean should normally be quoted to 2 dp , rounded to nearest 0.01 cm^3 . Example 26.667 cm^3 must be rounded to 26.67 not 26.65 cm^3 , 26.675 cm^3 must be rounded to 26.68 not 26.70 cm^3 . | | |
| | | Two special cases, where the mean may not be to 2 dp: Allow mean expressed to 3 dp, only for 0.025 or 0.075. Allow mean if expressed to 1 dp if all accurate burette readings were given to 1 dp (ignoring initial given as 0) and the mean is exactly correct e.g. 26.0 and $26.2 = 26.1$ is correct but 26.0 and $26.1 = 26.1$ is wrong – should be 26.05 . | | |
| | | <i>Do not award this mark if:</i> | | |
| | | <ul style="list-style-type: none"> The rough titre was used to calculate the mean. The candidate did only one accurate titration. Burette readings were incorrectly subtracted to obtain any of the accurate titre values. All burette readings (resulting in titre values used in calculation of mean) are integers. | | |
| | | Note: the candidate's mean will sometimes be marked correct even if it is different from the mean calculated by the Examiner for the purpose of assessing accuracy. | | [1] |
| 1 (c) | ACE interpretation | I Correctly calculates moles of $\text{Na}_2\text{S}_2\text{O}_3$ weighed in (i) = <u>mass of FB1 used</u> 248.2 | 1 | |
| | | II Correct expression for moles of $\text{Na}_2\text{S}_2\text{O}_3$ used in (ii) = <u>answer (i) \times mean titre</u> 250 | 1 | |
| | | III Correct calculations/expression in (iii) and (iv) (iii) : no moles of $\text{I}_2 = 0.5 \times$ (ii) | 1 | |
| | PDO display | IV Correct expression in (v) Mass = answer (iv) $\times 40 \times 158(.0)$ ($\times 40$ may be shown as $\times 1000/25$) | 1 | |
| | PDO display | V All quoted answers are given to 3 or 4 significant figures. (minimum of three answers) | 1 | [5] |

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|--------|-------------------------------------|----------|-------|
| Page 4 | Mark Scheme | Syllabus | Paper |
| | GCE A LEVEL – October/November 2013 | 9701 | 36 |

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|-------|--------------------|--|--------------------|-----|
| 1 (d) | ACE interpretation | error = 0.05 cm ³ in (i) and % error in volume of FB 5 = $\frac{2 \times 0.05}{\text{vol of FB 5 used}} \times 100$ in (ii) | 1 | [1] |
| | | | [Total: 14] | |
| 2 (a) | MMO collection | I The masses of FB 6 used by the candidate were between 2.0 – 2.4 g (expt 1) and 2.5 – 2.9 g (expt 2). | 1 | |
| | PDO display | II Suitable headings for a table or list, shown completely for at least one experiment. If 2 experiments, all headings must be correct. <ul style="list-style-type: none"> • (mass of) empty crucible • (mass of) crucible + FB 6 • (mass of) crucible + residue/FB 6 after heating • mass (water) lost or mass anhydrous remaining and unit covering every weighing. <i>Unit/g or (g) or in grams or g following each weighing.</i> | 1 | |
| | PDO recording | III Records all balance readings consistently to at least 1 dp <i>A minimum of three weighings are needed.</i> | 1 | |
| | MMO quality | Examiner calculates $\frac{\text{mass of hydrated salt}}{\text{mass of water}}$ for each experiment. Award IV if the ratio in expt 1 is between 0.95 and 1.15. Award V If the ratio in expt 2 is between 0.95 and 1.15. Award VI If the ratio in both of experiments 1 and 2 is between 0.85 and 1.25. | 1 1 1 | [6] |
| 2 (b) | MMO quality | (i) An appropriate choice of the more accurate experiment, and justification of choice. Three possibilities: <ul style="list-style-type: none"> • <i>Experiment 2 uses a larger mass and has a greater percentage accuracy.</i> • <i>A reference to either experiment “spitting” or “frothing” during heating is a valid reason for nominating the other experiment.</i> • <i>Experiment 1 as smaller mass takes less heating.</i> | 1 | |
| | ACE interpretation | (ii) Correctly calculates number of moles of water = $\frac{\text{mass of water lost}}{18}$ <i>Ans to 2–4 sf</i> <i>Candidate must use the mass loss for the experiment thought to be more accurate. (If no choice is expressed in (i), this should be expt 2.)</i> | 1 | |
| | ACE conclusion | (iii) $\text{MSO}_4 \cdot 7\text{H}_2\text{O}(\text{s}) \rightarrow \text{MSO}_4(\text{s}) + 7\text{H}_2\text{O}(\text{g})$ <i>Allow (l) for water.</i> | 1 | |

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|--------|-------------------------------------|----------|-------|
| Page 5 | Mark Scheme | Syllabus | Paper |
| | GCE A LEVEL – October/November 2013 | 9701 | 36 |

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|-------|--------------------|---|--------------------|-----|
| | ACE interpretation | (iv) Correct answer calculated $n(\text{MSO}_4) = \frac{n(\text{water})}{7}$ i.e. answer (ii) divided by 7 <i>Ans to 2–4 sf</i> | 1 | |
| | ACE interpretation | (v) Method mark showing the numbers for the expression Relative formula mass = $\frac{\text{mass of residue}}{\text{no of moles}}$ <i>Mass of residue from same expt as mass of water</i> <i>Ans to 2–4 sf</i> | 1 | |
| | ACE interpretation | (vi) Correct answer calculated $A_r = M_r - 96.1$. Candidates are allowed to use 126.3 as the M_r . In this case, the $A_r = 30.2$. <i>Ans 2–4 sf</i> <i>Penalise sf once only within (b)</i> | 1 | |
| | ACE conclusion | (vii) Correct identification of M as magnesium and explanation that this A_r is closest to value calculated. <i>Allow alternative identity of metal as ecf from A_r value.</i> | 1 | |
| | ACE conclusion | (viii) (M is divalent but) Al and Cr are both trivalent or (M forms 2+ ion whereas) Al and Cr are 3+ or sulfates of Cr/Al are not CrSO_4 and AlSO_4 (<i>ora</i>) <i>ref to both needed</i> | 1 | [8] |
| 2 (c) | ACE Improvements | Cool in a desiccator or cool in closed container with a (named) drying agent | 1 | [1] |
| | | | [Total: 15] | |

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|--------|-------------------------------------|----------|-------|
| Page 6 | Mark Scheme | Syllabus | Paper |
| | GCE A LEVEL – October/November 2013 | 9701 | 36 |

FB 6 = MgSO₄; FB 7 is H₂SO₄; FB 8 is Pb(NO₃)₂; FB 9 = KI

| 3 (a) | MMO collection | (i) White precipitate, insoluble in excess for both NaOH and NH ₃ | 1 | | | | | | | | | | | | | | | | | |
|----------------|---|--|-----------|--------------------|---|--|-------------|------|-----------|---|--|-------------|-------------|--|-----------|-------------|-------------|--|--|------------|
| | MMO decision | (ii) Use barium chloride/nitrate and hydrochloric/nitric acid | 1 | | | | | | | | | | | | | | | | | |
| | MMO collection | White precipitate formed, insoluble in acid. | 1 | | | | | | | | | | | | | | | | | |
| | ACE conclusion | (iii) Ba ²⁺ + SO ₄ ²⁻ → BaSO ₄ | 1 | [4] | | | | | | | | | | | | | | | | |
| 3 (b) | MMO collection | (i) One mark for each column | 1 | | | | | | | | | | | | | | | | | |
| | | <table border="1"> <thead> <tr> <th></th> <th>FB 7</th> <th>FB 8</th> <th>FB 9</th> </tr> </thead> <tbody> <tr> <td>Mg</td> <td>Fizzing or tube gets hot/heat given out or Mg dissolves and (gas) pops with lighted splint</td> <td>Black solid/ppt formed/Mg strip turns dark</td> <td>No reaction</td> </tr> <tr> <td>FB 7</td> <td></td> <td>White ppt</td> <td>No reaction</td> </tr> <tr> <td>FB 8</td> <td></td> <td></td> <td>Yellow ppt</td> </tr> </tbody> </table> | | | | FB 7 | FB 8 | FB 9 | Mg | Fizzing or tube gets hot/heat given out or Mg dissolves and (gas) pops with lighted splint | Black solid/ppt formed/Mg strip turns dark | No reaction | FB 7 | | White ppt | No reaction | FB 8 | | | Yellow ppt |
| | | | | | FB 7 | FB 8 | FB 9 | | | | | | | | | | | | | |
| | | Mg | | | Fizzing or tube gets hot/heat given out or Mg dissolves and (gas) pops with lighted splint | Black solid/ppt formed/Mg strip turns dark | No reaction | | | | | | | | | | | | | |
| | FB 7 | | White ppt | No reaction | | | | | | | | | | | | | | | | |
| | FB 8 | | | Yellow ppt | | | | | | | | | | | | | | | | |
| | | | 1 | | | | | | | | | | | | | | | | | |
| | ACE conclusion | (ii) FB 7 is sulfuric acid and it is acidic (or H ⁺ ions are present) because it fizzes/hydrogen produced with magnesium. | 1 | | | | | | | | | | | | | | | | | |
| MMO collection | (iii) Red-brown/brown/orange-brown/yellow-brown colour with KI (not red or orange or yellow) and blue or black colour with starch | 1 | | | | | | | | | | | | | | | | | | |
| ACE conclusion | Iodine produced and the anion in FB 9 is iodide. | 1 | | | | | | | | | | | | | | | | | | |
| ACE conclusion | (iv) PbI ₂ or AgI (or both) <i>Ecf possible for CrO₄²⁻ in (iii) with Ba²⁺ or Pb²⁺</i> | 1 | [7] | | | | | | | | | | | | | | | | | |
| | | | | [Total: 11] | | | | | | | | | | | | | | | | |