

## **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.

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

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1 (b)	MMO decision	<p>Candidate calculates the mean correctly.</p> <p>Candidate must take the average two (or more) titres where the total spread is <math>\leq 0.2 \text{ cm}^3</math>.</p> <p>Working must be shown <b>or</b> ticks must be put next to the accurate titres selected.</p> <p>The mean should normally be quoted to <b>2 dp</b>, rounded to nearest <math>0.01 \text{ cm}^3</math>. Example <math>26.667 \text{ cm}^3</math> must be rounded to <b>26.67 not</b> <math>26.65 \text{ cm}^3</math>, <math>26.675 \text{ cm}^3</math> must be rounded to <b>26.68 not</b> <math>26.70 \text{ cm}^3</math>.</p> <p>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. <math>26.0</math> and <math>26.2 = 26.1</math> is correct but <math>26.0</math> and <math>26.1 = 26.1</math> is wrong – should be <math>26.05</math>.</p> <p><i>Do not award this mark if:</i></p> <ul style="list-style-type: none"> <li>The rough titre was used to calculate the mean.</li> <li>The candidate did only one accurate titration.</li> <li>Burette readings were incorrectly subtracted to obtain any of the accurate titre values.</li> <li>All 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 is different from the mean calculated by the Examiner for the purpose of assessing accuracy.</p>	1	[1]
		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) <math>\times</math> 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	[5]
	PDO display	V All quoted answers are given to 3 or 4 significant figures. (minimum of three answers)	1	

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1 (d)	ACE interpretation	error = 0.05 cm <sup>3</sup> in (i) <b>and</b> % error in volume of <b>FB 5</b> = $\frac{2 \times 0.05}{\text{vol of FB 5 used}} \times 100$ in (ii)	1	[1]
<b>[Total: 14]</b>				
2 (a)	MMO collection	I The masses of <b>FB 6</b> used by the candidate were between 2.0 – 2.4 g (expt 1) <b>and</b> 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"> <li>• (mass of) empty crucible</li> <li>• (mass of) crucible + <b>FB 6</b></li> <li>• (mass of) crucible + residue/<b>FB 6</b> after heating</li> <li>• mass (water) lost or mass anhydrous remaining</li> </ul> <b>and</b> unit covering every weighing. <i>Unit/g or (g) or in grams or g following each weighing.</i>	1	
	PDO recording	III Records <b>all</b> balance readings consistently to at least 1 dp <i>A minimum of <b>three</b> weighings are needed.</i>	1	
	MMO quality	Examiner calculates $\frac{\text{mass of hydrated salt}}{\text{mass of water}}$ for each experiment. Award <b>IV</b> if the ratio in expt 1 is between 0.95 and 1.15. Award <b>V</b> If the ratio in expt 2 is between 0.95 and 1.15. Award <b>VI</b> If the ratio in <b>both</b> 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, <b>and</b> justification of choice. Three possibilities: <ul style="list-style-type: none"> <li>• <i>Experiment 2 uses a larger mass and has a greater <b>percentage</b> accuracy.</i></li> <li>• <i>A reference to either experiment “spitting” or “frothing” during heating is a valid reason for nominating the other experiment.</i></li> <li>• <i>Experiment 1 as smaller mass takes less heating.</i></li> </ul>	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) <b>MSO<sub>4</sub>·7H<sub>2</sub>O(s) → MSO<sub>4</sub>(s) + 7H<sub>2</sub>O(g)</b> <i>Allow (l) for water.</i>	1	

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	ACE interpretation	(iv) <b>Correct answer calculated</b> $n(\text{MSO}_4) = \frac{n(\text{water})}{7}$ i.e. answer (ii) divided by 7 <i>Ans to 2–4 sf</i>	1	
	ACE interpretation	(v) <b>Method mark showing the numbers for the expression</b> 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) <b>Correct answer calculated</b> $A_r = M_r - 96.1$ . 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) <b>Correct identification of M as magnesium and explanation that this <math>A_r</math> is closest to value calculated.</b> <i>Allow alternative identity of metal as ecf from <math>A_r</math> value.</i>	1	
	ACE conclusion	(viii) <b>(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 <math>\text{CrSO}_4</math> and <math>\text{AlSO}_4</math> (ora) ref to both needed</b>	1	[8]
2 (c)	ACE Improvements	Cool in a desiccator <b>or</b> cool in closed container with a (named) drying agent	1	[1]
				<b>[Total: 15]</b>

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**FB 6** = MgSO<sub>4</sub>; **FB 7** is H<sub>2</sub>SO<sub>4</sub>; **FB 8** is Pb(NO<sub>3</sub>)<sub>2</sub>; **FB 9** = KI

3 (a)	MMO collection	(i) White precipitate, insoluble in excess for <b>both</b> NaOH <b>and</b> NH <sub>3</sub>	1																	
	MMO decision	(ii) Use barium chloride/nitrate <b>and</b> hydrochloric/nitric acid	1																	
	MMO collection	White precipitate formed, insoluble in acid.	1																	
	ACE conclusion	(iii) Ba <sup>2+</sup> + SO <sub>4</sub> <sup>2-</sup> → BaSO <sub>4</sub>	1	[4]																
3 (b)	MMO collection	(i) One mark for each column	1																	
		<table><tr><td></td><td><b>FB 7</b></td><td><b>FB 8</b></td><td><b>FB 9</b></td></tr><tr><td><b>Mg</b></td><td>Fizzing or tube gets hot/heat given out or Mg dissolves <b>and</b> (gas) pops with lighted splint</td><td>Black solid/ppt formed/Mg strip turns dark</td><td>No reaction</td></tr><tr><td><b>FB 7</b></td><td></td><td>White ppt</td><td>No reaction</td></tr><tr><td><b>FB 8</b></td><td></td><td></td><td>Yellow ppt</td></tr></table>				<b>FB 7</b>	<b>FB 8</b>	<b>FB 9</b>	<b>Mg</b>	Fizzing or tube gets hot/heat given out or Mg dissolves <b>and</b> (gas) pops with lighted splint	Black solid/ppt formed/Mg strip turns dark	No reaction	<b>FB 7</b>		White ppt	No reaction	<b>FB 8</b>			Yellow ppt
					<b>FB 7</b>	<b>FB 8</b>	<b>FB 9</b>													
		<b>Mg</b>			Fizzing or tube gets hot/heat given out or Mg dissolves <b>and</b> (gas) pops with lighted splint	Black solid/ppt formed/Mg strip turns dark	No reaction													
		<b>FB 7</b>				White ppt	No reaction													
	<b>FB 8</b>			Yellow ppt																
ACE conclusion	(ii) <b>FB 7</b> is sulfuric acid <b>and</b> it is acidic ( <b>or</b> H <sup>+</sup> 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) <b>and</b> blue or black colour with starch	1																		
ACE conclusion	Iodine produced <b>and</b> the anion in <b>FB 9</b> is iodide.	1																		
ACE conclusion	(iv) PbI <sub>2</sub> or AgI (or both) <i>Ecf possible for CrO<sub>4</sub><sup>2-</sup> in (iii) with Ba<sup>2+</sup> or Pb<sup>2+</sup></i>	1	[7]																	
[Total: 11]																				