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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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 (*minimum of 2 × 2 box*)	1	
	II Titre values recorded for accurate titrations **and** Appropriate headings for the **accurate** titration table **and** cm^3 units. • initial / start burette reading / volume / value • final / end burette reading / volume / value (*not amount)* • titre **or** volume / **FA 4 and** used / added • unit: / cm^3 **or** (cm^3) **or** in cm^3 (for each heading)	1	
	III All **accurate** burette readings are to the nearest 0.05 cm^3. *Do **not** award this mark if:* • *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 • *Do **not** award this mark if, having performed two titres within 0.10 cm^3, a further titration is performed which is more than 0.10 cm^3 from the closer of the initial two titres, **unless** a further titration, within 0.10 cm^3 of any other, has also been carried out.* • *Do **not** award the mark if any "accurate" burette readings (apart from initial 0 cm^3) are given to **zero** dp*	1	
	Examiner rounds any burette readings to the nearest 0.05 cm^3, checks subtractions and then selects the **"best" titres** using the hierarchy: • two (or more) accurate identical titres, *then* • two (or more) accurate titres within 0.05 cm^3, *then* • two (or more) accurate titres within 0.10 cm^3, *etc* These best titres are used to calculate the mean titre, expressed to nearest 0.01 cm^3. Examiner calculates the difference (**δ**) between the mean titres obtained by the candidate and the Supervisor. Accuracy marks are awarded as shown. Award **V**, **VI** and **VII** if **δ ⩽ 0.20** (cm^3) Award **V** and **VI** if **0.20 < δ ⩽ 0.30** Award **V**, only, if **0.30 < δ ⩽ 0.50** ***Spread penalty**: if the two "best" (corrected) titres used by the Examiner were ⩾ 0.50 cm^3 apart, cancel **one** accuracy mark.*	3	[7]

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Question	Indicative material	Mark	Total
(b)	Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. 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 cm^3. Two special cases, where the mean need not be to 2 dp: • Allow mean expressed to 3 dp **only** for 0.025 or 0.075 *(e.g. 26.325 cm^3)* • 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)* ***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.*	1	[1]
(c)(i)(ii)	Correctly calculates • n(thio) = $0.10 \times$ **(b)** / $_{1000}$ • n(I_2) = $0.5 \times$ **(i)** *Both answers must be given to 3 or 4 significant figures*	1	
(iii)	Correctly calculates n($KMnO_4$) = $0.025 \times 0.018 = 0.00045$ or 0.000450 or 0.0004500	1	
(iv)	Correct expression, with answer given to 2, 3 or 4 sig fig n(I_2) = **(ii)** / **(iii)** $\times$ 2 *Theoretical answer = 5.0 (for 2.0 mol $KMnO_4$)*	1	
(v)	Correct equation ticked**,** corresponding to **(iv)**	1	
(vi)	Allow any **one** of the following answers: • **An** iodide ion loses **one** electron • $2I^- - 2e^- \rightarrow I_2$ (*ionic equation must be correctly balanced)* • Oxidation number of iodine **increases** from –1/ 1– (in iodide ion) to 0 (in iodine)	1	[5]
(d) (i)	% error = $^{0.06}/_{25} \times 100 = 0.24$ %	1	
(ii)	The student is wrong, since KI / **FA 3** is in **excess.**	1	[2]
Qn 1			**[Total: 15]**
2 (a)	**I** Table for readings, headings **and** correct units: Headings: • volume of **FA 5** / acid • (volume of water – *if included must be correct*) • Time *Units allow Vol or / cm^3 etc.*	1	

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Question	Indicative material	Mark	Total
	II Three reaction times all recorded to **nearest second**	1	

	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	[4]

(b) (i)	• Rates correctly calculated • All answers expressed to same sig fig (but not 1 sf) • Unit given.... / s^{-1} or (s^{-1})	1	
(ii)	Correctly calculates • Expt 1, conc = 0.08571 (or 0.0857 or 0.086) mol dm^{-3} **and** • Expt 3, conc = 0.02857 (or 0.0286 or 0.029) mol dm^{-3} *Both answers must be given to 2, 3 or 4 sig figs*	1	
(iii)	Rate increases with (increase of) concentration	1	
(iv)	• Time is shorter for sulfuric acid • Sulfuric acid has a greater / doubled **concentration** of H^+ ions.	1	
(v)	• time (for reaction) will be greater • less depth (of solution) in the 250 cm^3	1	[5]
Qn 2			**[Total: 9]**
FA 6 is Na_2SO_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** • white precipitate with Ba^{2+} ion • Precipitate dissolves / partially dissolves in (excess) HCl	1	
(ii)	**Both observations required** • white precipitate with Ba^{2+} 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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<table>
<tr><th>Question</th><th>Indicative material</th><th>Mark</th><th>Total</th></tr>
<tr><td>(v)</td><td>Anion is sulfite and <u>one</u> piece of evidence
• FA 6 with acid – SO_2 / gas which decolourises $KMnO_4$ is formed or
• FA 6 with Ba^{2+} – white precipitate / $BaSO_3$ formed which dissolves in acid / partially soluble in acid</td><td>1</td><td></td></tr>
<tr><td>(vi)</td><td>$Na_2SO_3 + H_2O_2 \rightarrow Na_2SO_4 + H_2O$</td><td>1</td><td>[7]</td></tr>
<tr><td>(b) (i)</td><td>
<table>
<tr><th></th><th>FA 7</th><th>FA 8</th><th>FA 9</th><th>FA 10</th></tr>
<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 (owtte)</td></tr>
<tr><td>NH_3</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 NH_3</td><td>(ignore)</td><td>no change or insoluble in excess</td><td>no change or insoluble in excess</td><td>insoluble in excess or ppt darkens (owtte)</td></tr>
</table>
</td><td>5</td><td></td></tr>
<tr><td>(ii)</td><td>Conclusions
• FA 7 – calcium / Ca^{2+} or barium/Ba^{2+}
• FA 8 – magnesium / Mg^{2+}
• FA 9 – aluminium / Al^{3+}
• FA 10 – manganese(II)/Mn^{2+}

Four correct = 2 marks
Two or three correct = 1 mark</td><td>2</td><td></td></tr>
<tr><td>(iii)</td><td>$M^{2+} + 2OH^- \rightarrow M(OH)_2$ (for any divalent cation)
or $M^{3+} + 3OH^- \rightarrow M(OH)_3$ (for any trivalent cation)</td><td>1</td><td></td></tr>
<tr><td>(iv)</td><td>Use higher concentration</td><td>1</td><td>[9]</td></tr>
<tr><td>Qn 3</td><td colspan="3">[Total: 16]</td></tr>
</table>

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