

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

**MARK SCHEME for the October/November 2014 series****9701 CHEMISTRY****9701/34**Paper 3 (Advanced Practical Skills 2),  
maximum raw mark 40

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Page 2	Mark Scheme	Syllabus	Page 4
	Cambridge International AS/A Level – October/November 2014	9701	DailyBased.com

Question	Indicative material	Mark	Total
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>	1	
	<p><b>II</b> Appropriate headings and units for accurate titration <b>and</b> volume <b>FB 1</b> added recorded for each accurate titre.</p> <p>Headings should match readings.</p> <ul style="list-style-type: none"> <li>initial/start <b>and</b> (burette) reading/volume</li> <li>final/end <b>and</b> (burette) reading/volume</li> <li>titre <b>or</b> volume/<b>FB 1 and</b> used/added 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</li> </ul>	1	
	<p><b>III</b> All accurate burette readings are to the nearest 0.05 cm<sup>3</sup>.  <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 <b>not</b> apply to the titre.</i>            Do <b>not</b> award this mark if:</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	
	<p><b>IV</b> There are two uncorrected <b>accurate</b> titres within 0.10 cm<sup>3</sup></p> <ul style="list-style-type: none"> <li>Do <b>not</b> include a reading if it is labelled “rough”.</li> <li>Do <b>not</b> award this mark if, having performed two titres within 0.10 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 <b>two</b> titres, <b>unless</b> a further titration, within 0.10 cm<sup>3</sup> of any other, has also been carried out.</li> <li>Do <b>not</b> award the mark if any ‘accurate’ burette readings (apart from initial 0) are given to <b>zero</b> dp.</li> </ul>	1	
	<p>Examiner rounds any 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 (ignoring rough), 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 are used to calculate the mean corrected titre to the nearest 0.01 cm<sup>3</sup>.</p>		
	<p>Award <b>V</b>, <b>VI</b> and <b>VII</b> if <math>\delta \leq 0.20</math> (cm<sup>3</sup>)            Award <b>V</b> and <b>VI</b> if <math>0.20 &lt; \delta \leq 0.40</math>            Award <b>V</b>, only, if <math>0.40 &lt; \delta \leq 0.80</math>  <b>Spread penalty:</b> if the two “best” (corrected) titres used by the Examiner were <math>\geq 0.50</math> cm<sup>3</sup> apart, cancel <b>one</b> Q mark.</p>	<p>1 1 1</p>	[7]

Page 3	Mark Scheme	Syllabus Paper
	Cambridge International AS/A Level – October/November 2014	9701 / 34

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(b)	<ul style="list-style-type: none"> <li>Candidate averages two (or more) titres where the total spread is <math>\leq 0.20 \text{ cm}^3</math>.</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 <b>2 dp</b>, and be correctly rounded to nearest <math>0.01 \text{ cm}^3</math>.</li> </ul> Two special cases, where the mean need not be to 2 dp: <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 \text{ cm}^3</math>)</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.</li> </ul> <i>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.</i>	1	[1]
(c) (i)	Number of moles of $\text{KMnO}_4$ used = $0.0250 \times \frac{\text{(b)}}{1000}$	1	
(ii)	$2\text{KMnO}_4 + 5\text{H}_2\text{O}_2 + 3\text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O} + 5\text{O}_2$	1	
(iii) + (iv)	(iii) number of moles of $\text{H}_2\text{O}_2$ (in $10 \text{ cm}^3$ ) = $2.5 \times \text{(i)}$ (iv) number of moles of $\text{H}_2\text{O}_2$ (in $1.0 \text{ dm}^3$ ) = $100 \times \text{(iii)}$ <i>Allow ecf in (iii) to incorrect equation</i>	1	
(v)	Concentration in <b>FB 3</b> = (iv) $\times 10$	1	
(c)	Answers to parts (i), (iii), (iv) and (v) given to 3 or 4 sf <i>A minimum of 3 answers is needed to qualify for the mark.</i> <i>All answers given must have appropriate sig figs.</i>	1	[5]
<b>Qn 1</b>		<b>Total</b>	<b>[13]</b>

Page 4	Mark Scheme	Syllabus	Page 4
	Cambridge International AS/A Level – October/November 2014	9701	DailyBased.com

Question	Indicative material	Mark	Total
2 (a)	<b>I</b> Table of data, showing all of the following: <ul style="list-style-type: none"> <li>unambiguous headings (<i>ignore units</i>)</li> <li>four initial temperature</li> <li>four final temperatures</li> <li>four temperature rises correctly calculated</li> </ul> <i>All data must be tabulated in the space provided on page 4.</i>	1	
	<b>II</b> Recording of data <ul style="list-style-type: none"> <li>correct units ‘covering’ all temperature readings.</li> <li>all readings recorded to .0 or .5 °C, with at least one shown as .5 °C or .0 °C</li> </ul> <i>Minimum of <b>six</b> temperatures required to qualify</i>	1	
	<ul style="list-style-type: none"> <li>Examiner checks Supervisor’s subtraction for temperature rise for experiment <b>4</b>.</li> <li>Examiner corrects thermometer readings to nearest .5 °C then subtracts.</li> <li>Examiner calculates the difference between the [corrected] candidate’s and Supervisor’s temperature rise for experiment <b>4</b>.</li> </ul>		[5]
	Award <b>III</b> if $\Delta T$ increases with increase in volume of <b>FA 3</b> . <b>Experiment 4</b> Award <b>IV</b> if $\delta \leq 2.0$ °C Award <b>V</b> if $\delta \leq 1.0$ °C <i>If expt 4 was not carried out, examiners may award mark <b>IV</b> if experiment 3 is within 1.0 °C of Supervisor.</i>	1	
		1	
(b)	<b>I</b> Suitable axes and scales to graph <ul style="list-style-type: none"> <li>both axes clearly labelled (units not required)</li> <li>temperature (rise) as y-axis</li> <li>suitable linear scales (<i>Points are plotted using more than half of the grid in both directions from (0,0). Must have at least one point plotted.</i>)</li> </ul>	1	
	<b>II</b> Four points plotted clearly and correctly (All points plotted to within half a square and in the correct square for y-axis and on line for x-axis.)	1	
	<b>III</b> 0,0 point either plotted <b>or</b> used for line (within one small square)	1	
	<b>IV</b> Best fit line <ul style="list-style-type: none"> <li>Minimum 4 points on the grid are needed. This may include (0,0) if plotted.</li> <li>Points above and below best fit line are “balanced”.</li> </ul>	1	[4]
(c) (i)	Correctly calculates temp rise per cm <sup>3</sup> (gradient of straight line) <ul style="list-style-type: none"> <li>All points from the best fit line must be correctly read to the nearest half square.</li> <li>Points used must differ by a minimum of <b>two</b> large squares, along each axis.</li> </ul>	1	

Page 5	Mark Scheme	Syllabus Paper
	Cambridge International AS/A Level – October/November 2014	9701 34

(ii)	Heat produced = $50 \times 4.2 \times$ temp rise calculated in (i)	1	[4]
(iii)	Number of moles of $\text{H}_2\text{O}_2 = 0.0010 \times$ <b>1(c)(v)</b> (2, 3 or 4 sig fig)	1	
(iv)	Correct expression including negative sign and evidence of $\div 1000$ $\Delta H = - \frac{\text{(ii)}}{1000 \times \text{(iii)}} \text{ or correct answer}$	1	
(d)	The <b>first</b> experiment, because it has the smallest temperature rise so greatest % error <b>or</b> smallest volume of <b>FA 3</b> / $\text{H}_2\text{O}_2$ so greatest % error. <b>or</b> The <b>final</b> experiment because it has the greatest heat loss. <b>or</b> Identifies experiment giving <b>most</b> anomalous point on graph.	1	[1]
<b>Qn 2</b>		<b>Total</b>	<b>[14]</b>

Page 6	Mark Scheme	Syllabus Paper
	Cambridge International AS/A Level – October/November 2014	9701 / 34

Question	Indicative material	Mark	Total
<b>FB 6</b> is $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$ ; <b>FB 7</b> is KI; <b>FB 8</b> is HCl; <b>FB 9</b> is $\text{AgNO}_3$			
<b>3 (a)</b>	<b>(i)</b> Green precipitate, insoluble in excess (NaOH)	1	
	(When mixture heated) gas/ ammonia turns (red) litmus blue	1	
	<b>Either</b> cation in <b>FB 6</b> identified from correct observations <ul style="list-style-type: none"> <li>• iron(II)/<math>\text{Fe}^{2+}</math></li> <li>• Ammonium/<math>\text{NH}_4^+</math></li> </ul>	1	
	<b>(ii)</b> <b>Both</b> observations are correct <ul style="list-style-type: none"> <li>• Precipitate/solid goes brown/red-brown/rust</li> <li>• Bubbles/fizzing/effervescence (<i>not "gas formed"</i>)</li> </ul>	1	
	Type of reaction <b>and</b> justification redox ( <b>or</b> oxidation <b>and</b> reduction) with any of the following: <ul style="list-style-type: none"> <li>• iron(II) ions converted to iron(III) ions</li> <li>• hydrogen peroxide converted to oxygen</li> <li>• colour change indicates different oxidation states</li> </ul> <b>or</b> oxidation of $\text{Fe}^{2+}$ to $\text{Fe}^{3+}$ <b>or</b> reduction of $\text{H}_2\text{O}_2$ as $\text{Fe}^{2+}$ oxidised/ $\text{Fe}^{2+}$ changes colour <b>or</b> (catalytic) decomposition of $\text{H}_2\text{O}_2$ to give ( $\text{H}_2\text{O}$ and) $\text{O}_2$ <b>or</b> exothermic as heat is given out / temp increases	1	
	<b>(iii)</b> Yellow/orange/red-orange/brown/red-brown ( <b>not red</b> ) with <b>FB 7</b> <b>and</b> black/blue-black/dark blue with starch	1	
	Both conclusions about <b>FB 7</b> are correct <ul style="list-style-type: none"> <li>• cation – not known</li> <li>• anion – iodide/<math>\text{I}^-</math></li> </ul>	1	
			[7]
<b>(b) (i)</b>	Two observations for the Mg tests are correct. <ul style="list-style-type: none"> <li>• Fizzing/bubbles/effervescence with <b>FB 8</b></li> <li>• Black/dark grey (solid/precipitate) with <b>FB 9</b></li> </ul>	1	
<b>(b) (i)</b>	Positive gas test performed and recorded: Gas/ $\text{H}_2$ (evolved from Mg + <b>FB 8</b> ) pops with a lighted splint/ when ignited/when burned <i>Mark may also be credited for positive <math>\text{O}_2</math> test in 3(a)(ii): gas/<math>\text{O}_2</math> relights glowing splint/glowing splint glows brighter.</i>	1	
	Remaining three observations in the table are correct <ul style="list-style-type: none"> <li>• <b>FB 7</b> + <b>FB 8</b> – no reaction/no change</li> <li>• <b>FB 7</b> + <b>FB 9</b> – (pale) yellow precipitate</li> <li>• <b>FB 8</b> + <b>FB 9</b> – white precipitate</li> </ul>	1	
	<b>(ii)</b> Cation in <b>FB 9</b> is silver/ $\text{Ag}^+$	1	

Page 7	Mark Scheme	Syllabus	Page
	Cambridge International AS/A Level – October/November 2014	9701	34

Question	Indicative material	Mark	Total
(iii)	$\text{Ag}^+ + \text{I}^- \rightarrow \text{AgI}$ ( <i>ecf from FB 7+FB 9: cream ppt <math>\text{Br}^-</math>, white ppt <math>\text{Cl}^-</math></i> ) ( <i>State symbols are not required but if given must be correct.</i> )	1	[6]
(iv)	<b>FB 8</b> is hydrochloric acid / $\text{HCl}$ ( <i>Allow <math>\text{HBr}</math> from cream/off-white ppt in table with <b>FB 8 + FB 9</b></i> )	1	
<b>Qn 3</b>		<b>Total</b>	<b>[13]</b>