

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the March 2016 series**9701 CHEMISTRY****9701/33**

Paper 3 (Advanced Practical Skills), 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 All thermometer readings and mass of FA 2 recorded. Do not award if mass of FA 2 > 0.50 g.	1	[4]																					
	II All temperatures recorded to 0.5 °C.	1																						
	Award III and IV if within ranges given of supervisor's value.	2																						
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">supervisor's $\Delta T / ^\circ\text{C}$</th> <th style="width: 35%; text-align: center;">III</th> <th style="width: 35%; text-align: center;">IV</th> </tr> </thead> <tbody> <tr> <td>≥ 46.0</td> <td style="text-align: center;">± 5.0</td> <td style="text-align: center;">± 2.5</td> </tr> <tr> <td>36.0–45.5</td> <td style="text-align: center;">± 4.0</td> <td style="text-align: center;">± 2.0</td> </tr> <tr> <td>26.0–35.5</td> <td style="text-align: center;">± 3.0</td> <td style="text-align: center;">± 1.5</td> </tr> <tr> <td>16.0–25.5</td> <td style="text-align: center;">± 2.0</td> <td style="text-align: center;">± 1.0</td> </tr> <tr> <td>6.0–15.5</td> <td style="text-align: center;">± 1.0</td> <td style="text-align: center;">± 0.5</td> </tr> <tr> <td>< 6.0</td> <td style="text-align: center;">± 0.5</td> <td style="text-align: center;">–</td> </tr> </tbody> </table>	supervisor's $\Delta T / ^\circ\text{C}$	III	IV	≥ 46.0	± 5.0	± 2.5	36.0–45.5	± 4.0	± 2.0	26.0–35.5	± 3.0	± 1.5	16.0–25.5	± 2.0	± 1.0	6.0–15.5	± 1.0	± 0.5	< 6.0	± 0.5	–		
	supervisor's $\Delta T / ^\circ\text{C}$	III	IV																					
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< 6.0	± 0.5	–																						
(b)	<p>I Axes labelled with units and uniform scale chosen to use more than half of each axis including 10 °C above the highest recorded temperature.</p> <p>II All recorded points plotted (minimum 9).</p> <p>III Appropriate lines of best fit drawn: <ul style="list-style-type: none"> • best fit lines must be or a smooth curve; • Points not on the line must be balanced on either side of the best-fit line and any points ringed or labelled as anomalous ignored. </p> <p>IV Lines extrapolated and correct value (within 0.5 °C) of ΔT read from graph.</p>	1 1 1 1	[4]																					
(c) (i)	Correctly calculates $Q = 25 \times 4.2 \times \Delta T$ from (b) .	1	[3]																					
(ii)	Correct expression for value of enthalpy change $= \frac{-(\text{c)(i)} \times 24.3}{\text{mass in (a)} \times 1000}$ (ignore sign)	1																						
	Negative sign and both answers recorded to 2–4 sig. fig. and no rounding to 1 sig. fig. during calculation (unless exact value).	1																						
(d)	Incorrect, as the acid was in excess already.	1	[1]																					
(e)	Any one from: <ul style="list-style-type: none"> • use lid or use specified extra insulation to reduce heat losses (by convection or conduction); • use a pipette or burette for FA 1 to reduce % error/as more accurately calibrated (owtte); • use magnesium turnings/powder so reaction complete sooner as there is heat loss while magnesium ribbon is still reacting; • use lid or plastic cup with higher walls to reduce acid spray; 	1	[1]																					

Page 3	Mark Scheme	Syllabus	Page 4
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question	indicative material	mark	total
2 (a)	I Initial and final burette readings and volume added recorded for rough titre and accurate titre details tabulated.	1	[7]
	II Initial and final burette readings recorded and volume of FA 4 added recorded for each accurate titration. All headings and units correct for accurate titrations: <ul style="list-style-type: none"> initial/final (burette) reading/volume or reading/volume at start/finish volume/FA 4 added/used or titre (cm³) or /cm³ or in cm³ or cm³ by every entry. 	1	
	III All accurate burette readings are recorded to the nearest 0.05 cm ³ .	1	
	IV Has two uncorrected, accurate titres within 0.1 cm ³ .	1	
	V, VI and VII Award V , VI and VII for $\delta \leq 0.20 \text{ cm}^3$ Award V and VI for $0.20 \text{ cm}^3 < \delta \leq 0.30 \text{ cm}^3$ Award V for $0.30 \text{ cm}^3 < \delta \leq 0.50 \text{ cm}^3$		
(b)	Mean titre correctly calculated from clearly selected values. <ul style="list-style-type: none"> Candidates must average two (or more) titres where the total spread is $\leq 0.20 \text{ cm}^3$. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. The mean should normally be quoted to 2 d.p. rounded to the nearest 0.01. <p><i>Note: the candidate's mean will sometimes be marked as correct even if it is different from the mean calculated by the examiner for the purpose of assessing accuracy.</i></p>	1	[1]
(c)(i)(ii)	Correctly calculates $\frac{0.100 \times (\mathbf{b})}{1000}$ and (ii) = (i)	1	[5]
(iii)	Correct expression $\frac{(\mathbf{c})(\mathbf{ii}) \times 1000 \times 10}{25}$	1	
(iv)	mol Mg = mass in 1(a) / 24.3 and mol HCl = (c)(iii) $\times 25 / 1000$	1	
	mol HCl > 2 \times mol Mg (owtte) so the statement is correct. Allow ecf from incorrect (iii) .	1	
	Final answers (i) , (ii) and (iii) to 3 or 4 sig. fig. and no rounding errors.	1	

Page 4	Mark Scheme	Syllabus Paper
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question	indicative material	mark	total
(d)	Correct expression $\frac{0.1 \times 100}{(b)}$ and answer to minimum 2 sig. fig. / correct answer to minimum 2 sig. fig. and FA 3 (is measured more accurately). Allow ecf from (b) > 41.67 cm ³ then FA 4 (is measured more accurately).	1	[1]

test	observations	
	FA 5	FA 6
NaOH	no reaction / no change / no ppt	white ppt, soluble in excess
NH ₃	no reaction / no change / no ppt	white ppt, insoluble in excess
HCl (warm)	blue solution brown gas / gas turning brown / gas turns blue litmus red / bleaches	no reaction / no change
H ⁺ / MnO ₄ ⁻	decolourises / purple to colourless or (solution) stays colourless	stays purple / pink or changes to purple / pink
Ba ²⁺ / HCl	no reaction / no change / no ppt	white ppt, insoluble in HCl

question	indicative material	mark	total
FA 5 is NaNO₂; FA 6 is Al₂(SO₄)₃; FA 7 is Na₂SO₃ (Na₂S₂O₅)			
3 (a)	Observations fully correct for both FA 5 and FA6 for NaOH. Observations fully correct for both FA 5 and FA6 for NH ₃ . Observation of blue solution or brown gas with FA 5 and no reaction with FA 6 for HCl. Observations fully correct for both FA 5 and FA6 for H ⁺ / MnO ₄ ⁻ . Observations fully correct for both FA 5 and FA6 for Ba ²⁺ / HCl. Cations: FA 5 unknown and FA 6 Al ³⁺ / aluminium Anions: FA 5 NO ₂ ⁻ / nitrite FA 6 SO ₄ ²⁻ / sulfate	1 1 1 1 1 1 1 1	[8]

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question	indicative material	mark	total
(b) (i)	(Warm with) Al and NaOH and test gas with (damp) red litmus paper.	1	[5]
	No reaction and not nitrate / N / same element as FA 5 .	1	
(ii)	BaCl ₂ / Ba(NO ₃) ₂ and HCl / HNO ₃	1	
	or H ⁺ / KMnO ₄ / acidified potassium manganate(VII)		
	or any named acid, (warm) and test gas with H ⁺ / KMnO ₄ .		
	Ba ²⁺ and acid: white ppt, soluble in acid	1	
(ii)	or H ⁺ / MnO ₄ ⁻ : solution decolourises / purple to colourless		
	or acid and test gas with H ⁺ / KMnO ₄ : gas (evolved with acid) which decolourises H ⁺ / MnO ₄ ⁻ (paper).		
	FA 7 contains sulfite / SO ₃ ²⁻	1	