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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.

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<table>
<tr><th>question</th><th>indicative material</th><th>mark</th><th>total</th></tr>
<tr><td>1 (a)</td><td>
I All thermometer readings and mass of FA 2 recorded.
Do not award if mass of FA 2 > 0.50 g.

II All temperatures recorded to 0.5 °C.

Award III and IV if within ranges given of supervisor’s value.
<table>
<tr><th>supervisor’s ΔT / °C</th><th>III</th><th>IV</th></tr>
<tr><td>⩾ 46.0</td><td>± 5.0</td><td>± 2.5</td></tr>
<tr><td>36.0–45.5</td><td>± 4.0</td><td>± 2.0</td></tr>
<tr><td>26.0–35.5</td><td>± 3.0</td><td>± 1.5</td></tr>
<tr><td>16.0–25.5</td><td>± 2.0</td><td>± 1.0</td></tr>
<tr><td>6.0–15.5</td><td>± 1.0</td><td>± 0.5</td></tr>
<tr><td>< 6.0</td><td>± 0.5</td><td>–</td></tr>
</table>
</td><td>1

1

2</td><td>[4]</td></tr>
<tr><td>(b)</td><td>
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.

II All recorded points plotted (minimum 9).

III Appropriate lines of best fit drawn:

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.

IV Lines extrapolated and correct value (within 0.5 °C) of ΔT read from graph.
</td><td>1

1

1

1</td><td>[4]</td></tr>
<tr><td>(c) (i)</td><td>Correctly calculates Q = 25 × 4.2 × ΔT from (b).</td><td>1</td><td>[3]</td></tr>
<tr><td>(ii)</td><td>Correct expression for value of enthalpy change
$= \frac{-\textbf{(c)(i)} \times 24.3}{\text{mass in } \textbf{(a)} \times 1000}$ (ignore sign)

Negative sign and both answers recorded to 2–4 sig. fig. and no rounding to 1 sig. fig. during calculation (unless exact value).</td><td>1

1</td><td></td></tr>
<tr><td>(d)</td><td>Incorrect, as the acid was in excess already.</td><td>1</td><td>[1]</td></tr>
<tr><td>(e)</td><td>Any one from:

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;

</td><td>1</td><td>[1]</td></tr>
</table>

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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: • initial / final (burette) reading / volume **or** reading / volume at start / finish • volume / **FA 4** added / used **or** titre • (cm^3) **or** / cm^3 **or** in cm^3 **or** cm^3 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 $\delta \leqslant 0.20\,cm^3$ Award **V** and **VI** for $0.20\,cm^3 < \delta \leqslant 0.30\,cm^3$ Award **V** for $0.30\,cm^3 < \delta \leqslant 0.50\,cm^3$		
(b)	Mean titre correctly calculated from clearly selected values. • Candidates must average two (or more) titres where the **total** spread is $\leqslant 0.20\,cm^3$. • 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. *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.*	1	[1]
(c)(i)(ii)	Correctly calculates $\frac{0.100 \times \textbf{(b)}}{1000}$ **and** **(ii)** = **(i)**	1	[5]
(iii)	Correct expression $\frac{\textbf{(c)(ii)} \times 1000 \times 10}{25}$	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	

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question	indicative material	mark	total
(d)	Correct expression $\frac{0.1\times100}{\textbf{(b)}}$ 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
HC*l* (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+} / HC*l*	no reaction / no change / no ppt	white ppt, insoluble in HC*l*

question	indicative material	mark	total
	FA 5 is $NaNO_2$; **FA 6** is $Al_2(SO_4)_3$; **FA 7** is Na_2SO_3 ($Na_2S_2O_5$)		
3 (a)	Observations fully correct for both **FA 5** and **FA6** for NaOH.	1	[8]
	Observations fully correct for both **FA 5** and **FA6** for NH_3.	1	
	Observation of blue solution or brown gas with **FA 5 and** no reaction with **FA 6** for HC*l*.	1	
	Observations fully correct for both **FA 5** and **FA6** for H^+ / MnO_4^-.	1	
	Observations fully correct for both **FA 5** and **FA6** for Ba^{2+} / HC*l*.	1	
	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	

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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 **or** H^+ / $KMnO_4$ / acidified potassium manganate(VII) **or** any named acid, (warm) and test gas with H^+ / $KMnO_4$.	1	
	Ba^{2+} and acid: white ppt, soluble in acid **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).	1	
	FA 7 contains sulfite / SO_3^{2-}	1	

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