

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the May/June 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.

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	31

Question	Indicative material	Mark	Total
1 (a)	I Initial and final burette readings and titre unambiguously recorded in rough and accurate titrations. <i>Minimum of 2×2 boxes for accurate.</i>	1	
	II Headings and units correct for accurate titration and headings match readings. <i>Headings: initial / final (burette) reading / volume or Reading / volume / vol / value at start / finish and Volume / vol / FA 1 added / used or titre [not “difference or “total”] and Units: (cm^3) or / cm^3 or in cm^3 or cm^3 by every entry</i>	1	
	III All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 <i>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)</i>	1	
	IV Has two uncorrected, accurate titres within 0.1 cm^3 <i>Do not award this mark if, having performed two titres within 0.1 cm^3, a further titration is performed that is more than 0.1 cm^3 from the closer of the two initial titres unless further titrations within 0.1 cm^3 of any other has also been carried out. Do not award the mark if any ‘accurate’ burette readings (apart from initial 0) are given to zero dp.</i>	1	
Examiner rounds all all burette readings to the nearest 0.05 cm^3 and checks subtractions. Examiner selects the ‘best’ titres using the hierarchy: two (or more) identical, then two (or more) within 0.05 cm^3 , then two (or more) within 0.1 cm^3, etc.			

Page 3	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
	Award V, VI and VII if $\delta \leq 0.20 \text{ cm}^3$ Award V and VI if $0.20 \leq \delta \leq 0.40 \text{ cm}^3$ Award V if $0.40 \leq \delta \leq 0.60 \text{ cm}^3$ <i>Spread penalty: if the two 'best' titres used by the examiner are more than 0.50 cm^3 apart cancel one of the Q marks.</i>	1 1 1	[7]
(b)	Calculation of mean Candidate must average two (or more) titres that are all within 0.20 cm^3. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. <i>The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67. Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075, e.g. 26.325; allow mean 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 correct but 26.0 and 26.1 = 26.1 is incorrect.</i>	1	[1]
(c)(i)(ii)	I Correctly calculates $\frac{0.0200 \times (b)}{1000}$ in step (i) and $\times 5$ in (ii)	1	
(iii)	II Expression (ii) / 0.025	1	
(iv)	III Expression (iii) $\times 392.0$ (or addition of A_s shown)	1	
	IV Answers to (i) to (iv) given to 3 or 4 sf (min 3 answers needed)	1	[4]
Qn 1	Total		[12]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	31

Question	Indicative material	Mark	Total
2 (a)	I Table with unambiguous headings and correct units All readings must be included.	1	
	II All temperatures recorded to .0 or .5 °C. Must include at least one ending in .0 and one ending in .5.	1	
Examiner calculates candidate's ΔT max from table.			
	III Award if the difference between candidate and Supervisor is within 4.0 °C	1	[4]
	IV Award if the difference between candidate and Supervisor is within 2.0 °C	1	
(b) (i)	Axes labelled temperature or T or °C or temperature and time or minutes or min or t. Linear scales chosen to use more than half of each axis and to include 5 °C more than the maximum temp.	1	
	All points recorded (minimum of 10). Correct plotting – each point accurately plotted (within $\frac{1}{2}$ small square and in the correct square).	1	
	(ii) All three straight lines drawn	1	
	Lines of best fit and extrapolated	1	
	(iii) Correct ΔT from graph to within .2 °C of examiner value using the candidate's lines.	1	
			[5]

Question	Indicative material	Mark	Total
(c) (i)	Correct answer to $4.2 \times 40 \times \text{ans}(\mathbf{b})(\mathbf{iii})$.	1	[3]
	Allow answers to 2–4 sf		
	(ii) Correct answer to (i) / 219000 Allow answers to 2–4 sf	1	
	(iii) Expression (ii) / 0.040 Allow answers to 2–4 sf	1	
(d) (i)	Correct answer correct to number of sf shown (min 2 sf): $0.5 / \text{highest temp} \times 100$	1	
(ii)	Do not agree as the zinc is in excess	1	[3]
(iii)	Incorrect as temperature rise is the same or Incorrect as (a smaller volume) has a greater % error ORA	1	
Qn 2	Total		[15]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	31

Question	Indicative material	Mark	Total
FA 5 is $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2(\text{aq})$; FA 6 is $\text{CuCO}_3 + \text{MgSO}_4 \cdot 7\text{H}_2\text{O}$			
3 (a)	Fizzing	1	[2]
	Acid or any named acid	1	
(b)(i)–(vi)	In (i) (solid goes from green) to black / grey	1	
	In (i) condensation / water / water vapour / steam / steamy fumes	1	
	In (ii) fizzing and forms a (light) blue solution .	1	
	Cloudy with limewater in (i) or (ii) or (a)	1	
	In (ii) blue ppt with sodium hydroxide and insoluble in excess.	1	
	Any 2 from:		
	In (iv) white ppt insoluble in excess	1	
	In (v) white ppt insoluble in excess	1	
	In (vi) white ppt		
	(vii)	Cation: Cu^{2+}	
Cation: Mg^{2+}		1	
Anions: CO_3^{2-} and SO_4^{2-} and SO_3^{2-}		1	
(viii)	Selects acid/ named acid to add to test (vi) (not H_2SO_4) or Selects named acid to add to FA 6 and tests with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ or $\text{H}^+/\text{MnO}_4^-$ and SO_4^{2-} insoluble and SO_3^{2-} soluble or SO_4^{2-} no change and SO_3^{2-} (orange) turns green or (purple) turns colourless	1	[11]
Qn 3	Total	[13]	

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MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/32

Paper 32 (Advanced Practical Skills 2),
maximum raw mark 40

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	32

Question	Indicative material	Mark	Total
1 (a)	I Follows instructions – adds between 13.00 and 13.50 cm³ II Initial and final burette readings and titre unambiguously recorded in rough and accurate titrations. III Headings and units correct for accurate titration and headings match readings. <i>Headings: initial / final (burette) reading / volume or Reading / volume at start / finish and Volume / FB 1 added / used or titre [not “difference”] and Units: (cm³) or / cm³ or in cm³ or cm³ by every entry</i> IV All accurate burette readings (initial and final) recorded to nearest 0.05 cm³ <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading;</i> <i>more than one final burette reading is 50.(00);</i> <i>any burette reading is greater than 50.(00)</i> V Has two uncorrected, accurate titres within 0.1 cm³ <i>Do not award this mark if, having performed two titres within 0.1 cm³, a further titration is performed that is more than 0.1 cm³ from the closer of the two initial titres unless further titrations within 0.1 cm³ of any other has also been carried out.</i> <i>Do not award the mark if any ‘accurate’ burette readings (apart from initial 0) are given to zero dp.</i>	1 1 1 1 1	
Examiner rounds all burette readings to the nearest 0.05 cm³ and checks subtractions. The ‘best’ titres should be selected using the hierarchy: two (or more) identical, then two (or more) within 0.05 cm³, then two (or more) within 0.1 cm³, etc. Examiner to calculate, correct to 2 dp, $\frac{\text{supervisor titre}}{\text{supervisor volume diluted}}$ and $\frac{\text{candidate titre}}{\text{cand vol diluted}}$ and find the difference, δ.			
	Award VI, VII and VIII if $\delta \leq 0.02$ Award VI and VII if $0.20 \leq \delta \leq 0.04$ Award VI if $0.40 \leq \delta \leq 0.06$ <i>Spread penalty: if the two ‘best’ titres used by the examiner are more than 0.50 cm³ apart cancel one of the Q marks.</i>	1 1 1	[8]

Page 3	Mark Scheme	Syllabus	Paper
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1 (b)	Calculation of mean Candidate must average two (or more) titres that are all within 0.20 cm^3. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. <i>The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67. Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075, e.g. 26.325; allow mean 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 correct but 26.0 and 26.1 = 26.1 is incorrect.</i>	1	[1]
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Question	Indicative material	Mark	Total
1 (c)(i)(ii)	I Uses the expression $\frac{0.100 \times (\mathbf{b})}{1000}$ in step (i) and use of $\times \frac{1}{2}$ in (ii)	1	
(iii)	II Correctly calculates (ii) / 0.025	1	
(iv)	III Correctly calculates (iii) $\times$ (250 / volume diluted)	1	
(v)	IV Correctly calculates (iv) $\times$ (106 / 125) $\times$ 100	1	
	V Answers to (i) to (iv) given to 3 or 4 sf	1	[5]
Qn 1	Total	[14]	

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	32

Question	Indicative material	Mark	Total
2 (a)	Table to include initial and final mass, initial and final temperature, mass added and temperature rise. All with correct units. All masses recorded to the same precision and all temperatures recorded to .0 or .5 °C.	1 1	
	III Award if the difference between candidate and Supervisor is within 4.0 °C IV Award if the difference between candidate and Supervisor is within 2.0 °C	1 1	[4]
2 (b) (i)	Correct answer to $4.2 \times 40 \times \Delta T$ Allow answers to 2 – 4 sf	1	
(ii)	Correct answer to (i) / 457 000 Allow answers to 2 – 4 sf	1	
(iii)	Correct answer to (ii) $\times (24.3/\text{mass of mixture}) \times 100$ Allow answers to 2 – 4 sf	1	
(iv)	Heat loss (not significant) or non-standard conditions (not significant)	1	[4]
2 (c) (i)	Correct working or answer correct to number of sf shown: $(1.0/\text{temp rise}) \times 100$	1	
(ii)	Reduce the volume of acid to give a greater temperature rise. Make sure that the acid remains in excess.	1 1	[3]
Qn 2	Total	[11]	

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	32

Question	Indicative material	Mark	Total
FB 6 is $\text{NH}_4\text{Cl}(\text{aq})$ and $\text{Zn}(\text{NO}_3)_2(\text{aq})$; FB 7 is 1-iodobutane; FB 8 is $\text{Na}_2\text{CO}_3(\text{aq})$; FB 9 is $\text{H}_2\text{SO}_4(\text{aq})$			
3 (a)	(i) Clear presentation of results – minimum two tests	1	[6]
	Selects $\text{NaOH}(\text{aq})$ and $\text{NH}_3(\text{aq})$	1	
	White ppt soluble in excess with both reagents	1	
	Gas/ NH_3 turns red litmus blue when warmed with NaOH .	1	
	Zn^{2+} and NH_4^+	1	
	(ii) Warming with NaOH in the presence of NH_4^+ will produce ammonia and so cannot tell if any ammonia is being produced by reduction of the nitrate ions	1	
3 (b)	(i) No reaction on mixing	1	[4]
	Yellow ppt or if observed on mixing then amount of ppt increases.	1	
	Iodine	1	
	(ii) Substitution / hydrolysis	1	
3 (c)	(i) Fizzing	1	[5]
	Limewater turns milky	1	
	White ppt with Ba^{2+}	1	
	(ii) cations: H^+	1	
	anions: CO_3^{2-} and then SO_4^{2-} and /or SO_3^{2-}	1	
Qn 3	Total	[15]	

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	Cambridge International AS/A Level – May/June 2015	9701	33

Question	Indicative material	Mark	Total
1 (a)	I The following data must be shown - burette readings and titre for rough titration 2 × 2 “box” showing both accurate burette readings	1	
	II Headings and units correct for accurate titration table and headings match readings. - initial / start (burette) reading / volume + unit - final / end (burette) reading / volume + unit - titre or volume / FA 1 used / added (<i>not “difference” or “total”</i>) + unit <i>Units: (cm³) or /cm³ or in cm³ or cm³ by every entry</i>	1	
	III All accurate burette readings to 0.05 cm ³ <i>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).</i>	1	
	IV Two accurate titres within 0.10 cm ³ . <i>Do not award if 3rd titre > 0.10 cm³ away from either previous titre unless a further titration is also carried out which is within 0.1 cm³ of any other. Do not award the mark if any ‘accurate’ burette readings (apart from initial 0) are given to zero dp.</i>	1	
<i>Examiner checks and corrects titre subtractions where necessary. Examiner selects the best mean titre using a hierarchy: two identical titres within 0.05 cm³, two or more titres within 0.10 cm³ etc. Examiner subtracts (corrected) candidate’s titre from Supervisor’s titre.</i>			
	Award V , VI and VII if $\delta < 0.20 \text{ cm}^3$ Award V and VI if $0.20 < \delta < 0.30 \text{ cm}^3$ Award V if $0.30 < \delta < 0.50 \text{ cm}^3$ <i>Spread penalty: if the two ‘best’ titres are $\geq 0.50 \text{ cm}^3$ apart, cancel one of the Q marks</i>	1 1 1	[7]

Page 3	Mark Scheme	Syllabus	Paper
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(b)	Candidate must average two (or more) titres that are all within 0.20 cm^3. Working must be shown or ticks must be put next to the two (or more) accurate titres selected. The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325; allow mean 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 correct but 26.0 and 26.1 = 26.1 is incorrect. 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 $\frac{0.1 \times 25}{1000} = 2.5(0) \times 10^{-3}$ and (ii) = (i)	1	[4]
(iii)	Correctly calculates $\frac{(\text{c})(\text{ii}) \times 1000}{(\text{b})}$	1	
(iv)	Correct expression $\frac{13.1}{(\text{iii})}$ or correct answer if no working	1	
	All answers to (iii) and (iv) are given to 3 or 4 sf (minimum of 3 parts attempted)	1	
(d)	If candidate titre $< 28.30 \text{ cm}^3$, student's M_r larger as smaller concentration / molarity / moles in 1 dm^3 of HA/FA 1 than candidate (for same mass) If candidate titre $> 28.30 \text{ cm}^3$, reverse argument to above If candidate titre $= 28.30 \text{ cm}^3$ no change / no difference in M_r as concentration same as HA/FA 1 (owtte)	1	[1]
Qn 1	[13]		

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	33

Question	Indicative material	Mark	Total
2 (a)	I Table for 10 sets of results with unambiguous headings and correctly displayed units or table for 9 sets of results with separate line for initial T or table for 9 sets of results with column for initial T .	1	
	II All volumes (apart from 0) recorded to 1 or 2 dp and all temperatures to 0.0 or 0.5 °C. <i>At least one thermometer reading should be recorded to 0.5 °C.</i> <i>(Minimum 8 readings)</i>	1	
<i>Examiner to calculate Supervisor's and candidate's maximum ΔT. Calculate the difference between the two values.</i>			
	III and IV awarded dependant on comparability between Supervisor's and candidate's ΔT value.	1 1	[4]
(b)	I Linear scales chosen so that graph occupies more than half the available length for both axes (including extra 2 °C for y-axis). and axes correctly labelled	1	
	II All points recorded accurately plotted (within ½ small square and in the correct square, those on lines must be correctly centred). <i>(If blobs shown then they must be correctly centred.)</i>	1	
	III Two lines of best fit drawn – one for increasing temperature and one for decreasing temperature. <i>(Allow a best fit (balanced points) straight line even if a smooth curve is more suitable for either or both.)</i>	1	
	IV Correct ΔT using correct readings from graph (T_{max} to within 0.2 °C of examiner value) and correct V recorded from the intersection on graph (to within 0.5 cm ³) <i>(T_{initial} may come from table or from graph plot or intercept on y-axis.)</i>	1	
(c) (i)	Correctly calculates $\frac{1.80 \times V(\mathbf{b})}{1000}$ to minimum 2 sf	1	
(ii)	Correctly calculates $(25 + V(\mathbf{b})) \times 4.2 \times \Delta T$ to min 2sf	1	
(iii)	Correct expression $\frac{(\mathbf{c})(\mathbf{ii})}{(\mathbf{c})(\mathbf{i}) \times 1000}$	1	

Page 5	Mark Scheme	Syllabus	Paper
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	Answer given to 2 to 4 sf with negative sign	1	[4]
(d)	Correctly calculates $\frac{1.0 \times 100}{\Delta T(b)}$ to minimum 2 sf	1	[1]
(e)	Safety – to prevent plastic cup tipping over/greater stability or (Reduce) heat loss – air jacket/ air trapped (owtte)	1	[1]
(f)	Use burette / pipette for FA 4 / instead of measuring cylinder. or Use smaller volumes close to max T	1	[1]
Qn 2	[15]		

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	33

Question	Indicative material	Mark	Total
FA 5 = (CO ₂) ₂ Na ₂ (s); FA 6 = (NH ₄) ₂ Fe(SO ₄) ₂ .6H ₂ O(s)			
3 (a)	(i) purple / pink (solution) turns colourless / (potassium) manganate(VII) turns colourless / decolourises / purple (colour) disappears	1	[9]
	(ii) (gas) turns (damp) (red) litmus blue / litmus goes blue Either condensation / liquid / water (further up tube) / water vapour / steamy fumes (not white fumes) or (green solid / contents of tube / FA 6) turn(s) white / (light) brown Allow yellow but not bright yellow. Do not allow dark brown.	1 1	
	(iv) green ppt insoluble in excess (Green may be qualified by intensity but not by hue – allow light / dark / dirty green but not grey–green / blue–green.) turning brown (in air)	1 1	
	(v) white ppt insoluble in acid Allow white ppt insoluble if “insoluble” clearly a separate line near bottom of box / next to adding acid.	1	
	(vi) solution turns yellow	1	
	(vii) ammonium / NH ₄ ⁺ from correct observation in (ii) (red litmus turns blue / ammonia produced / ...) iron(II) / Fe ²⁺ and sulfate / SO ₄ ²⁻	1 1	
	(b)	(i) Selects NH ₃ / NaOH or (acidified) KMnO ₄	
(ii) green ppt or purple / KMnO ₄ decolourised / solution turns yellow (Allow solution turns orange / orange–brown / yellow–brown)	1		
Student incorrect / cation not oxidised as still iron(II) (owtte) or Student incorrect / cation not oxidised as oxidation occurs with KMnO ₄ (if used) If brown ppt in (ii) with alkali allow student correct as now Fe ³⁺ or if purple not decolourised allow student correct as already oxidised. (Allow (acidified) potassium dichromate / K ₂ Cr ₂ O ₇ as reagent and orange to green in obs and conclusion analogous to that for KMnO ₄ .)	1		
Qn 3	[12]		

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Question	Indicative material	Mark	Total
1 (a) (i)	Initial and final burette readings and titre unambiguously recorded in rough and accurate titrations. (2×2 accurate boxes)	1	
(ii)	Headings and units correct for accurate titration and headings match readings. <i>Initial/final (burette) reading/volume or Reading/volume at start/finish and Titre or Volume/FB 2 added/used [not “difference”] and Units: (cm³) or /cm³ or in cm³ or cm³ by every entry</i>	1	
(iii)	All accurate burette readings to 0.05 cm ³ <i>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).</i>	1	
(iv)	Two accurate titres within 0.10 cm ³ . <i>Do not award if 3rd titre > 0.10 cm³ away from any other unless a further titration is also carried out which is within 0.1 cm³ of any other. Do not award the mark if any ‘accurate’ burette readings (apart from initial 0) are given to zero dp.</i>	1	
<i>Examiner checks and corrects titre subtractions where necessary. Examiner selects the best mean titre using a hierarchy:</i> <i>two identical titres within 0.05 cm³, two or more titres within 0.10 cm³ etc.</i> <i>Examiner subtracts (corrected) candidate’s titre from Supervisor’s titre.</i>			
	Award V, VI and VII if $\delta < 0.20 \text{ cm}^3$. Award V and VI if $0.20 < \delta < 0.40 \text{ cm}^3$. Award V if $0.40 < \delta < 0.60 \text{ cm}^3$. <i>Spread penalty: if the two ‘best’ titres are $\geq 0.50 \text{ cm}^3$ apart, cancel one of the Q marks</i>	1 1 1	[7]
(b)	Candidate must average two (or more) titres that are all within 0.20 cm³. 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 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67. Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325; allow mean 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 correct but 26.0 and 26.1 = 26.1 is incorrect. 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)	(answer to (b) × 0.1) / 1000 and (ii) = (i) and answer to 3 or 4 sf	1	

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – May/June 2015	9701	34

Question	Indicative material	Mark	Total
(iii)	(c)(ii) $\times 1000/25$ and answer expressed to 3 or 4 sf.	1	
(iv)	Correct expression is shown (c)(iii) $\times 1000/5.91$	1	[3]
(d)	15 – (c)(iv) $\times 100/15$ or 15 – (c)(iv) $\times 100/(c)(iv)$	1	[1]
Total			[12]
2 (a)	I (Table of) results with unambiguous headings (not weight) showing 4 balance readings 4 thermometer readings 2 $\times$ mass FB 3 added 2 $\times \Delta T$	1	
	II All balance readings recorded to the same number of dp (at least one dp) and thermometer readings to .0 or .5°C (<i>minimum 2 of each</i>)	1	
	III Masses of FB 3 used between the limits given in the question (2.9(0) to 3.1(0) g and 4.9(0) to 5.1(0) g)	1	
Examiner corrects thermometer readings to the nearest 0.5°C, checks subtractions then calculates $\Delta T_1 \times m_2 / \Delta T_2 \times m_1$ where ΔT_1 is the smaller temperature fall.			
	Award IV if ratio falls between 0.85 and 1.15 Award IV and V if ratio falls between 0.95 and 1.05	1 1	[5]
(b) (i)	mean mass correctly calculated from weighings to 2 dp	1	
(ii)	mean temperature fall correctly calculated from thermometer readings to 1 dp <i>Do not award if values used for calculating mean are from incorrect subtractions.</i>	1	[2]
(c) (i)	Correctly calculates (b)(i) / 53.5	1	

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Question	Indicative material	Mark	Total
(ii)	Correct overall expression $25 \times 4.2 \times (b)(ii)$ $(c)(i) \times 1000$ - fully correct = 2 marks - one error = 1 mark - two errors = 0 marks (÷ 1000 may be awarded from use to reach final answer)	1 1	
	Sign is + and final answers to (i) and (ii) are to 2–4 sf	1	[4]
(d) (ii)	Expression $(1.0/\text{smaller } \Delta T) \times 100$ or correct answer	1	[1]
(e) (i)	Advantages: any one of two values to check concordance/check whether further experiments should be carried out/find out whether mass added is proportional to ΔT /compare the two answers	1	
(ii)	No improvement as T drops so no heat loss (by convection)/as reaction is endothermic OR Improvement as prevents heat gain from surroundings	1	[2]
Total			[14]
FB 4 = $\text{MnCl}_2(\text{aq})$; FB 5 = $\text{MgSO}_4(\text{aq})$; FB 6 = $\text{NH}_4\text{Fe}(\text{SO}_4)_2(\text{s})$			
3 (a)	Correct observations for FB 4 and FB 5 in (i) Correct observations for FB 4 and FB 5 in (ii) and correct observations for FB 4 and FB 5 in (iii).	2 1	

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test	FB 4	FB 5
(i) NH_3	off-white / pale brown / beige / buff ppt and insoluble in excess / ppt turns (dark) brown/darkens	white ppt insol in excess
(ii) AgNO_3	white ppt (if excess used then insoluble)	no change / no ppt / no reaction
(iii) $\text{BaCl}_2/\text{Ba}(\text{NO}_3)_2$	no change / no ppt / no reaction	white ppt (if excess used then insoluble)

Question	Indicative material	Mark	Total
3 (a) (iv)	FB 4: manganese(II)/ Mn^{2+} and chloride/ Cl^- (If cream ppt with Ag^+ allow bromide/ Br^-)	1	
(v)	FB 5: Mg^{2+} , Al^{3+} , and SO_4^{2-} , SO_3^{2-} (or names)	1	
(vi)	selects NaOH and uses it in excess FB 5: magnesium/ Mg^{2+} from white ppt insoluble in excess	1 1	[7]
(b) (i)	Transition metal (as coloured)	1	
(ii)	Any two of: (pale purple) solid / crystals melt / dissolve / turn to liquid / form liquid or solution - any brown or qualified brown (liquid or solid not gas) - condensation / liquid / water (further up tube) / water vapour / steamy fumes (not white fumes) (gas) turns (red) litmus blue (then back to red)	1	
(iii)	yellow / (light) brown (solution) (formed)	1	
(iv)	brown / rust / red-brown ppt and gas/ NH_3 turns (damp) (red) litmus blue	1	
(v)	(solution darkens) dark blue / blue-black / black colour	1	
(vi)	Fe^{3+} and NH_4^+	1	
(vii)	redox / oxidation and reduction / oxidation of I^- / reduction of Fe^{3+}	1	
[Total: 14]			

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/35

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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Page 2	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	
1 (a)	I The following data must be shown - burette readings and titre for rough titration 2 × 2 “box” showing both accurate burette readings	1	
	II Headings and units correct for accurate titration table and headings match readings. - initial / start (burette) reading / volume + unit - final / end (burette) reading / volume + unit - titre or volume / FA 3 used / added (<i>not “difference” or “total”</i>) + unit <i>Units: (cm³) or /cm³ or in cm³ or cm³ by every entry</i>	1	
	III All accurate burette readings recorded to 0.05 cm ³ <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading</i> <i>or more than one final burette reading is 50.(00)</i> <i>or any burette reading is greater than 50.(00).</i>	1	
	IV Two accurate titres are within 0.10 cm ³ . <i>Do not award if 3rd titre > 0.10 cm³ away from either previous titre unless a further titration is also carried out which is within 0.1 cm³ of any other.</i> <i>Do not award the mark if any ‘accurate’ burette reading (apart from an initial 0) are given to zero dp.</i>	1	
<i>Examiner checks and corrects titre subtractions where necessary. Examiner selects the best mean titre using a hierarchy:</i> <i>two identical titres within 0.05 cm³, two or more titres within 0.10 cm³ etc.</i> <i>Examiner subtracts (corrected) candidate’s titre from Supervisor’s titre.</i>			
	Award V , VI and VII if $\delta < 0.20 \text{ cm}^3$ Award V and VI if $0.20 < \delta < 0.40 \text{ cm}^3$ Award V if $0.40 < \delta < 0.60 \text{ cm}^3$ <i>Spread penalty: if the two ‘best’ titres are $\geq 0.50 \text{ cm}^3$ apart, cancel one of the Q marks</i>	1 1 1	[7]
(b)	Candidate must average two (or more) titres that are all within 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 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67. Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 eg 26.325; allow mean to 1 dp if all accurate burette readings were given to 1 dp and the mean is exactly correct. eg 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect. 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]

Page 3	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	
(c)(i)(ii)	Correctly calculates Concentration = $0.1 \times 0.900 = 0.09(00)$ and No. of moles = (i) $\times$ ^(b) / ₁₀₀₀	1	
(iii)(iv)	Correctly calculates No. of moles of I ₂ = $0.5 \times$ (ii) and Concentration of I ₂ = (iii) $\times$ ¹⁰⁰⁰ / ₂₅	1	
(v)	Equation correctly balanced $2\text{Fe}^{3+} + 2\text{I}^{-} \rightarrow 2\text{Fe}^{2+} + \text{I}_2$ and use of 2:1 mole ratio: answer to (v) = $2 \times$ (iv)	1	
(vi)	Two steps are required: $M_r = \frac{38.56}{\text{(v)}}$ - Mass of water = $M_r - (55.8 + 18 + [2 \times 96.1])$ or $M_r - 266$	1	[6]
	Correctly calculates x from mass of water moles of water = ^{mass} / ₁₈ and answer expressed to nearest integer	1	
	Final answers to (i) – (v) shown to 2 – 4 sf (minimum 4 steps attempted)	1	
[Total: 14]			
2 (a)	Initial and highest thermometer readings shown and temperature rise correctly calculated with unambiguous headings and correctly displayed units.	1	
Examiner to calculate Supervisor's and candidate's ΔT . Calculate the difference between the two values.			
	III and IV awarded dependant on comparability between Supervisor's and candidate's ΔT values.	1 1	[3]
(b)(i)(ii)	Correctly calculates energy produced = $25 \times 4.2 \times \Delta T(\text{a})$ and moles of FA 6 = $0.5 \times \frac{25}{1000}$ (= 0.0125) and both answers to a minimum of 2 sf	1	
(iii)	Correct expression $\Delta H = (\text{i}) / 1000 \times (\text{ii})$	1	[2]
(c)	Precision of readings shown in (a) and (c) : all four thermometer readings shown to 0.0 or 0.5 °C	1	
Examiner to calculate Supervisor's and candidate's ΔT . Calculate the difference between the two values.			

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	Marks awarded dependant on comparability between Supervisor's and candidate's ΔT values.	1	[2]
(d)(i)(ii)	Correct expressions energy produced = $25 \times 4.2 \times \Delta T(c)$ and $\Delta H = (d)(i) / 1000 \times (b)(ii)$	1	
	Correct (negative) sign shown in answers to (b)(iii) and (d)(ii) and both answers shown to 2 – 4 sf	1	[2]
(e)	Hess' Law cycle drawn to show - displacement equation across top - left hand downward arrow, labelled (b)(iii) or calculated value - right hand downward arrow, labelled (d)(ii) or calculated value or allow from clear use of equations: Fe equation reversed and added to Zn equation or arrows showing correct directions	1	
	Correctly calculates (b)(iii) – (d)(ii), with correct sign.	1	[2]
(f)(i)	Correctly calculates: max % error = $(2 \times 0.5 / \Delta T(c)) \times 100$	1	
(ii)	One of the following: - use a more concentrated solution of copper(II) sulfate (and larger quantities of metals) - use a lid with hole for thermometer or another specific suggestion to improve insulation - plot a cooling curve - use a larger volume / use a burette / pipette to reduce percentage error in volume - use a pipette / burette instead of a measuring cylinder	1	[2]
[Total: 13]			

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FA 7 = Na ₂ S ₂ O ₃ (s); FA 8 = Zn(NO ₃) ₂ (aq); FA 9 = BaCl ₂ (aq)			
3 (a)(i)	Any two observations from the following: - solid melts/dissolves or changes to liquid/solution - condensation (inside tube) or steam/water vapour/water/steamy fumes (not white fumes) - effervescence (blue) litmus turns red (dark) brown residue obtained or yellow solid - bad egg smell	1	
(ii)	White/off-white/cream/yellow ppt/solid obtained (<i>in either part of (ii)</i>)	1	
	Gas turns potassium manganate(VII) to colourless	1	
(iii)	Any two observations from the following: - brown/yellow-brown/green-brown (mixture/precipitate) obtained (at first) - changes to white/off-white (ppt) (when FA 1 added) (colourless) solution formed/ppt/solid soluble (with excess FA 1)	1	
(iv)	Equation concludes with: + S + SO ₂	1	[5]
(b) test	observations		
	FA 8	FA 9	
(i) + NaOH	white ppt soluble in excess [1]		
(ii) + AgNO ₃ then NH ₃		white ppt soluble [1]	
(iii) + NH ₃	white ppt soluble in excess [1]		
(iv) + H ₂ SO ₄	no change/no reaction/no ppt (not clear solution)	white ppt [1]	
(v) + FA 9	no change/no reaction/no ppt (not clear solution) [1]		

Page 6	Mark Scheme	Syllabus	Paper
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3 (b)(vi)	3 identifications correct = two marks Any 2 identifications correct = one mark FA 8: cation is Zn^{2+} / zinc; anion is unknown FA 9: cation is Ba^{2+} / barium; anion is Cl^- / chloride	1 1	
(vii)	unknown ion = NO_3^- reagent(s) = NaOH and Al/Zn (and warm) observation(s) = (gas) turns red litmus blue or ammonia produced	1	[8]
[Total: 13]			