

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9701 CHEMISTRY

9701/31

Paper 3 (Advanced Practical Skill 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 – October/November 2014	9701	31

Question	Indicative material	Mark	Total
1 (a)	I Two balance readings and correct mass of magnesium recorded. Table to show temperature and time. Headings and units – must be temperature /°C, (°C), in °C and time/s, (s), or time in seconds or /min, /minutes, ... and /g, (g), ...	1	
	II Thermometer readings to $\pm 0.5^{\circ}\text{C}$ (at least 1 ending in .5 or .0) (Minimum 8 readings)	1	
	III All specified readings taken and balance readings to the same number of dp	1	
	Difference between temperature at 2 minutes and highest temperature (in table) calculated and compared with ΔT of Supervisor.		
	IV, V and VI ΔT within 10% of Supervisor IV and V ΔT within 15% of Supervisor IV only ΔT within 20% of Supervisor	3	[6]
(b) (i)	I Axes labelled, linear scales chosen so that more than half the available space is used on both axes for plotted points.	1	
	II Plotted points should be drawn clearly with a sharp pencil. Points should be plotted to within half a small square and in the correct square for y-axis and on line for x-axis.	1	
(ii)	III Correctly extrapolated best fit straight lines drawn up to time $2\frac{1}{2}$ minutes and after $2\frac{1}{2}$ minutes.	1	
(iii)	IV Examiner calculates ΔT from graph and checks answer is within 0.25°C of candidate's stated answer	1	[4]
(c) (i)	All the magnesium/solid dissolved/disappeared or all solid/Mg has gone/been used up or no solid/Mg left	1	
	(ii) Correctly calculates $25 \times 4.2 \times \Delta T$	1	
(iii)	Correctly calculates (ii) $\div$ number of moles of magnesium and converts to $\text{kJ} \left(\frac{\text{(ii)} \times 24.3}{1000 \times \text{mass Mg}} \right)$ and final answer to 2–4 sf	1	
	Sign is negative in (c)(iii) and (e)(iv)	1	[4]
(d)	8 readings (in space below printed area) • 4 $\times$ balance readings • 2 $\times$ initial temp • 2 $\times$ highest/max temp with unambiguous headings	1	
	Correctly calculates both masses of Mg and both ΔT s.	1	[2]

Page 3	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
(e) (i) & (ii)	Correctly calculates - mean ΔT - mean mass	1	
(iii)	Moles $\text{CuSO}_4 = \frac{25 \times 1}{1000} = 0.025$	1	
	Moles $\text{Mg} = \frac{\text{(ii) or max mass Mg}}{24.3}$ so CuSO_4 in excess or <0.025	1	
(iv)	Working to calculate ΔH using mean values of mass Mg and ΔT $\left(\frac{\Delta T(\text{i}) \times 25 \times 4.2 \times 24.3}{(\text{ii}) \times 1000} \right)$ or $\left(\frac{\Delta T(\text{i}) \times 25 \times 4.2}{\text{mol Mg from (iii)} \times 1000} \right)$	1	[4]
(f)	Attempt at use of Hess' law either by cycle or reverse reaction 2	1	
	Correctly calculates ΔH reaction 3 = ΔH reaction 1 – ΔH reaction 2	1	[2]
(g) (i)	Any 2 of Lower ΔH and so higher % error No correction made for loss of heat on cooling Some bubbles/gas/ H_2 in reaction 2 so wrong reaction taking place Not all Mg reacts/reaction does not go to completion in 2 (so not all energy released) Reaction 2 slower so more heat loss	1 1	
(ii)	No, since (larger volume of solution means) smaller ΔT OR Yes, since there would be a smaller T rise so less heat would be lost.	1	[3]
Qn 1		Total	[25]

Page 4	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
	FA 6 is $\text{NaNO}_3(\text{s})$; FA 7 is $\text{AgNO}_3(\text{aq})$; FA 8 is $\text{ZnCO}_3(\text{s})$		
2 (a) (i)	Chooses $\text{NaOH}(\text{aq})$ (+ heat) (to distinguish NH_4^+ / ammonium) Chooses named (allow name from (ii)) dilute acid / (acidified) KMnO_4 (to distinguish between NO_2^- / nitrite and NO_3^- / nitrate) 2 ions chosen: NH_4^+ & NO_3^- : NaOH (and warm) NO_2^- & NO_3^- : named (dilute) acid NH_4^+ & NO_2^- : either of the above	1 1	
(ii)	Correct obs with relevant tests With NaOH and warming / heating: no ammonia / no change / no reaction With acid(aq): no brown fumes / no change / no reaction <i>'No observation' is not credited anywhere in the observations.</i>	1 1	
(iii)	FA 6 contains NO_3^- (with sufficient obs to eliminate other ion(s) given in (i))	1	[5]
(b)	+ HCl (aq): white ppt + KI : yellow ppt + NH_3 : no effect / ppt insol + glucose: silver mirror / black / (dark) grey ppt	1 1 1 1	[4]
(c) (i)	(Solid is) yellow when heated Goes white / paler on cooling	1 1	
(ii)	effervescence / fizzing / rapid bubbling and limewater turns milky	1	
(iii)	White ppt and soluble in excess NaOH	1	
(iv)	White ppt and soluble in excess NH_3	1	
(v)	Ions present: Zn^{2+} and CO_3^{2-} (from fizz or limewater test correct)	1	[6]
Qn 2		Total	[15]

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Question	Indicative material	Mark	Total
1 (a)	I Two balance readings and correct mass of magnesium recorded. Table to show temperature and time. Headings and units – must be temperature /°C, (°C), in °C and time/s, (s), or time in seconds or /min, /minutes, ... and /g, (g), ...	1	
	II Thermometer readings to $\pm 0.5^{\circ}\text{C}$ (at least 1 ending in .5 or .0) (Minimum 8 readings)	1	
	III All specified readings taken and balance readings to the same number of dp	1	
	Difference between temperature at 2 minutes and highest temperature (in table) calculated and compared with ΔT of Supervisor.		
	IV, V and VI ΔT within 10% of Supervisor IV and V ΔT within 15% of Supervisor IV only ΔT within 20% of Supervisor	3	[6]
(b) (i)	I Axes labelled, linear scales chosen so that more than half the available space is used on both axes for plotted points.	1	
	II Plotted points should be drawn clearly with a sharp pencil. Points should be plotted to within half a small square and in the correct square for y-axis and on line for x-axis.	1	
(ii)	III Correctly extrapolated best fit straight lines drawn up to time $2\frac{1}{2}$ minutes and after $2\frac{1}{2}$ minutes.	1	
(iii)	IV Examiner calculates ΔT from graph and checks answer is within 0.25°C of candidate's stated answer	1	[4]
(c) (i)	All the magnesium/solid dissolved/disappeared or all solid/Mg has gone/been used up or no solid/Mg left	1	
	(ii) Correctly calculates $25 \times 4.2 \times \Delta T$	1	
(iii)	Correctly calculates (ii) $\div$ number of moles of magnesium and converts to $\text{kJ} \left(\frac{(\text{ii}) \times 24.3}{1000 \times \text{mass Mg}} \right)$ and final answer to 2–4 sf	1	[4]
	Sign is negative in (c)(iii) and (e)(iv)	1	
(d)	8 readings (in space below printed area) • 4 $\times$ balance readings • 2 $\times$ initial temp • 2 $\times$ highest/max temp with unambiguous headings	1	
	Correctly calculates both masses of Mg and both ΔT s.	1	[2]

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Question	Indicative material	Mark	Total
(e) (i) & (ii)	Correctly calculates - mean ΔT - mean mass	1	
(iii)	Moles $\text{CuSO}_4 = \frac{25 \times 1}{1000} = 0.025$	1	
	Moles $\text{Mg} = \frac{\text{(ii) or max mass Mg}}{24.3}$ so CuSO_4 in excess or <0.025	1	
(iv)	Working to calculate ΔH using mean values of mass Mg and ΔT $\left(\frac{\Delta T(\text{i}) \times 25 \times 4.2 \times 24.3}{(\text{ii}) \times 1000} \right)$ or $\left(\frac{\Delta T(\text{i}) \times 25 \times 4.2}{\text{mol Mg from (iii)} \times 1000} \right)$	1	[4]
(f)	Attempt at use of Hess' law either by cycle or reverse reaction 2	1	
	Correctly calculates ΔH reaction 3 = ΔH reaction 1 – ΔH reaction 2	1	[2]
(g) (i)	Any 2 of Lower ΔH and so higher % error No correction made for loss of heat on cooling Some bubbles/gas/ H_2 in reaction 2 so wrong reaction taking place Not all Mg reacts/reaction does not go to completion in 2 (so not all energy released) Reaction 2 slower so more heat loss	1 1	
(ii)	No, since (larger volume of solution means) smaller ΔT OR Yes, since there would be a smaller T rise so less heat would be lost.	1	[3]
Qn 1		Total	[25]

Page 4	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
	FA 6 is $\text{NaNO}_3(\text{s})$; FA 7 is $\text{AgNO}_3(\text{aq})$; FA 8 is $\text{ZnCO}_3(\text{s})$		
2 (a) (i)	Chooses $\text{NaOH}(\text{aq})$ (+ heat) (to distinguish NH_4^+ / ammonium) Chooses named (allow name from (ii)) dilute acid / (acidified) KMnO_4 (to distinguish between NO_2^- / nitrite and NO_3^- / nitrate) 2 ions chosen: NH_4^+ & NO_3^- : NaOH (and warm) NO_2^- & NO_3^- : named (dilute) acid NH_4^+ & NO_2^- : either of the above	1 1	
(ii)	Correct obs with relevant tests With NaOH and warming / heating: no ammonia / no change / no reaction With acid(aq): no brown fumes / no change / no reaction <i>'No observation' is not credited anywhere in the observations.</i>	1 1	
(iii)	FA 6 contains NO_3^- (with sufficient obs to eliminate other ion(s) given in (i))	1	[5]
(b)	+ HCl (aq): white ppt + KI : yellow ppt + NH_3 : no effect / ppt insol + glucose: silver mirror / black / (dark) grey ppt	1 1 1 1	[4]
(c) (i)	(Solid is) yellow when heated Goes white / paler on cooling	1 1	
(ii)	effervescence / fizzing / rapid bubbling and limewater turns milky	1	
(iii)	White ppt and soluble in excess NaOH	1	
(iv)	White ppt and soluble in excess NH_3	1	
(v)	Ions present: Zn^{2+} and CO_3^{2-} (from fizz or limewater test correct)	1	[6]
Qn 2		Total	[15]

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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Question	Indicative material	Mark	Total
1 (a)	I The following data is shown - two burette readings for the rough titration - titre for rough titration - initial and final burette readings for two (or more) accurate titrations (<i>i.e.</i> 2×2 “box”)	1	
	II Appropriate headings and units for accurate titration and volume FB 1 added recorded for each accurate titre. Headings should match readings. - initial / start and (burette) reading / volume - final / end and (burette) reading / volume - titre or volume / FB 1 and used / added unit / cm^3 or (cm^3) or in cm^3 or cm^3 for each entry	1	
	III All accurate burette readings are to the nearest 0.05 cm^3. <i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm^3 (if this was the initial reading), but it does not apply to the titre.</i> <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>	1	
	IV There are two uncorrected accurate titres within 0.10 cm^3 <i>Do not include a reading if it is labelled “rough”.</i> <i>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.</i> <i>Do not award the mark if any ‘accurate’ burette readings (apart from initial 0) are given to zero dp.</i>	1	
	Examiner rounds any burette readings to the nearest 0.05 cm^3 and then selects the ‘best’ titres using the hierarchy: - two (or more) accurate identical titres (ignoring rough), 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 corrected titre to the nearest 0.01 cm^3.		
	Award V, VI and VII if $\delta \leq 0.20 \text{ (cm}^3\text{)}$ Award V and VI if $0.20 < \delta \leq 0.40$ Award V, only, if $0.40 < \delta \leq 0.80$ Spread penalty: <i>if the two “best” (corrected) titres used by the Examiner were $\geq 0.50 \text{ cm}^3$ apart, cancel one Q mark.</i>	1 1 1	[7]

Page 3	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
(b)	- Candidate averages 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 be quoted to 2 dp, and be correctly rounded to nearest 0.01 cm^3. Two special cases, where the mean need not be to 2 dp: - Allow mean to 3 dp only for 0.025 or 0.075 (e.g. 26.325 cm^3) - Allow mean to 1 dp, if all accurate burette readings were given to 1 dp and the mean is exactly correct. 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)	Number of moles of KMnO_4 used = $0.0250 \times \frac{(b)}{1000}$	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 H_2O_2 (in 10 cm^3) = $2.5 \times (i)$ (iv) number of moles of H_2O_2 (in 1.0 dm^3) = $100 \times (iii)$ Allow ecf in (iii) to incorrect equation	1	[5]
(v)	Concentration in FB 3 = $(iv) \times 10$	1	
(c)	Answers to parts (i), (iii), (iv) and (v) given to 3 or 4 sf A minimum of 3 answers is needed to qualify for the mark. All answers given must have appropriate sig figs.	1	
Qn 1	Total		[13]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9701	34

Question	Indicative material	Mark	Total
2 (a)	I Table of data, showing all of the following: - unambiguous headings (<i>ignore units</i>) - four initial temperature - four final temperatures - four temperature rises correctly calculated <i>All data must be tabulated in the space provided on page 4.</i>	1	
	II Recording of data - correct units ‘covering’ all temperature readings. - all readings recorded to .0 or .5 °C, with at least one shown as .5 °C or .0 °C <i>Minimum of six temperatures required to qualify</i>	1	
	- Examiner checks Supervisor’s subtraction for temperature rise for experiment 4. - Examiner corrects thermometer readings to nearest .5 °C then subtracts. - Examiner calculates the difference between the [corrected] candidate’s and Supervisor’s temperature rise for experiment 4.		[5]
	Award III if ΔT increases with increase in volume of FA 3 . Experiment 4 Award IV if $\delta \leq 2.0^\circ\text{C}$ Award V if $\delta \leq 1.0^\circ\text{C}$ <i>If expt 4 was not carried out, examiners may award mark IV if experiment 3 is within 1.0 °C of Supervisor.</i>	1	
		1	
		1	
(b)	I Suitable axes and scales to graph - both axes clearly labelled (units not required) - temperature (rise) as y-axis - 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>)	1	
	II 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	
	III 0,0 point either plotted or used for line (within one small square)	1	
	IV Best fit line - Minimum 4 points on the grid are needed. This may include (0,0) if plotted. - Points above and below best fit line are “balanced”.	1	[4]
(c) (i)	Correctly calculates temp rise per cm^3 (gradient of straight line) - All points from the best fit line must be correctly read to the nearest half square. - Points used must differ by a minimum of two large squares, along each axis.	1	

Page 5	Mark Scheme	Syllabus	Paper
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(ii)	Heat produced = $50 \times 4.2 \times \text{temp rise calculated in (i)}$	1	[4]
(iii)	Number of moles of $\text{H}_2\text{O}_2 = 0.0010 \times \mathbf{1(c)(v)}$ (2, 3 or 4 sig fig)	1	
(iv)	Correct expression including negative sign and evidence of $\div 1000$ $\Delta H = - \frac{\mathbf{(ii)}}{1000 \times \mathbf{(iii)}} \text{ or correct answer}$	1	
(d)	The first experiment, because it has the smallest temperature rise so greatest % error or smallest volume of FA 3 / H_2O_2 so greatest % error. or The final experiment because it has the greatest heat loss. or Identifies experiment giving most anomalous point on graph.	1	[1]
Qn 2	Total		[14]

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

Question	Indicative material	Mark	Total
FB 6 is $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$; FB 7 is KI; FB 8 is HCl; FB 9 is AgNO_3			
3 (a) (i)	Green precipitate, insoluble in excess (NaOH)	1	
	(When mixture heated) gas/ ammonia turns (red) litmus blue	1	
	Either cation in FB 6 identified from correct observations - iron(II)/Fe^{2+} - Ammonium/NH_4^+	1	
	(ii) Both observations are correct - Precipitate/ solid goes brown/ red-brown/ rust - Bubbles/ fizzing/ effervescence (<i>not "gas formed"</i>)	1	
	Type of reaction and justification redox (or oxidation and reduction) with any of the following: - iron(II) ions converted to iron(III) ions - hydrogen peroxide converted to oxygen - colour change indicates different oxidation states or oxidation of Fe^{2+} to Fe^{3+} or reduction of H_2O_2 as Fe^{2+} oxidised/ Fe^{2+} changes colour or (catalytic) decomposition of H_2O_2 to give (H_2O and) O_2 or exothermic as heat is given out / temp increases	1	
	(iii) Yellow/ orange/ red-orange/ brown/ red-brown (not red) with FB 7 and black/ blue-black/ dark blue with starch	1	
	Both conclusions about FB 7 are correct - cation – not known - anion – iodide/ I^-	1	
			[7]
(b) (i)	Two observations for the Mg tests are correct. - Fizzing/ bubbles/ effervescence with FB 8 - Black/ dark grey (solid/precipitate) with FB 9	1	
(b) (i)	Positive gas test performed and recorded: Gas/ H_2 (evolved from Mg + FB 8) pops with a lighted splint/ when ignited/ when burned <i>Mark may also be credited for positive O_2 test in 3(a)(ii): gas/ O_2 relights glowing splint/ glowing splint glows brighter.</i>	1	
	Remaining three observations in the table are correct FB 7 + FB 8 – no reaction/ no change FB 7 + FB 9 – (pale) yellow precipitate FB 8 + FB 9 – white precipitate	1	
	(ii) Cation in FB 9 is silver/ Ag^+	1	

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

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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 (<i>minimum of 2×2 box</i>)	1	
	II Appropriate headings and units for accurate titration and volume FA 2 added recorded for each accurate titre. Headings should match readings. - initial / start (burette) reading / volume (not V or vol) - final / end (burette) reading / volume - titre or volume / FA 2 and used / added (<i>but not “difference”</i>) unit: / cm³ or (cm³) or in cm³ or cm³ for each entry	1	
	III All accurate burette readings recorded to 0.05 cm ³ . <i>The need to record to 0.05 applies only to the burette readings and not to the recorded titres.</i> <i>Do not award this mark if:</i> 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)	1	
	IV Has two uncorrected, accurate titres within 0.1 cm ³ <i>Do not consider the ‘rough’ even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.10 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a further titration, within 0.10 cm³ of any other titration 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> Round any burette readings to the nearest 0.05 cm ³ . Check and correct subtractions for Supervisor and candidate. Examiner then selects the “best” titre 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. Examiner compares candidate mean titre with Supervisor mean titre.	1	
	V, VI and VII Award V, VI and VII for a difference from Supervisor, $\delta \leq 0.20 \text{ cm}^3$ Award V and VI for $0.20 \text{ cm}^3 < \delta \leq 0.40 \text{ cm}^3$ Award V only for a difference of $0.40 < \delta \leq 0.60 \text{ cm}^3$ Spread penalty: if the ‘best’ titres are $> 0.50 \text{ cm}^3$ apart cancel one of the Q marks.	3	

[7]

Page 3	Mark Scheme	Syllabus	Paper
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(b)	Calculation of mean • Candidate must average two (or more) titres where the total spread is $<0.20\text{ cm}^3$. • 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 dp, and be correctly rounded to the nearest 0.01 cm^3. <i>Two special cases where the mean may not be to 2 dp:</i> • 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>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>	1	[1]
(c) (i)	Correct working shown $\frac{0.110 \times \text{mean titre}}{1000}$ in step (i)	1	
(ii)	Balanced equation with added state symbols $\text{Na}_2\text{CO}_3(\text{aq}) + 2\text{HNO}_3(\text{aq}) \rightarrow 2\text{NaNO}_3(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$	1	
(iii) and (iv)	Correctly calculates moles Na_2CO_3 (in 25 cm^3) = $\frac{1}{2} \times (\text{i})$ and moles Na_2CO_3 (in 250 cm^3) = $10 \times (\text{iii})$	1	
(v)	Correctly calculates $M_r = \frac{150.0}{4 \times (\text{iv}) \times 10}$ or $(3.75 / (\text{iv}))$ <i>Theoretical answer = 286</i>	1	

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	(vi)	Correctly calculates x to the nearest integer. $x = \frac{(v) - 106}{18}$ <i>Allow ecf</i> Answers to (i), (iii), (iv) and (v) shown to 3 or 4 sf. <i>Minimum of 3 answers needed to qualify for the mark.</i> <i>All answers given must have correct sf.</i>	1	
			1	[6]
(d) (i) and (ii)		0.05 cm^3 $\% = \frac{0.1 \times 100}{\text{accurate titre}}$ <i>Allow any accurate titre to be used (but not the mean).</i>	1	[1]
[Total: 15]				
2	(a)	Correct headings and units • mass of container and FA 4/ solid • mass of container (empty/plus residue) • mass of FA 4 (used) • initial temperature/thermometer reading • maximum/highest temperature/final/thermometer reading/ temp./T • temperature rise	1	
	(a) and (c)	All four weighings shown to <u>same</u> number of dp	1	
	(a)	Check and correct subtractions of Supervisor and candidate. Calculate difference between (corrected) candidate's and Supervisor's temperature rise, δ . Award if $\delta \leq 1.0^\circ\text{C}$ If ΔT is $< 6.5^\circ\text{C}$ only award if $\delta < 0.5^\circ\text{C}$.	1	[3]
	(b) (i)	Correctly calculates: energy produced = $25 \times 4.2 \times \text{temp rise}$ (to 2–4 sf)	1	
	(ii)	Correctly calculates moles of FA 4 = $\frac{\text{mass used}}{106}$ <i>Answer must be expressed to 2–4 sf</i>	1	

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(f)	Accept one of the following answers - Agree – acid spray is reduced (since reaction will be slower)/ smaller T rise so less heat loss/larger volume so volume measurement more accurate - Disagree – smaller temperature change, so higher (percentage) error of reading / reaction slower so more heat loss.	1	[1]
[Total: 13]			
FA 7 is $\text{Al}_2(\text{SO}_4)_3 + \text{NaCl}$; FA 8 is $\text{MgCO}_3 + \text{KI}$; FA 9 is $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$			
3 (a) (i)	Both observations with HNO_3 recorded correctly FA 7 no reaction / no change / dissolves FA 8 fizzing or (gas) turns limewater milky	1	
(ii) or (iii)	FA 7 + NaOH : white ppt, soluble in excess or FA 7 + NH_3 : (faint) white ppt, insoluble in excess	1	
(iv)	FA 7 + $\text{Ba}(\text{NO}_3)_2$: white ppt (insoluble in acid) and FA 8 + $\text{Ba}(\text{NO}_3)_2$: no ppt / no change / no reaction	1	
(v)	FA 7 + AgNO_3 : white ppt, soluble in ammonia and FA 8 + AgNO_3 : yellow ppt, insoluble in NH_3 <i>All four correct observations required.</i>	1	

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(vi)	<u>cation</u> cation is aluminium / Al^{3+} and white ppt with NH_3 insoluble in excess <u>anions</u> FA 7 anions: sulfate and chloride / SO_4^{2-} and Cl^- FA 8 anions: carbonate and iodide / CO_3^{2-} and I^- All four identities correct = 2 marks Any 2 or 3 identities correct = 1 mark	1	
		1 1	[7]
(b) (i)	Any two observations correct = 1 mark Any three (or more) correct = 2 marks	2	
	• FA 9 is (pale) green • steam / vapour / condensation / water / liquid • litmus turns blue • yellow / white / brown residue / formed • white smoke (produced on strong heating) • litmus turns red on strong heating		
	(ii) Uses NaOH as reagent	1	
	With NaOH or NH_3 (dark / dirty) green ppt formed and Fe^{2+} identified.	1	
	With NaOH and heat gas / ammonia turns litmus blue and NH_4^+ identified	1	[5]
[Total: 12]			

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2014 series

9701 CHEMISTRY

9701/36

Paper 3 (Advanced Practical Skills 2),
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	Total
1 (a)	I The following data is shown • two burette readings for the rough titration • titre for rough titration • initial and final burette readings for two (or more) accurate titrations (<i>Minimum of 2×2 boxes</i>) <i>Correct headings and units for accurate titrations.</i> <i>Headings should match readings</i> • <i>Initial/start and (burette) reading/volume (not V or vol)</i> • <i>Final/end and (burette) reading/volume</i> • <i>Titre or volume/FB 1 and used/added (not difference, total or change)</i> <i>Unit: /cm³ or (cm³) or in cm³ or cm³ for each reading.</i>	1	
	II All accurate burette readings are to nearest 0.05 cm³. The need to record to 0.05 cm³ applies to the burette readings and not to the recorded titres but it does apply to 0.00 cm³. Do not award this mark if: <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>	1	
	III Has two uncorrected, accurate titres within 0.1 cm³ <i>Do not consider the ‘rough’ even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.1 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless any further titrations, within 0.1 cm³ of any other titration have also been carried out.</i> <i>Do not award this mark if any accurate burette readings (apart from initial 0) are given to zero dp.</i>	1	
	Round any burette readings to the nearest 0.05 cm³. Examiner selects the ‘best’ titres using the hierarchy: • two (or more) accurate identical titres (ignoring rough), then • two (or more) accurate titres within 0.05 cm³, then • two (or more) accurate titres within 0.10 cm³ etc These best titres should be used to calculate the mean corrected titre to the nearest 0.01 cm³.		
	Award IV, V and VI if $\delta < 0.2 \text{ cm}^3$ Award IV and V if $\delta > 0.2$ but $< 0.3 \text{ cm}^3$ Award IV if $\delta > 0.3 \text{ cm}^3$ but $< 0.4 \text{ cm}^3$. Spread penalty: if the two best (corrected) titres used by the examiner were $> 0.5 \text{ cm}^3$ apart, cancel one Q mark.	1 1 1	[6]

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(b)	Calculation of mean Candidate must average two (or more) accurate titres with total spread of no more than 0.2 cm³ 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.</i> <i>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> <i>Do not award this mark if: any selected titre is not within 0.20 cm³ of any other selected titre; the rough titre was used to calculate the mean; the candidate carried out only 1 accurate titration; burette readings were incorrectly subtracted to obtain any of the accurate titre values; all burette readings (resulting in titre values used in calculation of mean) are integers.</i> <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>	1	[1]
(c) (i)	$M_r \text{ KIO}_3 = 214$ Moles dm⁻³ = $\frac{3.60}{40 \times 214} = 4.205/4.206/4.21/4.21 \times 10^{-4}$	1	
		1	
(ii)	Moles S ₂ O ₃ ²⁻ = (i) × 6 = (2.52 × 10 ⁻³)	1	
(iii)	$\frac{\text{(ii)} \times 1000}{\text{vol from (b)}}$ Answers given to 3 or 4 sf	1	[5]
[Total: 12]			
2 (a)	Round times to nearest second. Supervisor calculates time with 10 cm³ / time with 20 cm³ (to 1 dp) and awards 3 marks if within 1.9 to 2.1 awards 2 marks if within 1.8 to 2.2 (but not within 1.9 to 2.1) awards 1 mark if within 1.6 and 2.4 (but not within 1.8 to 2.2)	1 1 1	[3]
(b)	I 3 additional volumes chosen with intervals not less than 2 cm³. These must include 1 of < 10 cm³ and 1 of > 10 cm³ and have none < 4 cm³.	1	

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	II In all 3 additional experiments water is added to make a total of 20 cm ³ . III Tables in (a) and (b) to show volume FB 5 , volume water and reaction time. All volumes measured to 0.05 cm ³ . IV All times recorded to nearest second.	1 1 1	 [4]
(c)	Completes table correctly. Correct headings and units including cm ³ s.	1 1	 [2]
(d)	Agree: product FB5 × reaction time is (approx) constant Or Disagree: product of FB5 × reaction time is not constant	1	 [1]
(e)	sodium thiosulfate is in excess – all the iodine reacts with the thiosulfate so no iodine produced (to turn blue-black).	1	[1]
(f)	(Carry out a series of reactions) keeping volume S₂O₈²⁻ (FB5) constant (and timing to blue-black) Alter volume I ⁻ (FB4) but keep total volume (I ⁻ and water) constant / keep I ⁻ and water volumes constant but change concentration of I ⁻ .	1 1	 [2]
[Total: 13]			

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FB 7 is MnCl_2 , **FB 8** is KMnO_4 , **FB 9** is CuCO_3 , **FB 10** is CuSO_4

3	(a) (i)	White ppt	1	
	(ii)	Off-white / buff / beige / light brown ppt and darkens on standing / insoluble in excess.	1	
	(iii)	Brown / black colour	1	
	(iv)	Effervescence / bubbling / fizzing and relights glowing splint	1	
		(Colour change) purple / pink to colourless	1	[5]
	(b)	Manganese	1	[1]
	(c) (i)	(Solid goes) black	1	
	(ii)	Fizz / effervescence / bubbling and blue solution.	1	
		Limewater turns milky	1	
	(iii)	Any three from	2	
		Solution goes paler		
		Pink / black / brown solid formed		
		Solution gets warmer		
		Fizz		
		Pop with lighted splint		
		3 correct answers scores 2 2 correct answers scores 1		
	(iv)	Solution turns / goes yellow / green	1	
	(v)	Copper / Cu^{2+}	1	
	(vi)	0 to (+)2	1	[8]
	(e)	Transition (elements) / d-block	1	[1]
				[Total: 15]