
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

May/June 2016

MARK SCHEME

Maximum Mark: 40

Published

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 2016	9701	31

Question	Indicative material	Mark	Total
1 (a)	I Six identifiable masses recorded	1	
	II All recorded masses have unambiguous headings and unit: /g or (g) or g (for each heading) by each entry.	1	
	III Four measured masses all recorded to the same number of decimal places <i>minimum 1 decimal place</i>	1	
	IV Correctly calculates mass of FA1 added and mass of CO ₂ evolved.	1	
	V, VI and VII Examiner compares corrected mass of FA1 / corrected mass of CO ₂ with supervisor value. Accuracy marks are awarded as shown. Award V, VI and VII if $\delta \leq 0.10$ Award V and VI if $0.10 < \delta \leq 0.20$ Award V if $0.20 < \delta \leq 0.40$	3	
(b) (i)	I Correctly calculates $n(\text{CO}_2)$ (mass CO ₂ / 44)	1	
(ii)	II Correct equation and all state symbols $\text{XCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{XCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$	1	
(iii)	III (iii) = (i) and	1	
(iv)	Expression mass of FA1 / (iii) shown in (iv)		
(iv)	IV Correctly uses 60 and the M_r to calculate A_r of X (mass of FA1 / (iii) – 60)	1	
	V Identifies X as Group 2 metal or ion with nearest A_r value (must have some working for A_r used). Be 9.0, Mg 24.3, Ca 40.1, Sr 87.6, Ba 137.3	1	[5]
(c) (i)	Apparently more moles of CO ₂ (lost) so A_r of X is smaller. or Apparently more moles of XCO ₃ (used) so A_r of X is smaller.	1	
(ii)	Any 2 from: - Small loss in mass - not much difference to A_r so does not cause confusion in identity / still closest to identity of X	1	

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Question	Indicative material	Mark	Total
(iii)	Any 1 from - Add slowly/add a little at a time - Use a taller beaker (accept larger beaker)/use a conical flask - Use less solid - Use less concentrated acid - Use lumps of solid - Use cotton wool plug - Use a lower temperature	1	[3]
Question 1	[15]		
2 (a)	I Initial and final readings and titre value for rough titre and initial and final reading for two (or more) accurate titrations	1	
	II Titre values recorded for accurate titrations and Appropriate headings for the accurate titration table and cm ³ units. - initial/start burette reading/volume/value - final/end burette and reading/volume/value - titre or volume/FA4 and used/added - unit: /cm³ or (cm³) or in cm³ or cm³ (for each heading)	1	
	III All accurate burette readings are recorded to nearest 0.05 cm ³ <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) - there is only one accurate titration	1	
	IV There are two uncorrected, accurate titres within 0.10 cm ³ <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 two initial titres, unless a further titration, within 0.10 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 cm³) are given to zero dp</i>	1	
			[4]

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Question	Indicative material	Mark	Total
(b)	Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. 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, rounded to the nearest 0.01. Two special cases where the mean may not be to 2 dp: • Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325) • Allow mean if expressed 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 allowed) (e.g. 26.0 and 26.1 = 26.1 is incorrect – should be 26.05.) 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)	I Correctly calculates n(NaOH) = 0.001	1	[5]
(ii)	II Shows use of $\frac{250(\text{c})(\text{i})}{(\text{b})}$	1	
(iii)	III Correctly calculates $2 \times 1(\text{b})(\text{i})$	1	
(iv)	IV Shows use of 2(c)(ii) + 2(c)(iii) either as expression or correct calculation	1	
	V Shows use of /0.025(0) or $\times 40$ or $\times 1000/25$	1	
(d) (i)	States that the measuring cylinder/ volume of FA2 has the greatest error and should be replaced by burette or pipette	1	[2]
(ii)	Student is correct/greater volume HCl used and greater mass would <u>react with more HCl</u> /would leave <u>less HCl</u> <u>unreacted</u>	1	
Question 2	[12]		

Page 5	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
FA5 is MnSO ₄ and NH ₄ Cl; FA6 is propanone; FA7 is propanal;			
3 (a) (i)	Red litmus turns blue (then red)	1	[2]
	Condensation or sublimation / white smoke / white fumes	1	
(a) (ii) and (b) (i)	NH ₄ ⁺ / ammonium in 3(a)(ii) and Mn ²⁺ / manganese(II) in 3(b)(i).	1	
(b) (i)	Selects NaOH and NH ₃	1	
	Off-white / beige / light brown precipitate with both NaOH and NH ₃	1	
	Both precipitates turns brown / darkens	1	
(ii)	white precipitate and insoluble in acid	1	
(iii)	Selects AgNO ₃ / silver nitrate and NH ₃ / ammonia	1	
	White precipitate and insoluble / partially soluble in ammonia	1	
	Cannot see if precipitate dissolves in ammonia / Mn ²⁺ causes (off-white) precipitate (so cannot be used to distinguish between halides).	1	[8]
(c)	MnCl ₂ and (NH ₄) ₂ SO ₄ or MnSO ₄ and NH ₄ Cl	1	[1]
(d)	Both observations required FA6 no reaction / solution turns pink and FA7 turns colourless / decolourises the KMnO ₄	1	[2]
	FA6 is either 2-methylpropan-2-ol or propanone as they cannot be oxidised (only 1 needed) and FA7 is propanal as it can be oxidised.	1	
Question 3	[13]		

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Paper 3 Advanced Practical Skills 2

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Page 2	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
1 (a)	I Appropriate headings and units for • mass of FB 1 • initial and final volumes (of gas). • unit: /g, (g), in g and allow grams/grammes for g and /cm³, (cm³), in cm³ or cm³ (for each heading)	1	[2]
	II Award if candidate volume within appropriate range derived from Supervisor value	1	
(b) (i)	Correctly calculates $\frac{V(a)}{24.0 \times 1000}$	1	[3]
(ii)	Correct expression $\frac{\text{mass Mg in (a)}}{(b)(i)}$	1	
	Both answers in (b) to 2 to 4 significant figures	1	
Question 1	[5]		

Page 3	Mark Scheme	Syllabus	Paper
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2 (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 x 2 box</i>)	1	
	II Titre values recorded for accurate titrations and Appropriate headings for the accurate titration table and cm ³ units. - initial / start burette reading / volume / value - final / end burette and reading / volume / value - titre or volume / FA3 and used / added - unit: / cm³ or (cm³) or in cm³ or cm³ (for each heading)	1	
	III All accurate burette readings recorded to the nearest 0.05 cm ³ . <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 There are two (or more) uncorrected, accurate titres within 0.10 cm ³ <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 two initial titres, unless a further titration, within 0.10 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 cm³) are given to zero dp.</i>	1	
	V, VI and VII Examiner rounds any accurate burette to the nearest 0.05 cm ³ , checks subtractions and then select the ‘ best ’ titres using the hierarchy: - two (or more) accurate identical titres, <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc.</i> These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm ³ . Accuracy marks are awarded as shown. Award V, VI and VII for $\delta \leq 0.30$ (cm ³) Award V and VI for $0.30 \text{ cm}^3 < \delta \leq 0.60$ (cm ³) Award V for $0.60 \text{ cm}^3 < \delta \leq 1.00$ (cm ³)	3	

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(b)	Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. 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, rounded to the nearest 0.01. Two special cases where the mean may not be to 2 dp: • Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325) • Allow mean if expressed 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 allowed) (e.g. 26.0 and 26.1 = 26.1 is incorrect – should be 26.05.) 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)	Correctly calculates $n(\text{NaOH}) \frac{0.150 \times (b)}{1000}$	1	[6]
(ii)	Correctly uses (i) / 2	1	
(iii)	and (ii) × 10		
(iv)	Correctly calculates $1.00 \times 25.0 / 1000 = 0.025(0)$	1	
(v)	Correctly uses (c)(iv) – (c)(iii)	1	
(vi)	Correctly uses $\frac{\text{mass Mg in 1(a)}}{(v)}$	1	
	All final answers to 3 or 4 significant figures (minimum of four parts must be attempted)	1	[6]

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(d) (i)	(Experiment 1 is less accurate) One set of: Inaccuracy Improvement Inaccuracy - gas escaped before bung inserted Improvement - viable means of keeping solid and acid separate before being added (not put on lid faster) e.g. use divided flask - use more (excess) of a lower concentration of acid Inaccuracy - balance imprecise / inaccurate balance Improvement - use a balance calibrated to more decimal places (owtte) Inaccuracy - If candidate volume greater than 250 cm³ then allow problem of measuring volume of gas Improvement - use larger (capacity) measuring cylinder - use less / smaller mass Mg	1 1	[3]
	(ii)	Correct expression or correctly calculates $\frac{24.3 - 20.8}{24.3} = 14.4\%$	
Question 2		[17]	

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FB 5 is Al(s); FB 6 is NaNO ₃ (s); FB 7 is Al ₂ (SO ₄) ₃ (aq); FB 8 is MnCl ₂ (aq);			
3 (a) (i)	FB 5 + HCl: effervescence / fizzing / bubbling gas pops with lighted splint	1 1	[9]
	FB 5 + FB 6 + NaOH: vigorous / violent / exothermic / great / extreme / lots of and effervescence / fizzing / bubbling gas / NH ₃ turns (damp) red litmus (paper) blue	1 1	
	FB 6 + HCl: no reaction / no change / no gas / no ppt and FB 6 + NaOH: no reaction / no change / no ppt	1	
(ii)	FB 5 is Al (allow Zn) and Reason: effervescence / gives H ₂ / NH ₃ in test 1 and / or 2	1	
	FB 6 cation unknown or Ba ²⁺ or NH ₄ ⁺ or any group 1 metal and reason: from no reaction with NaOH	1	
	anion: NO ₃ ⁻ / NO ₂ ⁻ (or both) reason: If NO ₃ ⁻ then NH ₃ with NaOH + Al and no reaction with HCl	1 1	
(b) (i)	Clearly laid out test / observation / conclusion sections Layout has to show clearly where two reagents are used as part of the same test.	1	
	BaCl ₂ / Ba(NO ₃) ₂ and HCl / HNO ₃ AgNO ₃ and NH ₃	1 1	
	FB 7 only + Ba ²⁺ white precipitate and insoluble in HCl or HNO ₃	1	
	FB 8 only + Ag ⁺ white precipitate	1	
	FB 7 = sulfate / SO ₄ ²⁻ (allow from white precipitate with Ba ²⁺) FB 8 = chloride / Cl ⁻ (allow from white precipitate with Ag ⁺)	1 1	

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(ii)	Off-white / light / pale brown / buff / beige precipitate and darkening on standing with FB 8 Ignore observation with FB 7	1	[9]
	FB 8 = Mn ²⁺ / manganese(II) from some correct evidence	1	
Question 3	[18]		

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Question	Indicative material	Mark	Total
1 (a)	I Two burette readings and titre value given for the rough titre and initial and final burette readings for two (or more) accurate titrations	1	
	II Titre values recorded for accurate titrations and Appropriate headings for the accurate titration table and cm ³ units. - initial / start burette reading / volume / value - final / end burette reading / volume / value - titre or volume / FA 3 and used / added - unit: / cm³ or (cm³) or in cm³ (for each heading)	1	
	III All accurate burette readings are to the nearest 0.05 cm ³ . <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) - there is only one accurate titration.	1	
	IV There are two uncorrected accurate titres within 0.10 cm ³ - 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, has also been carried out. - Do not award the mark if any “accurate” burette readings (apart from initial 0 cm³) are given to zero dp.	1	
	V, VI and VII Examiner rounds any burette readings to the nearest 0.05 cm ³ , checks subtractions and then select the “ best ” titres using the hierarchy: - two (or more) accurate identical titres, <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc.</i> These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm ³ . Examiner calculates the difference (δ) between the mean titres obtained by the candidate and the Supervisor. Accuracy marks are awarded as shown. Award V, VI and VII for $\delta \leq 0.20$ (cm ³) Award V and VI for $0.20 < \delta \leq 0.40$ (cm ³) Award V , only, for $0.40 < \delta \leq 0.80$ (cm ³)	3	

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Question	Indicative material	Mark	Total
(b)	Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. Working / explanation 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 rounded to nearest 0.01 cm³. Two special cases, where the mean need not be to 2 dp: - Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325 cm³) - Allow mean expressed 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 allowed) (e.g. 26.0 and 26.1 = 26.1 is wrong – should be 26.05) 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)	$(1.06/40) \times 4 = 0.106$	1	[5]
(ii)	Correctly calculates $n(\text{NaOH}) = 0.106 \times (25/1000) = 0.00265$ and	1	
(iii)	$n(\text{HCl}) = 0.00265$		
(iv)	concentration FA 3 = $0.00265 \times 1000/(\text{b})$	1	
	concentration FA 2 = concentration FA 3 $\times 10$	1	
	All answers correct to 3 or 4 sf (minimum of 3 parts attempted)	1	
Question 1	[13]		
2 (a)	Table for results with - Unambiguous headings and correctly displayed units - Balance readings recorded to same no of dp - One or two measuring cylinder readings recorded (does not have to include volume collected) - Unit: / g or (g) or in g (for each heading), allow grams/grammes for g and / cm³ or (cm³) or in cm³ (for each heading) - Calculates volume of gas/mass FA 4 to 3 sf.	1	[2]
	Calculated value within 20% of supervisor value	1	
(b) (i)	Correctly calculates	1	
(ii)	$n(\text{gas}) = \text{correct vol gas} \div 24\,000$ to minimum 2 sf and - same number of moles of M₂CO₃		
(iii)	$M_r = \text{correct mass from (a)} \div (\text{ii})$	1	

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Question	Indicative material	Mark	Total
(iv)	$A_r = (M_r - 60)/2$ to minimum 2 sf Group 1 element identified as one with the closest A_r and an explanation <i>e.g as it is the nearest</i>	1 1	[4]
(c) (i)	% error = $(1 \times 100)/\text{vol gas collected}$ (if only volume collected shown in (a)) or $(1 \times 100)/\text{final reading}$ (when initial reading is zero) or $(2 \times 100)/\text{vol gas collected}$ (if 2 readings)	1	[5]
(ii)	Reason: gas dissolves (in water/solution)/reacts with water/water absorbs CO_2	1	
	Modification: use a gas syringe/saturate water with carbon dioxide/use hot water/use less water in tub/use smaller volume of more concentrated acid/use oil (other non-aqueous solvent) instead of water	1	
	Reason: gas escapes before stopper inserted/stopper not inserted quickly enough.	1	
	Modification: viable means of keeping solid and acid separate before being added/use larger lumps of solid/use more (excess) of a lower concentration of acid	1	
Question 2	[11]		

Page 5	Mark Scheme	Syllabus	Paper
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FA 5 is HCO_2H ; FA 6 is $\text{CH}_3\text{CO}_2\text{H}$; FA 7 is $\text{C}_2\text{H}_5\text{OH}$; FA 8 is $\text{C}_6\text{H}_{12}\text{O}_6$; FA 9 is $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$; FA 10 is NaNO_3

3 (a) (i)	FA 5	FA 6	FA 7	FA 8	4
	Fizz / bubbles / effervescence	Fizz / bubbles / effervescence	no change	no change	
	Gas turns limewater milky / cloudy white / white ppt / chalky	Gas turns limewater milky / cloudy white / white ppt / chalky	No reaction/no change	No reaction/no change	
	Silver / black / dark grey and mirror / solid / ppt	No reaction / no change / no silver mirror	No reaction / no change / no silver mirror	Silver / black / dark grey and mirror / solid / ppt	
	Purple to colourless or solution / MnO_4^- / manganate (VII) decolourised / disappeared	No reaction or remains / turns purple or pink	Purple to colourless or solution / MnO_4^- / manganate(VII) decolourised / disappeared	Purple to colourless or solution / MnO_4^- / manganate (VII) decolourised / disappeared	
	(ii)	(–)CO ₂ H / carboxylic acid			
(iii)	(–)CHO / aldehyde / alkanal or alkene / C=C				1
(iv)	Oxidation of organic compound / reduction of MnO_4^- / redox or if alkene in (iii) then electrophilic addition				1
(v)	(–)OH / (1° / 2°) alcohol / alkanol / hydroxy or alkene / C=C				1
(vi)	Add Na to give effervescence / hydrogen / gas which pops with lighted splint, or Add PCl_5 / SOCl_2 to give misty fumes / steamy fumes / HCl , or Add carboxylic acid AND (conc) sulfuric acid to produce fruity / sweet smell or if alkene in (v) Br_2 decolourised / brown to colourless				1

[9]

[9]

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(b) (i)		FA 9	FA 10	4
	NaOH	No marking points for observations here		
	Al	Effervescence / fizz / bubbles	Effervescence / fizz / bubbles	
		Fizz / gas / ammonia turns litmus blue	Fizz / gas / ammonia turns litmus blue	
	heat	Any 2 from: • Melts / dissolves / becomes liquid • Condensation / steam / water vapour • Brown gas / gas turns litmus red • Gas relights glowing splint • Solid turns yellow	Any 1 from: • Bubbles • Gas relights glowing splint • Melts / dissolves and to yellow (liquid / solution)	
(ii)	Nitrate / nitrite			1
(iii)	Add named acid and (observe) brown gas for nitrite or Add (acidified) potassium manganate(VII)/KMnO ₄ and purple to colourless / decolourised for nitrite			1
(iv)	No reaction for either so anion in each is nitrate / NO ₃ ⁻			1
Question 3				

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	II Titre values recorded for accurate titrations and Appropriate headings for the accurate titration table and cm ³ units. - initial / start burette reading / volume / value - final / end burette and reading / volume / value - titre or volume / FB3 and used / added - unit: / cm³ or (cm³) or in cm³ or cm³ (for each heading)	1	
	III All accurate burette readings are to the nearest 0.05 cm ³ . <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 There are two (or more) uncorrected, accurate titres within 0.10 cm ³ <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 two initial titres, unless a further titration, within 0.10 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 cm³) are given to zero dp.</i>	1	
	V, VI and VII Examiner rounds any accurate burette to the nearest 0.05 cm ³ , checks subtractions and then select the ‘best’ titres using the hierarchy: - two (or more) accurate identical titres, <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc.</i> These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm ³ . Accuracy marks are awarded as shown. Award V, VI and VII for $\delta \leq 0.30$ (cm ³) Award V and VI for $0.30 \text{ cm}^3 < \delta \leq 0.60$ (cm ³) Award V for $0.60 \text{ cm}^3 < \delta \leq 1.00$ (cm ³)	3	[7]

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Question	Indicative material	Mark	Total
(b)	Candidate must take the average of two (or more) titres that are within a total spread of not more than 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 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 expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325) - Allow mean if expressed to 1 dp and the mean is exactly correct. (e.g. 26.0 and 26.2 = 26.1 is allowed) (e.g. 26.0 and 26.1 = 26.1 is incorrect – should be 26.05.) 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)	Correctly calculates $n(\text{HCl})$ used = $\frac{0.008 \times (\text{b})}{1000}$	1	[5]
(ii)	Correct use of factors $n(\text{borax}) = 0.5 \times \text{answer (i)}$ and	1	
(iii)	$n(\text{borax}) = 40 \times \text{answer (ii)}$		
(iv)	Correct use of (iii) and 15.5 $M_r = \frac{15.5}{(\text{iii})}$	1	
(v)	Correct expression $x = \frac{(\text{iv}) - 338}{(10.8)}$	1	
	All answers to 3 or 4 significant figures and if answer (v) is attempted it must be an integer	1	[5]
Question 2	[13]		

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Question	Indicative material	Mark	Total
2 (a)	I Appropriate headings and units for the three balance readings (Mass of) crucible (and lid) (Mass of) crucible, (lid) and FB 4 (or “contents before heating”) (Mass of) crucible, (lid) and residue /MgO / contents after heating / FB 4 after heating - Unit covering all balance readings and subtracted values if shown: /g, (g), in g or g (for each heading)	1	[5]
	II Masses recorded - Mass of FB 4 used was claimed to be between 1.1–1.3 g All balance readings recorded to same number of decimal places (<i>at least one dp</i>)	1	
	III Mass of FB 4 and of residue - Mass of FB 4 used, correctly subtracted - Mass of residue, correctly subtracted	1	
	IV and V - Use corrected values - Examiner used corrected values and works out the ratio $\frac{\text{mass of FB 4}}{\text{mass of MgO}}$ to 1 dp for the candidate Accuracy marks are awarded as shown. Award IV if ratio between 1.4–2.5 Award V if ratio between 1.7–2.3	2	
(b) (i)	Correctly calculates $n(\text{MgO})$ $\frac{\text{mass of residue}}{40.3}$ <i>Answer must be expressed to 2, 3 or 4 significant figures</i>	1	[5]
(ii)	Correct use of (i) and mass of FB 4 $n(\text{FB 4}) = \frac{\text{answer (i)}}{2}$ $M_r = \frac{\text{mass of FB 4 used}}{\text{no of moles of FB 4}}$ <i>An answer for M_r must be quoted to 2 or more significant figures</i>	1	
(iii)	M_r calculated from A_r values in Periodic Table = 178.6	1	
(iv)	Correct expression shown $\frac{2.5}{100} \times M_r$ in (iii) (= 4.5, 4.47, 4.465) or expresses % difference of the two M_r values $= \frac{ (\text{iii}) - (\text{ii}) }{(\text{iii})} \times 100$ or (iii) $\times \frac{97.5}{100} / (\text{iii}) \times \frac{102.5}{100}$ to give range (= 174(.1) – 183(.1))	1	
	Makes a correct statement (support / does not support / yes / no) about the accuracy of the possible formula, explained by whether the experimental M_r value is close to the answer in (iii). <i>Numbers must be quoted or reference made to (ii) and (iii)</i>	1	[5]

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(c) (i)	Improvement Heat (crucible and residue) to constant mass <i>Accept a description of the procedure for the mark</i> or heat more strongly / to a higher temperature or heat for longer so more is decomposed If a 1 dp balance is used allow use a balance weighing to more dp and to reduce % error (in weighing)/give more precise mass	1	[4]
(ii)	Conclusion To find out whether the two experiments are reliable/consistent/ concordant or If the experiments do not agree then carry out a 3rd/another expt or If one experiment was inaccurate because it gave a poor M_r value it can be ignored	1	
(iii)	Error is 0.005 g or 0.01 g (<i>if 2 dp balance was used</i>) (<i>If a 3 dp balance was used, error is 0.0005 or 0.001 g</i>) (<i>If a 1 dp balance was used, error is 0.05 or 0.1 g</i>)	1	
	% = $100 \times 2 \times \text{error} / \text{mass of FB 4}$ <i>Accept correct expression or correct answer to 2, 3 or 4 significant figures</i>	1	
Question 2	[14]		

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		FB 5 is BaCl ₂ ; FB 6 is AgNO ₃ ; FB 7 is H ₂ SO ₄ ; FB 8 is NaHCO ₃					
3 (a)	Three correct observations with Mg Three correct observations with NaOH Three correct observations with KI					3	
	<i>test</i>	FB 5	FB 6	FB 7			
	Mg	no reaction / no change (ignore few bubbles (on Mg) / gas produced slowly)	grey / black and ppt / solid / coating / deposit or Mg goes black / grey	fizzing / bubbling / effervescence			
	NaOH	no change / no reaction / no ppt / (solution) stays colourless <i>Allow white ppt / cloudy white</i> soluble in excess is CON	(dark) brown ppt soluble in excess is CON <i>Allow brown ppt as final colour after a paler shade of brown but not a different colour (e.g. green / yellow / red)</i>	no change / no reaction / (solution) remains colourless / no ppt or temperature rises <i>Allow heat produced but not exothermic</i>			
	KI	no change / no reaction / (solution) remains colourless <i>Accept pale yellow solution</i>	(pale) yellow ppt <i>Allow greenish yellow (but not yellowish green)</i> <i>Allow cream-yellow</i>	no change / no reaction / (solution) remains colourless <i>Accept pale yellow solution</i>			
	FB 5		white ppt	white ppt			
	(Mg)			gas / H ₂ (evolved) pops with lighted splint / spill			
Two correct observations with FB 5						1	
Correct hydrogen gas test						1	[5]

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(b) (i)	Conclusion and reason Cation is silver / Ag^+ (allow lead(II) / Pb^{2+}) and Gives yellow precipitate (with iodide ions) or AgI (PbI_2) produced	1	[4]
	(ii) Both conclusions about FB 5 are correct - cation – barium / Ba^{2+} - anion – chloride / Cl^-	1	
	(iii) FB 7 is sulfuric acid / H_2SO_4	1	
	(iv) $\text{Mg} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2$	1	
(c) (i)	Any two observations from: - Condensation / water formed (inside test tube) - Steam liberated / hissing / (water) vapour produced / steamy / misty fumes - White residue / solid remains white / white solid formed	1	[4]
	<u>Gas / CO_2</u> turns lime water milky / white precipitate / cloudy white / chalky	1	
	(ii) Any two observations from: - Fizzing / bubbling / effervescence - Reaction is rapid / vigorous - Solid dissolves / colourless solution formed (at end) - Temperature drops / it gets colder	1	
	(iii) Both conclusions required - cation – not known / not transition metal - anion – carbonate / CO_3^{2-} or hydrogencarbonate / HCO_3^-	1	
Question 3			[13]

CHEMISTRY

9701/35

Paper 3 Advanced Practical Skills 1

May/June 2016

MARK SCHEME

Maximum Mark: 40

Published

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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

Page 2	Mark Scheme	Syllabus	Paper
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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 x 2 box</i>)	1	
	II Titre values recorded for accurate titrations and Appropriate headings for the accurate titration table and cm ³ units. - initial / start burette reading / volume / value - final / end burette and reading / volume / value - titre or volume / FA2 and used / added unit: / cm ³ or (cm ³) or in cm ³ or cm ³ (for each heading)	1	
	III All accurate burette readings recorded to the nearest 0.05 cm ³ . <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 There are two (or more) uncorrected, accurate titres within 0.10 cm ³ <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 two initial titres, unless a further titration, within 0.10 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 cm³) are given to zero dp.</i>	1	
	V, VI and VII Examiner rounds any accurate burette to the nearest 0.05 cm ³ , checks subtractions and then select the ‘best’ titres using the hierarchy: - two (or more) accurate identical titres, <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc.</i> These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm ³ . Accuracy marks are awarded as shown. Award V, VI and VII if $\delta \leq 0.20 \text{ cm}^3$ Award V and VI if $0.20 < \delta \leq 0.40 \text{ cm}^3$ Award V only if $0.40 < \delta \leq 0.60 \text{ cm}^3$	3	

[7]

Page 3	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
(b)	Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. 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, rounded to the nearest 0.01. Two special cases where the mean may not be to 2 dp: • Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325) • Allow mean if expressed 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 allowed) (e.g. 26.0 and 26.1 = 26.1 is incorrect – should be 26.05.) 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)	Correctly calculates $n(\text{NaOH}) \text{ used} = \frac{4.20}{40.0} \times \frac{(b)}{1000}$	1	[5]
(ii)	Equation correct $2\text{NaOH(aq)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O(l)}$ State and symbols must be correct	1	
(iii)	and answer (i) divided by 2		
(iv)	Correct use of $40 \times$ answer (iii)	1	
(v)	Correct use of $25 \times$ answer (iv)	1	
	All answers to 3 or 4 significant figures (minimum 3 answers attempted)	1	
Question 1	[13]		

Page 4	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
2 (a) (i)	Tables/lists of data in (a) and (b) - Three unambiguous headings - Unit 'covering' all temperatures - Four thermometer readings recorded - Two temperature changes recorded	1	
	Readings and subtraction in (a) and (b) - All four thermometer readings recorded to 0.0 or 0.5 °C - Both temperature changes correctly subtracted	1	
	Accuracy mark awarded as shown. <i>Examiner checks subtractions and compares the candidate's temperature rise with the Supervisor's. The difference is δ.</i> If $\delta \leq 1.0^\circ\text{C}$, award one mark If $\Delta T \geq 20.0^\circ\text{C}$ then award for $\delta \leq 2.0^\circ\text{C}$	1	
(ii)	Correctly calculates energy produced in (a) Energy produced = $25 \times 4.2 \times \text{temperature change}$ <i>Answer correct to 2 to 4 significant figures.</i>	1	[6]
(iii)	Correctly calculates $n(\text{H}_2\text{SO}_4) = 0.025 \times \mathbf{1(c)(v)}$ <i>Answer must be correct to 2, 3 or 4 significant figures.</i>	1	
(iv)	Correct expression and negative sign Enthalpy change = $-\frac{\text{ans(ii)}}{\text{ans(iii)}} \times \frac{1}{1000}$ <i>Answer must be correct to 2, 3 or 4 significant figures.</i>	1	
(b) (i)	Accuracy mark awarded as shown. <i>Examiner checks subtractions and compares the candidate's temperature rise with the supervisor's. The difference is δ</i> - If $\delta \leq 1.0^\circ\text{C}$, award two Q marks - If $1.0 < \delta \leq 2.0^\circ\text{C}$, award one Q mark	2	
	(ii) Correctly calculates energy produced in (b) - Energy produced = $25 \times 4.2 \times \text{temp rise}$ - Answer correct and expressed to 2, 3 or 4 significant figures.	1	[4]
	(iii) Correct expression and negative sign Enthalpy change = $\frac{\text{answer(b)(ii)}}{(\mathbf{a})(\text{iii})} \times \frac{1}{1000}$ <i>Answer must be correct to 2, 3 or 4 significant figures.</i>	1	

Page 5	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
(c)	Attempt at a Hess' Law energy cycle - Two correct arrows from the equation - Left arrow labelled with (a)(iv) or numerical value - Right arrow labelled with (b)(iii) or numerical value	1	[2]
	Correctly calculates enthalpy change Answer = (a)(iv) – (b)(iii)	1	
(d) (i)	$\% \text{ error} = \frac{2 \times 0.5}{\text{temp rise in (b)}} \times 100$	1	[2]
(ii)	The student is wrong because MgO is in excess or The student is wrong because H ₂ SO ₄ is the limiting reagent	1	
Question 2	[14]		

Page 6	Mark Scheme	Syllabus	Paper
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Question	Indicative material	Mark	Total
FA 6 is $\text{Mg}(\text{NO}_3)_2$; FA 7 is $\text{KI} + \text{ZnSO}_4 (= \text{ZnI}_2)$			
3 (a) (i)	Observations • (On gentle heating) it melts /dissolves or changes to liquid • Condensation inside tube or steam evolved or fizz /bubbles • (On strong heating) white residue/solid formed • Brown gas/fumes liberated • (Moist blue) litmus turns red • Gas/oxygen relights a glowing spill (or makes it glow brighter) <i>5 or 6 observations correct = 3 marks</i> <i>3 or 4 observations correct = 2 marks</i> <i>1 or 2 observations correct = 1 mark</i>	3	
(ii)	Observations in first two tests • With H_2SO_4 – no reaction/no change • With ammonia – white precipitate, insoluble/no change in excess • With cold NaOH - white precipitate and no change/insoluble excess	1	
		1	
	Subsequent observations • Ignore observation on heating alone unless a gas is identified or litmus turns blue • When Al is added, gas/NH_3 turns litmus blue	1	
(iii)	Conclusion FA 6 is $\text{Mg}(\text{NO}_3)_2$	1	[8]
	$\text{Mg}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2(\text{s})$	1	
(b) (i)	Observation with NaOH White precipitate (forms) and soluble in excess (NaOH)	1	
	Observation with NH_3 White precipitate (forms) and soluble in excess (NH_3)	1	
	Both observations required • Brown /orange /red-brown /yellow /yellow-brown (solution) formed and • Goes dark blue/black/blue-black when starch added	1	
(ii)	Conclusion FA 7 is zinc iodide / ZnI_2	1	[5]
	Correct test and result • Add silver nitrate • Yellow precipitate formed	1	
Question 3	[13]		