
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

May/June 2017

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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Question	Answer	Marks
1(a)	I: All the following data is recorded - rough titration: both burette readings and the titre - initial and final burette readings for two (or more) accurate titrations <i>Headings and units are not required for this mark</i>	1
	II: Titre values recorded for accurate titrations, and Appropriate headings and units in the accurate titration table - initial / start (burette) reading / volume - final / end (burette) reading / volume - titre or volume used / added (<i>not</i> “difference”) - unit: / cm³ or (cm³) or in cm³ (for each heading) or cm ³ unit given for each volume recorded	1
	III: All accurate burette readings are recorded to the nearest 0.05 cm ³ . <i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm³ (if this was the initial reading), but it does not apply to the titre.</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: Final uncorrected titre is within 0.10 cm ³ of any previous uncorrected accurate titre.	1

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Question	Answer	Marks
	Examiner rounds any accurate burette readings to the nearest 0.05 cm^3, check subtractions and then select the “best” titres using the hierarchy: - identical titres <i>then</i> - accurate titres within 0.05 cm^3, <i>then</i> - accurate titres within 0.10 cm^3, <i>etc.</i> These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm^3. Examiner compares candidate’s titre value with that of the Supervisor.	
	Award V , VI and VII if $\delta \leq 0.30 \text{ (cm}^3\text{)}$	1
	Award V and VI if $0.30 < \delta \leq 0.50$	1
	Award V , only, if $0.50 < \delta \leq 0.80$	1
1(b)	Candidate calculates the mean correctly. - 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 / 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 cm^3. (e.g. 26.667 cm^3 must be rounded to 26.67 cm^3)	1

Question	Answer	Marks
1(b)	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 cm^3) • 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 wrong – should be 26.05) Do not award this mark if: • The rough titre was used to calculate the mean. • The candidate did only one accurate titration. • Burette readings were incorrectly subtracted to obtain any of the accurate titre values. • All burette readings used to calculate the mean were recorded as integers 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(c)(i)	No of moles of thiosulfate used = $0.110 \times \frac{\text{mean titre}}{1000}$ (expressed to 3 or 4 sig fig)	1
1(c)(ii) + (iii)	Equation balanced $\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \rightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI}$ and no of moles of $\text{I}_2 = 0.5 \times \text{ans. in (i)}$	1
1(c)(iv)	Correct answer, No of moles of copper(II) ions = $2 \times \text{answer (iii)}$ (expressed to 3 or 4 sig fig)	1
1(c)(v)	$M_r = \frac{26.0}{\text{ans (iv)}} \times \frac{25}{1000}$	1
	Total:	12

Question	Answer	Marks
2(a)	I: Table of data , to include: - Unit “covering” all weighings, or given for each weighing - No repeat headings (<i>i.e. not two lists of weighings</i>) - Appropriate headings for the three weighings: - Mass of crucible and lid - Mass of crucible, lid and FA 5 (or “contents before heating”) - Mass of crucible, lid and residue / CuO / contents after heating	1
	II: Weighings recorded - Six weighings recorded in the space provided. - All weighings recorded to same number of decimal places (one or more) - Label/heading to indicate which is Expt 1 and Expt 2	1
	III: Both masses of FA 5 and residue, correctly subtracted - Masses of FA 5 used recorded on page 4, correctly subtracted - Masses of FA 5 used were between 2.5 – 3.0 g and 1.5 – 2.0 g - Masses of residue recorded on page 4, correctly subtracted	1
	For assessment of accuracy, examiner must check and correct (if necessary) the masses of FA 5 used and of CuO obtained by the supervisor and by the candidate for Experiment 1. - Examiner works out the ratio $\frac{\text{mass of FA5}}{\text{mass of CuO}}$ for the supervisor (2 dp) - Examiner works out the ratio (mass FA 5: mass CuO) for the candidate (2 dp) - Examiner calculates δ the difference between these two ratios. Award IV and V if $\delta \leq 0.08$ Award IV if $0.08 < \delta \leq 0.15$	2
	VI: Observations made during heating Solid goes black / black residue (formed) or reference to blue/green flame	1
2(b)(i)	- No of moles CuO = $\frac{\text{mass of residue}}{79.5}$ - Answer must be correct and expressed to 3 or 4 sig fig	1

Question	Answer	Marks
2(b)(ii)	- No of moles of FA 5 = $\frac{\text{answer (i)}}{2}$ $M_r = \frac{\text{mass of FA 5 used}}{\text{no of moles of FA 5}}$	1
2(b)(iii)	$M_r = \frac{\text{mass of FA5 used in Expt 2} \times 79.5 \times 2}{\text{mass of residue (CuO)}}$	1
2(b)(iv)	M_r of FA 5 calculated from A_r values = 239	1
2(b)(v)	Candidate should - correctly calculate the 2.5% of M_r in (iv) = 5.98 / 6.0, and - make a correct statement about the accuracy of the accepted formula, based on their result(s). or correctly calculate % difference for their result(s) from M_r in (iv) and correct comment	1
2(c)(i)	- heat (crucible and residue) to constant mass - heat more gently for longer period - cool in a desiccator	1
	- to ensure that decomposition (of FA 5) is complete or to ensure that <u>all</u> the residue is CuO - to prevent escape of dust / smoke / solid (during heating)	1
2(c)(ii)	Larger masses have lower <u>percentage</u> error in weighing	1
	Total:	14

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Question	Answer	Marks
FA 6 is $\text{Cu}(\text{NO}_3)_2$; FA 7 is FeCl_3		
3(a)(i)	• melts or dissolves or blue liquid / solution formed • condensation or steam / vapour produced • black residue / solid • brown gas / fumes • gas / oxygen relights a glowing spill 4 or 5 observations correct = 2 marks 2 or 3 observations correct = 1 mark	2
3(a)(ii)	FA 6 is $\text{Cu}(\text{NO}_3)_2$	1
3(b)(i)	• with KI, FA 7 gives a brown / red-brown / red / orange solution • with starch, blue / blue-black / dark colour	1
	• with FA 6, blue precipitate (formed) • on heating, (blue precipitate) turns black • With FA 7, red-brown / brown / rust ppt. (formed)	1
	• With FA 6, no reaction / no change / no ppt. • With FA 7, white precipitate formed	1
	• With FA 6, (pale) blue precipitate, then • deep/dark blue (solution) with excess • With FA 7, red-brown / brown / rust precipitate (forms)	1
	Mg test Both observations correct With FA 6, brown / black precipitate / solid formed or blue colour fades / disappears With FA 7, fizzing / bubbling / effervescence	1
	Test for hydrogen: (gas) “pops” with lighted splint	1

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Question	Answer	Marks
3(b)(ii)	FA 7 is acidic, because it fizzes / produces hydrogen with magnesium	1
3(b)(iii)	$\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$	1
3(b)(iv)	Redox because iodine was produced (from iodide ions)	1
3(b)(v)	You can't be certain about the colour of the precipitate (with AgNO_3) due to the coloured solution / colour of FA 7 . or You can't be sure whether the precipitate with AgNO_3 is white / AgCl or cream / AgBr	1
3(b)(vi)	Ammonia would react with the Fe^{3+} ions in FA 7 (masking the effect of ammonia on AgCl) or The cation in FA 7 gives a precipitate with ammonia (so the precipitate of AgCl would not appear to dissolve).	1
	Total:	14

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9701/32

Paper 3 (Advanced Practical Skills 2)

May/June 2017

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	I Initial and final burette readings and volume added recorded for rough titre and accurate titre details tabulated. [minimum 2 × 2 'boxes' with relevant information]	1
	II Initial and final burette readings recorded and volume of FB 2 added recorded for each accurate titration. Headings and units correct for accurate titrations Headings: initial / final (burette) reading / volume or reading / volume at start / finish and volume / FB 2 added/used or titre and Units: (cm ³) or / cm ³ or in cm ³ [or cm ³ by every entry]	1
	III All accurate burette readings are recorded to the nearest 0.05 cm ³ 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)	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1

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Question	Answer	Marks
1(a)	For assessment of accuracy (Q) marks, each Examiner should round any accurate burette readings to the nearest 0.05 cm³, check subtractions and then select the “best” titres for supervisor and candidate using the hierarchy: <i>two identical; titres within 0.05 cm³; titres within 0.1 cm³; etc.</i> These best titres should be used to calculate the mean titre, expressed to the nearest 0.01 cm³. The candidate’s titre is compared to the supervisor’s titre and δ calculated.	
	V, VI and VII Award V, VI and VII for $\delta \leq 0.20 \text{ cm}^3$ Award V and VI for $0.20 \text{ cm}^3 < \delta \leq 0.30 \text{ cm}^3$ Award V for $0.30 \text{ cm}^3 < \delta \leq 0.50 \text{ cm}^3$	3
1(b)	Check mean titre is correctly calculated from clearly selected values (ticks or working). • Candidate must average two (or more) titres where the total spread is $\leq 0.20 \text{ cm}^3$. • Working must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should normally be quoted to 2 dp rounded to the nearest 0.01. [e.g. 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.] Do not award this mark if: • the rough titre was used to calculate the mean; • 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>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)	Correctly calculates $\frac{0.100 \times 25}{1000} = 2.5(0) \times 10^{-3}$	1

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Question	Answer	Marks
1(c)(ii)	Correctly calculates $\frac{0.0025 \times 1000}{(b)}$ to 3 or 4 sf	1
1(c)(iii)	Correct expression $12.6 \div (ii)$	1
1(c)(iv)	Anion in FB 1 = $\text{CHCl}_2\text{COO}^-$ (allow ecf: for candidate's answer to (iii)) $\text{CH}_3\text{COO}^- : \leq 77$ $\text{CH}_2\text{ClCOO}^- : 77.5 - 111.5$ $\text{CHCl}_2\text{COO}^- : 112 - 146$ $\text{CCl}_3\text{COO}^- : \geq 146.5$	1
1(d)(i)	Conc NaOH lower = > titre smaller = > smaller M_r	1
1(d)(ii)	No effect on identification unless closer to smaller mass acid or (different M_r may lead to the) identification of a different acid with matching / close to M_r	1
	Total:	14

Question	Answer	Marks
2(a)	I Unambiguous headings and correct units tabulated for all 6 thermometer readings, mean temps, and ΔT s	1
	II All thermometer readings recorded to 0.5 °C and ΔT s correctly calculated and Mean temperatures correctly calculated to nearest .5 °C or to 1 or 2 dp	1
	Award III if candidate ΔT s within 1.5 °C	1
	Award III and IV if candidate ΔT s within 1.0 °C	1
2(b)(i)	Correctly calculates n acid = 0.05(0) mol and n NaOH = 0.045 mol	1

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Question	Answer	Marks
2(b)(ii)	Correctly calculates $50 \times 4.2 \times \Delta T_1$ to minimum 2 sf	1
2(b)(iii)	Correct expression $\frac{\text{(ii)}}{1000 \times 0.045}$	1
2(b)(iv) +(v)	2 × mol NaOH in (i) or 0.09(0) in (iv) and Correctly uses $\frac{100 \times 4.2 \times \Delta T(2)}{1000 \times \text{(iv)}}$ in (v)	1
	Negative signs shown in (iii) and (v) and final answers to 2–4 sf in (ii) , (iii) & (v)	1
2(c)(i)	% error in vol of FB 3 = $\frac{0.5 \times 100}{50} = 1.(0)\%$	1
	% error in vol of FB 4 = $\frac{2 \times 0.25 \times 100}{25} = 2.(0)\%$	1
2(c)(ii)	Use a burette / pipette for volume measurements / instead of a measuring cylinder or Add a lid to reduce heat loss (by convection) / to reduce convection or Use thermometer reading to 0.2 °C / smaller divisions / calibrations / more sensitive	1
	Total	12

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Question	Answer	Marks
FB 5 is CH_3COOH ; FB 6 is HCl ; FB 7 is HNO_3 ; FB 8 is $\text{CuSO}_4(\text{aq})$; FB 9 is Na_2edta		
3(a)(i)	Selects Na_2CO_3 / Mg	1
	Effervescence / bubbling / fizzing greater / faster with FB 6	1
	FB 5 is the weak acid (ora) with some evidence	1
3(a)(ii)	no reaction / no ppt / no change with Ag^+ and 'not needed' with Ba^{2+} (do not allow 'no change' unless there is no evidence of ammonia in 2nd test) Effervescence alone is not evidence so would expect 'no change'.	1
	Effervescence / gas / NH_3 and turns (damp red) litmus blue	1
	FB 7 is nitric acid from some evidence (can be effervescence in (ii))	1

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Question	Answer	Marks
3(b) (i) – (vi)	See below	6

Expected observations

<i>test</i>	<i>observation</i>	<i>mark</i>
(i) + Na_2CO_3	(pale) blue ppt (Allow blue-green / green-blue / turquoise / cyan)	1
(ii) + KI then	Yellow-brown / brown (not orange)	1
$\text{Na}_2\text{S}_2\text{O}_3$	white / off-white ppt and soluble in excess	1
(iii) + c.HCl and	(blue) (solution) turns green (shade greener)	
(iv) + H_2O	(green) (solution) turns (pale) blue (shade bluer)	1
(v) + NH_3	(in excess) forming dark/deep blue solution or solution much darker than (iv)	1
(vi) + edta	(solution) more blue / darker blue than (iv)	1

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Question	Answer	Marks
3(vii)	FB 8 contains Cu^{2+} /copper(II)	1
3(viii)	$\text{Cu}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CuCO}_3(\text{s})$ Allow $2\text{Cu}^{2+}(\text{aq}) + 4\text{I}^{-}(\text{aq}) \rightarrow 2\text{CuI}(\text{s}) + \text{I}_2(\text{aq or s})$ Allow $\text{Cu}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow 2\text{Cu}(\text{OH})_2(\text{s})$	1
	Total:	14

Mark allocation

<i>Skill</i>	<i>Minimum mark allocation</i>	Breakdown of marks			<i>Question 1</i>	<i>Question 2</i>	<i>Question 3</i>	<i>Total mark</i>
		<i>Statement</i>		Minimum Marks				
Manipulation, measurement and observation (MMO)	12 marks [17]	Successful <u>collection</u> of data and observations	C	8	1		9	10
		<u>Quality</u> of measurements and observations	Q	2	3	2		5
		<i>Decisions relating to measurements of observations</i>	De	2	1		1	2
Presentation of data and observations (PDO)	6 marks [7]	<u>Recording</u> data or observations	R	2	1	1		2
		<i>Display of calculation and reasoning</i>	Di	2	1	2		3
		<i>Data layout</i>	L	2	1	1		2
Analysis, conclusions and evaluation (ACE)	10 marks [16]	<i>Interpretation of data or observations and identifying sources of error</i>	I	4	3	5	1	9
		<i>Drawing conclusions</i>	Con	5	3		3	6
		<i>Suggesting improvements</i>	Imp	1		1		1
Total					14	12	14	40

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Question	Answer	Marks
1(a)	I Correct headings The following data are recorded in the space provided • mass of container with FA 2 • mass of (empty) container • mass of FA 2 <i>'Mass' must be stated for each piece of data.</i> <i>Unit / g (etc.) must be given for each piece of data.</i> <i>Subtraction for mass of FA 2 used must be correct.</i>	1
	II All the following data are recorded • two burette readings and titre for the rough titration • initial and final burette readings for two (or more) accurate titrations	1
	III Titre values recorded for accurate titrations, and Appropriate headings and units in the accurate titration table • initial / start (burette) reading / volume • final / end (burette) reading / volume • titre or volume / FA 1 and used / added • unit: / cm³ or (cm³) or in cm³ (for each heading) or cm³ unit given for each volume recorded	1
	IV All accurate burette readings are recorded to the nearest 0.05 cm ³ . <i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm³ (if this was the initial reading), but it does not apply to the titre.</i> <i>This mark is not awarded 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
	V The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre. • Do not include a reading if it is labelled "rough". • Do not award the mark if any 'accurate' burette readings (apart from initial 0 cm³) are given to zero dp.	1

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Question	Answer	Marks
	For assessment of accuracy (Q) marks, each Examiner should round any burette readings to the nearest 0.05 cm^3, check subtractions and then select the “best” titres using the hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled “rough”), <i>then</i> - two (or more) accurate titres within 0.05 cm^3, <i>then</i> - two (or more) accurate titres within 0.10 cm^3, <i>etc.</i> These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm^3. Calculate the candidate’s ratio to 1 dp, as shown below. Ratio = correct mean titre ÷ correct mass Calculate the difference (δ) between the candidate’s ratio and the supervisor’s ratio. Accuracy marks are awarded as follows.	
1(a)	Award VI , VII and VIII if $\delta \leq 0.2 \text{ (cm}^3 \text{ g}^{-1}\text{)}$	1
	Award VI and VII if $0.2 < \delta \leq 0.4$	1
	Award VI , only, if $0.4 < \delta \leq 0.6$	1
	Spread penalty: if the two “best” (corrected) titres used by the Examiner were $\geq 0.50 \text{ cm}^3$ apart, maximum 2 accuracy marks. - If only a rough titration is shown, award Q marks based on that, maximum 2 accuracy marks.	

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Question	Answer	Marks
1(b)	Candidate calculates the mean correctly. • 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. (e.g. 26.665 cm³ must be rounded to 26.67 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 if expressed to 1 dp, if all accurate burette readings (apart from initial 0) 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) <i>This mark is not awarded if:</i> • The rough titre was used to calculate the mean. • The candidate did only one accurate titration. • Burette readings were incorrectly subtracted to obtain any of the accurate titre values. • All burette readings used to calculate the mean were recorded as integers 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)	No of moles of H ₂ SO ₄ used = 0.05(0) × ^(b) / 1000 to minimum 2 sf	1
1(c)(ii) and 1(c)(iii)	2NaHCO₃ + H₂SO₄ → Na₂SO₄ + 2CO₂ + 2H₂O and No of moles of NaHCO₃ = 2 × answer (i)	1

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Question	Answer	Marks
1(c)(iv)	Mass of NaHCO_3 = answer (iii) $\times 10 \times 84$	1
1(c)(v)	$\% = \frac{\text{answer (iv)}}{\text{mass of FA 2 used}} \times 100$	1
	All answers attempted in (i), (iii), (iv) & (v) are shown to 3 or 4 sf <i>Minimum 3 answers attempted to gain the mark</i>	1
1(c)(vi)	Any one of the following answers. - the impurity does not react with (sulfuric) acid / FA 1 / NaHCO_3 - the impurity is not alkaline / acidic - the impurity is neutral	1
1(c)(vii)	% error ($= \frac{0.1}{250} \times 100$) = 0.04%	1
	Total:	16

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Question	Answer	Marks
2(a)	I Four weighings recorded and correct headings given and mass of FA 4 used and mass of residue recorded • (Mass of) crucible, (lid) • (Mass of) crucible, (lid) and FA 4 (or 'contents before heating) • (Mass of) crucible, (lid) and contents / residue / FA 4 after (first) heating • (Mass of) crucible, (lid) and contents / residue / FA 4 after re-heating • (Mass of) FA 4 • (Mass of) residue / FA 5 / contents after heating <i>If 'mass' not written then 'g' must be with each entry. Use of lid must be consistent.</i>	1
	II • All <u>weighings</u> recorded to same decimal places (one or more). • Third and fourth weighings are within 0.05 g of each other <i>(or both equal if a one decimal place balance was used)</i> • Mass of FA 4 and FA 5 / residue must be correctly subtracted.	1

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Question	Answer	Marks
2(a)	III and IV: - For assessment of accuracy, examiner must check and correct (if necessary) the masses of FA 4 used and of residue (smaller mass) obtained by the supervisor and by the candidate. - Work out ratio $\frac{\text{mass of FA4}}{\text{mass of residue}}$ for the supervisor (2 dp) - Work out ratio $\frac{\text{mass of FA4}}{\text{mass of residue}}$ for candidate (2 dp) - Calculate the difference (δ) between these two ratios. Award III and IV if $\delta \leq 0.05$ Award III if $0.05 < \delta \leq 0.10$	2
2(b)(i) and 2(b)(ii)	(i) $\text{Mass NaHCO}_3 = \left(\frac{\% \text{ purity from 1(c)(v)}}{100} \right) \times \text{mass of FA 4 used}$ and (ii) $\text{Mass impurity} = \text{mass of FA 4} - \text{answer (i)}$ or $\text{mass impurity} = \frac{\% \text{ impurity}}{100} \times \text{mass FA 4}$	1
2(b)(iii)	Mass of decomposition solid = mass of residue (FA 5) from table – mass of impurity (ii) and expressed to 2, 3 or 4 sig fig or mass of decomposition solid = mass of NaHCO_3 – mass lost on heating [(i) – (mass FA 4 – mass FA 5)]	1
2(b)(iv)	Mass of residue obtained = answer (iii) $\times \frac{84}{\text{answer (i)}}$	1

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Question	Answer	Marks
2(b)(v)	If correct, (84 g) NaHCO_3 would give 40 g residue / NaOH (<i>owtte</i>) or mole ratio 1: 1.3 (so not 1:1) or Answers could refer to mass / moles of CO_2	1
2(c)(i)	Lid reduces / stops absorption of water (vapour) by solid / residue / FA 5 while cooling	1
2(c)(ii)	Repeat the experiment and ignore anomalous results / to obtain concordant / consistent results or cool in a desiccator or use larger mass of FA 4 / contents / solid	1
2(d)(i)	Any two observations required - fizzing / effervescence / bubbling - gas turns limewater milky / chalky / cloudy white / white ppt - solid dissolves / colourless solution forms - rapid/brisk effervescence = 2 observations	1
2(d)(ii)	FA 5 contains carbonate ion / CO_3^{2-} and reference to fizzing (with acid) or to CO_2 liberated (with acid) or positive limewater test or correct equation	1
2(d)(iii)	$2\text{NaHCO}_3(\text{s}) \rightarrow \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g}) + \text{Na}_2\text{CO}_3(\text{s})$	1
2(d)(iv)	(From equation) 84 g NaHCO_3 should give 0.5×106 g residue (= 53 g) and gives a (sensible) comment based on student's 52.3 g	1
	Total:	14

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Question	Answer	Marks
FA 6 is MnCl_2 ; FA 7 is $\text{Al}_2(\text{SO}_4)_3$		
3(a)(i)	Ba²⁺ test: all observations correct FA 6 – no change / no reaction / no ppt / solution stays colourless with both FA 7 – white precipitate with Ba²⁺ and - white ppt (remains) / insoluble / no reaction with HNO₃	1
	AgNO₃ test: both observations correct FA 6 – white precipitate FA 7 – no change / no reaction / solution stays colourless / no ppt	1
	Na₂CO₃ test: both observations correct FA 6 – no reaction / solid does not dissolve / no effervescence FA 7 – fizzing / bubbling / effervescence / or gas / CO₂ turns limewater milky / chalky / cloudy white / (forms) white ppt	1
3(a)(ii)	FA 7 has lower pH and gas / CO ₂ given off / it fizzes (more rapidly if fizzing with both) with sodium carbonate	1

Question	Answer	Marks
3(b)	Reagents: NaOH and NH ₃ (names or correct formulae)	1
	Observations – (3 × 1 mark) FA 6 + NaOH : off-white / buff / beige / light brown ppt FA 6 + NH₃ : off-white / buff / beige / light brown ppt	1
	FA 6 : both ppts insoluble in excess and darken / turn brown with either	1
	FA 7 + NaOH : white ppt and soluble in excess FA 7 + NH₃ : white ppt and insoluble in excess	1
3(c)	Conclusions (one mark for each). FA 6 is MnCl₂ FA 7 is Al₂(SO₄)₃	2
	Total:	10

CHEMISTRY

9701/34

Paper 3 Advanced Practical Skills 2

May/June 2017

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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Question	Answer	Marks
1(a)	I Mass (of Mg) with correctly displayed unit and all temperatures recorded Initial T must be between 10–45 °C	1
	II All temperature readings to .5 °C with at least one ending in .0 °C and at least one ending in .5 °C	1
	Round any thermometer readings to the nearest .5 °C Calculate ΔT from T at 2 minutes to T max from the table. Compare with supervisor ΔT . Award III if ΔT within 2 °C of supervisor Award III and IV if ΔT within 1 °C of supervisor	2
1(b)	I Axes labelled (T on y-axis & t on x-axis). Scale chosen so that plotted points (and 10 °C extra on y-axis) occupy more than half the available space in both directions.	1
	II Points plotted to within half a small square. Points that should be on lines must be on the line and points that should not be on lines must not be on lines.	1
	III Two lines of best fit drawn – one up to 2 minutes and the other after the reaction has occurred.	1
	IV Both lines extrapolated to 2½ minutes and vertical line drawn at 2½ minutes	1
	V Examiner to calculate ΔT from candidate graph and award mark if within 0.5 °C of candidate's ΔT	1
1(c)(i)	Correctly calculates energy evolved = 25 × 4.2 × ΔT and answer to 2 – 4 sf.	1
1(c)(ii)	Correct use of moles of magnesium = $\frac{\text{mass Mg from (a)}}{24.3}$	1
	Correct use of $\Delta H = \frac{(i)}{n(\text{Mg}) \times 1000}$ and answer must be negative	1
1(d)	2 masses, 4 thermometer readings and 2 temperature rises with correct units and unambiguous headings shown	1
	Examiner to calculate $\frac{\Delta T \text{ longer piece}}{\Delta T \text{ shorter piece}}$ to 2 dp Award 2 marks if 1.80 to 2.20 Award 1 mark if 1.70 to 2.30	2

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Question	Answer	Marks
1(e)	• correct (larger) ΔT from thermometer readings and correct (larger) mass (from balance readings) • correct expression of $25 \times 4.2 \times \Delta T$ • correct expression for division by number of moles of Mg • answer with negative sign and evidence of division by 1000 and answer to 2 – 4 sf $\Delta H = - 25 \times 4.2 \times \Delta T \times 24.3 \div [m(\text{Mg}) \times 1000]$ 3 points correct = 1 mark 4 points correct = 2 marks	2
1(f)(i)	Either yes because the reaction is faster so less heat is lost or no because a catalyst does not alter $\Delta H / \Delta T$	1
1(f)(ii)	No effect because the acid is in excess / magnesium is the limiting reagent / all the Mg reacts or ΔT would be larger because the reaction is faster as acid is diprotic (<i>owtte</i>) so less heat lost	1

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Question	Answer	Marks
1(g)(i)	$\text{Mg(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{H}_2(\text{g})$ Chemical symbols = 1 mark Correct balancing and state symbols = 1 mark	2
1(g)(ii)	Answer = + 1.9 = 2 marks Answer = – 1.9 / 1.9 / + 3.8 = 1 mark Some working must be shown to score both marks	2
1(h)(i) and 1(h)(ii)	(i) & (ii) together Allow any two correct statements • a stronger acid or correct identification provides a greater concentration of H^+ / more hydrogen ions (<i>ora</i>) • (some) energy required to break O–H bond (allow OH bond) • –I effect/increased electronegativity of Cl increases strength of (trichloroethanoic) acid / makes it easier to release H^+ (compared to ethanoic acid)	2
	Total:	25

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Question	Answer	Marks
FB 5 is HCl; FB 6 is H ₂ SO ₄ ; FB 7 is HNO ₃ ; FB 8 is KI(aq)+Na ₂ CO ₃ (aq)		
2(a)(i)	AgNO ₃ observations correct	1
	Ba(NO ₃) ₂ observations correct	1
	Na ₂ CO ₃ observations correct	1
	Gas / CO ₂ / fizz turned limewater milky / chalky / cloudy white / formed white ppt with limewater in at least one box	1

Test	FB 5	FB 6	FB 7
AgNO ₃	White ppt	No reaction / no change / no ppt	No reaction / no change / no ppt
NH ₃	(ppt) soluble	No reaction / no change / no ppt	No reaction / no change / no ppt
		<i>(not 'no observation' or '–')</i>	
Ba(NO ₃) ₂	No reaction / no change / no ppt	White ppt	No reaction / no change / no ppt
HNO ₃	No reaction / no change / no ppt	(ppt) insoluble	No reaction / no change / no ppt
Na ₂ CO ₃	Effervescence / fizz / bubbles	Effervescence / fizz / bubbles	Effervescence / fizz / bubbles
	Positive limewater test – see above		

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Question	Answer	Marks
2(a)(ii)	H ⁺ / hydrogen ion	1
2(a)(iii)	Adds named reactive metal (or symbol) (Mg or Zn, <i>allow Al, Fe</i>) / named suitable acid-base indicator	1
	Effervescence / fizz / bubbles / gas / H ₂ pops with lighted splint / correct final colour (chosen indicator must change colour in the pH range < 7)	1
2(a)(iv)	FB 5 Cl ⁻ FB 6 SO ₄ ²⁻ FB 7 unknown Allow names of ions 3 correct scores 2 2 correct scores 1	2
2(a)(v)	Test: Name / correct formula of strong acid (and warm) or (acidified) potassium manganate(VII) / KMnO ₄ No (brown) gas or not decolourised Conclusion: FB 7 is NO ₃ ⁻ / nitrate	1
2(b)	see expected observations table	4
	Ions present I ⁻ and CO ₃ ²⁻	1
	Total:	15

Expected observations

<i>Test</i>	<i>Observation</i>
HCl	Fizz / etc. or gas / CO ₂ turns limewater milky / etc. and
H ₂ O ₂	Brown / yellow (darker yellow if yellow with HCl) / red-brown / orange-brown / yellow-brown (solution) and
Starch	Blue-black / black / dark blue (not purple) colour [1]
NaOH	No reaction / no ppt / solution remains colourless [1]
CuSO ₄	Blue/green/brown range of coloured ppt and
HCl	Brown colour [1]
Na ₂ S ₂ O ₃	White / cream / off-white / pale grey and solid / residue / ppt [1]

CHEMISTRY

9701/35

Paper 3 Advanced Practical Skills 1

May/June 2017

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	I Constructs a table for results showing volume of FA 1 , volume of water, reaction time, reaction rate for all experiments carried out	1
	II Appropriate headings and units for recorded data given. Volumes in cm^3 or cm^3 or (cm^3) . Time in seconds or s or (s) All volumes except zero given to .00.	1
	III All times recorded to the nearest second.	1
	IV 3 additional volumes chosen intervals not less than 2.00 cm^3 and all volumes of FA 1 $\geq 6.00 \text{ cm}^3$ and one volume of FA 1 $\leq 8.00 \text{ cm}^3$	1
	V In all 3 additional experiments water is added to make a total of 20.00 cm^3	1
	VI + VII Compare time for 20.00 cm^3 of FA 1 with that of supervisor. 2 marks for $\pm 3 \text{ s}$ 1 mark for $\pm 5 \text{ s}$	2
	VIII Compare ratio of time for 10.00 cm^3 of FA 1 / time for 20.00 cm^3 of FA 1 . 1 mark for ratio between 1.8 – 2.2	1
	IX All rates correctly calculated using $500 / \text{time}$ (minimum 2 sf and 1 dp)	1
	X Units for rate given as s^{-1}	1

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Question	Answer	Marks
1(b)	I Rate on <i>y-axis</i> and volume on <i>x-axis</i> . Axes clearly labelled and suitable linear scales.	1
	II Scale chosen to use more than half of each axis for origin and plotted points	1
	III All points plotted correctly to within half a square and in the correct square.	1
	IV Draws a line of best fit. This may be a straight line or a smooth curve with anomalous points indicated.	1
1(c)	Rate is (directly) proportional to concentration of peroxodisulfate or comment suitable to shape of graph	1
1(d)(i)	Reads rate from graph correct to one small square and shows use of this number in calculation	1
	Shows use of $500 / \text{rate}$	1
1(d)(ii)	Correctly calculates $(0.5 / \text{time for expt 1}) \times 100$ to 2 or more sf	1
1(d)(iii)	The student is correct as the reaction time would be longer and so the (percentage) error reduced.	1
1(d)(iv)	There is so much thiosulfate that all the iodide reacts so there is no iodine to turn the starch blue-black.	1

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Question	Answer	Marks
1(e)(i)	Record time to nearest second with units of s	1
	Candidate's time compared with that from Expt 1. 1 mark for ± 3 s	1
1(e)(ii)	Estimates a time as $4 \times \text{ans (i)}$	1
	Time / rate related to concentration of $\text{S}_2\text{O}_3^{2-}$ / FA 3 Increased concentration of FA 3 increases time of reaction / time longer / decreases rate of reaction / rate lower / smaller / reaction slower.	1
	Total:	24

Question	Answer	Marks																												
FA 4 is (NH4)2Fe(SO4)2 FA 5 is KAl(SO4)2 FA 6 is Na2SO3 FA 7 is H2SO4 FA 8 is NaNO2																														
2(a)(i)	<table><tr><th rowspan="2">test</th><th colspan="2">observation</th><th rowspan="2">mark</th></tr><tr><th>FA 4</th><th>FA 5</th></tr><tr><td rowspan="2">+ NaOH</td><td>green ppt</td><td>white ppt</td><td>1</td></tr><tr><td>insoluble in excess</td><td>soluble in excess</td><td>1</td></tr><tr><td>then warm</td><td>gas / ammonia turns (damp red) litmus blue</td><td>no reaction / litmus stays red</td><td>1</td></tr><tr><td rowspan="2">+ NH3</td><td>green ppt</td><td>white ppt</td><td>1</td></tr><tr><td>and turning brown (in air) in either alkali test</td><td></td><td></td></tr><tr><td></td><td>insoluble in excess</td><td>insoluble in excess</td><td>1</td></tr></table>	test	observation		mark	FA 4	FA 5	+ NaOH	green ppt	white ppt	1	insoluble in excess	soluble in excess	1	then warm	gas / ammonia turns (damp red) litmus blue	no reaction / litmus stays red	1	+ NH3	green ppt	white ppt	1	and turning brown (in air) in either alkali test				insoluble in excess	insoluble in excess	1	5
test	observation		mark																											
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+ NH3	green ppt	white ppt	1																											
	and turning brown (in air) in either alkali test																													
	insoluble in excess	insoluble in excess	1																											

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Question	Answer	Marks
2(a)(ii)	FA 4 contains NH_4^+ and Fe^{2+} FA 5 contains Al^{3+} 2 marks for all three correct 1 mark for any two correct	2
2(b)	Selects $\text{BaCl}_2(\text{aq})$ or $\text{Ba}(\text{NO}_3)_2(\text{aq})$ followed by appropriate acid (acid must be named) OR Selects acidified potassium manganate(VII) OR Selects named acid and tests gas with acidified potassium manganate(VII)	1
	White ppt that is soluble in acid OR Decolourises (potassium manganate(VII))	1
	SO_3^{2-}	1
2(c)(i)	+ Mg Effervescence / fizzing / bubbles	1
	Gas / H_2 / fizz pops with a lighted splint	1
	+ FA 8 Brown (yellow / orange) fumes or gas turns blue litmus red/bleached or blue solution	1
2(c)(ii)	H_2SO_4	1
	NaNO_2	1
2(c)(iii)	$\text{Mg}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{H}_2(\text{g})$	1
	Total:	16