
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

October/November 2017

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	I All the following data is recorded • both burette readings and the titre for the rough titration • 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 / value • final / end (burette) reading / volume / value • titre or volume / FA 4 and used / added • unit: / cm³ or (cm³) or in cm³ (for each heading) or cm³ unit given for each volume recorded	1
	III All accurate burette readings are to the nearest 0.05 cm³. <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 The final accurate titre recorded is within 0.10 cm³ of any other accurate titre.	1
	Examiner rounds any accurate burette readings to the nearest 0.05 cm³, checks subtractions and then selects the “best” titres using the hierarchy: • identical titres <i>then</i> • accurate titres within 0.05 cm³, <i>then</i> • 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 cm³. Examiner compares candidate’s mean titre value with that of the Supervisor.	
	Award V, VI and VII if $\delta \leq 0.20$ (cm³)	1
	Award V and VI if $0.20 < \delta \leq 0.40$	1
	Award V, only, if $0.40 < \delta \leq 0.60$	1

Question	Answer	Marks
1(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 / 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. 26.666 cm^3 must be rounded to 26.67 cm^3) 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	1
1(c)(i)	Correctly calculates No of moles of thiosulfate used $= 0.105 \times \frac{\text{mean titre}}{1000}$ to 3 or 4 sf	1
1(c)(ii) and (iii)	Correct use of data in both parts (ii) moles $\text{I}_2 = 0.5 \times \text{ans (i)}$ and (iii) moles FA1 $= 0.025 \times 0.0197 (= 0.000493, 0.0004925)$	1

Question	Answer	Marks
1(c)(iv)	Correctly calculates answer, expressed as integer No of moles = $\frac{(ii)}{(iii)}$	1
1(c)(v)	Correct balancing and value of x First mark: integer in answer (iv) shown in front of I ₂ and correct number of moles of I ⁻ entered in equation	1
	Second mark: any equation fully balanced IO ₃ ⁻ + 5I ⁻ + 6H ⁺ → 3I ₂ + 3H ₂ O	1
1(c)(vi)	Oxidation state = 2x – 1.	1

Question	Answer	Marks
2(a)	I (i) (Goes) yellow (ii) (On cooling, becomes) white solid / residue / powder	1
	II: Table of data Appropriate headings: Mass of crucible and lid Mass of crucible, lid and FA 5 (or “contents before heating”) Mass of crucible, lid and residue / ZnO / contents after heating Mass of FA 5 used Mass of residue	1
	III: Weighings shown in list / table Six weighings all recorded in the space provided All weighings recorded to same number of decimal places (one or more)	1
	IV: Both masses of FA 5 and residue, correctly subtracted - Masses of FA 5 used recorded on pages 4 and 5, correctly subtracted - Masses of FA 5 used were between 2.1 – 2.5 and 1.5 – 1.9 g - Masses of residue recorded on page 5, correctly subtracted	1
	Examiners check and correct (if necessary) the masses of FA 5 used and masses of ZnO obtained by the supervisor and by the candidate for both experiments. Examiners calculate the ratio $\frac{\text{mass of FA 5}}{\text{mass of ZnO}}$ for the supervisor and candidate for each experiment to 2 dp and take the average of the two to 2 dp. Examiner calculates δ the difference between these two ratios. Award V if δ for Expt 1 ≤ 0.10 Award VI if δ for Expt 2 ≤ 0.10	2
2(b)(i)	$M_r = 99.4$	1
2(b)(ii)	$M_r = 125.4 + 99.4y$	1
2(b)(iii)	No of moles = $\frac{\text{mass of FA 5 (expt 1)}}{\text{ans (ii)}}$	1

Question	Answer	Marks
2(b)(iv)	No of moles ZnO = $(1 + y) \times$ answer (iii)	1
2(b)(v)	Correctly calculates moles of ZnO - No of moles ZnO = $\frac{\text{mass of residue}}{81.4}$ - Answer must be expressed to 2 or more significant figures	1
2(b)(vi)	Use of (iv) = (v) with working shown and an answer to 1 dp	1
2(c)(i)	Heat (crucible and residue) to constant mass or cool in a desiccator	1
2(c)(ii)	Experiment 1 because (larger masses) have lower percentage error (in weighing).	1

Question	Answer	Marks												
3(a)	Tabulation of observations Clear presentation of results to show FA 6 , FA 7 and FA 8 with the reagents specified.	1												
		3												
	<table><tr><td></td><td>H₂SO₄</td><td>NaOH</td></tr><tr><td>FA 6</td><td>fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow</td><td>no reaction / no change / no ppt</td></tr><tr><td>FA 7</td><td>no reaction / no change</td><td>on warming, gas / NH₃ turns litmus blue</td></tr><tr><td>FA 8</td><td>white precipitate</td><td>no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH</td></tr></table>			H₂SO₄	NaOH	FA 6	fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow	no reaction / no change / no ppt	FA 7	no reaction / no change	on warming, gas / NH ₃ turns litmus blue	FA 8	white precipitate	no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH
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FA 8	white precipitate	no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH												
2 correct boxes for each mark														
3(b)	Add silver nitrate followed by ammonia or silver nitrate and nitric acid (and ammonia)	1												
	FA 7 cream ppt and FA 8 no reaction / no change / no ppt	1												

Question	Answer	Marks
3(c)(i)	For FA 6 and FA 7 or FA 8 not identified in (b) as a halide uses NaOH + Al and there is evidence of heating mixture	1
	Observations for both compounds tested gas / ammonia turns (red) litmus blue	1
3(c)(ii)	Uses the same unknowns as (i) and adds a named dilute acid or correct formula Allow if “acid” on reagent line and correct formula given in table, or adds (acidified) potassium manganate(VII)	1
	Observations: both must be correct for the reagent selected. If HCl or HNO₃ used - with FA 6, fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow - with FA 7, no reaction - with FA 8, no reaction If H₂SO₄ used - with FA 6, fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow - with FA 7, no reaction - with FA 8, white precipitate If acidified KMnO₄ used - with FA 6, decolourised / <u>goes</u> colourless / loses purple colour - with FA 7, no reaction / KMnO₄ not decolourised (or stays purple) - with FA 8, white / pink (allow “pale purple”) precipitate formed	1
3(d)	Correct formulae of unknowns FA 6 is NaNO₂ FA 7 is NH₄Br FA 8 is Ba(NO₃)₂ / Ca(NO₃)₂ three formulae correct = 2 marks one formula correct = 1 mark	2

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Question	Answer	Marks
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 FA 1 added recorded for each accurate titre. <i>Headings should match readings.</i> - initial / start and (burette) reading / volume (<i>allow vol but not V</i>) - final / end and (burette) reading / volume - titre or volume / FA 1 and used/added (<i>but not “difference” or “total” or “change”</i>) 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 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 The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Examiner rounds any accurate burette readings to the nearest 0.05 cm ³ and then selects the ‘best’ titres using the hierarchy: - two (or more) accurate identical titres, 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 cm ³ . Examiner compares candidate’s titre value with that of the Supervisor:	

Question	Answer	Marks
1(a)	Award V , VI and VII if $\delta \leq 0.30 \text{ (cm}^3\text{)}$	1
	Award V and VI if $0.30 < \delta \leq 0.60$	1
	Award V , only, if $0.60 < \delta \leq 1.00$	1
1(b)	Candidate calculates the mean correctly. • 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 rounded to nearest 0.01 cm^3. (e.g. 26.666 cm^3 must be rounded to 26.67 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. (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 performed only one 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. 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)	Correctly calculates $\text{Number of moles of } \text{S}_2\text{O}_3^{2-} \text{ used} = 0.150 \times \frac{\text{(b)}}{1000}$ Answer given to 3 or 4 sf	1
1(c)(ii)	Correctly calculates ans(ii) = ans(i) Answer given to 3 or 4 sf	1

Question	Answer	Marks
1(c)(iii)	Correct use ans(ii) / 0.0250 (or equivalent) Answer given to 3 or 4 sf	1
1(c)(iv)	Correct expression 32.5 / ans(iii) – 159.6	1
	Correct answer x = nearest integer to $\frac{[32.5 / \text{ans(iii)} - 159.6]}{18}$	1
1(d)(i)	Correct expression Use of $\frac{0.1(0)}{\text{any accurate titre}} \times 100$	1
1(d)(ii)	The volume from the burette has a smaller error / more precise	1
	FA 3 is in excess	1

Question	Answer	Marks
2(a)	I Table of data Must show all of the following: • mass of crucible (+ lid) • mass of crucible (+ lid) + FA 5 • mass of crucible (+ lid) + residue • mass of FA 5 • mass of residue • mass of water lost	1
	II Recording of data • Unit / g, (g) or in grams for all data recorded • all three balance readings recorded to same number of dp	1
	III Correctly calculates • mass of FA 5, • mass of residue, • mass of water lost	1
	Examiner checks supervisor's subtraction for mass of FA 5 and mass of residue and calculates the ratio mass of FA 5 ÷ mass of residue to 2 dp. Examiner compares candidate's value with that of Supervisor.	
	Award IV if $\delta \leq 0.10$	1
	Award V if $\delta \leq 0.05$	1
2(b)(i)	Correctly uses (i) = mass of residue / 208.3 Answer given to 2–4 sf	1
2(b)(ii)	Correctly calculates (ii) = mass of water lost / 18 Answer given to 2–4 sf	1
2(b)(iii)	Correctly calculates (ii) ÷ (i) and y as an integer	1

Question	Answer	Marks
2(c)(i)	Greater mass lost / smaller mass of residue / fewer moles of residue / greater mass of water (appears to be lost)	1
	so y would be greater	1
2(c)(ii)	heat to constant mass OWTTE / cooling in a desiccator	1

Question	Answer	Marks
FA 6 is $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$; FA 7 is $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$		
3(a)(i)	FA 6 (Heating) produces water vapour / steam / moisture or condensation / solution / liquid forms / melts / dissolves AND FA 7 (Heating) produces water vapour / steam / moisture or condensation / solution / liquid forms / melts	1
	FA 6 (stronger heating) gives a white solid/ residue AND FA 7 a yellow / green / brown / black solid/ residue	1
	Gas / chlorine / Cl_2 from heating FA 7 bleaches damp litmus paper or Gas / hydrogen chloride / HCl from heating FA 7 turns litmus red.	1
3(a)(ii)	water	1

Question	Answer	Marks															
3(b)(i)	Clear presentation of results to show FA 6 and FA 7 and two or more reagents.	1															
	Uses NaOH(aq) and NH ₃ (aq).	1															
		2															
	<table><tr><td></td><td>FA 6</td><td>FA 7</td></tr><tr><td>NaOH</td><td>white ppt and no change / insoluble with excess</td><td>(pale / light) blue ppt and no change / insoluble with excess</td></tr><tr><td>NH₃</td><td>white ppt and no change / insoluble with excess</td><td>(pale) blue ppt and dark / deep blue solution with excess</td></tr></table>		FA 6	FA 7	NaOH	white ppt and no change / insoluble with excess	(pale / light) blue ppt and no change / insoluble with excess	NH ₃	white ppt and no change / insoluble with excess	(pale) blue ppt and dark / deep blue solution with excess							
	FA 6	FA 7															
NaOH	white ppt and no change / insoluble with excess	(pale / light) blue ppt and no change / insoluble with excess															
NH ₃	white ppt and no change / insoluble with excess	(pale) blue ppt and dark / deep blue solution with excess															
	Two boxes correct for each mark.																
3(b)(ii)		3															
	<table><tr><td><i>test</i></td><td colspan="2"><i>observations</i></td></tr><tr><td rowspan="2">+ Ba²⁺(aq)</td><td>FA 6</td><td>FA 7</td></tr><tr><td>white ppt</td><td>no reaction / no ppt / no change</td></tr><tr><td>+ excess of HCl or HNO₃</td><td>insoluble</td><td>no reaction / no ppt / no change</td></tr><tr><td>+ Ag⁺(aq)</td><td>no reaction / no ppt / no change</td><td>white ppt</td></tr></table>		<i>test</i>	<i>observations</i>		+ Ba ²⁺ (aq)	FA 6	FA 7	white ppt	no reaction / no ppt / no change	+ excess of HCl or HNO ₃	insoluble	no reaction / no ppt / no change	+ Ag ⁺ (aq)	no reaction / no ppt / no change	white ppt	
	<i>test</i>		<i>observations</i>														
	+ Ba ²⁺ (aq)		FA 6	FA 7													
white ppt		no reaction / no ppt / no change															
+ excess of HCl or HNO ₃	insoluble	no reaction / no ppt / no change															
+ Ag ⁺ (aq)	no reaction / no ppt / no change	white ppt															
	Two boxes correct for each mark.																
3(b)(iii)	FA 6 contains Mg ²⁺ / magnesium and SO ₄ ²⁻ / sulfate FA 7 contains Cu ²⁺ / copper(II) and Cl ⁻ / chloride 1 mark for 2 correct ions	2															

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Question	Answer	Marks
1(a)	I 5 (or more) experiments completed and Table to show Volume of FB 1 , Volume of water, Time and Rate	1
	II Correct units for all data Volume: in cm^3 or cm^3 or (cm^3) or cm^3 by each volume Time: /s or (s) or s by each time (<i>not sec or seconds but allow 'in seconds'</i>) Rate: /s ⁻¹ or (s ⁻¹) or s ⁻¹ by each rate	1
	III All times recorded to nearest second (minimum of 3 times)	1
	IV Two additional experiments with volume FB 1 not less than 10 cm^3 , not more than 40 cm^3 and no volume $\leq 2 \text{ cm}^3$ close to another volume.	1
	V Volumes of water chosen so that FB1 + water = 40 cm^3 for additional experiments carried out.	1
	VI Correctly calculates rate for all experiments and shown to 2 – 4 sf.	1
	VII Award if all candidate's times increase with decrease in volume of FB 1 .	1
	VIII Award if candidate's time to nearest second for Experiment 2 is within 10% of the supervisor's result	1
	IX Award if candidate's (time for FB 1 = 20)/(time FB 1 = 40) is between 1.90 and 2.40	1
	X Award if candidate's (time for FB 1 = 20)/(time FB 1 = 40) is between 2.00 and 2.30	1
1(b)	Linear scales that cover more than half the space in both directions and axes labelled correctly (allow the correct unit as the label)	1
	Points plotted correctly. Points must be within half a small square of the correct position, if the point should be on a line it must be on the line and if it should not be on the line it must not be so.	1
	Line of best fit drawn which ignores anomalous results identified by the candidate	1

Question	Answer	Marks
1(c)	Correct line drawn within 1 small square (horizontal line must be shown and some mark shown at 8).	1
	Correctly calculates = $1000/\text{rate}$ (to 2 – 4 sf or a whole number of seconds).	1
1(d)(i)	The print (on the insert) would take longer to disappear	1
	The liquid would be less deep	1
1(d)(ii)	The reaction time would be longer / reaction is slower / rate is less	1
	Accuracy improved because the percentage error in time less OR Accuracy not improved because more difficult to judge when print disappeared	1
1(e)	Expression % = $(1 / \text{Reaction time Experiment 1}) \times 100$ OR $(0.5 / \text{Reaction time Experiment 1}) \times 100$	1
1(f)	Keep volume thiosulfate / FB1 constant and vary volume acid / FB 2	1
	Keep total volume FB 2 + water constant	1
	Keep temperature constant / use same (shape) reaction vessel / use same printed sheet / carry out 5 (or more) expts with different volumes HCl / FB 2	1
1(g)(i)	Straight line through origin (with positive gradient)	1
1(g)(ii)	Straight horizontal line	1

Question	Answer				Marks
FB 3 is NaOH(aq), FB 4 is NH ₃ (aq), FB 5 is MgCl ₂ (aq), FB 6 is CuCl ₂ (aq), FB 7 is Na ₂ S ₂ O ₃ (aq), FB 8 is Na ₂ S ₂ O ₈ (aq), FB 9 is Na ₂ SO ₄ (aq).					
2(a)(i)		FB 4	FB 5	FB 6	3
	FB 3	No reaction / no change / solution remains colourless	White ppt	(Pale / light) blue ppt	
	FB 4		White ppt	Dark / deep blue solution / (pale/light) blue ppt	
	FB 5			No reaction / no change	
	6 correct boxes = 3 marks, 4 or 5 correct boxes = 2 marks, 2 or 3 correct boxes = 1 mark.				
2(a)(ii)	OH ⁻ / hydroxide				1
2(a)(iii)	Named indicator eg red litmus ('red' could be in the results) or formula / named (aqueous) salt that gives insoluble hydroxides				1
	Positive result for alkali				1
2(a)(iv)	Two of Mg ²⁺ , Zn ²⁺ , Al ³⁺ , Ca ²⁺ , Ba ²⁺				1
2(a)(v)	Test to distinguish ions in (iv)				1
	Result of test and appropriate conclusion				1

Question	Answer				Marks
2(b)(i)		FB 7	FB 8	FB 9	3
	KI	No reaction / no change / solution remains colourless	Yellow / brown colour	No reaction / no change / solution remains colourless	
	starch		then blue-black / black / dark blue		
	I ₂	Decolourises	No reaction	No reaction / (stays) yellow / brown	
	Ba ²⁺	No reaction no change / solution remains colourless / no ppt	(ignore responses here)	White ppt	
	9 correct boxes = 3 marks 6, 7 or 8 correct boxes = 2 marks 3, 4 or 5 correct boxes = 1 mark				

Question	Answer	Marks
2(b)(ii)	SO_4^{2-} or SO_3^{2-} (both needed)	1
2(b)(iii)	Add suitable named acid to FB 9 and $\text{Ba}(\text{NO}_3)_2$ / BaCl_2 ppt or Add (acidified aqueous) potassium manganate(VII) / KMnO_4 to FB 9 or Add named acid and test (any) gas evolved with (acidified aqueous) potassium manganate(VII)	1
	Anion present: SO_4^{2-} and No effect of acid on (white) ppt or (Solution) turns purple / purple not decolourised or No bubbles / manganate(VII) paper remains purple / blue litmus remains blue	1

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1(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 / 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. 26.666 cm^3 must be rounded to 26.67 cm^3) 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	1
1(c)(i)	Correctly calculates No of moles of thiosulfate used $= 0.105 \times \frac{\text{mean titre}}{1000}$ to 3 or 4 sf	1
1(c)(ii) and (iii)	Correct use of data in both parts (ii) moles $\text{I}_2 = 0.5 \times \text{ans (i)}$ and (iii) moles FA1 $= 0.025 \times 0.0197 (= 0.000493, 0.0004925)$	1

Question	Answer	Marks
1(c)(iv)	Correctly calculates answer, expressed as integer No of moles = $\frac{(ii)}{(iii)}$	1
1(c)(v)	Correct balancing and value of x First mark: integer in answer (iv) shown in front of I ₂ and correct number of moles of I ⁻ entered in equation	1
	Second mark: any equation fully balanced IO ₃ ⁻ + 5I ⁻ + 6H ⁺ → 3I ₂ + 3H ₂ O	1
1(c)(vi)	Oxidation state = 2x – 1.	1

Question	Answer	Marks
2(a)	I (i) (Goes) yellow (ii) (On cooling, becomes) white solid / residue / powder	1
	II: Table of data Appropriate headings: Mass of crucible and lid Mass of crucible, lid and FA 5 (or “contents before heating”) Mass of crucible, lid and residue / ZnO / contents after heating Mass of FA 5 used Mass of residue	1
	III: Weighings shown in list / table Six weighings all recorded in the space provided All weighings recorded to same number of decimal places (one or more)	1
	IV: Both masses of FA 5 and residue, correctly subtracted - Masses of FA 5 used recorded on pages 4 and 5, correctly subtracted - Masses of FA 5 used were between 2.1 – 2.5 and 1.5 – 1.9 g - Masses of residue recorded on page 5, correctly subtracted	1
	Examiners check and correct (if necessary) the masses of FA 5 used and masses of ZnO obtained by the supervisor and by the candidate for both experiments. Examiners calculate the ratio $\frac{\text{mass of FA 5}}{\text{mass of ZnO}}$ for the supervisor and candidate for each experiment to 2 dp and take the average of the two to 2 dp. Examiner calculates δ the difference between these two ratios. Award V if δ for Expt 1 ≤ 0.10 Award VI if δ for Expt 2 ≤ 0.10	2
2(b)(i)	$M_r = 99.4$	1
2(b)(ii)	$M_r = 125.4 + 99.4y$	1
2(b)(iii)	No of moles = $\frac{\text{mass of FA 5 (expt 1)}}{\text{ans (ii)}}$	1

Question	Answer	Marks
2(b)(iv)	No of moles ZnO = $(1 + y) \times \text{answer (iii)}$	1
2(b)(v)	Correctly calculates moles of ZnO - No of moles ZnO = $\frac{\text{mass of residue}}{81.4}$ - Answer must be expressed to 2 or more significant figures	1
2(b)(vi)	Use of (iv) = (v) with working shown and an answer to 1 dp	1
2(c)(i)	Heat (crucible and residue) to constant mass or cool in a desiccator	1
2(c)(ii)	Experiment 1 because (larger masses) have lower percentage error (in weighing).	1

Question	Answer	Marks												
3(a)	Tabulation of observations Clear presentation of results to show FA 6 , FA 7 and FA 8 with the reagents specified.	1												
		3												
	<table><tr><td></td><td>H₂SO₄</td><td>NaOH</td></tr><tr><td>FA 6</td><td>fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow</td><td>no reaction / no change / no ppt</td></tr><tr><td>FA 7</td><td>no reaction / no change</td><td>on warming, gas / NH₃ turns litmus blue</td></tr><tr><td>FA 8</td><td>white precipitate</td><td>no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH</td></tr></table>			H₂SO₄	NaOH	FA 6	fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow	no reaction / no change / no ppt	FA 7	no reaction / no change	on warming, gas / NH ₃ turns litmus blue	FA 8	white precipitate	no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH
			H₂SO₄	NaOH										
	FA 6		fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow	no reaction / no change / no ppt										
FA 7	no reaction / no change	on warming, gas / NH ₃ turns litmus blue												
FA 8	white precipitate	no reaction / no change / no ppt or (faint) white ppt and insoluble in excess NaOH												
2 correct boxes for each mark														
3(b)	Add silver nitrate followed by ammonia or silver nitrate and nitric acid (and ammonia)	1												
	FA 7 cream ppt and FA 8 no reaction / no change / no ppt	1												

Question	Answer	Marks
3(c)(i)	For FA 6 and FA 7 or FA 8 not identified in (b) as a halide uses NaOH + Al and there is evidence of heating mixture	1
	Observations for both compounds tested gas / ammonia turns (red) litmus blue	1
3(c)(ii)	Uses the same unknowns as (i) and adds a named dilute acid or correct formula Allow if “acid” on reagent line and correct formula given in table, or adds (acidified) potassium manganate(VII)	1
	Observations: both must be correct for the reagent selected. If HCl or HNO₃ used - with FA 6, fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow - with FA 7, no reaction - with FA 8, no reaction If H₂SO₄ used - with FA 6, fizzing / bubbling or pale brown gas (formed) or yellow solution (formed) or goes yellow - with FA 7, no reaction - with FA 8, white precipitate If acidified KMnO₄ used - with FA 6, decolourised / <u>goes</u> colourless / loses purple colour - with FA 7, no reaction / KMnO₄ not decolourised (or stays purple) - with FA 8, white / pink (allow “pale purple”) precipitate formed	1
3(d)	Correct formulae of unknowns FA 6 is NaNO₂ FA 7 is NH₄Br FA 8 is Ba(NO₃)₂ / Ca(NO₃)₂ three formulae correct = 2 marks one formula correct = 1 mark	2

CHEMISTRY

9701/36

Paper 3 Advanced Practical Skills 2

October/November 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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2017 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

Question	Answer	Marks
1(a)	I All the following data is recorded • burette readings and titre for rough titration • initial and final burette readings for two (or more) accurate titrations (<i>i.e.</i> 2×2 box). <i>Headings and units are not required for this mark</i>	1
	II Headings and units correct for accurate titration table and headings match readings. • initial / start (burette) reading / volume • final / end (burette) reading / volume • titre or volume / FB 2 and used / added • units: (cm^3) or / cm^3 or in cm^3 or cm^3 for each volume recorded	1
	III All accurate burette readings to 0.05 cm^3. <i>Do not award this mark if:</i> • <i>50.(00) is used as an initial burette reading;</i> • <i>more than one final burette reading is 50.(00);</i> • <i>any burette reading is greater than 50.(00).</i>	1
	IV The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	1
	Examiner rounds any accurate burette readings to the nearest 0.05 cm^3, checks subtractions and then selects 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 mean titre value with that of the Supervisor.	

Question	Answer	Marks
1(a)	Award V and VI if $\delta \leq 0.30 \text{ cm}^3$	1
	Award V if $0.30 < \delta \leq 0.60 \text{ cm}^3$	1
1(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 / 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. 26.666 cm^3 must be rounded to 26.67 cm^3) 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) <i>Do not award this mark 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	1
1(c)(i)	Correctly calculates number of moles of $\text{MnO}_4^- = \frac{0.02 \times \text{vol in (b)}}{1000}$	1
1(c)(ii)	Correctly uses: (i) $\times 5/2$ (to a minimum of 2 sf)	1

Question	Answer	Marks
1(d)	$(\text{COOH})_2(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow (\text{COONa})_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$	1
1(e)	Table clearly showing 2 (or more) accurate initial and final volumes and titres. Subtraction for titres must be correct.	1
	Examiner rounds any accurate burette readings to the nearest 0.05 cm^3 , checks subtractions and then selects 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 mean titre value with that of the Supervisor.	
	Award 3 marks if $\delta \leq 0.20 \text{ cm}^3$.	1
	Award 2 marks if $0.20 < \delta \leq 0.40 \text{ cm}^3$.	1
	Award 1 mark if $0.40 < \delta \leq 0.60 \text{ cm}^3$.	1
1(f)(i), (ii) and (iii)	Correctly uses mean in (i) and number of moles of NaOH = $\frac{0.04 \times \text{vol in (i)}}{1000}$ in (ii) and moles $(\text{COOH})_2 = (\text{ii})/2$ in (iii)	1
1(g)(i)	Correctly uses (c)(ii) – (f)(iii)	1
1(g)(ii)	Correctly uses mass $(\text{COONa})_2 = (\text{g})(\text{i}) \times 134$	1
1(g)(iii)	Correctly uses mass $(\text{COOH})_2 = (\text{f})(\text{iii}) \times 90$	1

Question	Answer	Marks
1(g)(iv)	Correct expression $\frac{(g)(iii)}{(g)(ii) + (g)(iii)} \times 100$ (or correct answer)	1
	Significant figures mark Answers to (c) , (f) and (g) all to 3 or 4 sf (Minimum 6 answers attempted)	1
1(h)(i)	No change • since the number of moles of acid stays the same, or • as the water will not react, or • as the mole ratio stays the same, or • as the concentration of acid (FB 1) stays the same	1
1(h)(ii)	% mass of acid decreases as there is now water as part of the total mass or M_r of (hydrated) acid increases so multiply moles by bigger number so % mass of (hydrated) acid increases	1
1(i)	Would be more accurate since the titre volume is bigger so smaller percentage error.	1

Question	Answer	Marks
FB 5 is $\text{MnCl}_2(\text{aq})$, FB 6 is $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2(\text{aq})$, FB 7 is $\text{KMnO}_4(\text{aq})$, FB 8 is $\text{KMnO}_4(\text{s})$		
2(a)(i)	sodium hydroxide buff / pale or light brown / fawn / beige / off-white ppt	1
	hydrogen peroxide (turns) dark brown / black solid / ppt	1
	effervescence / bubbling / fizz and gas relights glowing splint	1
2(a)(ii)	green ppt insoluble in excess	1
2(a)(iii)	brown ppt insoluble in excess	1
2(a)(iv)	purple to colourless (allow purple to (pale) yellow / pale orange)	1
2(a)(v)	brown solid / ppt	1
2(a)(vi)	yellow / brown (solution) and blue-black / black / dark blue with starch	1
2(b)	FB 5 manganese / Mn / Mn^{2+} / Mn(II)	1
	FB 6 iron / Fe / Fe^{2+} / Fe(II)	1
	FB 7 manganese / Mn / Mn(VII)	1
2(c)	(iodide ions are) oxidised to iodine / (iodide ions) lose electrons to form iodine / $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^{(-)}$	1
2(d)(i)	Gas relights glowing splint	1
2(d)(ii)	Green solution / liquid	1

Question	Answer	Marks
2(e)(i)	Tests: (aqueous) silver nitrate and (aqueous) barium nitrate / chloride	1
	white ppt with Ba ²⁺ and insoluble in named acid (not sulfuric acid) and no ppt with Ag ⁺	1
2(e)(ii)	anion = sulfate / SO ₄ ²⁻	1