
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

May/June 2019

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	Unambiguous recording of volume of gas, 2 balance readings to same dp and correct mass of FA 2 used. Units as /cm ³ or (cm ³) and / g or (g).	1
	Volume of gas within range 0.9 – 1.1 × supervisor volume	1
	Volume of gas within range 0.8 – 1.2 × supervisor volume	1
1(b)(i)	Correctly calculates moles = vol of gas / 24 000 AND answer given to 2 – 4 sf	1
1(b)(ii)	Correct use of $M_r = \frac{\text{mass from (a)}}{(b)(i)}$	1
	Use of 60	1
	Correct (from candidate's value of M_r) A_r and correct to 2 to 4 sf $\text{Be} \leq 16.65$; $16.65 \leq \text{Mg} \leq 32.10$; $32.10 \leq \text{Ca} \leq 63.85$; $63.85 \leq \text{Sr} \leq 112.45$; $112.45 \leq \text{Ba}$	1
1(b)(iii)	Identification of M as Group 2 metal with nearest A_r	1
1(c)(i)	Student not correct as too much gas for measuring cylinder OR Student not correct as the acid is not in excess.	1
1(c)(ii)	Student correct because CO ₂ soluble in water / reacts with water.	1

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Question	Answer	Marks
2(a)	I Correct headings and units shown. Mass of crucible (+ lid) (Use of lid must be consistent) Mass of crucible (+ lid) + FA 3 Mass of crucible (+ lid) + residue / contents after heating Mass of FA 3 (used) Mass of residue	1
	II All balance readings to same dp and recorded mass QCO₃ between 1.30 g and 1.50 g AND Mass QCO₃ and residue correctly calculated	1
	Award III and IV if $\delta \leq 0.10$	1
	Award IV if $\delta \leq 0.20$ Do not allow any Q marks if mass of residue $\geq$ mass of FA 3.	1
2(b)(i)	Correctly calculates moles = candidate's mass lost / 44 and answer to 2 – 4 sf	1

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Question	Answer	Marks
2(b)(ii)	Correct use of $M_r = \frac{\text{candidate's mass of } \text{QCO}_3}{\text{(b)(i)}}$	1
	Use of 60	1
	Use of 3 – 4 sf for M_r and correct A_r If no subtraction at step 2 then step 3 cannot be awarded.	1
	Identification of Q as Group 2 metal with nearest A_r Do not allow ecf if no evidence to support conclusion.	
	$\text{Be} \leq 16.65$; $16.65 \leq \text{Mg} \leq 32.10$; $32.10 \leq \text{Ca} \leq 63.85$; $63.85 \leq \text{Sr} \leq 112.45$; $112.45 \leq \text{Ba}$	1
2(c)	So that water vapour / carbon dioxide (from air) not absorbed.	1
2(d)(i)	Heat to constant mass.	1
2(d)(ii)	Add an acid and it will fizz / bubble / effervesce or Add named acid and pass gas through limewater which turns milky / cloudy white / chalky / forms white ppt	1
2(e)(i)	(Mass lost too low $\rightarrow$) moles CO₂ too low ($\rightarrow$ moles QCO₃ (or residue) too low $\rightarrow$ M_r too high $\rightarrow$) A_r too high	1
2(e)(ii)	Method is valid since 1 mol QCO₃ gives 1 mol QO . OR moles QO : CO₂ = 1 : 1	1

Question	Answer			Marks
3(a)(i)		FA 4	FA 5	5
	HCl	No (visible) reaction / no change * <i>Allow pale yellow solution / colourless solution</i>	Pale yellow / cream / white / off-white ppt *(ignore excess)	
	CuSO ₄	Brown (ppt/ colour / soln) * <i>Do not allow orange/-brown or red-brown</i>	Green soln * allow blue-green / cyan / turquoise ppt is CON	
	AgNO ₃	(pale) Yellow ppt *	Yellow ppt / black ppt / grey ppt / (allow solid/ particles for ppt) *	
	+ NH ₃	Insol in NH ₃ * <i>Allow no change</i>	ignore NH ₃	
	Cl ₂	Yellow or brown or red-brown / orange-brown / yellow-brown soln * <i>Do not allow orange. Ppt is CON</i>	No (visible) reaction / no change * <i>Allow colourless solution.</i>	
	+ FA 5	Decolourised * If Cl ₂ reaction is incorrect then allow ecf e.g. colourless solution		
	For every two correct observations (*) award 1 mark (round down) Allow no observation for no (visible) change.			
3(a)(ii)	FA 4 contains iodide / I ⁻ Or FA 5 contains thiosulfate / S ₂ O ₃ ²⁻			1
3(a)(iii)	Reagent: starch Observation expected: dark blue or blue / black colour			1

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Question	Answer	Marks
3(b)(i)	(Red) litmus turns blue Gas turns litmus blue is CON	1
3(b)(ii)	$\text{QO(s)} + \text{H}_2\text{O(l)} \rightarrow \text{Q(OH)}_2\text{(s)} / \text{(aq)}$	1
3(c)(i)	hydrochloric / nitric acid allow sulfuric acid accept correct formula	1
3(c)(ii)	Clear layout to show tests, observations and conclusions.	1
	(Chooses) NH_3 Ignore NaOH / named sulfate / H_2SO_4 Any other reagent is CON	1
	FA 6: no ppt / no (visible) change / no reaction / colourless solution. (allow no observation)	1
	FA 7: white ppt insoluble in excess Ignore observations with other reagents	1
	M is calcium (or barium), Q is magnesium	1
3(c)(iii)	Conclusions to follow identification of M or Q in Questions 1 and 2 and conclusions of tests in (b)(ii)	1

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1(a)	I: All the following data is recorded, with 'g' units - three masses with unambiguous headings (<i>not</i> 'weight') - both weighings recorded to same number of d.p. (one or more) - mass of FB 1 is correctly subtracted - mass of FB 1 used is between 2.5 and 2.7 g	1
	II: All the following data is recorded - rough titration: both burette readings and the rough titre - initial and final burette readings for two (or more) accurate titrations (<i>i.e.</i> a 2×2 'box') <i>Headings and units are not required for this mark</i>	1
	III: Correct headings and units given in the accurate titration table - initial / start and (burette) reading / volume - final / end and (burette) reading / volume - titre or volume / FB 2 and used / added (<i>not</i> 'amount') - 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 .	1
	V: The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre	1
	Award VI, VII and VIII if $\delta \leq 0.10$ (cm ³ g ⁻¹)	1
	Award VI and VII if $0.10 < \delta \leq 0.20$	1
	Award VI , only if $0.20 < \delta \leq 0.40$	1

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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. • the mean should be quoted to 2 d.p., and be rounded to nearest 0.01 cm³.	1
1(c)(i)	Significant figures The answers to (ii), (iii) and (iv) must all be expressed to 3 or 4 sig. fig.	1
1(c)(ii)	Correctly calculates no of moles NaOH No. of moles of NaOH used = $0.110 \times \text{mean titre} / 1000$	1
1(c)(iii)	Equation balanced with state symbols correct. $\text{NaOH(aq)} + \text{HSO}_x\text{NH}_2\text{(aq)} \rightarrow \text{NaSO}_x\text{NH}_2\text{(aq)} + \text{H}_2\text{O(l)}$ and correct answer: no. of moles of FB 3 = ans (ii)	1
1(c)(iv)	Correct use of M_r of FB 1 = mass of FB 1 weighed out / $10 \times \text{no of moles of FB 3 (from (iii))}$	1
1(c)(v)	Correct expression and gives the answer as an integer $x = [\text{ans (iv)} - 49.1] / 16$	1

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Question	Answer	Marks
1(d)	Method: Dissolve FB 1 in water or use FB 3 and add (aqueous) BaCl_2 / $\text{Ba}(\text{NO}_3)_2$ or (aqueous) barium chloride / barium nitrate	1
	Observation: no reaction / no precipitate / solution stays colourless and Deduction: barium amidosulfonate is soluble in water	1

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Question	Answer	Marks
2(a)	I: Table / list of data , to include values and correct headings and units: - Mass of crucible (and lid) - Mass of crucible, (lid) + FB 4 (or ‘contents before heating’) - Mass of crucible, (lid) + residue / CuO / contents after heating - Mass of FB 4 (used) - Mass of residue / CuO (obtained)	1
	Accuracy (Q) marks in 2(a) - To assess accuracy, check the masses of FB 4 used and of CuO obtained by the supervisor and by the candidate. - Work out the ratio $\frac{\text{mass of FB4}}{\text{mass of CuO}}$ for the supervisor (to 2 d.p.) - Work out ratio (mass FB 4: mass CuO) for the candidate (2 d.p.) - Calculate δ, the difference between these two ratios.	
	Award II and III if $\delta \leq 0.05$	1
	Award III if $0.05 < \delta \leq 0.10$	1
	IV: Observations made during heating (Solid changes from) green / turquoise / cyan / blue-green to black (<i>both colours required</i>) or black solid / residue (formed)	1
2(b)(i)	Correctly calculated no. of moles of CuO - No. of moles CuO = $\frac{\text{mass of residue}}{79.5}$ - Answer must be correct and expressed to 2, 3 or 4 sig. fig.	1

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Question	Answer	Marks
2(b)(ii)	Correct use of mole ratio 1 : 2 No. of moles of FB 4 = $\text{answer (i)} / 2$	1
	Correctly uses n to calculate M_r of copper hydroxycarbonate, $M_r = \text{mass of FB 4 used} / \text{no. of moles of FB 4}$ - Answer (for M_r) must be expressed to 2, 3 or 4 sig. fig. - Some working must be shown to access the second mark	1
2(b)(iii)	$M_r = 221$	1
	Appropriate comment on the value of y - If answer 2(b)(ii) is less than 221, candidate should state that y is negative, so the experiment has been inaccurate - If answer 2(b)(ii) is between 213 and 229, then (within experimental error) there is no water of crystallisation - If answer 2(b)(ii) is greater than 221, candidate should calculate the value of y and state that it should be an integer	1
2(c)	Heat to constant mass (or description of procedure)	1

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Question	Answer	Marks
3(a)(i)	Observations when heating FB 5: • <u>gas / ammonia</u> turns (red) litmus blue	1
	Any of the following score one mark each: • condensation produced or water droplets (at top of tube); • white smoke / steam / steamy fumes produced; • solid sublimes / solid forms at the top of the tube; • no residue at the end of the expt. / solid changes to a gas / solid disappears	2
3(a)(ii)	Both observations required for first mark • fizzing / bubbling / effervescence • solid dissolved or colourless solution formed or (reaction is) rapid / vigorous	1
	Gas tested: gas / carbon dioxide turns lime water milky / cloudy white / white ppt / chalky	1
3(a)(iii)	$(\text{NH}_4)_2\text{CO}_3$	1

Question	Answer	Marks																
3(b)(i)	Award one mark for every two correct observations (*)	4																
	<table><tr><th>test</th><th>observations</th></tr><tr><td>+ U.I.</td><td>violet / blue / dark blue / purple *</td></tr><tr><td>+ Mn²⁺</td><td>off-white / pale brown / buff / beige precipitate * turns (darker) brown / dark on standing *</td></tr><tr><td>+ H₂SO₄</td><td>white precipitate *</td></tr><tr><td>+ Ag⁺</td><td>brown / grey precipitate *</td></tr><tr><td>+ NH₃</td><td>(brown / grey ppt) soluble (in excess) / ppt disappears / forms colourless solution or white ppt forms (on standing) *</td></tr><tr><td>+ Cu²⁺</td><td>(gives a) blue precipitate *</td></tr><tr><td>+ HCl</td><td>precipitate becomes paler or white / off-white precipitate / solid *</td></tr></table>		test	observations	+ U.I.	violet / blue / dark blue / purple *	+ Mn ²⁺	off-white / pale brown / buff / beige precipitate * turns (darker) brown / dark on standing *	+ H ₂ SO ₄	white precipitate *	+ Ag ⁺	brown / grey precipitate *	+ NH ₃	(brown / grey ppt) soluble (in excess) / ppt disappears / forms colourless solution or white ppt forms (on standing) *	+ Cu ²⁺	(gives a) blue precipitate *	+ HCl	precipitate becomes paler or white / off-white precipitate / solid *
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1(a)	I Constructs a table for results 4 columns, 2 rows (or vice versa) No data needed for this mark.	1
	II <u>Correct headings and units given on page 4.</u> (Volume of) FA 1 and (Volume of distilled) water in cm^3 or cm^3 or (cm^3) (reject ml) Time in seconds or s or (s) . Rate in s^{-1} or s^{-1} or (s^{-1}) (reject 1 / s) Ignore 500.	1
	III Precision of readings All times recorded to the nearest second and all volumes of FA 1 and water recorded to the nearest 0.05 cm^3 . A minimum of 4 experiments must be carried out and these must include volumes of FA 1 = 45.00 and 20.00 cm^3 for this mark.	1
	IV 3 additional volumes chosen with intervals not less than 5.00 cm^3 and all volumes of FA 1 $\geq 25.00 \text{ cm}^3$ (Allow 4 extra expts: 25, 30, 35, 40 cm^3)	1
	V In all 3 additional experiments water is added to make a total of 45.00 cm^3 (i.e. total FA 1 + water)	1
	VI Reaction times all decreasing as volume of FA 1 increases for all five experiments.	1
	Calculate the ratio t_{20} / t_{45} to 2 dp. If either/both expts 1 and 2 are omitted then VII and VIII are not available.	
	VII Award 1 mark for ratio between 2.10 and 2.60.	1
	VIII Award 2 marks for ratio between 2.20 and 2.50.	1
	IX All rates correctly calculated using $\frac{500}{\text{time}}$ for at least 3 expts. All recorded to a minimum of 2 sf.	1

Question	Answer	Marks
1(b)	I Rate on y-axis and volume of FA 1 on the x-axis and some numbers for scales and with unambiguous names or units.	1
	II Linear scales chosen so that the graph occupies more than half the available length for both axes (count origin if included only if used by a point or extrapolation to x- or y-axis) (7 vertical, 5 horizontal big squares used)	1
	III All points recorded and accurately plotted. (A point needed for all rates calculated, minimum 4 rates) If the point should be on a line it must be on the line. If the point should not be on a line it must not be on a line and must be correct to within half a small square.	1
	IV Line of best fit drawn (straight or smoothly curved line) Ignore points marked anomalous	1
1(c)	Answer must match candidate's graph. (Rate is) proportional (to conc of thiosulfate)	1
1(d)	I Shows use of: time for experiment 2 (20 cm³) and time +2 or –2 (or ± 2 or shows use of 2)	1
	II Shows use of: $\frac{500}{(\text{candidate time for expt 2}) + 2}$	1
1(e)(i)	Concludes: Time would be greater AND as <u>depth</u> of solution is less or sulfur is spread over a larger (cross-sectional) area.	1
1(e)(ii)	Concludes: Not enough S / ppt / solid is produced (to obscure insert)	1

Question	Answer	Marks
2(a)	I Unambiguous headings for 3 masses and 3 temperatures AND Correct units.	1
	II Both balance readings recorded to the same dp AND Both thermometer readings recorded to either 0.0 or 0.5 °C	1
	III and IV Compare $\Delta T / m$ for candidate with that of supervisor. Award 2 marks if δ is within 0.15 of supervisor Award 1 mark if δ is within 0.30 of supervisor	2
2(b)(i)	Correctly calculates mass used AND Correctly calculates $\text{mass} / 248.2$ AND answer displayed to 3 or 4 sf	1
2(b)(ii)	Correctly calculates temperature change AND Correctly calculates $\Delta T \times 4.2 \times 25$ to a minimum of 2 sf	1
2(b)(iii)	Correctly uses $\text{ans(ii)} / \text{ans(i)}$ AND answer given to a minimum of 2 sf AND + sign AND appropriate units of kJ mol^{-1} or J mol^{-1}	1

Question	Answer	Marks
2(c)	Each correct suggestion = * Each correct explanation = * (Explanation must follow from available suggestion) 2 * = 1 mark, 3* = 2 marks Insulate the cup (or use a vacuum flask or use lid) * to prevent heat energy entering * Use a thermometer with smaller scale divisions / finer calibration / reads to more dp* to record the temperature with greater precision / increase accuracy (of temperature reading) * Use more FA 3 or less water * to make ΔT greater * Use burette or pipette (instead of measuring cylinder) * to record the volume with greater precision / increase accuracy (of volume reading) * Allow decrease in % error or increase accuracy only once as an explanation. If more than two suggestions given mark the first two only.	2
2(d)	Concludes: Solution was colder / lower temperature (so longer time/ lower rate)	1

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Question	Answer	Marks
FA 4 is H_2SO_4 ; FA 5 is CuCO_3		
3(a)(i)	Fizzing / effervescence / bubbles	1
	Uses limewater to test for CO_2 AND records positive result for gas / CO_2 / fizz (if no fizz recorded then gas / CO_2 must be specified) Allowed observations: limewater turns milky/ cloudy white/ forms white ppt.	1
3(a)(ii)	BaCl_2 or $\text{Ba}(\text{NO}_3)_2$ and HCl or HNO_3 (or names) Reject Ba^{2+} OR acidified KMnO_4 / potassium manganate(VII) / potassium permanganate / $\text{K}_2\text{Cr}_2\text{O}_7$ / potassium dichromate OR add named acid and test any gas with acidified KMnO_4 paper / $\text{K}_2\text{Cr}_2\text{O}_7$ paper	1
	White ppt insoluble in acid OR remains purple (ignore colour of ppt) / remains orange OR paper remains purple / remains orange	1
3(a)(iii)	Concludes: H_2SO_4	1

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Question	Answer	Marks
3(b)(i)	Solid / it / FA 5 turns black / green to black (ppt is CON)	1
	Condensation / water vapour / steam / tube becomes wet	1
	Effervescence / fizzing / bubbling AND blue solution / liquid formed Reject dark blue / green-blue for colour of solution. Reject blue solid / ppt. Ignore any incorrect gas test results.	1
	(pale) blue ppt AND insoluble in excess	1
	(pale) blue ppt AND (soluble) in excess to dark / deep blue solution Reject ink blue	1
3(b)(ii)	Concludes: Thermal decomposition Allow dehydration if water observed on heating.	1
3(b)(iii)	Concludes: Cu^{2+} AND CO_3^{2-} This is a stand-alone mark. Allow Cu^{2+} AND OH^- only if condensation in (b)(i)	1

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- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

PUBLISHED**GENERIC MARKING PRINCIPLE 5:**

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)	I The following data must be shown • burette readings and titre for rough titration • 2 × 2 'box' showing both accurate burette readings	1
	II Headings and units correct for accurate titration table and headings match readings. • initial / start (burette) reading / volume + unit • final / end (burette) reading / volume + unit • titre or volume / FB 1 and used / added + unit Units: (cm ³) or / cm ³ or in cm ³ or cm ³ by every entry	1
	III All accurate burette readings to 0.05 cm ³	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre	1
	Award V if $0.30 < \delta \leq 0.50 \text{ cm}^3$	1
	Award VI if $0.20 < \delta \leq 0.30 \text{ cm}^3$	1
	Award VII if $\delta \leq 0.20 \text{ cm}^3$	1
1(b)	Candidate must average two (or more) titres that are all within 0.20 cm ³ . Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	1
1(c)(i)	All final answers to (ii)–(v) to 3 or 4 sf Minimum 3 answers displayed	1
1(c)(ii)	Correctly calculates $\frac{0.02 \times (\mathbf{b})}{1000}$	1
1(c)(iii)	Correct use of (ii) × 5	1
1(c)(iv)	Correct use of (iii) × 55.8	1
1(c)(v)	Correctly uses $\frac{(\mathbf{c})(\mathbf{iv}) \times 40 \times 100}{6.02}$ or $\frac{(\mathbf{c})(\mathbf{iv}) \times 100}{0.1505}$	1

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Question	Answer	Marks
1(d)	Student incorrect sodium hydroxide will also react with Fe²⁺ / iron(II) / iron(II) sulfate OR Impurity (in wire) reacts with sulfuric acid / sodium hydroxide	1

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Question	Answer	Marks															
2(a)	I All 9 specified volumes recorded to nearest 0.05 cm ³ and all temperatures to .0 or .5 °C.	1															
	II Award this mark based on the tolerance table	1															
	III Award this mark based on the tolerance table	1															
	<table><tr><td>Sup $\Delta T_{\max}$</td><td>$\geq 10.5\text{ }^{\circ}\text{C}$</td><td>6.5–10.0 °C</td><td>3.5–6.0 °C</td><td>$\leq 3.0\text{ }^{\circ}\text{C}$</td></tr><tr><td>1 mark</td><td>$\delta = 2.0\text{ }^{\circ}\text{C}$</td><td>$\delta = 1.5\text{ }^{\circ}\text{C}$</td><td>$\delta = 1.0\text{ }^{\circ}\text{C}$</td><td>$\delta = 0.5\text{ }^{\circ}\text{C}$</td></tr><tr><td>2 marks</td><td>$\delta = 1.0\text{ }^{\circ}\text{C}$</td><td>$\delta = 1.0\text{ }^{\circ}\text{C}$</td><td>$\delta = 0.5\text{ }^{\circ}\text{C}$</td><td>not available</td></tr></table>	Sup $\Delta T_{\max}$	$\geq 10.5\text{ }^{\circ}\text{C}$	6.5–10.0 °C	3.5–6.0 °C	$\leq 3.0\text{ }^{\circ}\text{C}$	1 mark	$\delta = 2.0\text{ }^{\circ}\text{C}$	$\delta = 1.5\text{ }^{\circ}\text{C}$	$\delta = 1.0\text{ }^{\circ}\text{C}$	$\delta = 0.5\text{ }^{\circ}\text{C}$	2 marks	$\delta = 1.0\text{ }^{\circ}\text{C}$	$\delta = 1.0\text{ }^{\circ}\text{C}$	$\delta = 0.5\text{ }^{\circ}\text{C}$	not available	
	Sup $\Delta T_{\max}$	$\geq 10.5\text{ }^{\circ}\text{C}$	6.5–10.0 °C	3.5–6.0 °C	$\leq 3.0\text{ }^{\circ}\text{C}$												
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2 marks	$\delta = 1.0\text{ }^{\circ}\text{C}$	$\delta = 1.0\text{ }^{\circ}\text{C}$	$\delta = 0.5\text{ }^{\circ}\text{C}$	not available													
2(b)	I Linear scales chosen so that graph occupies more than half the available length for both axes (including extra 2 °C for y-axis). (6 big squares on y-axis & 5 on x-axis) and axes labelled with name or unit	1															
	II All points recorded accurately plotted (<i>within ½ small square and in the correct square of linear scale within plotting area</i>).	1															
	III Two best fit straight lines / curves drawn so they intersect / meet – one for increasing temperature and one for decreasing temperature (or no change in temperature). <i>Reject an intersection below the highest temperature recorded unless that point has been labelled as anomalous.</i>	1															
	IV Correct volume from suitable intersect to 1 or 2 dp <i>A continuous curve cannot score either mark III or IV Neither III nor IV can be scored if there is no max T</i>	1															

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Question	Answer	Marks
2(c)(i)	Correctly calculates $\frac{0.90 \times V(\mathbf{b})}{1000}$ to minimum 2 sf	1
2(c)(ii)	Correct expression: (c)(i) / 2 and answer $\times 1000 / 10$	1
2(d)	Explain how to get m or ΔT using words or figures m = 10 / volume of acid used + volume of NaOH / FB 4 at intersect / at highest temperature / from maximum on graph / needed to neutralise the acid ΔT = T at intersect – initial T_{acid} / FB 3 (or mean initial $T_{\text{acid} + \text{base}}$) / T_{max} – initial $T_{(\text{acid} / \mathbf{FB 3})}$ from table <i>Allow quoted correct figures from the table (ΔT) or the graph (ΔT or m)</i>	1
	Use of $mc\Delta T$	1
	Divide heat energy produced / moles of acid / 1st part of (c)(ii)	1

Question	Answer				Marks																																			
FB 5 = (CO ₂) ₂ Na ₂ ; FB 6 = CaCl ₂ ; FB 7 = FeSO ₄																																								
3(a)	Award one mark for every two correct observations (*) On warming with KMnO ₄ any test that positively identifies a gas is CON for that test apart from with FB 5 (CO ₂).				7																																			
3(a)	<table><tr><th rowspan="2">test</th><th colspan="3">observations</th></tr><tr><th>FB 5</th><th>FB 6</th><th>FB 7</th></tr><tr><td>+ H⁺ / MnO₄⁻</td><td>no change / no (visible) reaction / stays / turns pink *</td><td>no change / no (visible) reaction / stays / turns pink / purple and</td><td>(purple) turns colourless / decolourises / turns yellow *</td></tr><tr><td>warm</td><td>Decolourises *</td><td>no change / stays purple *</td><td>ignore</td></tr><tr><td>+ HNO₃</td><td>no change / no (visible) reaction *</td><td>no change / no (visible) reaction *</td><td>no change / no (visible) reaction and</td></tr><tr><td>then Ag⁺</td><td>white ppt *</td><td>white ppt *</td><td>no change / no visible reaction / no ppt *</td></tr><tr><td>+ HCl</td><td></td><td>no change / no (visible) reaction / no ppt and</td><td>no change / no (visible) reaction / no ppt *</td></tr><tr><td>then Ba²⁺</td><td></td><td>no change / no (visible) reaction / no ppt *</td><td>white ppt *</td></tr><tr><td>+ FB 5</td><td></td><td>white ppt *</td><td>(solution) turns yellow *</td></tr></table>				test	observations			FB 5	FB 6	FB 7	+ H ⁺ / MnO ₄ ⁻	no change / no (visible) reaction / stays / turns pink *	no change / no (visible) reaction / stays / turns pink / purple and	(purple) turns colourless / decolourises / turns yellow *	warm	Decolourises *	no change / stays purple *	ignore	+ HNO ₃	no change / no (visible) reaction *	no change / no (visible) reaction *	no change / no (visible) reaction and	then Ag ⁺	white ppt *	white ppt *	no change / no visible reaction / no ppt *	+ HCl		no change / no (visible) reaction / no ppt and	no change / no (visible) reaction / no ppt *	then Ba ²⁺		no change / no (visible) reaction / no ppt *	white ppt *	+ FB 5		white ppt *	(solution) turns yellow *	
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+ FB 5		white ppt *	(solution) turns yellow *																																					

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Question	Answer	Marks									
3(b)(i)	Selects NaOH and NH ₃ (<i>allow</i> NH ₄ OH) <i>Ignore a named sulfate (including sulfuric acid)</i>	1									
	<table border="1"> <thead> <tr> <th></th><th>FB 6</th><th>FB 7</th></tr> </thead> <tbody> <tr> <td>+ NaOH</td><td>white ppt and insoluble in excess *</td><td>green ppt and insoluble in excess *</td></tr> <tr> <td>+ NH₃</td><td>no (visible) reaction / no change / no ppt *</td><td>green ppt and insoluble in excess *</td></tr> </tbody> </table> For two correct observations (*) award one mark <i>Mark vertically or horizontally.</i>		FB 6	FB 7	+ NaOH	white ppt and insoluble in excess *	green ppt and insoluble in excess *	+ NH ₃	no (visible) reaction / no change / no ppt *	green ppt and insoluble in excess *	2
	FB 6	FB 7									
+ NaOH	white ppt and insoluble in excess *	green ppt and insoluble in excess *									
+ NH ₃	no (visible) reaction / no change / no ppt *	green ppt and insoluble in excess *									
	FB 7 (ppt) turns brown on standing / in air with either alkali OR No (white) ppt / no reaction stated for FB 6 with the named sulfate.	1									
3(b)(ii)	<table border="1"> <thead> <tr> <th></th><th>FB 6</th><th>FB 7</th></tr> </thead> <tbody> <tr> <td>cation</td><td>Ca²⁺ / Ba²⁺ * <i>allow both</i> <i>allow unknown if no sulfate test carried out</i></td><td>Fe²⁺ *</td></tr> <tr> <td>anion</td><td>Cl⁻</td><td>SO₄²⁻ *</td></tr> </tbody> </table> For two correct observations (*) award one mark <i>Allow 1 mark if all correct names given (iron(II)) instead of formulae.</i>		FB 6	FB 7	cation	Ca ²⁺ / Ba ²⁺ * <i>allow both</i> <i>allow unknown if no sulfate test carried out</i>	Fe ²⁺ *	anion	Cl ⁻	SO ₄ ²⁻ *	2
	FB 6	FB 7									
cation	Ca ²⁺ / Ba ²⁺ * <i>allow both</i> <i>allow unknown if no sulfate test carried out</i>	Fe ²⁺ *									
anion	Cl ⁻	SO ₄ ²⁻ *									

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Question	Answer	Marks
3(b)(iii)	Precipitation reaction for FB 7 : $\text{Fe}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_2(\text{s})$ or $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$	1

CHEMISTRY

9701/35

Paper 3 Advanced Practical Skills 1

May/June 2019

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 May/June 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **11** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks															
1(a)	I All thermometer readings are recorded to .0 or .5 °C.	1															
Examiner to calculate Supervisor's maximum ΔT from table and candidate's ΔT from same volumes. Calculate the difference between the two values. $\Delta T = T_{\text{max}} - (T_{\text{acid}} + T_{\text{alkali}}) / 2$ (correct to 1 DP)																	
1(a)	II Award this mark based on the tolerance table	1															
	III Award this mark based on the tolerance table	1															
	<table><tr><td>Sup ΔT_{max}</td><td>> 16.0 °C</td><td>8.5–16.0 °C</td><td>4.5–8.0 °C</td><td>≤ 4.0 °C</td></tr><tr><td>1 mark</td><td>δ = 2.0 °C</td><td>δ = 1.5 °C</td><td>δ = 1.0 °C</td><td>δ = 0.5 °C</td></tr><tr><td>2 marks</td><td>δ = 1.0 °C</td><td>δ = 1.0 °C</td><td>δ = 0.5 °C</td><td>not available</td></tr></table>		Sup ΔT _{max}	> 16.0 °C	8.5–16.0 °C	4.5–8.0 °C	≤ 4.0 °C	1 mark	δ = 2.0 °C	δ = 1.5 °C	δ = 1.0 °C	δ = 0.5 °C	2 marks	δ = 1.0 °C	δ = 1.0 °C	δ = 0.5 °C	not available
	Sup ΔT _{max}	> 16.0 °C	8.5–16.0 °C	4.5–8.0 °C	≤ 4.0 °C												
1 mark	δ = 2.0 °C	δ = 1.5 °C	δ = 1.0 °C	δ = 0.5 °C													
2 marks	δ = 1.0 °C	δ = 1.0 °C	δ = 0.5 °C	not available													

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Question	Answer	Marks
1(b)(i)	I Linear scales chosen so that graph occupies more than half the available length for both axes (including extra 2 °C for y-axis). (points on y-axis and 0–40 cm³ on x-axis occupying at least 5 large squares on x-axis and 6 large squares on y-axis) AND axes labelled with name and / or unit	1
	II All points recorded (minimum 7 recorded) accurately plotted If the point should be on a line it must be on the line. If the point should not be on a line it must not be on a line and must be correct to within half a small square.	1
	III Two lines of best fit drawn (straight or smoothly curved lines) – one for increasing temperature and one for decreasing temperature. Ignore points marked anomalous	1
1(b)(ii)	Correct volume of FA 2 read from the intersection (to within .25 cm³ of examiner value) AND Volume FA 1 = 40.0 – volume FA 2 Volumes of FA 1 and FA 2 must be given to 1 dp Allow discontinuity for intersection. A continuous curve cannot score either mark (b)(i)III or (b)(ii). Neither (b)(i)III nor (b)(ii) are available if there is no max T.	1
1(c)(i)	Correctly calculates $\frac{2.0 \times \text{Vol}(\text{FA 2 in (b)})}{1000}$ to 3 or 4 sf	1
1(c)(ii)	Correct expression $\frac{(\text{c)(i)} \times 1000}{\text{Vol}(\text{FA 1 in (b)})}$ and answer to 3 or 4 sf	1

Question	Answer	Marks
1(d)	Explain how to get ΔT (from graph or table) ($T_{\text{max}} - \text{initial } T$ or $T_{\text{max}} - \text{average of initial } T\text{s}$) Allow use rise in temperature.	1
	Use of $Q = mc\Delta T$	1
	Divide $\text{heat energy produced} / \text{moles of alkali neutralised}$ (moles of alkali neutralised = (c)(i))	1

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Question	Answer	Marks
2(a)	I The following data must be shown • burette readings and titre for rough titration • 2 × 2 'box' showing both accurate burette readings <i>'Correct' 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 and (burette) reading / volume + unit • final / end and (burette) reading / volume + unit • titre or volume / FA 4 used / added + unit <i>Units: (cm³) or /cm³ or in cm³ or cm³ by every entry</i>	1
	III All accurate burette readings to 0.05 cm ³	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1

Question	Answer	Marks
2(a)	Award V if $0.50 < \delta \leq 0.80 \text{ cm}^3$	1
	Award VI if $0.30 < \delta \leq 0.50 \text{ cm}^3$	1
	Award VII if $\delta \leq 0.30 \text{ cm}^3$	1
2(b)	Candidate must average two (or more) titres that are all within 0.20 cm^3 . Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	1
2(c)(i)	Final answers to (ii)–(iv) to 3 or 4 sf	1
2(c)(ii)	Correctly calculates $\frac{0.0353 \times 25}{1000} = 8.825 \times 10^{-4}$	1
2(c)(iii)	Correctly calculates $8.825 \times 10^{-4} \times 2 = 1.765 \times 10^{-3}$ Allow ecf from (c)(ii)	1
2(c)(iv)	Correctly uses $\frac{\text{(c)(iii)} \times 1000 \times 250}{\text{volume in (b)} \times 10}$	1

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Question	Answer	Marks
2(d)	One of: Experiment 1 is more accurate: Intersection (<i>allow extrapolation</i>) gives accurate max T or gives accurate volumes needed for neutralisation / calculation or Extra dilution step increases errors in titration values. OR Experiment 2 is more accurate: Acid diluted so 1 drop contains fewer moles so end point more precise or More precisely calibrated / smaller % volume error and in apparatus / pipette / burette for FA 2 OR Both of equal accuracy because concentrations are very similar (in Experiments 1 and 2). Reject expt 2 is more accurate as heat is lost through the top of the cup. (ΔT is in a range such that the heat energy loss is minimal in the time taken to complete the experiment.)	1
2(e)	Correctly calculates $M_r \text{ CH}_3\text{COOH} = 60$ and $60 \times \text{(c)(iv)}$ (Default value = 124.8 g dm^{-3}) or $112.3 / 60$ and compare with (c)(iv) ($112.3 / 60 = 1.87$) or $112.3 / \text{(c)(iv)}$ and compare with 60 (Default $M_r = 54 / 54.0 / 53.99$)	1

Question	Answer			Marks	
FA 5 = FeCl ₃ (aq); FA 6 = H ₂ SO ₄ (aq); FA 7 = AgNO ₃ (aq)					
3(a)	Award one mark for every two correct observations (*)			10	
	test	observations			
		FA 5	FA 6		FA 7
	+ Na ₂ CO ₃		effervescence / fizzing / bubbling *		off white / pale brown / cream ppt *
			gas / CO ₂ turns limewater milky / chalky / cloudy white / forms white ppt *		
	+ Mg		effervescence / fizzing / bubbling *		black ppt / black solid formed *
			gas / H ₂ pops with lighted splint *		
	+ AgNO ₃	white ppt * Allow off-white ppt	no change / no (visible) reaction / no ppt *		no change / no (visible) reaction / no ppt *
	+ NH ₃	brown / red-brown / orange-brown / rust ppt *	Ignore		Ignore
	+ Ba(NO ₃) ₂	no change / no (visible) reaction / no ppt *	white ppt *		no change / no (visible) reaction / no ppt *
					Ignore faint white ppt
	+ HCl	Ignore	ppt insoluble * Allow no change		white ppt * Soluble in excess is CON
+ NaOH	brown / red-brown / orange-brown / rust ppt and insoluble in excess *	no change / no (visible) reaction / no ppt / temp increases *	(dark) brown / grey-brown ppt and insoluble in excess *		
+ FA 7	white ppt * allow off-white ppt	no change / no (visible) reaction / no ppt *			

Question	Answer				Marks
3(b)		FA 5	FA 6	FA 7	3
	cation	Fe ³⁺ *	H ⁺ *	Ag ⁺ / unknown *	
	anion	Cl ⁻ *	SO ₄ ²⁻ *	unknown *	
	2 * = 1 mark (round down)				
3(c)	precipitation reaction involving FA 5 Fe ³⁺ (aq) + 3OH ⁻ (aq) → Fe(OH) ₃ (s) or Ag ⁺ (aq) + Cl ⁻ (aq) → AgCl(s)				1