
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

May/June 2018

MARK SCHEME

Maximum Mark: 40

Published

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- the specific skills defined in the mark scheme or in the generic level descriptors for the question
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GENERIC MARKING PRINCIPLE 2:

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

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- 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
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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.

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GENERIC MARKING PRINCIPLE 6:

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Question	Answer	Marks
1(a)	I Initial and final readings and titre recorded for rough titre and accurate titre details tabulated (<i>minimum 2 × 2 'boxes'</i>)	1
	II All three headings and units correct for accurate titrations Headings: initial / final (burette) and reading / volume / vol or reading / volume / vol at start / finish (but not V) and volume / FA 2 and 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 0.1 cm ³ of any other accurate titre.	1
All burette readings should be rounded to the nearest 0.05 cm³. Subtractions should be checked. The 'best' titres should be selected using the hierarchy: two (or more) identical; then 2 (or more) within 0.05 cm³; then two (or more) within 0.1 cm³, etc, the mean titre calculated and this then compared with the supervisor mean titre.		
	V, VI and VII Award V, VI and VII for a difference from supervisor within 0.20 cm ³ Award V and VI for $0.20 < \delta \leq 0.40 \text{ cm}^3$ Award V for $0.40 < \delta \leq 0.60 \text{ cm}^3$	3

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Question	Answer	Marks
1(b)	Candidate must average two (or more) titres for which the total spread is not greater than 0.2 cm^3. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. <i>The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67.</i> <i>Two special cases where the mean may not be to 2 dp:</i> <i>allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325;</i> <i>allow mean to 1 dp if all accurate burette readings were given to 1 dp and the mean is exactly correct e.g. 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect.</i> <i>Do not award this mark if:</i> <i>any selected titre is not within 0.20 cm^3 of any other selected titre;</i> <i>the rough titre was used to calculate the mean;</i> <i>the candidate carried out only 1 accurate titration;</i> <i>burette readings were incorrectly subtracted to obtain any of the accurate titre values.</i> <i>All burette readings, excluding initial 0, (resulting in titre values used in calculation of mean) are integers.</i> <i>Note: the candidate's mean will sometimes be marked as correct even if it is different from the mean calculated by the examiner for the purpose of assessing accuracy.</i>	1
1(c)(i)	All answers to (c) correct to 3 or 4 sig figs.	1
1(c)(ii)	Correctly calculates moles Na_2CO_3 in 25.0 cm^3 FB 1 = $\frac{1.30}{106 \times 10}$	1
1(c)(iii)	Correctly calculates answer to (c)(ii) $\times 2$	1
1(c)(iv)	Correctly uses $\frac{\text{answer to (iii)} \times 1000}{\text{Volume from (b)}}$	1

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Question	Answer	Marks
2(a)	I Initial and final readings and titre recorded for a minimum of two accurate titre details tabulated (<i>minimum 2 × 3 'boxes'</i>)	1
All burette readings should be rounded to the nearest 0.05 cm³. Subtractions should be checked. The 'best' titres should be selected using the hierarchy: two (or more) identical; then 2 (or more) within 0.05 cm³; then two (or more) within 0.1 cm³, etc the mean titre calculated and this then compared with the supervisor's value.		
	II and III Award II and III for $\delta \leq 0.20 \text{ cm}^3$ Award II for $0.20 < \delta \leq 0.40 \text{ cm}^3$	2
2(b)(i)	Correctly calculates moles HCl = $\frac{\text{vol of FA 2 from (a)} \times 0.100}{1000}$ and moles NaOH are the same	1
2(b)(ii)	Correctly calculates moles NaOH added to W = $0.40 \times 250 \div 1000 = 0.10$ and moles NaOH remaining = answer to (b)(i) × 10	1
2(b)(iii)	Correctly uses moles NaOH reacting with W = 1st answer in (b)(ii) – 2nd answer in (b)(ii) (0.10 – 2nd answer in (b)(ii)) and moles W = answer ÷ 2	1
2(b)(iv)	Correctly uses M_r of W = $4 \div$ answer to (b)(iii)	1
2(b)(v)	Expression to show $59 + A_r \text{ of X} = M_r$ from (b)(iv)	1
	Identification of X as halogen with nearest A_r to that calculated	1
2(c)	Error: Mass was given correct to 1 sig fig / nearest g Modification: Use a more accurate balance or Error: Hydrolysis of halogeno group may be incomplete Modification: Use more concentrated NaOH / heat for longer	1

Question	Answer	Marks
2(d)	If F chosen then 87 If Cl chosen then 86 or 117 If Br chosen then 116 or 163 If I chosen then 162	1

Question	Answer	Marks
FA 5 is HCOOH ; FA 7 is ZnCO ₃ ; FA 8 is Cu(NO ₃) ₂		
3(a)(i)	+ Na ₂ CO ₃ : fizz / effervescence / bubbling	1
	+ KMnO ₄ : purple (allow pink) to colourless (allow pale yellow)	1
	+ AgNO ₃ : no (visible) reaction / no change / no ppt / solution remains colourless	1
	+ Tollens': silver mirror / black ppt / grey ppt	1
3(a)(ii)	(Carboxylic) acid	1
	Aldehyde / primary alcohol / secondary alcohol / alkene	1
3(b)(i)	+ acid: fizz / effervescence / bubbling	1
	Gas / CO ₂ / fizz turns limewater milky / cloudy white / forms white ppt	1
	+ NaOH: white ppt soluble in excess NaOH	1

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Question	Answer	Marks
3(b)(ii)	+ NaOH: (pale) blue ppt (reference to dark blue or dissolving is CON)	1
	Warming: goes black / brown / grey	1
	+ Al & NaOH: gas / ammonia turns litmus blue	1
3(b)(iii)	Cu^{2+} / copper(II) definitely present	1
	Zn^{2+} or Al^{3+} / aluminium or zinc could be present	1
	Add (aqueous) ammonia – give (white) ppt but only (that from) zinc dissolves in excess	1
3(b)(iv)	CO_3^{2-} / carbonate definitely present	1
	NO_3^- or NO_2^- / nitrate or nitrite could be present	1

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Question	Answer	Marks
1(a)	I Table of data , to include the following: Unit ‘covering’ all weighings, and correct headings • Mass of crucible and lid • Mass of crucible, lid and FB 1 (or ‘contents before heating’) • Mass of crucible, lid and residue / oxide / contents after heating / contents after cooling • Mass of FB 1 used • Mass of residue / (metal) oxide / MO (obtained) <i>Do not accept ‘mass of FB 1 after heating’ in third weighing.</i>	1
	II Weighings recorded appropriately • Six weighings recorded in the space provided (<i>3 for each of expts 1 and 2</i>) • All weighings recorded to same number of decimal places (one or more)	1
	III Correctly calculates masses of FB 1 and residue for Experiment 2 • Mass of FB 1 used recorded on page 2, correctly subtracted • Mass of FB 1 used between 0.80–1.00 g • Mass of residue recorded on page 2, correctly subtracted	1
	Accuracy marks based on Experiment 2 • For assessment of accuracy, examiner checks and corrects (if necessary) the masses of FB 1 used and of MO obtained by the supervisor and by the candidate for Experiment 2. • Examiner calculates the ratio (mass FB 1: mass MO) for the supervisor (2 dp) • Examiner calculates the ratio (mass FB 1: mass MO) for the candidate (2 dp) • Examiner calculates δ, the difference between these two ratios. Award IV and V if $\delta \leq 0.10$ Award IV if $0.10 < \delta \leq 0.20$	2
1(b)(i)	Correctly calculates both mean masses (to 2 dp)	1
1(b)(ii)	Mass of water = difference between the answers in (i) or from the table Moles of water = $\frac{\text{mass}}{18}$	1

Question	Answer	Marks
1(b)(iii)	$M_r = \frac{\text{mass of MO obtained}}{\text{moles of water}}$ or $M_r = \left(\frac{\text{mass of M(OH)}_2 \text{ obtained}}{\text{moles of water}} \right) - 18$ Answer to 2 – 4 sf	1
1(b)(iv)	$A_r = \text{ans(iii)} - 16$ (expressed to 2, 3 or 4 sig fig) and Identity of M correct (ie. the closest A_r value in Group 2) (Be $\leq$ 16.65 $\leq$ Mg $\leq$ 32.20 $\leq$ Ca $\leq$ 63.85 $\leq$ Sr $\leq$ 112.45 $\leq$ Ba)	1
1(c)(i)	Heat to constant mass	1
1(c)(ii)	MCO ₃ will give off CO ₂ ,	1
	A_r determined will be smaller (due to the impurity) and the (%) mass of CO ₂ (given off from MgCO ₃) is greater than the mass of water (given off by Mg(OH) ₂)	1

Question	Answer	Marks
2(a)(i)	Unambiguous headings, units and six pieces of data listed. • mass of container and FB 3 • mass of container • mass of FB 3 used • first / start / initial temperature • maximum temperature (<i>allow final temp, temp after mixing</i>) • temperature rise / change	1
	Precision of readings shown in 2(a) and 2(b) • all four thermometer readings are shown to 0.0 or 0.5 °C • all four temperature readings > 30 °C	1

Question	Answer	Marks
2(a)(ii)	Accuracy marks - Check subtractions of supervisor and candidate temperature. - Calculate the difference between the corrected candidate's and supervisor's temp rise (δ) If $\delta \leq 3.0^\circ\text{C}$ award two marks If $\delta \leq 5.0^\circ\text{C}$ award one mark	2
2(a)(ii)	Energy change = $30 \times 4.2 \times \text{temp rise}$ Answer must be expressed to 2, 3 or 4 sf	1
2(a)(iii)	Moles of FB 3 = $\frac{\text{mass used}}{74.1}$ Answer must be expressed to 2, 3 or 4 sf.	1
2(a)(iv)	$\Delta H_1 = \frac{\text{answer (ii)}}{\text{answer (iii)}} \times 1000$ - Negative sign must be shown on answer line. - Answer should be expressed to 2, 3 or 4 sig fig	1
2(b)(i)	Six pieces of data. - mass of container and FB 4 - mass of container - mass of FB 4 used - first / start / initial temperature - final temperature - temperature rise	1
	Accuracy mark - Check subtractions of supervisor and candidate. - Calculate the difference between corrected candidate's and supervisor's temp rise (δ) If $\delta \leq 5.0^\circ\text{C}$ award one mark	1

Question	Answer	Marks
2(b)(ii)	• Energy released ($30 \times 4.2 \times \text{temp rise}$) • No of moles used = $\frac{\text{mass of FB 4 used}}{56.1}$ • $\Delta H_2 = \frac{(\text{energy})}{\text{no of moles}} \times 1000$ • Negative sign Four correct bullets award 2 marks Two correct bullets award 1 mark.	2
2(c)	Attempt at Hess Cycle diagram • Downward arrow from Ca(OH)_2, labelled with value and sign of ΔH_1 from (a)(iv) • Downward arrow from CaO, labelled with value and sign of ΔH_2 from (b)(ii)	1
	$\Delta H_r = \Delta H_1 - \Delta H_2$	1
2(d)(i)	To speed up the reaction / it is slow at room temperature / to supply the activation energy	1
2(d)(ii)	Acid is in excess / FB 4 is the limiting reagent (in both cases). Therefore temp rise would be the same	1

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Question	Answer				Marks
FB 5 is H ₂ SO ₄ ; FB 6 is BaCl ₂ ; FB 7 is AgNO ₃					
3(a)	2 asterisks (*) = 1 mark				9
	test	FB 5	FB 6	FB 7	
	+ Mg	effervescence / bubbling / fizzing* gas / H ₂ pops with a lighted splint* heat produced / exothermic*	no reaction / no change / no effervescence / solution remains colourless*	grey / black and ppt / solid*	
	+ Na ₂ CO ₃	effervescence / bubbling / fizzing* gas / CO ₂ turns limewater milky / chalky / cloudy white / forms a white ppt*	white ppt*	white / off-white / cream / pale yellow ppt*	
	+ NaOH	no reaction / no change / no ppt / temperature increase*	no reaction / no change / no ppt*	brown ppt and insoluble in excess *	
	+ Ba ²⁺	white ppt*	no reaction / no change / no ppt*	(ignore any observations here)	
	+ FB 5		white ppt*	no reaction / no change / no ppt*	
	+ FB 6			white ppt*	
	+ KI			(pale) yellow ppt*	
3(b)(i)	FB 7 is Ag ⁺ / silver				1
3(b)(ii)	Mg + 2H ⁺ → Mg ²⁺ + H ₂				1
3(b)(iii)	Precipitation				1

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Question	Answer	Marks
3(b)(iv)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$	1

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	II All three headings and units correct for accurate titrations Headings: initial / final (burette) and reading / volume / vol or reading / volume / vol at start / finish (but not V) and volume / FA 2 and 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 <i>Do not award this mark if:</i> • 50(.00) is used as an initial burette reading; • more than one final burette reading is 50(.00); • any burette reading is greater than 50(.00) • there is only one accurate titration	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre. <i>Do not award the mark if any 'accurate' burette readings (apart from initial 0) are given to zero dp.</i>	1
For assessment of accuracy (Q marks) the examiner should round all burette readings to the nearest 0.05 cm³. Subtractions should be checked. The 'best' titres should be selected using the hierarchy: two (or more) identical; then 2 (or more) within 0.05 cm³; then two (or more) within 0.1 cm³ etc. These best titres should be used to calculate the mean corrected titre to the nearest 0.01 cm³ and this compared to the supervisor value. Award accuracy marks as shown below.		
	V, VI and VII Award V, VI and VII for $\delta \leq 0.20 \text{ cm}^3$ Award V and VI for $0.20 < \delta \leq 0.30 \text{ cm}^3$ Award V for $0.30 < \delta \leq 0.50 \text{ cm}^3$	3

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Question	Answer	Marks
1(b)	Candidate must average two (or more) accurate titres with total spread of not more than 0.20 cm^3. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. <i>The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67.</i> Two special cases where the mean may not be to 2 dp: allow mean to 3 dp only for 0.025 or 0.075 eg 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 spread of selected titres is greater than 0.20 cm^3; the rough titre was used to calculate the mean; the candidate carried out only 1 accurate titration; burette readings were incorrectly subtracted to obtain any of the accurate titre values; all burette readings, excluding initial 0, (resulting in titre values used in calculation of mean) are integers. Note: the candidate's mean will sometimes be marked as correct even if it is different from the mean calculated by the examiner for the purpose of assessing accuracy.	1
1(c)(i)	Correctly calculates: $(b) \times 0.105 / 1000$ and moles H^+ = moles NaOH and answers to 3 or 4 sf	1
1(c)(ii)	Expression: H^+ from (c)(i) $\times (1000 / 25)$ and answer to 3 or 4 sf	1
1(c)(iii)	Correctly calculates $6.10 / 126 = 4.84(1) \times 10^{-2}$ and answer to 3 or 4 sf	1
1(c)(iv)	Expression (c)(ii) / (c)(iii) and makes correct statement regarding FA 1 based on answer	1

Question	Answer	Marks
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Question	Answer	Marks
2(a)	I Table with appropriate headings to show 11 results Volume FA 3 or FA 3 / cm³ or burette readings and Temperature / Temp / T or °C Allow initial temperature recorded on a separate line under method section. Allow volume added and allow vol / V for volume. The figures in this section may relate to total volume added (0, 5, 10, ...) or volume added each time (0, 5, 5, 5, ...) or be burette readings	1
	II All temperatures recorded to .0 or .5 °C All results follow the pattern (up and down)	1
Round thermometer readings to the nearest .5 °C Examiner to calculate (and correct) supervisor's ΔT – initial T to highest T recorded in table. Calculate candidate's ΔT from table, calculate δ from supervisor and award marks as shown.		
	III and IV Award III and IV if $\delta \pm 1.0$ °C Award III if $\delta \pm 2.5$ °C	2
2(b)	Axes labelled and uniform scales chosen for plotted points (and $T_{\max}$ plus 2 °C) to occupy more than half the available space on both axes	1
	All recorded points plotted (min of 8 recorded). Points must be accurate to within half a small square, be clearly on a line or not on a line (whichever is appropriate). If crosses used must be centred on correct point, not be large blobs.	1
	Two lines of best fit drawn (can be straight or curved) – one for increase in temperature and the other for decrease in temperature.	1
	Both lines are extrapolated to cross or to a discontinuity	1
2(c)	Records correctly from graph candidate's max T and vol FA 3	1
2(d)(i)	Correctly uses: Energy = (vol from (c) + 25) $\times$ 4.2 $\times$ (max T – initial T)	1
2(d)(ii)	Correctly calculates: moles X = 25 $\times$ 2.00 / 1000 = 0.05	1

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Question	Answer	Marks
2(d)(iii)	Expression: (d)(i) / ((d)(ii) × 1000) or correct answer and answer to 2 to 4 sf with negative sign	1
2(e)	Repeat the experiment with volumes of FA 3 near to that needed for T_{max} / near the end point	1
2(f)	(X less exothermic than HCl shows) it is a weak acid/ shows X is not HCl / small(er) acid dissociation (constant)	1
	Some of the energy that could be released is used to ionise HX	1

Question	Answer	Marks										
FA 5 is 0.1 mol dm ⁻³ H ₂ SO ₄ ; FA 6 is 1.0 mol dm ⁻³ H ₂ SO ₄ ; FA 7 is 1.0 mol dm ⁻³ HCl; FA 8 is Mg(OH) ₂ ; FA 9 is NH ₄ Cl												
3(a)	Choice of suitable reagents in table / clear layout. One reagent to show sulfate or chloride (BaCl ₂ or Ba(NO ₃) ₂ or AgNO ₃) One reagent to show different concentration of H ⁺ in samples with sulfate (Mg, Zn, named carbonate)	1										
	White ppt with FA 7 and Ag ⁺ (aq) / white ppt with FA 5 and FA 6 with Ba ²⁺ (aq) and no (visible) reaction / no change / no ppt for others (ignore faint white ppt with Ag ⁺) For each reagent used all three observations must be recorded and correct	1										
	Difference in rate of bubbling / fizzing / effervescence of FA 5 and FA 6 with suitable metal or carbonate Allow less and more fizz without time being mentioned	1										
	FA 5 is 0.1 mol dm ⁻³ H ₂ SO ₄ ; FA 6 is 1.0 mol dm ⁻³ H ₂ SO ₄ ; FA 7 is (1.0 mol dm ⁻³) HCl.	1										
3(b)(i)	2* = 1 mark <table><thead><tr><th>FA 8</th><th>FA 9</th></tr></thead><tbody><tr><td>Blue / blue-green / blue-purple / dark green* pH 8–11*</td><td>Yellow or orange-yellow or orange* pH 3–6*</td></tr><tr><td>Water vapour /condensation / steam*</td><td>Any two * from this box: sublimes / solid or white forms on cold part / top of tube / white smoke * Effect on litmus red to blue* Allow blue litmus to red on strong heating*</td></tr><tr><td>White ppt / white solid* insoluble in excess*</td><td>No (observable) reaction / no change / no ppt and</td></tr><tr><td>White ppt / white solid* insoluble in excess *</td><td>No (observable) reaction / no change / no ppt *</td></tr></tbody></table>	FA 8	FA 9	Blue / blue-green / blue-purple / dark green* pH 8–11*	Yellow or orange-yellow or orange* pH 3–6*	Water vapour /condensation / steam*	Any two * from this box: sublimes / solid or white forms on cold part / top of tube / white smoke * Effect on litmus red to blue* Allow blue litmus to red on strong heating*	White ppt / white solid* insoluble in excess*	No (observable) reaction / no change / no ppt and	White ppt / white solid* insoluble in excess *	No (observable) reaction / no change / no ppt *	6
FA 8	FA 9											
Blue / blue-green / blue-purple / dark green* pH 8–11*	Yellow or orange-yellow or orange* pH 3–6*											
Water vapour /condensation / steam*	Any two * from this box: sublimes / solid or white forms on cold part / top of tube / white smoke * Effect on litmus red to blue* Allow blue litmus to red on strong heating*											
White ppt / white solid* insoluble in excess*	No (observable) reaction / no change / no ppt and											
White ppt / white solid* insoluble in excess *	No (observable) reaction / no change / no ppt *											
3(b)(ii)	(gas / ammonia) turns (red) litmus blue	1										

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Question	Answer	Marks
3(b)(iii)	any 2 correct answers for 1 mark all 4 correct answers for 2 marks	
	FA 8 Mg^{2+} OH^- FA 9 NH_4^+ unknown	2

CHEMISTRY

9701/34

Paper 3 Advanced Practical Skills 2

May/June 2018

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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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**:

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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.

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 Table(s) to show data for 5 experiments on pages 2, 3 and / or 4 • initial temperature (owtte) • final temperature • mean temperature • time • rate	1
	II Headings unambiguous and units correct for all data recorded: ($^{\circ}\text{C}$), / s, in s^{-1}	1
	III All thermometer readings recorded to .0 or .5 and all times as integers.	1
	IV Selects initial temperatures in experiments 3, 4 & 5 that are at least 5°C apart from any other and none $> 75^{\circ}\text{C}$.	1
	V All mean temperatures correctly calculated to 1 dp	1
	VI All rates correctly calculated to 2–4 sf	1
	Award VII if all rates increase with increase in temperature or all times decrease with increase in temperature	1
	Award VIII from graph if all results give an increasing gradient.	1

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Question	Answer	Marks
1(b)	I Axes correctly labelled Rate on y-axis and temperature on x-axis (average temperature must have been plotted) Linear scales chosen so graph occupies more than half the available length for both axes including 15 °C on x-axis. Points in 6 large squares on y-axis and y-axis must not go below 0	1
	II All points from data recorded (minimum 4 experiments carried out) accurately plotted (within ½ small square) <i>Any point that is supposed to be on a line must be on the line, and any point that is supposed to be inside a small square must not be on a boundary line.</i>	1
	III Line of best fit drawn	1
	IV Curved line extrapolated to 15.0 °C	1
1(c)	2 construction lines correct to within a small square shown at 52.5 °C	1
	Rate correctly read (from candidate's construction line) to half a small square and correctly calculates time to nearest second from 1000 / rate	1

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Question	Answer	Marks
1(d)	Rate of reaction increases with increase in temperature or rate is proportional to temperature	1
	Rate of rate of reaction increases because gradient increases with temperature / rate of reaction increases more / at a greater rate than increase in temperature as gradient increases / graph is exponential / acceleration of rate with temperature increase	1
1(e)(i)	Correctly calculates $32.8 / 180(.0) = 0.182 / 0.1822 \text{ mol dm}^{-3}$ and answer to 3 or 4 sf	1
1(e)(ii)	Correctly uses $n(\text{glucose}) = (\text{e})(\text{i}) \div 40 (= 0.00455 / 0.00456 \text{ mol})$	1
	Correctly uses $n(\text{KMnO}_4) = \text{ans} \times 2 / 5 (= 0.00182 \text{ mol})$	1
	Correctly uses $V(\text{KMnO}_4) = \text{ans} \times 1000 / 0.01 (= 182 \text{ cm}^3)$ or $\text{ans} \div 0.01 (= 0.182 \text{ dm}^3)$ Correct units required.	1
1(e)(iii)	Allow terminal CHO oxidised to COOH, terminal CH ₂ OH oxidised to CHO or COOH any CHOH oxidised to C = O any combination of the above	1
1(f)(i)	Correct expression $1 \times 100 / \text{time for Experiment 1 and}$ answer to 2–4 sf	1
1(f)(ii)	Identifies no anomaly as all points are near line of best fit or Identifies one anomaly as point is too far from line of best fit If 2 or more anomalies, then the one furthest from the line must be selected. or Highest temperature experiment as shortest time so largest / large (%) error in timing or Lowest temperature experiment as difficult to judge the end point (owtte)	1

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Question	Answer	Marks
1(g)	Any two of • Use thermostatically controlled water bath (to heat both reagents / keep reagents at const T). • Take the temperature on initial mixing (and the temperature as soon as the mixture turns colourless and calculate a mean T). • Use more precisely calibrated thermometer (allow more precise but not more accurate or more sensitive) not ‘use a digital thermometer’ • Use light sensor / colorimeter (to avoid subjective judgement of colour fade). • Use (graduated) pipette / burette / measuring cylinders calibrated to greater precision (to measure volumes of FB 2 and FB 3).	2

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Question	Answer				Marks
FB 4 = starch(aq); FB 5 = glucose(aq); FB 6 = sucrose(aq); FB 7 = CuSO ₄ (aq); FB 8 = NaOH(aq)					
2(a)(i)	3 asterisks (*) = 1 mark				3
	test	FB 4	FB 5	FB 6	
	+ I ₂	blue-black / black / dark blue*	no reaction / no change / yellow / brown*	no reaction / no change / yellow / brown*	
	+ H ⁺ / MnO ₄ ⁻	no reaction / no change / (turns / remains) purple / pink*	purple / pink / KMnO ₄ / MnO ₄ ⁻ to colourless*	no reaction / no change / (turns / remains) purple / pink*	
	+ Sandell's	no reaction / no change / blue / green*	(blue / green to) brick red / orange / red-brown / orange-brown / yellow-brown / green-brown / brown ppt*	no reaction / no change / blue / green*	

Question	Answer	Marks																												
2(a)(ii)	FB 4 = starch and FB 5 = aldehyde	1																												
2(a)(iii)	Either selects Tollens' (reagent) and silver (mirror / ppt / solid) / black ppt / dark grey ppt or selects acidified potassium dichromate / H ⁺ / K ₂ Cr ₂ O ₇ , (warm) and orange to green solution	1																												
2(b)(i)	2 asterisks (*) = 1 mark <table><tr><th>test</th><th>FB 7</th><th colspan="2">FB 8</th></tr><tr><td>+ Ag⁺</td><td>no reaction / no change / no ppt* allow paler (blue)</td><td colspan="2">brown ppt * (ppt dissolves in excess is CON)</td></tr><tr><td>+ Ba²⁺</td><td>white ppt*</td><td>Either no ppt / no change / no reaction*</td><td>or (faint) white ppt*</td></tr><tr><td>+ H⁺</td><td>Insoluble / no change / white ppt (remains)*</td><td>no change / no reaction*</td><td>ppt soluble*</td></tr><tr><td>+ I₂</td><td>ppt in green-yellow-brown-grey range*</td><td colspan="2">decolourises / solution paler (yellow)*</td></tr><tr><td>+ Fe²⁺</td><td>no reaction / no change*</td><td colspan="2">green ppt* turns brown (at surface) / brown ppt*</td></tr><tr><td>+ FB 8</td><td>blue ppt *</td><td colspan="2"></td></tr></table>	test	FB 7	FB 8		+ Ag ⁺	no reaction / no change / no ppt* allow paler (blue)	brown ppt * (ppt dissolves in excess is CON)		+ Ba ²⁺	white ppt*	Either no ppt / no change / no reaction*	or (faint) white ppt*	+ H ⁺	Insoluble / no change / white ppt (remains)*	no change / no reaction*	ppt soluble*	+ I ₂	ppt in green-yellow-brown-grey range*	decolourises / solution paler (yellow)*		+ Fe ²⁺	no reaction / no change*	green ppt* turns brown (at surface) / brown ppt*		+ FB 8	blue ppt *			6
test	FB 7	FB 8																												
+ Ag ⁺	no reaction / no change / no ppt* allow paler (blue)	brown ppt * (ppt dissolves in excess is CON)																												
+ Ba ²⁺	white ppt*	Either no ppt / no change / no reaction*	or (faint) white ppt*																											
+ H ⁺	Insoluble / no change / white ppt (remains)*	no change / no reaction*	ppt soluble*																											
+ I ₂	ppt in green-yellow-brown-grey range*	decolourises / solution paler (yellow)*																												
+ Fe ²⁺	no reaction / no change*	green ppt* turns brown (at surface) / brown ppt*																												
+ FB 8	blue ppt *																													

Question	Answer	Marks
2(b)(ii)	FB 7 cation Cu^{2+} / copper(II)* anion SO_4^{2-} / sulfate* FB 8 cation unknown* anion OH^- / hydroxide* 2 asterisks (*) = 1 mark	2
2(b)(iii)	Correct ions for precipitation reaction observed in (i) and correct product and no spectator ions	1
	Equation balanced and correct state symbols	1

CHEMISTRY

9701/35

Paper 35 (Advanced Practical Skills 1)

May/June 2018

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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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 Three masses recorded and two burette readings and titre for the rough titration and initial and final readings for two (or more) accurate titrations (<i>minimum 2 × 2 box</i>)	1
	II All three headings and units correct for accurate titrations Headings: initial / final (burette) and reading / volume / vol or reading / volume / vol at start / finish (but not V) and volume / FA 2 and 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 <i>The requirement to record to 0.05 applies to burette readings, including 0.00 (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); • there is only one accurate titration	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre. • Do not award the mark if any 'accurate' burette readings (apart from initial 0) are given to zero dp .	1
For assessment of accuracy (Q marks) the examiner should round any burette reading to the nearest 0.05 cm³. Subtractions should be checked. The 'best' titres should be selected using the hierarchy: two (or more) identical; then 2 (or more) within 0.05 cm³; then two (or more) within 0.1 cm³ etc. These best titres should be used to calculate the mean corrected titre to the nearest 0.01 cm³. Calculate mean titre/mass used to 2 dp, calculate the supervisor titre/mass, calculate the difference, δ, and award accuracy (Q) marks as shown below.		
1(a)	V, VI and VII Award V, VI and VII for a difference from supervisor within 0.10 Award V and VI for a difference from supervisor $0.10 < \delta \leq 0.20$ Award V for a difference from supervisor $0.20 < \delta \leq 0.30$	3

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Question	Answer	Marks
1(b)	Candidate must average two (or more) for which the total spread is not greater than 0.2 cm³. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. <i>The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67.</i> 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: any selected titre is not within 0.20 cm³ of any other selected titre; the rough titre was used to calculate the mean; the candidate carried out only 1 accurate titration; burette readings were incorrectly subtracted to obtain any of the accurate titre values. All burette readings, excluding initial 0, (resulting in titre values used in calculation of mean) are integers.	1
	Note: the candidate's mean will sometimes be marked as correct even if it is different from the mean calculated by the examiner for the purpose of assessing accuracy.	
1(c)(i)	Answers to (c)(ii)–(iv) correct to 3 or 4 sig figs. (minimum of 3 answers attempted)	1
1(c)(ii)	Correctly calculates moles acid = (b) × 0.110 / 1000	1
1(c)(iii)	$\text{Na}_2\text{CO}_3(\text{aq}) + 2\text{HCl}(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ and correctly uses moles sodium carbonate = (c)(ii) ÷ 2	1
1(c)(iv)	Correctly uses (c)(iii) × 10 and $M_r = \text{mass from (a)} \div (\text{answer to (c)(iii)} \times 10)$	1
1(c)(v)	$\frac{M_r - 106}{18}$ and answer as integer from working	1
1(d)	Percentage error increases as volume is smaller.	1
	Half the volume of sulfuric acid is needed	1

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Question	Answer	Marks
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Question	Answer	Marks
2(a)	Data recorded (in table) showing all headings and units • Mass of crucible + lid • Mass of crucible + lid + FA 4 • Mass of crucible + lid + residue / anhydrous FA 4 • Mass of FA 4 • Mass residue / anhydrous FA 4 • Mass water (lost) and the 3 balance readings clearly recorded to consistent number of dp. <i>Do not allow weight.</i>	1
	Mass between 1.80 g and 2.00 g used and masses water, hydrated and anhydrous solid correctly calculated	1

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Question	Answer	Marks
For assessment of accuracy (Q) marks the examiner should check and correct the masses of water and anhydrous solid and calculate ratio of mass water/mass anhydrous solid correct to 2 dp. (theoretical value 1.05)		
2(a)	Award 2 marks if ratio 0.95–1.10 Award 1 mark if ratio 0.80–1.15	2
2(b)(i)	Correctly calculates: mass water for (a) ÷ 18, to 2 – 4 sf	1
2(b)(ii)	Correctly uses (b)(i) ÷ 7 and answer to 2 – 4 sf	1
2(b)(iii)	Expression: $M_r = \text{mass anhydrous solid} \div \textbf{(b)(ii)}$	1
	Expression: $A_r = M_r - 96.1$	1
2(b)(iv)	Identification of Y as Group 2 element with A_r nearest to (b)(iii)	1
2(c)	Moles / mass water too small / not all water lost so A_r too large	1
	 as moles YSO_4 too small	1

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Question	Answer	Marks
FA 4 is MgSO_4 ; FA 5 is $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$		
3(a)(i)	Chooses NaOH and NH_3	1
	Uses both reagents in excess	1
	White ppt and insoluble in excess for both	1
3(a)(ii)	If $\text{Mg}^{(2+)}$ in Q2 then (observations) confirm it (owtte) or If other cation / metal identified in Q2 then not confirmed as (FA 4 contains) Mg^{2+} / magnesium (owtte)	1
3(b)(i)	Observations (4 possible): • Water vapour / condensation • Gas turns litmus red • White smoke (not white fumes / white gas) • Brown / yellow / grey residue Any 3 obs = 2 marks, any 2 obs = 1 mark	2

Question	Answer		Marks
3(b)(ii)	<i>test</i>	<i>observations</i>	6
	+ NaOH	Green ppt and insol in excess / turns brown [1]	
	+ KMnO ₄	Purple to colourless / yellow [1]	
	+ NH ₄ SCN	Red / blood-red / blood-orange (solution) [1]	
	+H ₂ O ₂	Fizz and gas relights glowing splint [1]	
	then + NaOH	Brown / rust / red-brown ppt and insol in excess [1]	
	+ AgNO ₃	No visible reaction / no change / no ppt (ignore faint white ppt) and	
	+ Ba(NO ₃) ₂	White ppt and	
	then + HCl	(ppt) insoluble [1]	
3(b)(iii)	Fe ²⁺ and SO ₄ ²⁻		1
3(b)(iv)	redox / Fe ²⁺ is oxidised / MnO ₄ ⁻ is reduced		1