
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

October/November 2018

MARK SCHEME

Maximum Mark: 40

Published

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Cambridge Assessment
International Education

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Question	Answer	Marks
1(a)	I Table drawn with suitable headings and units; Temperature / T and time / t / °C, (s) or / minutes or mins or min	1
	II Table completed with all temperature readings from 0 to 9 minutes at half minute intervals and 2 balance readings shown to the same number of decimal places	1
	III All recorded thermometer readings to .5 °C with at least one ending in .0 °C and at least one ending in .5 °C.	1
	Calculate ΔT from T at 2 minutes to $T_{\max}$ from table. Compare with supervisor ΔT . Award IV if ΔT within 1 °C of supervisor. Award IV and V if ΔT within 0.5 °C of supervisor.	2
1(b)(i)	Axes unambiguously labelled. Scale chosen so that plotted points (and 2 °C extra on y-axis) occupy more than half the available space in both directions.	1
	All recorded points plotted. Points plotted to within half a small square. Points that should be on lines must be on the line and points that should not be on lines must not be on lines. Do not award if crosses / blobs are > half square thick.	1
	Two straight lines of best fit drawn (with a ruler) – one up 2 minutes and the other after the maximum temperature.	1
	Both lines extrapolated to 2½ minutes.	1
1(b)(ii)	Candidate ΔT to at least 1 decimal place is within half a small square or 1 decimal place (whichever is more appropriate) of examiner's calculated ΔT .	1
1(c)(i)	Correctly calculates energy evolved = $25 \times 4.2 \times \Delta T$ ΔT from (b)(ii) or table and answer to 2–4 sf	1
1(c)(ii)	Correct use of moles $\text{Na}_2\text{CO}_3 = \text{(c)(i)} / 27000$	1
	Correct use of % mass $\text{Na}_2\text{CO}_3 = \text{moles} \times 106 / \text{sum of } A_r$ and answer to 2–4 sf	1

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Question	Answer	Marks
1(c)(iii)	Correct use of % $\text{Na}_2\text{CO}_3 = (\text{c})(\text{ii}) / \text{mass FA1 used and answer to 2–4 sf.}$	1
1(d)	Assumption: the impurity does not react with hydrochloric acid or FA 2 or impurities are not alkaline	1
1(e)	Data with unambiguous headings (not weight). and Correct subtraction of mass and ΔT .	1
	Examiner calculates expression: mass FA 1 $\times \Delta T$ in (e) / mass FA 3 $\times \Delta T$ in (a) to 2 decimal place. Award mark if this value lies in range 0.80 to 1.25	1
1(f)	All 4 stages in method (same as (c)(i) – (iii)) scores 2 marks 2 or 3 stages shown clearly scores 1	2
1(g)	First box ticked (If there is a temperature fall after the max in Method 1 then this is more accurate) because as heat lost is compensated for / cooling curve plotted OR Third box ticked (special case if no temp fall in (a)) If there is no temperature fall after the maximum in Method 2 then both seem to be equally accurate because the temperature rise is potentially the same for both methods.	1
1(h)	(The student used) fewer moles / less amount of carbonate	1
	(The temperature increase is less and hence calculated) enthalpy change would be less exothermic / ΔH is less negative.	1
1(i)	Correctly calculates Moles $\text{Na}_2\text{CO}_3 = (3 / 106) \times 0.8 = 0.0226 / 0.02264$	1
	Ratio 1: 2 moles $\text{HCl} = 0.0452 / 0.0453$	1

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Question	Answer	Marks
	Vol HCl = $0.0452 / 0.002 = 22.6(0) / 22.7(0) \text{ cm}^3$ and answer to 3 or 4 significant figures (or nearest 0.05 cm^3)	1

Question	Answer	Marks
FA 4 is sodium chloride; FA 6 is copper(II) carbonate; FA 7 is a mixture of zinc sulfate and zinc nitrate		
2(a)(i)	Make a solution of FA 4 and add aqueous AgNO_3	1
	white ppt shows anion is Cl^-	1
2(a)(ii)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$	1
2(b)(i)	Hydrochloric acid Effervescence / bubbling and blue / green / cyan / turquoise solution formed	1
	gas / CO_2 turns limewater milky / cloudy white / chalky / forms a white ppt	1
	Ammonia (pale) blue ppt and dark blue solution with excess	1
	Heating (FA 6) turns black / black solid formed / it turns black	1

Question	Answer	Marks														
2(b)(ii)	2 * = 1 mark <table><tr><td>NaOH</td><td>White ppt * sol in excess *</td></tr><tr><td>NH₃</td><td>White ppt * sol in excess *</td></tr><tr><td>AgNO₃</td><td>No reaction / no ppt *</td></tr><tr><td>Ba(NO₃)₂</td><td>White ppt *</td></tr><tr><td>HNO₃</td><td>Ppt remains / no change*</td></tr><tr><td>NaOH and warm</td><td>No gas / no reaction *</td></tr><tr><td>+ A /</td><td>Gas / NH₃ / effervescence / fizzing / bubbles* turns litmus blue *</td></tr></table>	NaOH	White ppt * sol in excess *	NH ₃	White ppt * sol in excess *	AgNO ₃	No reaction / no ppt *	Ba(NO ₃) ₂	White ppt *	HNO ₃	Ppt remains / no change*	NaOH and warm	No gas / no reaction *	+ A /	Gas / NH ₃ / effervescence / fizzing / bubbles* turns litmus blue *	5
NaOH	White ppt * sol in excess *															
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AgNO ₃	No reaction / no ppt *															
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NaOH and warm	No gas / no reaction *															
+ A /	Gas / NH ₃ / effervescence / fizzing / bubbles* turns litmus blue *															
2(b)(iii)	Cations: Cu ²⁺ and Zn ²⁺ / copper(II) and zinc	1														
2(b)(iv)	Anions: any two of CO ₃ ²⁻ , NO ₃ ⁻ , NO ₂ ⁻ , SO ₄ ²⁻ / carbonate, nitrate, nitrite, sulfate	1														
2(b)(v)	NO ₃ ⁻ , NO ₂ ⁻ / nitrate and nitrite / nitrate(V) and nitrate(III)	1														

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Rounding errors and transcription errors are penalised only once in the paper.

Question	Answer	Marks																				
1(a)	I Headings and units correct Balance readings recorded to same dp (to at least 1 dp) Mass of Mg correctly calculated • Mass of container + FA 2 / Mg (not weight) • Mass of container (+ residue/empty) • Mass of FA 2 / Mg Units: (g), / g, in g, in grams / grammes (not gm) or g by each entry	1																				
	II Thermometer readings to $\pm 0.5\text{ }^{\circ}\text{C}$ (at least one ending in .5 and one at .0) (<i>Minimum 12 readings</i>)	1																				
	Examiner corrects thermometer readings to the nearest $0.5\text{ }^{\circ}\text{C}$ Examiner calculates max ΔT from table for supervisor and candidate $\Delta T = \max T - T$ at 2 min. Examiner calculates the difference, δ , from candidate.																					
	Award III and IV according to the table below	2																				
	<table><tr><td>Sup $\Delta T_{\max}$</td><td>$>50.0\text{ }^{\circ}\text{C}$</td><td>$40.5\text{--}50.0\text{ }^{\circ}\text{C}$</td><td>$30.5\text{--}40.0\text{ }^{\circ}\text{C}$</td><td>$20.5\text{--}30.0\text{ }^{\circ}\text{C}$</td><td>$10.5\text{--}20.0\text{ }^{\circ}\text{C}$</td><td>$<10.0\text{ }^{\circ}\text{C}$</td></tr><tr><td>1 mark</td><td>$\delta \leq 7.5\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 6.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 4.5\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 3.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 2.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 1.0\text{ }^{\circ}\text{C}$</td></tr><tr><td>2 marks</td><td>$\delta \leq 5.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 4.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 3.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 2.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 1.0\text{ }^{\circ}\text{C}$</td><td>not available</td></tr></table>	Sup $\Delta T_{\max}$	$>50.0\text{ }^{\circ}\text{C}$	$40.5\text{--}50.0\text{ }^{\circ}\text{C}$	$30.5\text{--}40.0\text{ }^{\circ}\text{C}$	$20.5\text{--}30.0\text{ }^{\circ}\text{C}$	$10.5\text{--}20.0\text{ }^{\circ}\text{C}$	$<10.0\text{ }^{\circ}\text{C}$	1 mark	$\delta \leq 7.5\text{ }^{\circ}\text{C}$	$\delta \leq 6.0\text{ }^{\circ}\text{C}$	$\delta \leq 4.5\text{ }^{\circ}\text{C}$	$\delta \leq 3.0\text{ }^{\circ}\text{C}$	$\delta \leq 2.0\text{ }^{\circ}\text{C}$	$\delta \leq 1.0\text{ }^{\circ}\text{C}$	2 marks	$\delta \leq 5.0\text{ }^{\circ}\text{C}$	$\delta \leq 4.0\text{ }^{\circ}\text{C}$	$\delta \leq 3.0\text{ }^{\circ}\text{C}$	$\delta \leq 2.0\text{ }^{\circ}\text{C}$	$\delta \leq 1.0\text{ }^{\circ}\text{C}$	not available
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Question	Answer	Marks
1(b)(i)	I Axes labelled, linear scales chosen so that more than half the available space is used on both axes for plotted points and 10 °C above highest T	1
	II All points recorded are correctly plotted Points plotted to within half a small square and in the correct square for y -axis and (normally) on line for x -axis.	1
	III Two best-fit lines (straight or smooth curve) drawn before adding Mg and after solution starts cooling or temperature remains constant (for a minimum of 3 points). (Best fit: points must be balanced either side of the line.)	1
1(b)(ii)	Correctly extrapolated (best fit) lines drawn up to time 2½ minutes and after 2½ minutes and vertical line drawn at 2½ minutes.	1
	ΔT read correctly from graph to within half a small square.	1
1(c)(i)	Correctly calculates $(^{151.9}_{159.6}) = 0.952 / 0.9518 \text{ mol dm}^{-3}$ (3 or 4 sf only)	1
1(c)(ii)	Correctly uses $n(\text{CuSO}_4) = (^{(c)(i)})_{/40} = 0.024 / 0.0238 / 0.02379$ and answer to 2–4 sf Allow ecf	1
1(c)(iii)	Correctly calculates $25 \times 4.2 \times \text{(b)(ii)}$ and answer to 2–4 sf	1
1(c)(iv)	Correctly uses $\frac{\text{(iii)}}{\text{(ii)} \times 1000}$ and answer to 2–4 sf (Ignore sign here for this mark.) Infer use of 1000 from answer. Allow ecf	1
1(c)(v)	Correctly calculates $\text{moles(Mg)} = \frac{\text{mass(Mg)}}{24.3}$ and states answer $> 0.024 / 0.0238$ <i>ora</i> (Allow ecf for value of moles of CuSO_4 in (c)(ii) .)	1

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Question	Answer	Marks
1(d)(i)	No – slower so might not finish within 8 minutes / maximum temperature rise does not occur within 8 minutes / temperature may not fall within 8 minutes No – cooling curve used and to eliminate heat losses / ΔT not affected	1
1(d)(ii)	Any one of Use lid to reduce heat loss Use burette / pipette to measure volume of FA 1 as more accurately calibrated/smaller percentage error Use thermometer with smaller calibrations to reduce percentage error	1

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Question	Answer	Marks																	
2(a)	I Data tabulated / listed with unambiguous headings (Ignore units unless word ‘mass’ or ‘temperature’ missing) • 2 balance readings • 2 thermometer readings • mass Zn correctly calculated and between 1.80 and 2.00 g • ΔT correctly calculated (Not ‘weight’, not ‘amount’)	1																	
	Examiner checks subtractions of supervisor and candidate. Examiner calculates the difference, δ , from candidate.																		
	Award II and III according to the table below	2																	
	<table><tr><td>Sup ΔT</td><td>40.5–50.0 °C</td><td>30.5–40.0 °C</td><td>20.5–30.0 °C</td><td>10.5–20.0 °C</td><td><10.0 °C</td></tr><tr><td>1 mark</td><td>$\delta \leq 6.0$ °C</td><td>$\delta \leq 4.5$ °C</td><td>$\delta \leq 3.0$ °C</td><td>$\delta \leq 2.0$ °C</td><td>$\delta \leq 1.0$ °C</td></tr><tr><td>2 marks</td><td>$\delta \leq 4.0$ °C</td><td>$\delta \leq 3.0$ °C</td><td>$\delta \leq 2.0$ °C</td><td>$\delta \leq 1.0$ °C</td><td>not available</td></tr></table>	Sup ΔT	40.5–50.0 °C	30.5–40.0 °C	20.5–30.0 °C	10.5–20.0 °C	<10.0 °C	1 mark	$\delta \leq 6.0$ °C	$\delta \leq 4.5$ °C	$\delta \leq 3.0$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.0$ °C	2 marks	$\delta \leq 4.0$ °C	$\delta \leq 3.0$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.0$ °C	not available
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2 marks	$\delta \leq 4.0$ °C	$\delta \leq 3.0$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.0$ °C	not available														
2(b)(i)	Correctly uses $\Delta H = (-) \frac{25 \times 4.2 \times \Delta T}{\mathbf{1(c)(ii)} \times 1000}$ and to minimum 2 sf	1																	
	Appropriate signs shown in answers to both 1(c)(iv) and 2(b)(i)	1																	
2(b)(ii)	Correctly calculates $(^{2 \times 0.5}_{\Delta T}) \times 100$ and answer given to at least 2 sf	1																	
2(c)	Ticks temp rise would be the same and double the volume but also double the moles / amount of CuSO_4 / FA 1 reacting (<i>owtte</i> or by calculation)	1																	

Question	Answer	Marks
2(d)(i)	Attempt at use of Hess' law (Minimum: equation for reaction, correct direction of arrows and correct numbers shown)	1
	Correctly calculates 1(c)(iv) – 2(b)(i) (Default answer = –119)	1

Question	Answer	Marks
FA 4 is $\text{NH}_4\text{VO}_3(\text{aq})$; FA 5 is $\text{H}_2\text{SO}_4(\text{aq})$		
3(a)	+ KI Solution (turns) brown / red-brown / orange-brown / yellow-brown or black ppt / solid	1
	+ sodium thiosulfate (Solution) turns blue Allow blue-green / green solution; ignore 'cloudy' or 'milky'.	1
	+ Zn Expected solution colour changes: yellow → green → blue → green → violet 3 colours of solution correct (in the correct order) = 2 marks, 2 colours of solution correct (in the correct order) = 1 mark	2
	bubbles / effervescence/ fizzing or gas pops with lighted splint	1
3(b)(i)	Selects BaCl_2 / $\text{Ba}(\text{NO}_3)_2$ and for H_2SO_4 and AgNO_3 and for HCl	1
	Selects NaOH + Al and for HNO_3	1

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Question	Answer	Marks
3(b)(ii)	White ppt with Ba^{2+} / no reaction with any other appropriate anion tests listed in (b)(i)	1
	SO_4^{2-} / 'unknown' (from appropriate observation)	1
3(c)	+ KMnO_4 Expected colour changes of solution: violet / final colour given in 3(a) → green → blue → green → yellow (<i>allow orange</i>) → pink / purple 3 colours correct (in the correct order) = 2 marks, 2 colours correct (in the correct order) = 1 mark	2
	+ FA 4 Turns blue / green (ignore state)	1
3(d)(i)	Redox	1
	manganate(VII) / MnO_4^- (<i>allow KMnO_4</i>) is an oxidising agent / is reduced / changes from purple to colourless (<i>allow is decolourised</i>) or different colours indicate different oxidation states	1
3(d)(ii)	(+) 5	1

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1(a)	I Unambiguous data recorded (mass or g) - two weighings with clear indication to what they refer. (mass of) FB 1, correctly subtracted and between 2.80 and 3.00	1
	II All the following data is recorded - rough titration: both burette readings and the titre - initial and final burette readings for two (or more) accurate titrations	1
	III Titre values recorded for accurate titrations, and correct headings and units in the accurate titration table - initial / start and (burette) reading / volume (<i>allow vol, but not V</i>) - final / end and (burette) reading / volume - titre or volume / FB 2 and used / added (<i>not 'difference' or 'total volume'</i>) - unit: / cm³ or (cm³) or in cm³ (for each heading) or cm ³ unit given for each volume recorded	1
	IV All accurate burette readings are recorded to the nearest 0.05 cm ³ . <i>The requirement to record to 0.05 applies to burette readings, including 0.00 cm³ (if this was the initial reading), but it does not apply to the titre.</i> <i>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
	V The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Examiner calculates supervisor mean titre and hence the supervisor's value of mean titre / mass of FB 1 . Examiner calculates candidate's mean titre and hence the candidate's value of mean titre / mass of FB 1 . Examiner compares the two values.	
	Q Award VI, VII and VIII if $\delta \leq 0.10$ (cm ³ g ⁻¹)	1
	Q Award VI and VII if $0.10 < \delta \leq 0.30$	1
	Q Award VI only if $0.30 < \delta \leq 0.50$	1

Question	Answer	Marks
1(b)	Candidate calculates the mean correctly. • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working / explanation must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 dp, and be rounded to nearest 0.01 cm³. (e.g. 26.667 cm³ must be rounded to 26.67 cm³) Two special cases, where the mean need not be to 2 dp: • Allow mean expressed to 3 dp only for 0.025 or 0.075 (e.g. 26.325 cm³) • Allow mean if expressed to 1 dp, if all accurate burette readings 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 – mean 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. 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)	All answers quoted in parts (ii)–(v) are given to 3 or 4 sig fig. A minimum of three answers is required to earn this mark	1
1(c)(ii)	Correctly calculates moles of HCl No of moles of HCl used = $0.105 \times \frac{\text{mean titre}}{1000}$	1
1(c)(iii)	Equation with correct state symbols and moles NaHCO₃ correct $\text{NaHCO}_3(\text{aq} / \text{s}) + \text{HCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{CO}_2(\text{aq} / \text{g}) + \text{H}_2\text{O}(\text{l})$ and no of moles of NaHCO₃ = ans in (ii)	1
1(c)(iv)	Correctly uses (c)(iii) for moles of NaHCO₃ No of moles of NaHCO₃ in FB 1 = 10 × answer (iii)	1
1(c)(v)	Correctly uses answer (c)(iv) in calculating % by mass of NaHCO₃ % by mass = $\frac{(\text{ans (iv)} \times 84)}{\text{mass of FB1 used in (a)}} \times 100$ 84 may be shown as the sum of the A_r values.	1

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Question	Answer	Marks
2(a)	I Six headings and units in list/table of data: • Mass of crucible and lid (<i>not 'weight' in any reading</i>) • Mass of crucible, lid and FB 1 (or 'contents before heating') • Mass of crucible, lid and residue / contents after first heating / heating 1 / owtte • Mass of crucible, lid and residue / contents after 2nd heating • Mass of FB 1 (used) • Mass of residue <i>Do not allow 'mass of FB 1 after heating' in third or fourth weighing.</i> <i>Unit must be given correctly in each case</i> <i>Inclusion or not of lid must be consistent.</i>	1
	II Four weighings recorded, all in the space provided • Four weighings (or more) recorded in the space provided. • All readings recorded to same number of decimal places. • Final weighing is within 0.04 g of the previous one. <i>If balance used read to 1 dp, the 3rd and 4th readings must be the same.</i>	1
	III Mass of FB 1 and residue , both written in the space provided • Mass of FB 1 used, correctly subtracted • Mass of FB 1 used was between 2.8 and 3.0 g • Mass of residue correctly subtracted.	1
	Accuracy marks • For assessment of accuracy, examiner must check and correct (if necessary) the masses of FB 1 used and of residue obtained by the supervisor and by the candidate. • Work out ratio $\frac{\text{mass of FB 1}}{\text{mass of residue (from lower mass weighing)}}$ for the supervisor (2 dp) • Work out ratio (mass FB 1: mass residue) for candidate (2 dp) • Calculate δ, the difference between these two ratios. Award IV and V if $\delta \leq 0.05$ Award IV if $0.05 < \delta \leq 0.10$	2

Question	Answer	Marks
2(b)(i)	Correctly calculates moles of CO₂ - No of moles CO₂ = $\frac{\text{mass lost}}{62}$ - Answer must be correct and expressed to 2–4 sig fig. <i>Mass loss must be correctly subtracted, either using original weighings or using the masses of FB1 and residue.</i>	1
2(b)(ii)	Correctly uses (i) for mass of NaHCO₃ Mass of NaHCO₃ = ans (i) × 2 × 84 and answer to 2–4 sig fig Do not penalise sf more than once in 2(b)	1
2(b)(iii)	Correctly calculates percentage mass of NaHCO₃ % = $\frac{\text{ans (ii)}}{\text{mass of FB1 used}} \times 100$ and answer to 2–4 sig fig.	1
2(c)(i)	To obtain constant mass (<i>owtte</i>) This shows that the reaction / decomposition is complete / only Na ₂ CO ₃ is left	1
	<i>Allow: to remove all CO₂ and H₂O</i>	1
2(c)(ii)	(Assumption is that) the impurity does not decompose when heated or The impurity does not react with air when heated or The impurity does not react with NaHCO₃ / Na₂CO₃ on heating	1
2(c)(iii)	Disagree because there is no frothing / spitting out (<i>owtte</i>)	1
2(c)(iv)	Possible answers, stating and explaining which experiment is more accurate: - Titration, because repeated titres are consistent. - Gravimetric, because fewer measurements / fewer cumulative / combined errors - Gravimetric, because heating is to constant mass. - Gravimetric, because colour change (of methyl orange) is indistinct / gradual.	1

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Question	Answer	Marks
FB 4 is a mixture of $\text{Na}_2\text{CO}_3 + \text{NaCl}$		
3(a)(i)	Fizzing / effervescence / bubbling	1
	<u>Gas</u> / CO_2 turns lime water milky / cloudy white or gas gives white precipitate with lime water	1
3(a)(ii)	White ppt with AgNO_3 and ppt is soluble in (excess) ammonia / colourless solution formed.	1
3(a)(iii)	Either equation correct: $\text{Na}_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NaNO}_3 + \text{CO}_2 + \text{H}_2\text{O}$ or $\text{Ca}(\text{OH})_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$	1
3(b)(i)	Blue precipitate (with CuSO_4) and (pale) (not dark) blue solution (formed with H_2SO_4)	1
	Fizzing / effervescence / bubbling with acid in both this test and addition of acid to BaCO_3 ppt in next test.	1
	White precipitate (with Ba^{2+}) and precipitate dissolves / colourless solution formed (with HNO_3)	1
	Yellow / orange-yellow / yellowy-orange (solution) (formed)	1
	White / off-white precipitate (with Ag^+)	1
	Fizzes / bubbles / effervescence (with HNO_3) or ppt is <u>partially</u> soluble (in HNO_3) (<i>owtte</i>)	1
3(b)(ii)	Fizzing / effervescence / bubbling with aluminium	1
3(b)(iii)	Sodium chloride / NaCl	1
3(b)(iv)	Mark ecf on colour Yellow: alkaline / neutral / weakly acidic Orange: neutral / weakly acidic	1

CHEMISTRY

9701/35

Paper 3 Advanced Practical Skills 1

October/November 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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This document consists of **8** printed pages.



Cambridge Assessment
International Education

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
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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:

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Question	Answer	Marks
1(a)	I Table drawn with suitable headings and units; Temperature / T and time / t / °C, (s) or / minutes or mins or min	1
	II Table completed with all temperature readings from 0 to 9 minutes at half minute intervals and 2 balance readings shown to the same number of decimal places	1
	III All recorded thermometer readings to .5 °C with at least one ending in .0 °C and at least one ending in .5 °C.	1
	Calculate ΔT from T at 2 minutes to $T_{\max}$ from table. Compare with supervisor ΔT . Award IV if ΔT within 1 °C of supervisor. Award IV and V if ΔT within 0.5 °C of supervisor.	2
1(b)(i)	Axes unambiguously labelled. Scale chosen so that plotted points (and 2 °C extra on y-axis) occupy more than half the available space in both directions.	1
	All recorded points plotted. Points plotted to within half a small square. Points that should be on lines must be on the line and points that should not be on lines must not be on lines. Do not award if crosses / blobs are > half square thick.	1
	Two straight lines of best fit drawn (with a ruler) – one up 2 minutes and the other after the maximum temperature.	1
	Both lines extrapolated to 2½ minutes.	1
1(b)(ii)	Candidate ΔT to at least 1 decimal place is within half a small square or 1 decimal place (whichever is more appropriate) of examiner's calculated ΔT .	1
1(c)(i)	Correctly calculates energy evolved = $25 \times 4.2 \times \Delta T$ ΔT from (b)(ii) or table and answer to 2–4 sf	1
1(c)(ii)	Correct use of moles $\text{Na}_2\text{CO}_3 = \text{(c)(i)} / 27000$	1
	Correct use of % mass $\text{Na}_2\text{CO}_3 = \text{moles} \times 106 / \text{sum of } A_r$ and answer to 2–4 sf	1

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Question	Answer	Marks
1(c)(iii)	Correct use of % $\text{Na}_2\text{CO}_3 = (\text{c})(\text{ii}) / \text{mass FA1 used and answer to 2–4 sf.}$	1
1(d)	Assumption: the impurity does not react with hydrochloric acid or FA 2 or impurities are not alkaline	1
1(e)	Data with unambiguous headings (not weight). and Correct subtraction of mass and ΔT .	1
	Examiner calculates expression: mass FA 1 $\times \Delta T$ in (e) / mass FA 3 $\times \Delta T$ in (a) to 2 decimal place. Award mark if this value lies in range 0.80 to 1.25	1
1(f)	All 4 stages in method (same as (c)(i) – (iii)) scores 2 marks 2 or 3 stages shown clearly scores 1	2
1(g)	First box ticked (If there is a temperature fall after the max in Method 1 then this is more accurate) because as heat lost is compensated for / cooling curve plotted OR Third box ticked (special case if no temp fall in (a)) If there is no temperature fall after the maximum in Method 2 then both seem to be equally accurate because the temperature rise is potentially the same for both methods.	1
1(h)	(The student used) fewer moles / less amount of carbonate	1
	(The temperature increase is less and hence calculated) enthalpy change would be less exothermic / ΔH is less negative.	1
1(i)	Correctly calculates Moles $\text{Na}_2\text{CO}_3 = (3 / 106) \times 0.8 = 0.0226 / 0.02264$	1
	Ratio 1: 2 moles $\text{HCl} = 0.0452 / 0.0453$	1

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Question	Answer	Marks
	Vol HC/ = $0.0452 / 0.002 = 22.6(0) / 22.7(0) \text{ cm}^3$ and answer to 3 or 4 significant figures (or nearest 0.05 cm^3)	1

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Question	Answer	Marks
FA 4 is sodium chloride; FA 6 is copper(II) carbonate; FA 7 is a mixture of zinc sulfate and zinc nitrate		
2(a)(i)	Make a solution of FA 4 and add aqueous AgNO_3	1
	white ppt shows anion is Cl^-	1
2(a)(ii)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$	1
2(b)(i)	Hydrochloric acid Effervescence / bubbling and blue / green / cyan / turquoise solution formed	1
	gas / CO_2 turns limewater milky / cloudy white / chalky / forms a white ppt	1
	Ammonia (pale) blue ppt and dark blue solution with excess	1
	Heating (FA 6) turns black / black solid formed / it turns black	1

Question	Answer	Marks														
2(b)(ii)	2 * = 1 mark <table><tr><td>NaOH</td><td>White ppt * sol in excess *</td></tr><tr><td>NH₃</td><td>White ppt * sol in excess *</td></tr><tr><td>AgNO₃</td><td>No reaction / no ppt *</td></tr><tr><td>Ba(NO₃)₂</td><td>White ppt *</td></tr><tr><td>HNO₃</td><td>Ppt remains / no change*</td></tr><tr><td>NaOH and warm</td><td>No gas / no reaction *</td></tr><tr><td>+ A /</td><td>Gas / NH₃ / effervescence / fizzing / bubbles* turns litmus blue *</td></tr></table>	NaOH	White ppt * sol in excess *	NH ₃	White ppt * sol in excess *	AgNO ₃	No reaction / no ppt *	Ba(NO ₃) ₂	White ppt *	HNO ₃	Ppt remains / no change*	NaOH and warm	No gas / no reaction *	+ A /	Gas / NH ₃ / effervescence / fizzing / bubbles* turns litmus blue *	5
NaOH	White ppt * sol in excess *															
NH ₃	White ppt * sol in excess *															
AgNO ₃	No reaction / no ppt *															
Ba(NO ₃) ₂	White ppt *															
HNO ₃	Ppt remains / no change*															
NaOH and warm	No gas / no reaction *															
+ A /	Gas / NH ₃ / effervescence / fizzing / bubbles* turns litmus blue *															
2(b)(iii)	Cations: Cu ²⁺ and Zn ²⁺ / copper(II) and zinc	1														
2(b)(iv)	Anions: any two of CO ₃ ²⁻ , NO ₃ ⁻ , NO ₂ ⁻ , SO ₄ ²⁻ / carbonate, nitrate, nitrite, sulfate	1														
2(b)(v)	NO ₃ ⁻ , NO ₂ ⁻ / nitrate and nitrite / nitrate(V) and nitrate(III)	1														

CHEMISTRY

9701/36

Paper 3 Advanced Practical Skills 2

October/November 2018

MARK SCHEME

Maximum Mark: 40

Published

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GENERIC MARKING PRINCIPLE 6:

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Rounding errors and transcription errors are penalised only once in the paper.

Question	Answer	Marks
1(a)	I Constructs a table for results for 5 experiments and 4 columns.	1
	II Appropriate headings and units for all recorded data given. Volumes in cm^3 or cm^3 or (cm^3) . Time in seconds or s or (s) . Units for rate given as s^{-1}	1
	III All times recorded to the nearest second and volumes of FB 1 and water to at least 1 decimal place.	1
	IV Three additional volumes chosen with intervals not less than 2.00 cm^3 AND No experiment with FB 1 = 15.00 cm^3 AND all volumes of FB 1 $\geq 5.00 \text{ cm}^3$ AND at least one experiment between 5 cm^3 and 10 cm^3	1
	V In all additional experiments water is added to make the same total volume.	1
	VI All rates correctly calculated using $1000 / \text{time}$ AND 1 or 2 decimal place	1
	VII + VIII Compare time for 20.00 cm^3 of FB 1 with that of supervisor. Award VII for within 20% of supervisor rounded to nearest s. Award VII + VIII for within 10% of supervisor rounded to nearest s.	2
	Examiner calculates supervisor's ratio time expt 2 / time expt 1 to 2 dp. Calculate candidate t_2 / t_1 to 2 dp	
	IX + X Compare ratio of time for 10.00 cm^3 FB 1 / time for 20.00 cm^3 FB 1 with that of supervisor. Award IX for within 0.20. Award IX + X for within 0.10.	2

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Question	Answer	Marks
1(b)	I Rate on <i>y</i> -axis and volume on <i>x</i> -axis. Axes clearly labelled (labels or units).	1
	II Linear scales including origin; scale chosen so that plotted points and the origin use more than half of each axis	1
	III All recorded points plotted correctly to within half a small square and in the correct square. Points that should be plotted on lines must be on lines, points that should not be on lines must not be on lines. Do not award for crosses or blobs more than half a small square thick.	1
	IV Draws a line of best fit. This may be a straight line or smooth curve. Points must be balanced and line cannot be improved by rotation.	1
1(c)	Straight line: Rate is proportional to volume of FB 1 OR Curved line: Rate is proportional to volume of FB 1	1
	Rate is directly proportional to volume of FB 1 because straight line goes through origin / OR Rate is proportional to volume of FB 1 as straight line but not through origin. OR for curved line: It is not directly proportional because not a straight line	1
1(d)(i)	Reads rate from graph to the nearest small square using vertical and horizontal construction lines and some evidence of its use in the calculation.	1
	Correctly calculates time from candidate's value for <i>y</i> -axis intercept to 2–4 sf	1
1(d)(ii)	Correctly uses % difference to 2–4 significant figures	1

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Question	Answer	Marks
1(e)	Uses 20 cm ³ of FB 2 and records time less than Experiment 2 (with 10 cm ³ FB 1).	1
	Volumes: FB 1 = 10 cm ³ FB 2 = 20 cm ³ FB 3 = 20 cm ³ FB 4 = 10 cm ³	1
1(f)(i)	Moles Fe ³⁺ = 0.001(0) or 0.05 × 20/1000 Moles I ₂ = 0.0005(0)	1 1
1(f)(ii)	moles I ₂ in (i) × 2/0.035 Concentration for correct n(I ₂) = 0.029 / 0.0286 / 0.02857 mol dm ⁻³ and answer to 2–4 sf	1

Question	Answer	Marks
(FB 1 = Fe³⁺; FB 5 = S₂O₃²⁻; FB 6 = KBr(aq); FB 7 = CuSO₄(aq); FB 8 = Al₂(SO₄)₃)		
2(a)(i)	(turns) purple and turns colourless (solution) / white or (pale) yellow ppt (on standing)	1
	green / black / brown ppt on adding NaOH	1
	white ppt	1
2(a)(ii)	One of: Yes, as the Fe ³⁺ does not all react with I ⁻ Yes, as all the S ₂ O ₃ ²⁻ does not react with I ₂ Yes, as less S ₂ O ₃ ²⁻ (present) to react with I ₂ No, as concentration of S ₂ O ₃ ²⁻ is much lower in Q1 than in Q2	1

Question	Answer	Marks										
2(b)(i)	<table><tr><th><i>test</i></th><th><i>observation</i></th></tr><tr><td>+ Ag⁺(aq)</td><td>cream ppt ●</td></tr><tr><td>+ NH₃(aq)</td><td>ppt insoluble / partially soluble / no reaction / no (visible) change ●</td></tr><tr><td>+ Ag⁺(aq)</td><td>cream ppt ●</td></tr><tr><td>+ FB 5</td><td>ppt soluble / (colourless) solution formed ●</td></tr></table> Two ● = 1 mark	<i>test</i>	<i>observation</i>	+ Ag ⁺ (aq)	cream ppt ●	+ NH ₃ (aq)	ppt insoluble / partially soluble / no reaction / no (visible) change ●	+ Ag ⁺ (aq)	cream ppt ●	+ FB 5	ppt soluble / (colourless) solution formed ●	2
<i>test</i>	<i>observation</i>											
+ Ag ⁺ (aq)	cream ppt ●											
+ NH ₃ (aq)	ppt insoluble / partially soluble / no reaction / no (visible) change ●											
+ Ag ⁺ (aq)	cream ppt ●											
+ FB 5	ppt soluble / (colourless) solution formed ●											
2(b)(ii)	Halide in FB 6 is Br ⁻ / bromide	1										
2(c)(i)	(solution) turns brown OR white / off-white / brown ppt not yellow ppt nor yellow solution AND black / blue-black / dark blue on addition of starch	1										
	Final colour and either initial colour or solution must be given. Solution turns from blue to pale yellow	1										
	no (colour) change / no reaction (on addition of FB 2 or of starch)	1										
2(c)(ii)	I ₂ OR CuI	1										

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Question	Answer	Marks
2(d)(i)	NaOH and NH ₃	1
	BaCl ₂ / Ba(NO ₃) ₂ AND HCl / HNO ₃ OR acidified (aqueous) KMnO ₄ OR named mineral acid AND test any gas with KMnO ₄	1
	With NaOH white ppt and sol in excess AND with NH ₃ white ppt and insol in excess	1
	With BaCl ₂ / Ba(NO ₃) ₂ white ppt AND insoluble in acid OR (with KMnO ₄) no change / no reaction AND solution remains purple OR dichromate – no change AND solution remains orange OR (with named acid) no gas evolved / no change / no reaction AND KMnO ₄ (paper) stays purple	1
2(d)(ii)	FB 8 is Al ₂ (SO ₄) ₃	1