

MARK SCHEME for the May/June 2010 question paper for the guidance of teachers

9701 CHEMISTRY

9701/33 Paper 31 (Advanced Practical Skills), maximum raw mark 40

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 must be read in conjunction with the question papers and the report on the examination.

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Question 1 Round all thermometer readings to the nearest 0.5°C.

Supervisor's Report

Calculate $m/\Delta T$ correct to 3 s.f. for each experiment.

Candidate's scripts

Calculate $m/\Delta T$ correct to 3 s.f. for each experiment.

Question	Sections	Indicative material	Mark
1 (a)	MMO Collection PDO Recording	<p>(i) Follows instructions with regard to times and temperature readings <i>0–3 minutes at 1 minute intervals; 5–8 minutes at ½ minute intervals, and T_1 recorded in box. (Ignore if also in table)</i></p> <p>(ii) All columns correctly labelled with appropriate unit shown. <i>Must use solidus, brackets or describe unit fully in words.</i> <i>If units not included in column headings every entry must have the correct unit shown</i> Accept min, mins or minutes</p> <p>(iii) <i>Look at results here and in (d).</i> All balance readings consistent to at least 1 decimal place. and All thermometer readings (table and box) recorded to nearest 0.5 °C. There must be at least one at 0.5 in (a).</p>	1 1 1 [3]

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Question	Sections	Indicative material	Mark
(b)	PDO Layout ACE Interpretation	<p>(i) Temperature of water in the beaker plotted on <i>y-axis</i> against time on <i>x-axis</i>. Clearly labelled axes (ignore units) [<i>temp/time are minimum acceptable labels</i>] <i>but</i> <i>accept T / °C and t / min as labels.</i> <i>The unit is necessary in this case</i></p> <p>(ii) Uniform and sensible scales for candidate's choice of graph. Plotted points must be in at least 4 large squares on the temperature axis and 5 large squares on the time axis. <i>Do not include any plotted value of T₁.</i></p> <p>(iii) <i>There should be a minimum of 5 plotted points between 5 and 8 minutes.</i> Examiner then checks plotting of points at t_{0 min}, t_{5 min} and t_{8 min} and the plotting of any suspect point. If any of the t_{0 min}, t_{5 min} and t_{8 min} points is missing check the adjacent point. <i>Points should be within ½ of a small square of the correct position and in the correct small square</i></p> <p>(iv) Acceptable straight lines drawn – <i>an acceptable straight line is one passing through the majority of points or has balanced points on either side of the line and</i> correct values of T₂ and T₃ read (to within ½ small square) from the graph. <i>Extrapolation need not be drawn on the graph</i></p>	1 1 1 1 [4]
(c)	ACE Interpretation	<p>(i) and (ii) Award one mark if both of the following expressions are <u>correctly evaluated</u>. heat gained = 210 × candidate value of (T₃ – T₂) heat lost = 210 × candidate value of (T₁ – T₃) <i>Units should be consistent. Ignore any sign given.</i></p> <p>(iii) No mark.</p>	1 [1]

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Question	Sections	Indicative material	Mark	
(d)	MMO Quality	<p>Compare the two $m/\Delta T$ values ($\text{g}^{\circ}\text{C}^{-1}$) for the candidate's two experiments. Award three marks for a difference up to 0.2 Award two of these three marks for a difference of $0.2+^{\circ}\text{C} - 0.3$ Award one of these three marks for a difference of $0.3+^{\circ}\text{C} - 0.4$</p> <p>Compare the standard $m/\Delta T$ value of $1.70 \text{ g}^{\circ}\text{C}^{-1}$ with the closer value from the candidate's results. Award three marks for a difference up to 0.2 Award two of these three marks for a difference of $0.2+^{\circ}\text{C} - 0.3$ Award one of these three marks for a difference of $0.3+^{\circ}\text{C} - 0.4$</p>	3	
			3	
				[6]
(e)	ACE Interpretation ACE Conclusions	<p>(i) Give one mark for correct <u>evaluation</u> of $430 \times$ candidate's $\Delta T_{(\text{expt 1})}$</p> <p>(ii) The candidate explains that the beaker as well as the solution has cooled Short term – beaker loses heat energy as it cools Long term – Heat energy is absorbed by beaker (and solution) Read in context – Beware of: <i>Heat is absorbed by beaker and surroundings (con)</i></p>	1	
	ACE Interpretation	<p>(iii) Give one mark if the candidate adds $(\Delta T_{(\text{expt 1})}) \times$ answer in (c)(iii)) to the answer in (e)(i). <i>Correct expression is sufficient, evaluation not required.</i></p> <p>(iv) The candidate <u>correctly</u> calculates the moles of FA 1 (<i>candidate's mass / 53.5</i>) used in expt 1.</p> <p><i>In (i), (iii) or (iv) withhold one mark for use of data from expt 2 the first time it is seen. Do not withhold more than one mark for this.</i></p>	1	
	ACE Conclusions	<p>(v) The candidate correctly divides the answer to (e)(iii) by the answer to (e)(iv) and by 1000. <i>Ignore errors in evaluation and sign</i></p>	1	
	PDO Display	<p>(vi) Award this mark if the candidate has given a +ve sign and explains that: the reaction is endothermic or heat is absorbed in the reaction or the temperature falls during the reaction.</p> <p>(vii) Award this mark if working is shown in sections (c)(i), or (c)(ii) or (e)(i) and (e)(iv) and (e)(v).</p>	1	

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Question	Sections	Indicative material	Mark	
(e) contd	PDO Display	(viii) Award this mark if the final answer in section (iii) of (c) and section (iv) of (e) is given to 2 or 3 significant figures.	1	[8]
(f)	ACE Interpretation	Correctly calculates the difference and the percentage error. <i>Ignore significant figures. Beware mixed units</i>	1	[1]
(g)	ACE Conclusions	Clearly described source of error (i) Heat loss / gain (ii) Use of glass beaker (iii) Precision of thermometer (iv) Small temperature fall	1	
	ACE Improvements	Specific improvement given with some attempt at justification. (i) Lid – prevents convection or evaporation Insulation – prevents conduction Use plastic beaker – provides insulation (ii) Polystyrene cup – lower heat capacity (iii) Use thermometer at 0.5 °C or better, gives smaller % error. (iv) Larger mass of NH_4Cl or smaller water volume. Gives greater temperature change Do not award either of these marks for answers referring to use of measurement of volume or measurement of mass.	1	[2]
	Total			[25]

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Question	Sections	Indicative material	Mark
FA 2 is Na_2SO_4 (aq); FA 3 is Na_2CO_3 (aq); FA 4 is a mixture of Na_2SO_4 (aq) and Na_2CO_3 (aq)			
2 (a)	MMO Decisions	<p>(i) reagent 1 – chooses any specified acid to detect the carbonate present (<i>name or formula</i> may be in results table) and reagent 2 – chooses BaCl_2 or $\text{Ba}(\text{NO}_3)_2$. <i>Accept Ba^{2+}(aq) or soln containing Ba^{2+}(aq) as reagent.</i> <i>Also accept incorrect formulae for a compound, e.g. BaCl_1, providing the identity of the reagent is obvious.</i></p> <p>(ii) Explains significance of order in which reagents added. acid first – to remove carbonate from solution or after Ba^{2+} – to dissolve any barium carbonate precipitated. Candidates must make clear the relationship of acid to barium carbonate. <i>Do not award this mark if sulfuric acid has been used in (i)</i> In section (iii), <u>assume reagents follow each other in the same test-tube unless otherwise stated.</u> Allow lead(II) nitrate as the 2nd reagent providing it is used with nitric acid.</p> <p>(iii) Addition of acid No reaction with FA 2, effervescence/bubbles/bubbling (or gas tested with limewater) for FA 3 and FA 4 Addition of Ba^{2+}(aq) white ppt with all three solutions, if added as first reagent or to a separate sample or white ppt, insoluble in acid for FA 2, soluble in acid for FA 3 and insoluble/partially soluble in acid for FA 4 if added before the addition of acid or white ppt with FA 2 and FA 4 and no ppt with FA 3 if added after addition of acid <i>Do not award this mark if sulfuric acid has been used unless it has been stated that Ba^{2+}(aq) was added to a fresh sample</i> Allow deductions from lead nitrate (as for barium salt) ONLY if nitric acid has been specified. If a candidate selects limewater as a reagent, can get observation marks, CaSO_4 soluble at this concentration.</p>	1
	MMO Collection		1

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Question	Sections	Indicative material	Mark	
FA 5 is $\text{CuSO}_4\text{(aq)}$; FA 6 is $\text{NH}_4\text{Cl(aq)}$; FA 7 is $\text{CoCl}_2\text{(aq)}$; FA 8 is $\text{MnSO}_4\text{(aq)}$				
(a) contd	ACE Conclusions	<p>No ecf to be applied in these conclusions</p> <p>(iv) Give one mark for identifying carbonate in FA 3 and FA 4, with supporting evidence. Minimum acceptable evidence – gas with acid or white ppt (barium carbonate) soluble in acid</p> <p>Give one mark for identifying sulfate in FA 2 and FA 4 only, with supporting evidence. Minimum acceptable evidence – white ppt with Ba^{2+} (if insoluble in acid) but con if soluble. If no mark has been awarded in (iii) or (iv), allow one mark if evidence given is consistent with the ions identified</p>	1	
				[6]
(b)	MMO Collection	(i) For FA 5 , records blue ppt, insoluble in an excess of NaOH blue ppt with ammonia; soluble or <u>forming a deep blue colour</u> with excess of the reagent	1	
	MMO Decisions	(ii) For FA 6 , records no precipitate with both NaOH and $\text{NH}_3\text{(aq)}$, and ammonia detected or red litmus turning blue on heating with NaOH (<i>No reference to a gas is necessary</i>)	1	
	MMO Collection	(iii) Describes <u>test carried out on gas evolved</u> to identify ammonia. <i>An observation of no ppt with either reagent and a gas turning red litmus blue on heating with NaOH would earn both the C3 and the De7 mark.</i> If the mark is not awarded for ammonia test a retrospective mark can be given here for testing gas evolved with limewater in (a)	1	
	MMO Collection	(iv) For FA 7 records blue (only) ppt, on initial addition of NaOH blue/green ppt, insoluble in excess ammonia	1	
		(v) Any reference to pink in either precipitate on initial formation, in excess or on standing.	1	

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Question	Sections	Indicative material	Mark	
(b) contd	MMO Collection	<p>(vi) For FA 8, records off-white/pale brown/buff/beige precipitate insoluble in an excess of NaOH off-white/pale brown/buff/beige precipitate insoluble in an excess of ammonia Do not accept a cream ppt.</p> <p>(vii) Darkening of the initial precipitate or appropriate coloured precipitate (allow white or cream ppt here as colour of initial ppt) turning brown at any stage with either reagent.</p>	1 1 [7]	
(c)	ACE Conclusions	<p>No ecf to be applied in these conclusions Identifies all cations correctly: FA 5 is Cu^{2+} / copper(II) FA 6 is NH_4^+ / ammonium FA 8 is Mn^{2+} / manganese(II)</p> <p>Gives appropriate supporting evidence for two of the three ions Minimum evidence for each of the ions.</p> <p>Cu²⁺</p> <p>(i) Blue ppt with both NaOH and NH_3(aq), or (ii) Blue ppt with NaOH, insoluble in excess of the reagent, or (iii) Blue ppt with NH_3(aq), soluble in excess of the reagent, or (iii) Dark blue colour formed at any stage with NH_3(aq)</p> <p>NH₄⁺</p> <p>(i) Ammonia, NH_3, alkaline gas, or gas turning red litmus blue with NaOH (hot or cold)</p> <p>Mn²⁺</p> <p>(i) Initial off-white to beige ppt with NaOH and with NH_3(aq) or (ii) Precipitate darkening / turning brown with either reagent – providing the colour of the initial precipitate is not completely inappropriate (e.g. blue or green).</p>	1 1 [2]	
	Total		[15]	