

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

9701 CHEMISTRY

9701/31

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.

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

Question	Sections	Indicative material	Mark	
1 (a)	PDO Recording	(i) Presents data in single table of results – <i>to include volume of FA 2, initial and final temperatures and temperature change.</i>	1	
		(ii) All columns correctly labelled with appropriate unit shown. <i>Must use solidus, brackets or describe unit fully in words. If units not included in column headings every entry must have the correct unit shown.</i>	1	
	MMO Collection	(iii) All thermometer readings recorded to 0.5°C	1	
		(iv) Follows instructions – uses 10, 20, 30, 40, 50 cm ³ of FA 2 + two additional volumes	1	
	MMO Decisions	(v) One extra volume of FA 2 on either side of the maximum for the first five expts. or Two extra volumes between identical values for the first five expts. or Two extra volumes the same side as the next highest reading.	1	
	MMO Quality	(vi) and (vii) Check and correct ΔT where necessary. <i>(If multiple readings for max. T then apply hierarchy: take value of consistent readings; take average and correct to nearest 0.5°C)</i> Compare temp rise with that obtained by the Supervisor (<i>Expected value is 14.0°C</i>) For 30 cm ³ FA 2 : Award (vi) and (vii) for a temp rise of 0.0°, 0.5°, 1.0°C <i>Award (vi) only for a difference of 1.5°C</i>	2	
	MMO Quality	(viii) and (ix) Check and correct ΔT where necessary. Compare temp rise with that obtained by the Supervisor (<i>Expected value is 13.5°C</i>) For 40 cm ³ FA 2 : Award (viii) and (ix) for a temp rise of 0.0°, 0.5°, 1.0°C <i>Award (viii) only for a difference of 1.5°C</i>	2	[9]

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Question	Sections	Indicative material	Mark	
(h)	ACE Interpretation	Uses the expression: (answer from (c) + 10) $\times 4.3 \times \Delta T$ read from graph Divides the answer above by answer to (f)(i) and gives answer in kJ mol^{-1} with –ve sign <i>Do not award this second mark unless candidate has calculated (<u>a volume of soln</u> $\times 4.3 \times \Delta T$)</i>	1 1	[2]
(i)	ACE Improvements	<u>Advantage</u> of burette: Lower % error or more accurately calibrated (<i>must refer to or infer scale/graduations/markings/divisions</i>) <u>Disadvantage</u> of burette: Takes longer to add the FA 2	1 1	[2]
(j)	ACE Interpretation	Candidate gives two of the following as significant sources of error. Heat loss (to the surroundings) Thermometer graduated at 1°C intervals Drying of cup/thermometer Initial temps of both solutions should be taken <i>Other acceptable sources of error may be seen.</i>	1	[1]
(k)	ACE Interpretation	(i) Maximum error in reading a 1°C graduated thermometer is given as 0.5°C (iii) Calculates answer in $\frac{\text{answer in (k)(i)} \times 2}{\text{answer in (k)(ii)}} \times 100\%$	1 1	[2]
	Total			[26]

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Question 2

Question	Sections	Indicative material	Mark	
FA 3 is $\text{BaCl}_2(\text{aq})$; FA 4 is $\text{MgBr}_2(\text{aq})$ [$\text{MgCl}_2 + \text{NaBr}$]; FA 5 is $\text{CaI}_2(\text{aq})$ [$\text{CaCl}_2 + \text{NaI}$]; FA 6 is $\text{K}_2\text{CrO}_4(\text{aq})$				
2 (a)	MMO Decisions	Chooses silver nitrate/ $\text{Ag}^+(\text{aq})$ /solution containing Ag^+ ions followed by (aqueous) ammonia.	1	[1]
(b)	PDO Recording	Results for three solutions and the two reagents from (a) (or three reagents if (a) : ' $\text{Ag}^+ + \text{NH}_3$ ', Pb^{2+}) if recorded in a single table (<i>no repetition of solutions or reagents</i>)	1	[2]
	MMO Collection	Give one mark for correct observations with FA 3 , FA 4 and FA 5 . FA 3 – white ppt with Ag^+ , soluble in $\text{NH}_3(\text{aq})$ FA 4 – cream ppt with Ag^+ , partially soluble or insoluble in $\text{NH}_3(\text{aq})$ (allow “creamy” not “creamy white”) FA 5 – yellow ppt with Ag^+ , insoluble in $\text{NH}_3(\text{aq})$ If Ag^+ and Pb^{2+} in (a) , all observations must be correct (ignore any ‘extra’ NH_3 if not in (a)) (Pb^{2+} : white, white, yellow ppts respectively)	1	
(c)	ACE Conclusion	Mark consequentially on observations in (b) Expected conclusion Identifies FA 3 as solution containing Cl^- from “white ppt with Ag^+ (soluble in $\text{NH}_3(\text{aq})$) given as evidence. <i>Mark consequentially – ecf allowed here.</i> <i>(No retrospective to observations)</i>	1	[1]
(d)	MMO Collection	Mark each of the boxes and see whether correct columns or rows give the better mark. Award the better mark. See table below for the expected observations	1 1 1	[3]

	FA 3	FA 4	FA 5
+ $\text{NaOH}(\text{aq})$	ignore	white ppt	white ppt or “cloudiness”
+ $\text{NH}_3(\text{aq})$	no ppt (allow reference to “cloudiness”/“slight white ppt”)	white ppt	no ppt/no change/ no reaction
+ FA 6	yellow ppt	no ppt/no change/ no reaction/yellow soln	no ppt/no change/ no reaction/yellow soln

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(e)	MMO Collection	Records (yellow) <u>solution turning orange</u> (or <i>wtte</i> , e.g. orange solution forms)	1	[1]
(f)	ACE Conclusions	Mark consequentially on observations in (d) and (e) Expected conclusions: Anion in FA 6 is chromate, CrO_4^{2-} , from yellow soln turning orange in (e) or yellow ppt with FA 3 in (d) <i>provided FA 3 not also identified from (d) and FA 3 contains Ba^{2+} from observations with NaOH and NH_3 (or just NaOH if obs with FA 4 and FA 5 are correct with it) or FA 6 in (d)</i>	1	[1]
FA 7 is a tertiary alcohol; FA 8 is an aldehyde; FA 9 is a ketone; FA 10 is a primary alcohol				
(g)	MMO Collection	One mark for two correct observations with FA 7 One mark for correct observations with FA 8 and FA 9 One mark for two correct observations with FA 10 See table below for expected observations	1 1 1	[3]

reagent	observations			
	FA 7	FA 8	FA 9	FA 10
acidified dichromate	no reaction		no reaction	(colour change to green/blue-green/cyan/turquoise (solution not ppt)
2,4-DNPH	no reaction	yellow ppt	yellow ppt	
Tollens' reagent	no reaction	silver mirror or black/grey solution or ppt		no reaction

(h)	ACE Conclusions	No ecf from (g) FA 7 contains the tertiary alcohol from <u>no reaction with all three reagents</u> or <u>no reaction</u> with dichromate and 2,4-DNPH provided there is no CON in the observation with Tollens' FA 8 contains the aldehyde from the silver (mirror), black or grey precipitate or solution with ammoniacal silver nitrate Allow from brown ppt if it is the only positive result with Tollens'.	1 1	[2]
	Total			[14]

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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	(i) Follows instructions with regard to times and temperature readings <i>0–3 minutes at 1 minute intervals;</i> <i>5–8 minutes at ½ minute intervals, and T₁ recorded in box. (Ignore if also in table)</i>	1	
	PDO Recording	(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	1	
		(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) .	1	[3]

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Question	Sections	Indicative material	Mark	
(b)	PDO Layout	(i) Temperature of water in the beaker plotted on <i>y</i> -axis against time on <i>x</i> -axis. Clearly labelled axes (ignore units) [<i>temp/time are minimum acceptable labels</i>] <i>but</i> accept T / °C and t / min as labels. <i>The unit is necessary in this case</i>	1	
		(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>	1	
		(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>	1	
	ACE Interpretation	(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</i> and 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>	1	[4]
(c)	ACE Interpretation	(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> (iii) No mark.	1	[1]

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Question	Sections	Indicative material	Mark	
(d)	MMO Quality	Compare the two $m/\Delta T$ values ($g^{\circ}C^{-1}$) 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+ $^{\circ}C - 0.3$ Award one of these three marks for a difference of 0.3+ $^{\circ}C - 0.4$ Compare the <u>standard</u> $m/\Delta T$ value of 1.70 $g^{\circ}C^{-1}$ 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+ $^{\circ}C - 0.3$ Award one of these three marks for a difference of 0.3+ $^{\circ}C - 0.4$	3	[6]
			3	
(e)	ACE Interpretation ACE Conclusions	(i) Give one mark for correct <u>evaluation</u> of 430 × candidate's $\Delta T_{(expt\ 1)}$	1	
		(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: Heat is absorbed by beaker and surroundings (con)	1	
	ACE Interpretation	(iii) Give one mark if the candidate adds ($\Delta T_{(expt\ 1)}$ × answer in (c)(iii)) to the answer in (e)(i) . Correct expression is sufficient, evaluation not required.	1	
		(iv) The candidate <u>correctly</u> calculates the moles of FA 1 (candidate's mass / 53.5) used in expt 1. 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.	1	
		(v) The candidate correctly divides the answer to (e)(iii) by the answer to (e)(iv) and by 1000. Ignore errors in evaluation and sign	1	
	ACE Conclusions	(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.	1	
	PDO Display	(vii) Award this mark if working is shown in sections (c)(i), or (c)(ii) or (e)(i) <u>and</u> (e)(iv) and (e)(v).	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	[2]
	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 ₄ Cl 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	
	Total			[25]

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Question	Sections	Indicative material	Mark	
FA 2 is Na ₂ SO ₄ (aq); FA 3 is Na ₂ CO ₃ (aq); FA 4 is a mixture of Na ₂ SO ₄ (aq) and Na ₂ CO ₃ (aq)				
2 (a)	MMO Decisions	(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 Ba(NO ₃) ₂ . <i>Accept Ba²⁺(aq) or soln containing Ba²⁺(aq) as reagent.</i> <i>Also accept incorrect formulae for a compound, e.g. BaCl, providing the identity of the reagent is obvious.</i>	1	
		(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 <u>providing it is used with nitric acid.</u>	1	
		(iii) Addition of acid No reaction with FA 2 , effervescence/bubbles/bubbling (or gas tested with limewater) for FA 3 and FA 4	1	
	MMO Collection	Addition of Ba²⁺(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 Ba²⁺(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, CaSO₄ soluble at this concentration.	1	

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FA 5 is $\text{CuSO}_4(\text{aq})$; FA 6 is $\text{NH}_4\text{Cl}(\text{aq})$; FA 7 is $\text{CoCl}_2(\text{aq})$; FA 8 is $\text{MnSO}_4(\text{aq})$				
(a) contd	ACE Conclusions	No ecf to be applied in these conclusions (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 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	1 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	
		(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 (No reference to a gas is necessary)	1	
	MMO Decisions	(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	(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.	1	[7]
		(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.	1	
(c)	ACE Conclusions	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)	1	[2]
		Gives appropriate supporting evidence for two of the three ions Minimum evidence for each of the ions. Cu^{2+} (i) Blue ppt with both NaOH and $\text{NH}_3(\text{aq})$, or (ii) Blue ppt with NaOH, insoluble in excess of the reagent, or (iii) Blue ppt with $\text{NH}_3(\text{aq})$, soluble in excess of the reagent, or (iii) Dark blue colour formed at any stage with $\text{NH}_3(\text{aq})$ NH_4^+ (i) Ammonia, NH_3 , alkaline gas, or gas turning red litmus blue with NaOH (hot or cold) Mn^{2+} (i) Initial off-white to beige ppt with NaOH and with $\text{NH}_3(\text{aq})$ 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).	1	
	Total			[15]

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

Question	Sections	Indicative material	Mark	
1 (a)	PDO Recording	(i) Presents data in single table of results – <i>to include masses of tube with solid and residue, (mass of solid), initial and final temperatures and temperature change.</i>	1	
		(ii) All columns correctly labelled with appropriate unit shown. <i>Must use solidus, brackets or describe unit fully in words. There must be at least one mass and one temperature. If units not included in column headings every entry must have the correct unit shown.</i>	1	
	MMO Collection	(iii) All balance readings recorded to 1 or more decimal places and showing same precision of measurement	1	
		(iv) All thermometer readings recorded to 0.5°C (must be at least one at 0.5°C)	1	
	MMO Decisions	(v) Two additional masses of NaHCO ₃ evenly spaced between the other readings or one or both extending the plot (Not two between same pair) (Not within 0.5 g of any other) (Not >3.0 g away from any other)	1	
	MMO Quality	(vi) and (vii) Check and correct ΔT where necessary. Compare temperature fall with that obtained by the Supervisor for FB 2 Award (vi) and (vii) for a temp fall difference of 0.0°, 0.5° or 1.0°C Award (vi) only for a difference of 1.5°C	2	
		(viii) and (ix) Check and correct ΔT where necessary. Compare temperature fall with that obtained by the Supervisor for FB 3 Award (viii) and (ix) for a temp fall difference of 0.0°, 0.5° or 1.0°C Award (viii) only for a difference of 1.5°C	2	
				[9]

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Question	Sections	Indicative material	Mark	
(b)	PDO Layout	(i) Temperature (fall) plotted on <i>y-axis</i> against mass of sodium hydrogencarbonate on <i>x-axis</i> . Clearly labelled axes (ignore units unless $T/\delta T/\theta$ or m as labels) Award even if final temp plotted	1	
		(ii) Uniform and sensible scales that allow points to be plotted in at least half of the squares on each axis. (6 × 4 big squares)	1	
		(iii) check the “sweep” that points plotted for all experiments recorded. Check the plotting of points for FB 1 , FB 2 and FB 3 (and any other “suspect” point). <i>Points should be within ½ of a small square, in the correct half of the small square.</i> Not awarded if final T is plotted Not awarded if only FB 1 , FB 2 and FB 3 are recorded	1	
		(iv) Straight line drawn, passing within ½ small square of the origin and close to the majority of the points	1	[4]
(c)	PDO Layout	Explains that the mass of sodium hydrogencarbonate is the independent (controlled) variable or Temperature change is the dependent variable (<i>or words to that effect</i>)	1	[1]
(d)	ACE Conclusion	Gives correct equation for the reaction $\text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$ (Not H_2CO_3) (<i>Ignore state symbols</i>)	1	[1]
(e)	PDO Display	Construction on graph for determining the gradient clearly shown (<i>Must span at least 3 large squares in each direction</i>) and working shown for calculation (<i>could be found on graph page</i>)	1	
	ACE Interpretation	Reads intercepts or selects two points <u>on the line</u> to within ½ small square in either direction.	1	
		Evaluates $\Delta y/\Delta x$ from candidate's intercept figures to find gradient correctly to sf shown	1	[3]
(f)	ACE Interpretation	Multiplies answer to (e) by 84	1	[1]
(g)	ACE Interpretation	Some use of $30 \times 4.3 \times$ (answer to (f))	1	
	PDO Display	Answer, in kJ mol^{-1} , correct to 2 or 3 significant figures and showing +ve sign <i>Correct answer is given by $0.129 \times$ answer to (f)</i> (No ecf from first part)	1	[2]

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FB 7 is $(\text{NH}_4)_2\text{SO}_4 \cdot \text{FeSO}_4(\text{aq})$; FB 8 is $\text{NH}_4\text{Cl}(\text{aq})$				
2 (a)	MMO Decisions	Chooses barium chloride (or nitrate)/ $\text{Ba}^{2+}(\text{aq})$ /solution containing Ba^{2+} (ions) followed by a <u>specified</u> mineral acid other than sulfuric acid or vice versa. (Allow if acid name specified in (b)) Do not accept lead nitrate/lead ions	1	[1]
(b)	PDO Recording	Results for two solutions and two reagents (ecf from (a)) recorded in a single table with distinct separation between reagents (no repetition of solutions or reagents)	1	[2]
	MMO Collection	Give one mark for correct observations with FB 7 and FB 8 Expected results: FB 7 – white ppt with Ba^{2+} , insoluble in acid (<i>do not award if H_2SO_4 added</i>) FB 8 – No reaction or no precipitate If Pb^{2+} used then white ppt with both or obs as for Ba^{2+} <i>Do not award if any obs are dashes except for FB 8 adding acid after Ba^{2+}</i>	1	
(c)	ACE Conclusion	Mark consequentially on observations in (b) Expected conclusion Identifies FB 7 as solution containing SO_4^{2-} from “white ppt with Ba^{2+} , insoluble in acid given in evidence <i>ecf allowed here. Allow deduction if H_2SO_4 has been added after Ba^{2+} (not with Pb^{2+})</i>	1	[1]
(d)	MMO Collection	One mark for two correct observations with $\text{NaOH}(\text{aq})$ – before heating FB 7 – green/dirty green/muddy green ppt FB 8 – no ppt/no change/no reaction The mark from (e) may be awarded here if the green ppt with FB 7 is recorded as <u>turning brown</u>	1	[3]
		One mark for correct observations with $\text{NaOH}(\text{aq})$ – after heating gas evolved turns red litmus paper blue for both FB 7 and FB 8	1	
		One mark for correct observations with $\text{NH}_3(\text{aq})$ FB 7 – green ppt (as above) FB 8 – no ppt/no change/no reaction	1	
(e)	MMO Collection	Records brown precipitate/residue provided <u>green ppt</u> in first box of (d)	1	[1]

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Question	Sections	Indicative material	Mark	
(f)	ACE Conclusions	Mark consequentially on observations in (d) and (e) Expected conclusions: (i) Common cation is ammonium/ NH_4^+ , from evolution of ammonia or alkaline gas (minimum) or clear ref back to relevant obs (ii) Second cation is Fe^{2+} in FB 7 from green ppt with NaOH and NH_3 or green ppt, turning brown, with either. If Cr^{3+} then grey-green ppt with both alkalis or grey-green ppt with NaOH soluble in excess giving (dark) green solution or grey-green ppt insol in excess NH_3 (no con obs)	1	[1]
FB 9 is a ketone; FB 10 is a primary alcohol; FB 11 is a secondary alcohol; FB 12 is an aldehyde				
(g)	MMO Collection	One mark for correct observations with FB 9 and FB 12 One mark for two correct observations with FB 10 One mark for two correct observations with FB 11 See table below for expected observations	1 1 1	[3]

reagent	observations			
	FA 9	FA 10	FA 11	FA 12
acidified dichromate	no reaction/no change/yellow or orange soln (not no ppt*)	(colour change to) green/blue-green/cyan/turquoise (solution not ppt*)	(colour change to) green/blue-green/cyan/turquoise (solution not ppt*)	*penalise ppt error once in this row If FB9 colour wrong penalise 1 st of additional ppts
2,4-DNPH	yellow ppt		no reaction/ no change	yellow ppt
Tollens' reagent		no reaction/ no change/no ppt	no reaction/ no change/no ppt	silver mirror or black/grey solution or ppt

(h)	ACE Conclusions	Mark consequentially on observations in (g) FB 10 and FB 11 contain the alcohols from both oxidised by dichromate(VI) and give no ppt with Tollens' FB 9 contains the ketone from No reaction with dichromate ($\text{Cr}_2\text{O}_7^{2-}$ obs all correct) or no reaction with $\text{Cr}_2\text{O}_7^{2-}$ and yellow ppt with 2,4-DNPH. (If FB 12 selected evidence must have yellow ppt with 2,4-DNPH and no reaction with Tollens')	1 1	[2]
	Total			[14]

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

9701 CHEMISTRY

9701/35

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.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
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Question 1

Question	Sections	Indicative material	Mark	
1 (a)	MMO Collection	(i) Follows instructions with regard to weighings and mass of NaHCO_3 <i>2 balance readings and mass of NaHCO_3 and times and temperature readings</i> <i>0–3 minutes at 1 minute intervals;</i> <i>5–8 minutes at ½ minute intervals</i>	1	
	PDO Recording	(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	1	
		(iii) <i>Look at results here and in (d).</i> All balance readings consistent to at least 1 decimal place. and All thermometer readings recorded to nearest 0.5°C. There must be at least one at 0.5 in (a).	1	[3]

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Question	Sections	Indicative material	Mark	
(b)	PDO Layout	(i) Temperature of acid/solution in the beaker plotted on y-axis against time on x-axis. Clearly labelled axes (ignore units) <i>[temp/time are minimum acceptable labels]</i> but accept T / °C and t / min as labels. The unit is necessary in this case	1	
		(ii) Uniform and sensible scales for candidate's choice of graph. Plotted points must be in at least 5 large squares on the temperature axis and 5 large squares on the time axis.	1	
		(iii) <i>There should be a minimum of 5 plotted points between 5 and 8 minutes.</i> Examiner then checks plotting of points at $t_{0 \text{ min}}$, $t_{5 \text{ min}}$ and $t_{8 \text{ min}}$ and the plotting of any suspect point. If any of the $t_{0 \text{ min}}$, $t_{5 \text{ min}}$ and $t_{8 \text{ min}}$ points is missing check the adjacent point. <i>Points should be within $\frac{1}{2}$ of a small square of the correct position and in the correct small square</i>	1	
	ACE Interpretation	(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</i> and correct values of the minimum and maximum temperatures at $t = 4$ minutes are read (to within $\frac{1}{2}$ small square) from the graph. <i>Extrapolation need not be drawn on the graph</i>	1	[4]
(c)	ACE Interpretation	(i) No mark. (ii) The candidate <u>correctly</u> calculates (to sig figs displayed) the moles of FA 1 used, (<i>cand mass of FA 1/84</i>)	1	
	ACE Conclusions	(iii) The candidate correctly divides their answer to (i) by their answer to (ii) and by 1000. <i>Ignore errors in evaluation and sign.</i>	1	
		(iv) 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	1	[3]

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Question	Sections	Indicative material	Mark	
(d)	MMO Quality	Compare the two $\Delta T/m$ values ($^{\circ}\text{C g}^{-1}$) 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 Compare the <u>standard</u> $m/\Delta T$ value of $1.55^{\circ}\text{C g}^{-1}$ 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	3	
			3	[6]
(e)	ACE Interpretation	(i) No mark is awarded for this section but check that temperature rise from expt 1 has been used	1	
		(ii) The candidate <u>correctly</u> calculates (to sig figs displayed) the moles of FA 2 used in expt 1. Do not award this mark if data from expt 2 has been used in (i) or (ii).	1	
		(iii) The candidate correctly divides the answer to (e)(i) by the answer to (e)(ii) and by 1000. <i>Ignore errors in evaluation and sign</i>	1	
	ACE Conclusions	(iii) Award this mark if the candidate has given a –ve sign and explains that: the reaction is exothermic or heat is released in the reaction or the temperature rises during the reaction	1	
	PDO Display	Award this mark if working is shown in sections (c)(ii), (c)(iii), (e)(ii) and (e)(iii) Award this mark if the final answer in section (c)(iii) and (e)(iii) is given to 2 or 3 sig fig.	1	[5]
(f)	ACE Interpretation	Correctly calculates $\Delta H_{\text{decomposition}}$ from candidate values in (c)(iii) and (e)(iii). Allow (± 1) on final significant figure given The answer given must include a mathematically correct sign	1	[1]
(g)	ACE Interpretation	Correctly calculates the difference and the percentage error. <i>Ignore significant figures.</i>	1	[1]

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Question	Sections	Indicative material	Mark	
(h)	ACE Conclusions	Clearly described source of error (i) Heat loss / gain (ii) Precision of thermometer (iii) Acid spray (iv) Use of a glass beaker	1	[2]
	ACE Improvements	Specific improvement given with some attempt at justification. (i) Lid – prevents convection or evaporation Insulation – prevents conduction (ii) Use thermometer at 0.5°C or better, gives smaller % error. (iii) Lid – acts as a physical barrier (iv) Use of plastic cup – better insulator or lower (specific) heat capacity Do not credit either mark for answers referring to use of measurement of volume or measurement of mass.	1	
	Total			[25]

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Question 2

Question	Sections	Indicative material	Mark	
2 (a)	MMO Decisions	(i) reagent 1 – chooses any specified acid to detect the carbonate present (name or formula may be in results table) and reagent 2 – chooses AgNO₃. Accept Ag⁺(aq) or soln containing Ag⁺ as reagent. Also accept incorrect formulae for a compound, e.g. Ag(NO₃)₂, providing the identity of the reagent is obvious.	1	
		(ii) Explains significance of order in which reagents added. acid first – to remove carbonate from solution or after Ag⁺ – to dissolve any silver carbonate precipitated. Candidates must make clear the relationship of acid to silver carbonate. Do not award this mark if hydrochloric acid has been used in (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 <u>providing it is used with nitric acid.</u>	1	
	MMO Collection	(iii) Addition of acid No reaction with FA 4, effervescence/bubbles/bubbling (or gas tested with limewater) for FA 5 and FA 6	1	
		Addition of Ag⁺(aq) Ignore any addition of NH₃(aq) after Ag⁺ white ppt with FA 4, if added as first reagent or to a separate sample Allow off-white to brownish ppt with FA 6 or white ppt, insoluble in acid for FA 4, soluble in acid for FA 6 and insoluble/partially soluble in acid for FA 5 if added before the addition of acid or white ppt with FA 4 and FA 5 and no ppt with FA 6 if added after addition of acid Do not award this mark if hydrochloric acid has been used unless it has been stated that Ag⁺(aq) was added to a fresh sample Allow deductions from lead nitrate (as for silver salt) <u>ONLY</u> if nitric acid has been specified	1	

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Question	Sections	Indicative material	Mark	
2 (a) contd	ACE Conclusions	No ecf to be applied in these conclusions (iv) Give one mark for identifying carbonate in FA 5 and FA 6 , with supporting evidence. Minimum acceptable evidence – gas with acid or off-white, white, cream. brownish ppt (silver carbonate) soluble in acid <i>Do not award this mark from the colour of the precipitate alone.</i>	1	[6]
		Give one mark for identifying chloride in FA 4 and FA 5 only , with supporting evidence. Minimum acceptable evidence – white ppt with Ag ⁺ (if insoluble in acid) but con if soluble. <i>Do not award this mark from the colour of the precipitates with Ag⁺ alone</i> If no mark has been awarded in (iii) or (iv) , allow one mark if evidence given is consistent with the ions identified	1	
FA 7 is AlK(SO ₄) ₂ (aq); FA 8 is NiCl ₂ (aq); FA 9 is CrCl ₃ (aq); FA 10 is Pb(NO ₃) ₂ (aq)				
(b)	MMO Collection	For FA 7 , records (i) white ppt, soluble in an excess of NaOH and white ppt, insoluble in excess ammonia	1	
		For FA 8 , records (ii) green ppt, insoluble in an excess of NaOH and Dark or deep blue solution with (excess) ammonia or Initial blue solution, darkening with excess of the reagent	1	
		For FA 9 records (iii) grey-green ppt, soluble in an excess of NaOH to give a dark green solution	1	
		(iv) grey-green ppt, insoluble in excess ammonia	1	
		For FA 10 , records (v) white ppt, soluble in an excess of NaOH and white ppt, insoluble in excess ammonia	1	

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Question	Sections	Indicative material	Mark	
(b) contd	MMO Decisions	(vi) Selects hydrochloric acid, sulfuric acid potassium iodide, potassium chromate (or dichromate) as suitable reagent Not barium chloride <i>If no reagent is chosen, a retrospective De7 mark can be given here for testing gas evolved with limewater in (a)</i>	1	[7]
	MMO Collection	(vii) Observes appropriate ppt with chosen reagent and FA 10 but not with FA 7 . <i>Do not award this mark if reagent is added to any solution recorded as giving a coloured ppt or no ppt with NaOH or with NH₃ or barium chloride is used</i>	1	
(c)	ACE Conclusions	No ecf to be applied in these conclusions Identifies all cations correctly: FA 7 is Al ³⁺ / aluminium FA 9 is Cr ³⁺ / chromium(III) FA 10 is Pb ²⁺ / lead <i>The correct ions must be identified for each solution.</i>	1	[2]
		Gives appropriate supporting evidence for two of the three ions <i>Allow evidence for reversed Al³⁺/Pb²⁺ if barium chloride has been used</i> Minimum evidence for each of the ions. Al³⁺ white ppt with NaOH and NH ₃ (aq); ppt soluble in excess NaOH, ppt insoluble in excess NH ₃ (aq) and no reaction with HCl, H ₂ SO ₄ , KI Cr³⁺ (i) grey-green ppt with both NaOH and NH ₃ (aq), or (ii) grey-green ppt with NaOH, soluble in excess of the reagent, or (iii) grey-green ppt with NH ₃ (aq), insoluble in excess of the reagent, or (iii) Dark green solution with excess NaOH Pb²⁺ white ppt with NaOH and NH ₃ (aq); ppt soluble in excess NaOH, ppt insoluble in excess NH ₃ (aq) and white ppt with HCl or H ₂ SO ₄ or yellow ppt with KI	1	
If an appropriate reagent has been chosen but no observations recorded in (b)(iii) : Allow deduction of the identity of the ions if the observations have been correctly recorded in the evidence section Do not however award the mark for appropriate evidence – from observations				
Total				[15]