

MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/31

Paper 31 (Advanced Practical Skills 1),
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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Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2013	9701	31

Question	Sections	Indicative material	Mark
1 (a)	PDO layout	I Constructs a table for results with space for 10 volumes.	1
	PDO recording	II Appropriate headings and units for data given. Volumes in cm ³ or /cm ³ or (cm ³), temperature in °C or /°C or (°C) in table. All volumes to same dp.	1
	PDO recording	III All temperatures recorded to the nearest 0.5 °C both in the table and for T_1 . At least one ending in .0 and one in .5.	1
	MMO quality	IV + V Compare temp rise for addition of 25 cm ³ of FA 2 with the Supervisor value. Award 2 marks for ΔT within ± 1 °C. Award 1 mark for ΔT within ± 2 °C.	2 [5]
(b)	ACE interpretation	Correctly calculates ΔT , V_T and $\Delta T \times V_T$ (assume correct data from (a)) (min 8 results)	1 [1]
(c) (i)	PDO layout	I $\Delta T \times V_T$ on <i>y-axis</i> and volume of FA 2 on <i>x-axis</i> . Axes clearly labelled (ignore units).	1
		II Uniform scales chosen to use more than half of each axis. Only include 0 if point plotted. Points plotted use 5 large squares vertically and 4 horizontally.	1
		III All points plotted. Examiner to check points at $V = 5, 10, 15, 20$ and 25 . The points should be within $\frac{1}{2}$ small square and in correct small square. Min 8	1
(c) (ii)		IV Draws both straight lines of best fit.	1
(c) (iii)	ACE interpretation	Reads correctly the value of FA 2 from the intercept of the two lines. Answer within 0.5 cm ³ . Ignore sf.	1 [5]
(d) (i)		0.0500 mol (Allow 0.050)	1
(d) (ii)		0.0250 mol (allow 0.025) Allow ecf from (i)/2	1
(d) (iii)		$1000 \times \text{(d)(ii)} / \text{(c)(iii)}$ (2–4 sf) Allow ecf from (ii) . Penalise sf once only.	1 [3]

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(e)	ACE improvements	Accuracy of temperature measurement – use a 0 to 50 °C thermometer or a thermometer with smaller scale divisions (not just more accurate/ electronic thermometer/parallax). Uncertainty about where the lines cross – sample more values of FA 2 in the region of the intersection. Repeat/ extra readings on LHS of intersection/ near maximum. Initial temperatures of acid and alkali not same – measure both. Other answers acceptable if specific.	1 [1]
	[Total: 15]		
2 (a)	MMO collection	I Initial and final volumes recorded for rough AND initial, final and volume added recorded for accurate titre.	1
	PDO recording	II All accurate readings recorded to 0.05 cm ³ . <i>Do not award 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.(0).</i>	1
	MMO decision	III Two uncorrected accurate titres within 0.1 cm ³ . <i>Do not award if, having performed 2 titres within 0.1 cm³, a further titration is performed that is >0.1 cm³ from the closer of the original 2 titres unless a further titration has been carried out which is within 0.1 cm³ of any other.</i>	1
	MMO quality	IV + V Award 2 marks if difference from Supervisor within 0.20 cm³. Award 1 mark if difference from Supervisor within 0.50 cm³. Examiner compares candidate mean titre with Supervisor mean titre. If best titres are $\geq 0.5 \text{ cm}^3$, cancel one of the Q marks.	2 [5]

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(b)	ACE interpretation	Calculates the mean to appropriate decimal places. <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: 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. eg 26.0 and $26.2 = 26.1$ is correct but 26.0 and $26.1 = 26.1$ is incorrect.</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)	ACE interpretation	All answers correct. (i) $0.15 \times (\mathbf{b}) / 1000$ (ii) (i)/2 (iii) (ii) $\times 400$	1
	PDO display	Working shown in (i) and (iii)	1
	PDO display	All answers given to 3 or 4 sig figs (minimum 2).	1 [3]
(d)	ACE interpretation	Correctly works out % difference to min 2 sig figs.	1 [1]
[Total: 10]			

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FA 5 = HCl FA 6 = Pb(NO ₃) ₂ FA 7 = K ₂ CrO ₄ FA 8 = Na ₂ CO ₃ FA 9 = KBr											
3 (a)	MMO collection	I FA 5 and FA 6: a white ppt insoluble in excess	1								
		II FA 5 and FA 7: solution turns from yellow or colourless to orange	1								
		III FA 5 and FA 8: bubbles or effervescence	1								
	MMO decisions	IV Uses limewater to test for gas and result.	1								
	ACE conclusion	V Identifies gas as CO ₂ .	1								
	MMO collection	VI FA 6 and FA 7: a yellow ppt (insol in excess)	1								
		VII FA 6 and FA 8: a white ppt (insol in excess)	1								
		VIII FA 7 and FA 8: no reaction/ colourless to yellow (solution)	1 [8]								
(b)	ACE conclusion	<table border="1"> <tr> <td>Pb²⁺</td><td>Cl⁻</td><td>CO₃²⁻</td><td>CrO₄²⁻</td></tr> <tr> <td>FA 6</td><td>FA 5</td><td>FA 8</td><td>FA 7</td></tr> </table> 4 correct scores 2 marks 3 correct scores 1 mark	Pb ²⁺	Cl ⁻	CO ₃ ²⁻	CrO ₄ ²⁻	FA 6	FA 5	FA 8	FA 7	2 [2]
Pb ²⁺	Cl ⁻	CO ₃ ²⁻	CrO ₄ ²⁻								
FA 6	FA 5	FA 8	FA 7								
(c)	ACE conclusion	H ⁺ because of colour change with chromate or CO ₂ / gas released with carbonate.	1 [1]								
(d) (i)	ACE conclusion	No as PbBr ₂ / lead bromide is also a white ppt / gives the same observation (if correct in table).	1								
(d) (ii)	MMO decision	Add AgNO ₃ followed by NH ₃ .	1								
	MMO collection	Cream ppt partially soluble or insoluble in ammonia/ soluble in conc. NH ₃ .	1								
	ACE conclusion	Bromide / Br can be allowed from 'off white / buff'.	1 [4]								
[Total: 15]											

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	GCE AS/A LEVEL – May/June 2013	9701	32

Question	Sections	Indicative material	Mark
1 (a)	MMO Collection	I All thermometer readings and two weighings + correct mass of FB 1 recorded.	1
	PDO Recording	II Correct headings and units in table (lines not needed). Weighings and mass to same no. dp. <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
		III Temperature recorded to 0.5°C (<i>must have at least one ending in .5 °C and one ending in .0 °C</i>).	1
	MMO Quality	Award IV and V if $\delta \leq 0.30\text{ °C g}^{-1}$ Award IV if $0.30 < \delta \leq 0.60\text{ °C g}^{-1}$	1 1 [5]
1 (b)	PDO Layout	I Uniform scales chosen to use more than half of each axis. At least 5 large squares on y-axis. Axes labelled, units not needed. Scale extends at least 1 °C below lowest recorded point.	1
		II All points correctly plotted to within ½ small square and in correct small square.	1
		III Appropriate lines of best fit drawn.	1
	ACE Interpretation	IV Lines extrapolated and correct value (within 0.5°C) of ΔT from graph (ignore sf and sign).	1 [4]
1 (c)	PDO Recording	I Table drawn to include weighings, correct mass of FB 2 , initial and final thermometer readings (ignore units), headings must be unambiguous.	1
	MMO Quality	Award II and III if $\delta \leq 0.30\text{ °C g}^{-1}$ Award II if $0.30 < \delta \leq 0.60\text{ °C g}^{-1}$	1 1 [3]

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(d)	(i)	PDO Display	I Shows $25 \times 4.3 \times \Delta T$ for step 1 and for step 2 (no need to check calculation).	1	
	(iii)		II Should be $\frac{\text{answer to (i)} \times 84.0}{\text{mass FB 1} \times 1000}$		
	(ii)				
	(iv)		III Calculates $\frac{\text{answer to (iii)} \times 106.0}{\text{mass FB 2} \times 1000}$	1	
	(v)	ACE Conclusions	Award IV and V if correctly calculates ΔH from answers to (ii) and (iv) with correct sign (answer to (iv) – 2 × answer to (ii) scores 2 (iv) – (ii) scores 1 2(ii) – (iv) scores 1)	1	
		PDO Display	VI Signs in (ii) (+ve) and (iv) (–ve).	1	
			VII All final answers given to 2 or 4 sf (minimum of 3 answers attempted).	1	[7]
(e)	(i)	ACE Interpretation	Single balance reading ± 0.005 or 0.01 g for 2dp balance. $\Delta m \pm 0.01$ or 0.02 g for 2 dp balance. <i>0.05 or 0.1 g for 1 dp balance / 0.0005 or 0.001 for 3 dp.</i>	1	
	(ii)		<i>Number of dps must correspond to candidate's own readings.</i> Calculates max Δm error / mass FB 2 in Step 2 to 2 or more sf (2 minimum for 1 dp balance and up to 4 for 3 dp balance). <i>Allow ecf.</i>	1	[2]
(f)	(i)	ACE Improvements	Student incorrect as acid already in excess/ greater volume gives smaller ΔT /greater volume needs more heat energy and/or greater % error.	1	[1]
	(ii)	MMO Interpretation	Attempts to calculate $\Delta T / m$ or $m / \Delta T$ for each result or ratios of m_1/m_2 and T_1 / T_2 or similar (not averages of two).	1	
		MMO Decisions	Correct calculation ($1.35 / 1.37$ or $0.74 / 0.73$). Conclusion – yes, values concordant / consistent or no, values differ.	1	[2]
					[Total: 24]

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FB 4 MnCl_2		FB 5 $\text{Fe}(\text{NO}_3)_3 + \text{HNO}_3$	FB 6 $\text{ZnSO}_4 + \text{H}_2\text{SO}_4$
2 (a)	MMO <i>Decisions</i> MMO <i>Collection</i>	I Selects any 2 from barium chloride or nitrate, silver nitrate or lead nitrate. II NaOH (allow OH if ion formulae already penalised) + Al and warm for NO_3^-. For III and IV any two from - only FB 4 gives white ppt with Ag^+ - only FB 6 gives white ppt with Ba^{2+} FB 4 and FB 6 give a white ppt with Pb^{2+} (allow relevant dash as alternative to ppt) (ppt in any other test with Ag^+, Pb^{2+} or Ba^{2+} is a CON) V FB 5 only forms gas/ NH_3 turns litmus paper blue	1 1 1 1 1 [5]
2 (b)	MMO Collection	FB 4 gives off-white / buff / light brown ppt insoluble in both and darkening of the ppt in either. FB 5 gives red-brown/brown/rust/orange-brown (not red, not orange) ppt insoluble in excess of both. FB 6 gives white ppt soluble in excess of both or Award 1 mark if all NaOH or NH_3 observations, including in excess, are correct except 'darkening of ppt in (i).	1 1 1 [3]
2 (c)	ACE Conclusions	FB 4 contains Mn^{2+} and Cl^-. FB 5 contains Fe^{3+} and NO_3^-. FB 6 contains Zn^{2+} and SO_4^{2-}.	1 1 1[3]
2 (d)	MMO Decisions PDO Layout MMO Collection ACE Conclusions	I Selects suitable tests: two of Mg / Zn / Fe / Na_2CO_3, litmus paper/U.I. paper, chromate. (specific names of reagents not needed) (expected results not needed) II Single table (no repeat headings)(must be the 2 reagents stated above). III Correct observations for FB 4 and either FB 5 or FB 6. For FB 4 correct observation is allowed if no +ve test for gas. IV Correct observations for other from FB 5 and FB 6. V FB 5 and FB 6 contain H^+.	1 1 1 1 1 [5]
[Total: 16]			

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO Recording	Table completed and all temperatures recorded to 0.5°C; must include initial T and at least one of the nine readings must be .5 (others .0) or vice versa.	1	[2]
	MMO Decision	Suitable choice of volumes (FA 2 + water = 35 cm ³): one either side of maximum or two between maximum and one of the values differing by 5 cm ³ . If 'max' at 35 then allow 2 between 30 & 35 or allow two volumes > 35. (ignore water volume)	1	
(b) (i)	PDO Layout	Scales chosen so that graph occupies more than half the available length for x- and y-axis and axes labelled volume/cm ³ or FA 2 /cm ³ and temperature/°C (or brackets).	1	
	PDO Layout	All points plotted to within half a small square. (6 min)	1	
(ii)	PDO Layout	Two appropriate/sensible best fit lines drawn – must intersect at or above max temperature.	1	
(iii)	ACE Interpretation	ΔT calculated from graph.	1	
	MMO Quality	Award if ΔT within 1.0°C of Supervisor.	1	[5]
(c) (i)	PDO Display	Shows $Q = 60 \times 4.3 \times \Delta T$	1	
(ii)	ACE Interpretation	Moles = $\frac{25 \times 0.950}{1000} = 0.024$ (0.0238 or 0.02375)	1	
(iii)	ACE Interpretation	Correctly calculates enthalpy change, including sign, to 2–4 sf = – $\frac{(c)(i)}{1000 \times (c)(ii)}$	1	[3]
				[Total: 10]

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2 (a)	PDO Layout	I Volume given for rough titre and accurate titre details tabulated. (Minimum 2×2 boxes)	1	
	MMO Collection	II Initial and final burette readings recorded for rough titre and volume of FA 4 added recorded for each accurate titre. Headings and units correct for accurate titration.	1	
	PDO Recording	III All accurate burette readings to 0.05 cm^3 . <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading;</i> <i>more than one final burette reading is 50(.00);</i> <i>any burette reading is greater than 50(.0).</i>	1	
	MMO Decisions	IV Has two uncorrected accurate titres within 0.1 cm^3 . Do not award if, having performed two titres within 0.1 cm^3 , a further titration is performed that is more than 0.1 cm^3 from the closer of the original 2 titres unless a further titration has been carried out which is within 0.1 cm^3 of any others. Do not award if titres from burette readings to no dp are used (apart from use of 0 for initial reading).	1	
Examiner rounds any accurate burette readings to the nearest 0.05 cm^3, checks subtractions and then selects the 'best' titres for Supervisor and candidate using the hierarchy: <i>two identical; titres within 0.05 cm^3; titres within 0.1 cm^3; etc.</i> to calculate mean correct to 0.01 cm^3. Examiner compares candidate mean titre with Supervisor mean titre.				
	MMO Quality	V, VI and VII Award V , VI and VII for $\delta \leq 0.20 \text{ cm}^3$ Award V and VI for $0.20 \text{ cm}^3 < \delta \leq 0.40 \text{ cm}^3$ Award V for $0.40 \text{ cm}^3 < \delta \leq 0.60 \text{ cm}^3$ <i>Apply spread penalty as follows:</i> <i>If best titres are $\geq 0.50 \text{ cm}^3$ cancel one of the Q marks.</i>	3	[7]

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(b)	ACE Interpretation	Mean titre is correctly calculated from clearly selected values (ticks or working). Candidate must average two (or more) titres that are within 0.20 cm^3 of each other. 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.</i> <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. eg 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect.</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)	ACE Interpretation	Correctly calculates $\frac{0.095 \times (\mathbf{b})}{1000}$ to 3 or 4 sf.	1	
(ii)	ACE Interpretation	Correctly calculates $\frac{(\mathbf{c})(\mathbf{i})}{2}$ to 3 or 4 sf		
(iii)		and $\frac{(\mathbf{c})(\mathbf{ii}) \times 1000}{25.0}$ to 3 or 4 sf (<i>do not penalise sf twice</i>).	1	
(iv)	ACE Interpretation	$A_r = \frac{[6.90/(\mathbf{c})(\mathbf{ii})] - 60}{2}$ calculated to 0–2 dp	1	
(v)	ACE Conclusion	Corresponding identity of M (must be Group 1) (<i>can be from negative number – ignore sign</i>).	1	
	PDO Display	Working in the correct direction shown in at least 3 stages in (i), (ii), (iii) and (iv).	1	[5]

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(d) (i)	ACE Interpretation	(Titration more accurate) because temperature rises are small or titration apparatus/burette/pipette is more accurately calibrated or more precise or lower % error or is more accurate than measuring cylinder (<i>ora</i> for measuring cylinder) or the indicator gives an exact/precise end point but measuring temperature rise does not.	1	
(ii)	ACE Improvement	use more volumes near the maximum ΔT or use burette/pipette or better insulation/use of lid or use more accurately calibrated thermometer or increase concentration(s) or measuring initial T of solutions for each expt carried out	1	[2]
[Total: 15]				

FA 5 is $\text{ZnCO}_3 + \text{NaBr}$; FA 6 is NaNO_2 ; FA 7 is Na_2SO_4				
3 (b) (i)	MMO Collection	Effervescence / fizzing / bubbling or gas (evolved) which turns limewater milky.	1	
(ii)	MMO Collection	White precipitate, dissolves in excess sodium hydroxide.	1	
	ACE Conclusion	Zn^{2+} , Al^{3+} and Pb^{2+} <i>Allow zinc, aluminium, lead no ecf.</i>	1	
(iii)	MMO Decisions	Suitable pair of reagents chosen to distinguish between the 3 expected ions (NH_3 + one other).	1	
	PDO Display	Six correct theoretical results for the three ions. <i>Allow '--' for no reaction</i> Award one mark if one set of theoretical results match the given reagent (ie mark horizontally or vertically) ecf possible from observations in (ii) (for 1 mark) as pairs require a single reagent Mg^{2+} and Ca^{2+} if white ppt insoluble in excess in (ii); Ba^{2+} and NH_4^+ if no ppt obtained in (ii); two out of the correct three ions are chosen	1	

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reagent	Zn ²⁺	Al ³⁺	Pb ²⁺
aqueous NH ₃	white ppt soluble in excess	white ppt insol in excess	white ppt insol in excess
aqueous KI	no reaction/sol	no reaction/sol	yellow ppt/insol
aq named sulfate	no reaction/sol	no reaction/sol	white ppt/insol
aq named chromate	no reaction/sol	no reaction/sol	yellow ppt/insol
aq named chloride	no reaction/sol	no reaction/sol	white ppt/insol

reagent	Mg ²⁺	Ca ²⁺
aqueous NH ₃	white ppt insoluble in excess	no ppt
allow aq named SO ₄ ²⁻	no reaction	white ppt
reagent	Ba ²⁺	NH ₄ ⁺
aq NaOH + heat	no reaction	NH ₃ given off/gas turns red litmus blue
or aq named SO ₄ ²⁻	white ppt	no reaction

(iii) cont.	MMO Collection	Practical results: (<i>independent of earlier work</i>) White ppt soluble in excess NH ₃ (ignore 2nd reagent)	1	[7]
	ACE Conclusion	cation is Zn ²⁺ /zinc (<i>allow from ppt soluble in excess – no mention of white</i>)	1	
(c)	MMO Collection	Cream ppt with silver nitrate and ppt partially dissolves with ammonia/ insoluble in ammonia/ soluble in conc. NH ₃ .	1	[2]
	ACE Conclusion	bromide/Br⁻ ecf from off-white or qualified cream ppt with AgNO ₃	1	
(d)	ACE Conclusion	carbonate/CO ₃ ²⁻ (candidate must have 'gas' in (b)(i))	1	[1]
(e) (i)	MMO Collection	1 for each correct horizontal row or vertical column	3	

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<i>test</i>	FA 6	FA 7
$Al + NaOH$	ammonia/gas turns (damp) red litmus blue	no reaction / dash (ignore gases evolved unless turns red litmus blue or other con)
Ba^{2+}	no reaction	white ppt
acid	allow (brown) gas/ effervescence	ppt insol/no change / no reaction (not dash)
HCl	brown gas / blue solution	no reaction / no change / dash

(ii)	ACE Conclusion	FA 6 contains NO_2^- minimum evidence needed is (brown) gas produced with acid (may be in 2nd or 3rd test) FA 7 contains SO_4^{2-} (<i>from correct obs with $Ba^{2+} + HCl$</i>)	1	
(iii)	ACE Conclusion	Redox / oxidation of Al / reduction of $N / NO_2^- / H / OH^-$	1	[5]
[Total: 15]				

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO layout	I Constructs one table for all 7 results. <i>(Table does not need lines, does need something entered for each experiment)</i>	1	
	PDO recording	II Appropriate headings and units for data given. Volume in cm ³ or /cm ³ or (cm ³). Temperature in °C or /°C or (°C). <i>(All 4 correct headings and units must appear in the table.)</i>	1	
	PDO recording	III All temperatures recorded to the nearest 0.5 °C both in the table and for T₁ , at least one of the readings must be .5 (others .0) or vice versa.	1	
	ACE interpretation	IV Correctly calculates all 7 temperature rises <i>(from the table(s))</i> .	1	
	MMO quality	V + VI Compare temp rise for addition of 14 cm ³ of FB 1 with Supervisor value. Default value = 11.0 °C Award 2 marks for ΔT within ± 1.0 °C. Award 1 mark for ΔT within ± 2.0 °C.	2	
				[6]
(b)	(i) PDO layout	I ΔT on y-axis and volume of FB 1 on x-axis. Axes clearly labelled (ignore units).	1	
		II Linear scale chosen to go at least 2 °C above highest reading and to be a minimum of 6 squares vertically including the 2°C; minimum 5 large squares for volume.	1	
		III All points plotted to within half a small square (6 min).	1	
	(ii) ACE interpretation	IV Draws both straight lines of best fit.	1	
	(iii)	V Reads correctly the value of FB 1 from the intercept of the two lines.	1	
				[5]

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(c) (i) and (ii) (iii)	ACE interpret- ation	I Correctly calculates $\frac{2.00 \times (b)(iii)}{1000}$ and same answer for (c)(ii)	1	[3]
		II Correctly calculates $\frac{1000 \times (c)(ii)}{[30.00 - (b)(iii)]}$	1	
	PDO Display	III Show use of $2 \times (b)(iii)/1000$ in (i) and all 3 answers to 3 or 4 sf	1	
(d)	ACE interpret- ation	Any two of: - change in volume makes no difference to the accuracy as temp rise the same - decreased accuracy as less accurate measurement of volume with reference to measuring cylinder or burette (comparative needed or reference to precision/calibration or % error) - more accurate as greater number of experiments so more points to get an accurate intercept or better lines of best fit	2	[2]
[Total: 16]				

2 (a)	MMO collection	I Initial and final volumes recorded for rough and initial, final and volume added recorded for accurate titrations.	1	
	PDO recording	II All accurate burette readings recorded to 0.05 cm ³ . <i>Do not award this mark if:</i> <i>50(.00) is used as an initial burette reading;</i> <i>more than one final burette reading is 50(.00);</i> <i>any burette reading is greater than 50(.0).</i>	1	
	MMO decision	III Two uncorrected accurate titres within 0.1 cm ³ . Do not award if, having performed two titres within 0.1 cm ³ , a further titration is performed that is more than 0.1 cm ³ from the closer of the original 2 titres unless a further titration has been carried out which is within 0.1 cm ³ of any others. Do not award if titres from burette readings to no dp are used (apart from use of 0 for initial reading).	1	

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Examiner rounds any accurate burette readings to the nearest 0.05 cm^3 , checks subtractions and then selects the 'best' titres for Supervisor and candidate using the hierarchy:
two identical; titres within 0.05 cm^3 ; titres within 0.1 cm^3 ; etc.
to calculate mean correct to 0.01 cm^3 .

Examiner compares candidate mean titre with Supervisor mean titre.

(a) (cont.)	MMO quality	IV + V Award 2 marks if $\delta \leq 0.20 \text{ cm}^3$. Award 1 mark if $0.20 < \delta \leq 0.50 \text{ cm}^3$. <i>If best titres are $\geq 0.50 \text{ cm}^3$, cancel one of the Q marks.</i>	2	[5]
(b)	ACE interpretation	Check mean titre is correctly calculated from clearly selected values (ticks or working). Candidate must average two (or more) titres that are within 0.20 cm^3 of each other. 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.</i> <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. eg 26.0 and $26.2 = 26.1$ is correct but 26.0 and $26.1 = 26.1$ is incorrect.</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)	ACE interpretation	I (i) Correctly calculates $0.2 \times \text{(b)}/1000$ and same ans in (ii) to 3 or 4 sf	1	
		II (c)(ii) $\times 400$	1	
	PDO display	III Working in the correct direction shown in (i) and (iii).	1	[3]
[Total: 9]				

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FB 5 is NaOH(aq); **FB 6** is FeSO₄(aq); **FB 7** is (Zn(NO₃)₂ + KI)(aq); **FB 8** is Pb(NO₃)₂(aq);
FB 9 is Na₂SO₄(aq)

(a)	MMO collection	I FB 5 and FB 6 : a green ppt, insol in excess	1	[6]
		II turning brown/darkening	1	
		III FB 5 and FB 7 : a white ppt, sol in excess	1	
		If excess omitted in the tests above then allow 1 mark for three correctly coloured ppts.		
		IV FB 5 and FB 8 : white ppt, sol in excess	1	
		V FB 6 and FB 7 : no reaction/no change (<i>not dash</i>) (ignore any ref to solution turning yellow/orange/brown)	1	
		VI FB 6 and FB 8 : white ppt and FB 7 and FB 8 : yellow ppt	1	

(b)	ion	Fe ²⁺	Pb ²⁺	Zn ²⁺	I ⁻	OH ⁻	SO ₄ ²⁻
	solution	FB 6	FB 8	FB 7	FB 7	FB 5	FB 6

(b)	ACE conclusion	6 correct scores 3 marks 5 correct scores 2 marks 3 or 4 correct scores 1 mark (freestanding marks)	3	[3]
(c)	MMO decision	(Aqueous) BaCl ₂ or Ba(NO ₃) ₂ and HCl or HNO ₃ (or names) or Pb(NO ₃) ₂ and HNO ₃ (either way round but check that obs fit)	1	[2]
	MMO collection	or add HCl, HNO ₃ , H ₂ SO ₄ and observe fizzing with SO ₃ ²⁻ or test gas with (acidified) dichromate/ manganate(VII) or add acidified sodium/potassium dichromate/ manganate(VII) (to solution) with SO ₃ ²⁻ : colour change from orange/purple to green/colourless or decolourises White ppt insol/no gas/no (further) reaction in acid or no reaction/no gas/no colour change of indicator (from obs) (with Ba ²⁺ route may gain reagent mark if suitable acid is only named in obs) or no colour change of solution/ (from obs) and SO ₄ ²⁻ identified	1	

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(d)	MMO decision	I	Choice of first reagent from following list (<i>any</i>)	1	[4]
	ACE conclusion	II	Correct deduction(s) from correct positive obs.	1	
	MMO decision	III	Choice of second reagent which is capable of distinguishing between the pair** (e.g. carbonate / dichromate pairing cannot be credited as cannot identify if the two are ethanol and ethanal; ditto Tollens' and Na)	1	
	ACE conclusion	IV	Correct deduction from correct obs.	1	
[Total: 15]					

** If both tests identify the same compound, award marks for the higher scoring answer.

reagent	ethanol	ethanal	ethanoic acid
*acidified potassium (or sodium) dichromate	orange/solution turns green	orange/solution turns green	(no reaction)
*acidified potassium manganate(VII)	purple/solution turns colourless/pale pink	purple/solution turns colourless/pale pink	(no reaction)
Brady's (2,4–DNP(H))	(no reaction)	yellow-orange/ orange/red ppt	(no reaction)
Tollens'/ammoniacal silver nitrate	(no reaction)	silver (mirror) grey/black ppt	(no reaction)
Fehling's	(no reaction)	orange/red/orange-brown/red-brown ppt	(no reaction)
Benedict's	(no reaction)	orange/red/orange-brown/red-brown ppt	(no reaction)
named carbonate or hydrogen carbonate	(no reaction)	(no reaction)	effervescence/ gas which turns limewater milky
magnesium	(no reaction)	(no reaction)	effervescence/ gas which pops with lighted splint

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sodium	effervescence/ gas which pops with lighted splint	(no reaction)	effervescence/ gas which pops with lighted splint
sodium hydroxide + ref to checking temperature	(no reaction)	(no reaction)	temp increases
named indicator (not phenolphthalein)	(no reaction)	(no reaction)	turns correct final colour
named alcohol + c. H_2SO_4 warm/heat	(no reaction)	(no reaction)	sweet/fruity/ester smell
named carboxylic acid + c. H_2SO_4 & warm/heat	sweet/fruity/ester smell	(no reaction)	(no reaction)
PCl_5 or $\text{PCl}_3/\text{SOCl}_2$	misty/steamy fumes	(no reaction)	misty/steamy fumes
triiodomethane test/ $\text{I}_2 + \text{NaOH}$	(pale) yellow ppt	(pale) yellow ppt	(no reaction)
named –oyl chloride	sweet/fruity/ester smell	(no reaction)	(no reaction)

* deduction marks allowed from no acidification/ H^+

MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/35

Paper 3 (Advanced Practical Skills 1), 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 should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2013	9701	35

Question	Sections	Indicative material	Mark	Total
1 (a)	MMO Collection	I All thermometer readings recorded and two weighings + correct mass of FA 1 recorded.	1	
	PDO Recording	II Correct headings and units in both tables in (a) (Mass) and (c) (Mass and temperature). <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 Quality	III Temperature recorded to 0.5°C (<i>must have at least one at 0.5°C and one to 0.0 °C</i>) and weighings to same number of dp (on page 2). Examiner to calculate Supervisor – candidate $\Delta T/m$ (ΔT from table). Award IV and V if $\delta \leq 0.20^\circ\text{C g}^{-1}$ Award IV if $0.20 < \delta \leq 0.50^\circ\text{C g}^{-1}$	1 1	
(b)	PDO Layout	I Uniform scales chosen to use more than half of each axis. Axes labelled, ignore units.	1	
		II All points correctly plotted within $\frac{1}{2}$ small square and in correct small square on y-axis and on the line on x-axis.	1	
		III Appropriate lines of best fit are drawn.	1	
	ACE Interpretation	IV Correct value of ΔT (or to nearest 0.5°C) from extrapolated lines (ignore sf).	1	[4]
(c)	PDO Recording	I Table drawn to include weighings, correct mass of FA 2 , initial and final thermometer readings. Examiner to calculate Supervisor – candidate ΔT	1	
	MMO Quality	Award II and III if $\delta \leq 0.5^\circ\text{C}$ Award II only if $0.5 < \delta \leq 1.0^\circ\text{C}$	1 1	

Page 3	Mark Scheme	Syllabus	Paper
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(d) (i) & (iii)	ACE Interpretation	I Correctly calculates $25 \times 4.3 \times \Delta T$ for step 1 and for step 2.	1	
	(ii)	II Correctly calculates $\frac{\text{answer to (i)} \times 120.4}{\text{mass FA 1} \times 1000}$ (if number of moles calculated, value used must be to at least 2 sf).	1	
	(iv)	III Correctly calculates $\frac{\text{answer to (iii)} \times 246.4}{\text{mass FA 2} \times 1000}$ (do not penalise incorrect sign a second time).	1	
	(v)	IV Correctly calculates ΔH from answers to (ii) and (iv) with correct sign ((ii) – (iv)) (allow ecf for sign)	1	
	PDO Display	V Working in the right direction shown in parts (i) – (iv). (i) and (iii) use of $mc\Delta T$; (ii) use of 120.4; (iv) use of 246.4	1	[6]
		VI All final answers given to 3 or 4 sf (minimum of 3 answers).	1	
1 (e) (i)	ACE Interpretation	Single thermometer reading $\pm 0.5^\circ\text{C}$ (or $\pm 0.1^\circ\text{C}$ if candidate recorded T to 0.1°C). $\Delta T \pm 1.0^\circ\text{C}$ (or $\pm 0.2^\circ\text{C}$)	1	[2]
	(ii)	Calculates $\{1.0/\Delta T\} \times 100$ (or $\{0.2/\Delta T\} \times 100$) for step 2 to 2 or more sf. Allow ecf.	1	
(f) (i)	ACE Improvements	Student incorrect as smaller temp change or % error in temp change increased.	1	[1]
	(ii) MMO Interpretation	Calculates $\Delta T/m$ or $m/\Delta T$ or Q/m for each result. Allow mass of solid $\times c \times \Delta T$.	1	
	MMO Decisions	Yes, values concordant/consistent (shown:– $\Delta T/m$: 1.2/1.20/1.198 and 1.2/1.20/1.196 or $m/\Delta T$: 0.84/0.835 and 0.84/0.836 or Q/m : 128.7 and 128.6 respectively).	1	
				[2]
				[Total: 23]

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FA 3 is CrCl_3 ; FA 4 is $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$; FA 5 is $\text{Pb}(\text{NO}_3)_2$					
2	(a)	MMO Collection	FA 3 gives grey-green ppt soluble in NaOH/ giving dark green solution in excess and grey-green ppt insoluble in excess NH_3	1	[3]
			FA 4 gives green/dirty green ppt insoluble in excess of both and turning brown/darkening in at least one	1	
			FA 5 gives white ppt soluble in excess NaOH and white ppt insoluble in excess NH_3 or Award 1 mark if all NaOH observations, including in excess, are correct. Award 1 mark if all NH_3 observations, including in excess, are correct.	1	
(b)	MMO Decisions	Selects products with excess NaOH in (i) and warms the product in (ii).	1	[4]	
		Tests gas /ammonia with (damp) red litmus and turns blue in (ii). (Stand-alone mark irrespective of reagent chosen.)	1		
	MMO Collection	FA 4 gives (gas) turning red litmus blue Neither of the others give a positive result.	1 1		
(c)	MMO Decisions	I Selects any 2 from: AgNO_3 , BaCl_2 or $\text{Ba}(\text{NO}_3)_2$, $\text{Pb}(\text{NO}_3)_2$ (full reagent names or formulae needed)	1	[5]	
		II $\text{NaOH} + \text{Al}$ and warm do not penalise $\text{OH}^- + \text{Al}$ and warm if full names not given above	1		
	MMO Collection	III and IV Any 2 of: only FA 3 gives (white) ppt with Ag^+ ; only FA 4 gives white ppt with Ba^{2+} (allow off-white); FA 3 and FA 4 give white ppt with Pb^{2+}	2		
		V FA 5 and FA 4 (if tested) form gas/ammonia on warming (or warm in reagent column) which turns (damp) red litmus paper blue	1		

Page 5	Mark Scheme	Syllabus	Paper
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(d)	ACE Conclusions	I FA 3 contains Cr^{3+} and Cl^-	1	
		II FA 4 contains Fe^{2+} and SO_4^{2-}	1	
		III Only FA 4 contains NH_4^+	1	
		IV FA 5 contains either Pb^{2+} or Al^{3+} (both given)	1	
		V Only FA 5 contains NO_3^-	1	[5]
[Total: 17]				