

MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers

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 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2012	9701	31

Question	Sections	Indicative material	Mark
(d)	PDO layout	I Rate on y-axis and volume on x-axis. Axes clearly labelled (ignore units) II Linear scale chosen to use at least half of each axis (need not include 0, 0) If no point at 0, 0 cannot count for > half. III Plotting of points. Minimum of 3 readings. IV Draws a line of best fit. Minimum 4 readings including 0, 0 (if plotted).	1 1 1 1 [4]
(e)	ACE conclusion	Rate is proportional to peroxodisulfate concentration Rate increases as concentration (volume) increases would score one	2 [2]
(f)	ACE interpretation	(i) correctly calculates $(0.5 / \text{time from Expt 1}) \times 100$. Minimum of 2 s.f. (ii) $\frac{\text{ans (b)(iii)}}{\text{Expt 1 time} + 0.5} \times 10^6 \text{ mol dm}^{-3} \text{ s}^{-1}$ or Rate– (% from (i) $\times$ rate) (iii) Any reasonable suggestion e.g. difficult to judge colour change / measurement of volumes / variation in T	1 1 1
	ACE improvement	use of colorimeter / burettes for all volumes / (thermostatic) waterbath. Not air conditioning.	1 [4]
(g)	ACE conclusion	(ii) Thiosulfate concentration / number moles / volume is doubled (1) Time is longer/ reaction is slower with more thiosulfate (1)	2 [2]
			[Total: 26]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
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Question	Sections	Indicative material			Mark
FA 5 = CuCl ₂ ; FA 6 = NaOH; FA 7 = Pb(NO ₃) ₂ ; FA 8 = K ₂ CrO ₄ ; FA 9 = MgSO ₄					
2 (a)	MMO collection	Blue ppt insol in excess (1) Not 'dark blue'	White ppt (1) Ignore 'excess'. White ppt soluble in excess (1)	Yellow / brown / greenish-brown ppt (1) Not 'orange, red, red / brown' Ignore excess. No reaction / yellow solution and yellow ppt soluble in excess CONs ppt (1)	[5]
(b)	ACE conclusion	Cu ²⁺ in FA 5 AND CrO ₄ ²⁻ in FA 8 Pb ²⁺ in FA 7 AND OH ⁻ in FA 6 Cl ⁻ in FA 5			1 1 1 [3]
(c)	MMO decision MMO decision PDO recording MMO collection MMO collection ACE conclusion	I Add Pb (NO ₃) ₂ or BaCl ₂ or Ba(NO ₃) ₂ II Add HNO ₃ or HCl III Presents observations in a single table – no extra reagents. Must be > 2 'boxes' IV White ppt V No SO ₂ evolved or ppt insoluble VI sulfate			1 1 1 1 1 [6]
	[Total: 14]				

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9701/32

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Question	Sections	Indicative material	Mark
(d)	PDO layout	I Rate on y-axis and volume on x-axis. Axes clearly labelled	1
		II Linear scale chosen to use at least half of each axis (need not include 0,0) If no point at 0, 0 cannot count for > half.	1
		III Plotting of points. Minimum of 3 readings.	1
		IV Draws a line of best fit. Minimum of 4 readings including 0, 0 (if plotted).	1
(e)	ACE conclusion	Rate is (directly) proportional to Fe^{3+} concentration . Rate increases as concentration (volume) increases would score one	2 [2]
(f)	ACE	(i) $2 \times 0.05 / 0.1$ $0.10 / 20.00 \times 100 = 0.5\%$ 0.25 scores 1 mark. No ecf.	1 1
		(ii) Difficult to judge colour change / measurement of reaction time / some thiosulfate reacting with acid / formation of (S) ppt / variation in T.	1
	ACE improvement	(iii) Investigate reaction between Fe^{3+} and $\text{S}_2\text{O}_3^{2-}$	1 [4]
(g)	ACE conclusion	(ii) Thiosulfate concentration / number of moles / volume is halved (1) Time is shorter / reaction is faster with less thiosulfate (1) ora.	2 [2]
			[Total: 26]

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Question	Sections	Indicative material			Mark
FB 5 = H ₂ SO ₄ ; FB 6 = K ₂ CrO ₄ ; FB 7 = BaCl ₂ ; FB 8 = Pb(NO ₃) ₂ ; FB 9 = NaNO ₂					
2 (a)	MMO collection	Orange solution (1)	White ppt and (white ppt in RH column)	White ppt (1)	[5]
			Yellow/cream ppt (1)	Yellow ppt (1)	
				White ppt (1)	
Ignore excess of any reagent.					
(b)	ACE conclusion	Pb ²⁺ in FB 8 AND Ba ²⁺ in FB 7			1
		H ⁺ in FB 5 AND CrO ₄ ²⁻ in FB 6			1
		SO ₄ ²⁻ in FB 5 AND Cl ⁻ in FB 7			1 [3]
(c)	MMO decision	I Warms with NaOH and Al in (i).			1
	MMO decision	II Adds named (dilute) acid in (ii).			1
	PDO recording	III Presents observations in a single table – no extra reagents in (iii).			1
	MMO collection	IV Ammonia / gas turns litmus blue in (iii). If ammonia mentioned first, assume it is the gas that affects the litmus.			1
	MMO collection	V Brown fumes (of NO ₂) / gas that turns blue litmus red in (iii).			1
	ACE conclusion	VI nitrite (needs evidence).			1 [6]
	[Total: 14]				

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO Layout	I Two balance readings and mass used unambiguously recorded.	1	
	MMO Collection	II Two rough titres and burette readings recorded.	1	
		III Single table for each accurate titration <i>Minimum of 2×2 “boxes”</i>	1	
	PDO Recording	IV Correct headings and units in weighing table and accurate titration table(s) <i>Acceptable headings:</i> <i>mass of tube + FA 4;</i> <i>mass of tube + residue/mass of empty tube (mass of FA 4 used);</i> <i>initial/final or 1st/2nd (burette)(reading)/ (volume)/ (reading at)/(volume at) start/finish;</i> <i>volume added/used/ titre; or wtte,</i> not “difference” or “total volume” <i>Acceptable units are solidus:/cm³; brackets: (cm³);</i> <i>in words: volume in cubic centimeters, volume in cm³. Similarly for mass in g, etc.</i> If units are not included in the heading every entry in the table must have the correct unit.	1	
	MMO Collection	V 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.(00)</i>	1	
	MMO Decisions	VI Two uncorrected accurate titres within 0.10 cm ³ in both steps <i>Do not allow the Rough even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.10 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a fourth titration, within 0.1 cm³ of any other has also been carried out. Mark not awarded if any burette reading is given to zero dp apart from an initial reading of 0</i>	1	
(a) cont.	Step 2: Examiner subtracts candidate's titre (corrected to 0.01 cm ³) from supervisor's titre.			
	MMO Quality	Award VII, VIII, IX if $\delta \leq 0.1 \text{ cm}^3$	1	
		Award VII, VIII if $0.10 < \delta \leq 0.20 \text{ cm}^3$	1	
		Award VII if $0.20 < \delta \leq 0.40 \text{ cm}^3$	1	
		Spread penalty (see below)		

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		Step 3: Examiner calculates <u>corrected candidate titre × candidate mass added</u> supervisor mass added and subtracts the corrected value from the supervisor's titre. <i>If 1 g > candidate mass > 3g then use default value of 2.00 g for the Q marks and do not award one mark (from marks X to XII)</i>		
(a) cont.	MMO Quality	Award X, XI, XII if $\delta \leq 1.00 \text{ cm}^3$ Award X, XI if $1.00 < \delta \leq 2.00 \text{ cm}^3$ Award X only if $2.00 < \delta \leq 4.00 \text{ cm}^3$ If Supervisor's $t_3 < 10.00 \text{ cm}^3$ then halve the tolerances. <i>Apply spread penalty to each of steps 2 & 3 as follows: titres selected (by examiner) differ by $> 0.50 \text{ cm}^3 = -1$; Apply a spread penalty of -1 if only one accurate titration is performed.</i>	1 1 1	[12]
(b)	ACE Interpretation	(i) Check mean titre correctly calculated from clearly selected values (ticks or working) no mark awarded here (ii) Expression $\{(\mathbf{b})(\mathbf{i}) \times 0.10\}/1000$ and (iii) as (ii) <i>If no working shown then answer must be correct</i> (iv) Expression $(\mathbf{b})(\mathbf{iii}) \times 2 \times 10$ <i>If no working shown then answer must be correct</i>	1 1	[2]

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Question	Sections	Indicative material	Mark	Total
(c)	ACE Interpretation	I (i) Calculation of mean for (b)(i) and (c)(i) Candidate must average two (or more) titres that are within 0.20 cm³ 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. Example: 26.667 must be rounded to 26.67.</i> <i>Two special cases where the mean may not be to 2 dp:</i> <i>allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325;</i> <i>allow mean to 1 dp if all accurate burette readings were given to 1 dp and the mean is exactly correct, e.g. 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect.</i> <i>Do not award this mark if:</i> <i>any selected titre is not within 0.20 cm³ of any other selected titre unless a spread penalty has been applied or two pairs of accurate titres shown (eg 21.1, 21.2, 21.4, 21.5 should have a mean of 21.3);</i> <i>the rough titre was used to calculate the mean;</i> <i>the candidate carried out only 1 accurate titration in both steps 2 and 3;</i> <i>burette readings were incorrectly subtracted to obtain any of the accurate titre values.</i>	1	
		II (ii) (c)(i) × 0.1/1000 and (iii) as (c)(ii) <i>If no working shown then answer must be correct</i>	1	
		III (iv) (c)(iii) × 10 <i>If no working shown then answer must be correct</i>	1	
	PDO Display	IV Working is shown in every step of (b)(ii) and (iv), (c)(ii) and (iv) and at least 3 steps attempted <i>Working must be a step in the right direction</i>	1	[4]

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(d)	ACE Conclusion	I (i) $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ <i>Allow H_2CO_3</i>	1	[4]
	PDO Display	II (iii) $\{(\text{d})(\text{ii})/2\} \times 100.1$ <i>If the balancing is incorrect then the value of (d)(ii) must be correct for ecf to be allowed.</i>	1	
	ACE Conclusion	III (iv) expression $\{(\text{d})(\text{iii})/\text{mass in (a)}\} \times 100$ <i>If no working shown then answer must be correct</i>	1	
	PDO Display	IV Final answer to every step attempted out of (b), (c) and (d) apart from (b)(iv) to 3 or 4 sf (minimum 6 steps attempted)	1	
(e)	ACE Interpretation	(i) $(\pm)0.05 \text{ cm}^3$	1	[2]
		(ii) $\{0.1/\text{one of the titre values in step 3}\} \times 100$ (ecf (i) $\times 2$ for error)	1	
(f)	ACE Improvement	Explanation must not contradict suggested improvement: larger mass reacts with more HCl so smaller titre so larger % error; larger mass may be excess and won't dissolve in HCl; larger mass would result in smaller % mass error; greater acid spray would result in greater % error.	1	[1]
			[Total: 25]	

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Question	Sections	Indicative material	Mark	Total
FA 6 = $\text{KMnO}_4(\text{aq})$; FA 7 = $\text{MnSO}_4(\text{aq})$; FA 8 = MnO_2 ; FA 9 = $\text{KI}(\text{aq})$; FA 10 = $\text{NaCl}(\text{aq})$				
2 (a)	MMO Collection	I (ii) (purple) turns colourless and effervescence/fizzing/bubbling or solution turns colourless/ solution remains colourless <i>Note: positive O_2 test may be reported here</i>	1	
		II (iii) solution <u>turns</u> brown/red-brown/ orange/yellow or black solid (formed)	1	
		III (iv) off-white/buff/beige/pale brown ppt darkens/turns brown on standing and	1	
		(v) off-white/ buff/beige/pale brown ppt insoluble in excess NH_3	1	
		IV (vi) (pale) brown solution/(dark) brown ppt	1	
		V (vii)effervescence and (gas) reignites glowing splint in (vii) or (ii) or gas reignites glowing splint	1	
		VI (viii) (gas) bleaches (damp) litmus paper		
(b)	ACE Conclusions	(i) Mn from two pieces of evidence: FA 7 off-white/etc ppt with NaOH and NH_3 or off-white/etc ppt with NaOH darkening or off-white/etc ppt with NH_3 insoluble in excess <i>allow: white/cream ppt darkening in both NaOH and NH_3/white/cream ppt turning brown and insoluble in excess of either</i> or FA 6 is purple and an oxidising agent	1	
(ii) redox or iodide/ I^- oxidised or manganese/manganate/ Mn(VII) / MnO_4^- reduced	1			
(iii) FA 7 +2 and product +3 to +6	1			
				[6]
				[3]

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Question	Sections	Indicative material	Mark	Total
(c)	MMO Decisions PDO Layout	I (i) $\text{AgNO}_3(\text{aq})$, then $\text{NH}_3(\text{aq})$ (ignore HNO_3)	1	[6]
		II (ii) Tabulated with no repeated headings <i>Allow from incorrect reagents but withhold if extra reagent introduced (unless HNO_3).</i>	1	
	MMO Collection	III FA 9 yellow ppt with Ag^+ insoluble in NH_3 and FA 10 white ppt with Ag^+ soluble in NH_3 <i>Allow correct obs for Ag^+ and Pb^{2+}</i>	1	
	ACE Conclusions	IV (iii) FA9 = iodide/ I^- and FA10 = chloride/ Cl^- <i>Allow from correct colour of Ag^+ ppt provided AgI not soluble/AgCl not insoluble in NH_3</i>	1	
		V (iv) Both correct – ecf from (iii) iodide: purple fumes/gas or black solid chloride: misty/white/steamy fumes bromide: red-brown/orange solid or red-brown vapour (not brown)	1	
	MMO Collection	VI (v) (blue) solution/turns green/yellow-green (not yellow)	1	
			[Total: 15]	

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Question	Sections	Indicative material	Mark	Total
1 (a)	MMO Collection PDO Layout	I Two rough titres recorded.	1	
		II Single table for each titration (step 1 and 2) <i>Minimum of 2 × 2 “boxes”</i>	1	
	PDO Recording	III Initial and final burette readings unambiguously recorded for rough and accurate titrations carried out.	1	
		IV Correct headings and units in both titration tables. <i>Acceptable headings:</i> <i>initial/final or 1st/2nd (burette)</i> <i>(reading)/(volume)/(reading at)/(volume at)</i> <i>start/finish; volume added/used/titre; or wtte,</i> not <i>difference, total volume or volume FB 1</i> <i>Acceptable units are solidus: /cm³; brackets: (cm³);</i> <i>in words: volume in cubic centimetres, volume in</i> <i>cm³.</i> If units are not included in the heading every entry in the table must have the correct unit.	1	
	MMO Collection	V 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.(00)</i>	1	
	Decisions	VI Two burette readings within 0.10 cm ³ in each titration step. <i>Do not allow the Rough even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.1 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a fourth titration, within 0.1 cm³ of any other has also been carried out.</i> <i>Mark not awarded if any accurate reading is given to zero dp apart from initial ‘0’.</i>	1	
	Step 1: Examiner subtracts candidate's titre (corrected to 0.01 cm ³) from supervisor's titre			
	MMO Quality	Award VII, VIII, IX if $\delta \leq 0.1 \text{ cm}^3$ Award VII, VIII if $0.10 < \delta \leq 0.20 \text{ cm}^3$ Award VII if $0.20 < \delta \leq 0.40 \text{ cm}^3$ If Supervisor's titre < 10.00 cm ³ then halve the tolerances Spread penalty (see below)	1 1 1	
	Step 2: Examiner subtracts (corrected) candidate's titre from supervisor's titre. Check and correct titre as above.			

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Question	Sections	Indicative material	Mark	Total
1 (a) cont.	MMO Quality	Award X, XI, XII if $\delta \leq 0.20 \text{ cm}^3$ Award X, XI if $0.20 < \delta \leq 0.40 \text{ cm}^3$ Award X only if $0.40 < \delta \leq 0.80 \text{ cm}^3$ If Supervisor's titre $< 10.00 \text{ cm}^3$ then halve the tolerances <i>Apply spread penalty to each of steps 1 and 2 as follows:</i> <i>titres selected (by examiner) differ by</i> <i>$> 0.50 \text{ cm}^3 = -1$;</i> <i>Apply a spread penalty of -1 if only one accurate titration is performed.</i>	1 1 1	[12]
(b)	ACE Conclusion Interpret- ation	(i) Check mean titre correctly calculated from clearly selected values (ticks or working) (ii) $\text{C}_2\text{O}_4\text{H}_2 + 2\text{NaOH} \rightarrow \text{C}_2\text{O}_4\text{Na}_2 + 2\text{H}_2\text{O}$ (iii) Correctly calculate $\{(\text{b})(\text{i}) \times 0.10\}/1000$ and (iv) (iii)/2 (ecf from equation)	1 1	[2]

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(c)	ACE Interpretation	I (i) Calculation of mean for (b)(i) and (c)(i) 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. Example: 26.667 must be rounded to 26.67.</i> <i>Two special cases where the mean may not be to 2 dp:</i> <i>allow mean to 3 dp only for 0.025 or 0.075 e.g. 26.325;</i> <i>allow mean to 1 dp if all accurate burette readings were given to 1 or zero dp and the mean is exactly correct. e.g. 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect.</i> <i>Do not award this mark if:</i> <i>any selected titre is not within 0.20 cm^3 of any other selected titre unless a spread penalty has been applied or two pairs of accurate titres shown (e.g. 21.1, 21.2, 21.4, 21.5 should have a mean of 21.3);</i> <i>the rough titre was used to calculate the mean;</i> <i>the candidate carried out only 1 accurate titration in both steps 1 and 2;</i> <i>burette readings were incorrectly subtracted to obtain any of the accurate titre values.</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	[4]
	PDO Display	II Correctly calculates (ii) (c)(i) $\times 0.02/1000$ and (iii) (c)(ii) $\times 5/2$	1	
		III (iv) Expression (c)(iii) – (b)(iv)	1	
		IV Working in the correct direction is shown in any 4 steps of (b)(iii) and (iv), (c)(ii), (iii) and (iv)	1	

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(d)	ACE Interpretation	I Correct M_r in both (i) 90(.0) and (ii) 134(.0) Allow ecf from misprint in (ii) of 102(.0) II Correct calculation of (i) $C_2O_4H_2 = (b)(iv) \times 90.0$ (allow ecf) and (ii) $C_2O_4Na_2 = (c)(iv) \times 134.0$ (allow ecf) [Default values: (i) 0.05859/0.0586; (ii) 0.05534/0.0553 or 0.04213/0.0421] If one of (d)(i) or (d)(ii) is fully correct then one mark may be awarded. i.e. mark horizontally or vertically	1	[4]
	Conclusion	III (iii) Expression {mass $C_2O_4Na_2$ in (ii)/total mass} $\times 100$ [total mass = (d)(i) + (d)(ii)] If $\times 100$ missing from expression then correct % needed	1	
	PDO Display	IV Final answer to each step attempted of (b)(ii), (iv), (c)(ii), (iii), (iv) and (d)(i), (ii), (iii) to 3 or 4 sf (minimum 5 steps)	1	
(e)	ACE Interpretation	(i) $(\pm)0.05 \text{ cm}^3$	1	[2]
		(ii) (i) $\times 2$ (ecf) so burette less accurate/ student incorrect use of $\{0.10/25\} \times 100$ or $(\pm)0.06$ compared with $(\pm)0.10$	1	
(f)	ACE Improvement	No improvement as acid in excess	1	[1]
[Total: 25]				

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FB 5 = NaNO ₂ ; FB 6 = NH ₄ Cl; FB 7 = NaNO ₃ ; FB 8 = NiSO ₄ (aq); FB 9 = FeSO ₄ (aq)				
2 (a)	MMO Collection	I (i) effervescence/bubbling/fizzing and either brown gas or blue solution	1	
		II (ii) (colourless) solution (turns) yellow/orange/red-brown/brown or forms black/dark grey ppt/solid	1	
		III (iii) (purple) solution/KMnO ₄ turns colourless/blue or solution remains colourless/turns blue	1	
		IV (iv) solid sublimates//solid/ppt reforms (on cooler part of tube)//white solid/ppt further up tube	1	
		V (v) gas/NH ₃ turns (damp) red litmus blue and no reaction in (vii) (ignore bubbling/ etc. on heating) (If gas not tested in (v) but is in (iv) then mark may be awarded provided NH ₃ appears in (v))	1	
		VI (vi) gas relights glowing splint or solid melts/dissolves/forms solution and pale yellow/white/cream/off-white solid/ppt forms on cooling	1	
(b)	ACE Conclusion	(i) N from single correct obs [brown gas (i)(ii)(iii)/blue solution (i)(iii)/NH ₃ (iv)(v)/O ₂ (vi)] (allow N ₂)	1	
		(ii) FB 5 +3 FB 6 –3	1	
		(iii) redox/oxidation and reduction// oxidation of N/NO ₂ ⁻ //reduction of Mn/MnO ₄ ⁻	1	
				[6]
				[3]

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Question	Sections	Indicative material	Mark	Total
(c)	MMO Decisions	I (i) NaOH and NH ₃ Allow KMnO ₄ and/or K ₂ Cr ₂ O ₇	1	
	PDO Layout	II (ii) Tabulated with no repeated headings <i>Allow from incorrect reagents but do not award if extra reagent introduced.</i>	1	
	MMO Collection	III Both give green ppt with NaOH. FB 8 blue solution with NH ₃ (not dark blue) FB 9 green ppt with NH ₃ FB 8 no change/no reaction with KMnO ₄ and K ₂ Cr ₂ O ₇ FB 9 (KMnO ₄) turns yellow/decolourised/yellow-brown/orange; (K ₂ Cr ₂ O ₇) turns green/yellow-green <i>Allow Fe(OH)₂ ppt as dirty or dark green</i>	1	
	ACE Conclusion	IV (iii) Fe ²⁺ = FB 9 from green/etc. ppt insol in excess NH ₃ (ora) (= 2 obs) or green/etc. ppt turning brown in NH ₃ (= 2 obs) green/etc. ppt with NH ₃ (= 1 obs) (positive MnO ₄ ⁻ = 1 obs) (positive Cr ₂ O ₇ ²⁻ = 1 obs) Evidence must match observations in (ii)	1	
		V (iv) (green) solution/turns blue (Ni ²⁺) <i>allow towards blue e.g. cyan</i> If Fe ²⁺ = FB 8 in (iii) then ecf obs: solution/turns (pale) yellow/no reaction/no change	1	
	MMO Collection	VI (v) (purple)/KMnO ₄ turns yellow/decolourised/yellow-brown/orange	1	
				[6]
				[Total: 15]

**MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/35

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.

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

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

Cambridge is publishing the mark schemes for the May/June 2012 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	Sections	Indicative material	Mark	Total
1 (a)	PDO layout	I mass of acid used and both weighings with unit shown correctly (g), /g, mass in g or mass in grams	1	
	PDO recording	II Rough titre shown and acceptable/appropriate headings and units for accurate titration table <i>Minimum of 2 × 2 “boxes”</i> <i>Acceptable headings:</i> <i>initial/final or 1st/2nd (burette)</i> <i>(reading)/(volume)/(reading at)/(volume at)</i> <i>start/finish;</i> <i>volume added/used/titre;</i> not “difference”, “total volume” or “volume of FA 2” <i>Acceptable units are solidus: /cm³; brackets: (cm³);</i> <i>in words: volume in cubic centimeters, volume in cm³.</i> <i>If cm³ units are not given in the heading, every entry in the table must have the correct unit.</i>	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.(00)</i>	1	
	MMO decision	IV Two uncorrected accurate titres within 0.10 cm ³ <i>Do not allow the Rough even if ticked.</i> <i>Do not award this mark if having performed two titres within 0.1 cm³ a further titration is performed which is more than 0.10 cm³ from the closer of the initial two titres, unless a fourth titration, within 0.1 cm³ of any other has also been carried out.</i> <i>Mark not awarded if any accurate reading is given to zero dp apart from initial ‘0’.</i>	1	
	MMO quality	Calculate candidates scaled titre = candidate mean titre × $\frac{\text{supervisor's mass of acid}}{\text{candidates mass}}$ Then compare scaled titre with the supervisor's mean titre Award V , VI and VII if $\delta \leq 0.20 \text{ cm}^3$ Award V and VI if $0.20 < \delta \leq 0.40 \text{ cm}^3$ Award V , only, if $0.40 < \delta \leq 0.80 \text{ cm}^3$ <i>Apply spread penalty as follows: titres selected (by examiner) differ by $> 0.50 \text{ cm}^3 = -1$;</i> <i>Apply a spread penalty of -1 if only one accurate titration is performed.</i>	1 1 1	[7]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
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Question	Sections	Indicative material	Mark	Total
(b)	MMO decision	Check mean titre 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. 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, e.g. 26.0 and $26.2 = 26.1$ is correct but 26.0 and $26.1 = 26.1$ is incorrect.</i> Do not award this mark if: any selected titre is not within 0.20 cm^3 of any other selected titre; the rough titre was used to calculate the mean; candidate carried out only 1 accurate titration; burette readings were incorrectly subtracted to obtain any of the accurate titre values used.	1	[1]
(c) (i) (ii)	PDO display	Correct working shown in both (i) and (ii) In (i), no of moles of NaOH = $0.115 \times \frac{\text{mean volume}}{1000}$ In (ii), mass of pure H_3PO_4 = $0.084 \times \text{mass FA 1 weighed}$	1	
(c)	PDO display	All three answers given in parts (i), (ii) and (iii) are quoted to 3 or 4 sig figs	1	
(iii)	ACE interpretation	Correct calculation of answer to step (iii): $\frac{\text{(ii)}}{98.0} \div 10$	1	
(iv)	ACE interpretation	Ratio of moles NaOH:H_3PO_4 correctly calculated, to nearest integer: $\frac{\text{(i)}}{\text{(ii)}}$ ecf for 1:3 with mol NaOH = 0.33 <i>Enough working must be shown to indicate that the answer was obtained by a correct method.</i>	1	
(v)	ACE conclusions	Correctly balanced equation, corresponding to the ratio (n) given in part (iv) <i>If calculated value of n was not 1, 2 or 3 (when rounded to the nearest integer), then this mark cannot be awarded</i> ecf for 1:3 “corrected” to mol NaOH = 3 <i>If n = 1; then $\text{NaOH} + \text{H}_3\text{PO}_4 \rightarrow \text{NaH}_2\text{PO}_4 + \text{H}_2\text{O}$ If n = 2; then $2\text{NaOH} + \text{H}_3\text{PO}_4 \rightarrow \text{Na}_2\text{HPO}_4 + 2\text{H}_2\text{O}$ If n = 3; then $3\text{NaOH} + \text{H}_3\text{PO}_4 \rightarrow \text{Na}_3\text{PO}_4 + 3\text{H}_2\text{O}$</i>	1	[5]

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Question	Sections	Indicative material	Mark	Total
(d) (i)	ACE interpretation	% error for pipette = $\frac{0.06}{25} \times 100 = 0.24\%$ (or 0.240%)	1	
(ii) (iii)	ACE interpretation	<i>No mark is allocated specifically for part (ii), but the candidate's answer must be appropriate:</i> <i>if a two dp balance was used in question 1, the answer to (ii) must be 0.01 or 0.005;</i> <i>if a one dp balance was used, the answer to (ii) must be 0.1 or 0.05</i> % error in mass of FA1, given in (iii) $= (2 \times \frac{\text{answer to (ii)}}{\text{mass of FA 1 used}}) \times 100 = \text{approx } 0.1\%$ <i>Accept numerical answer correct to 2, 3 or 4 sig fig</i> <i>The answer must be within ± 1 in final figure for 3 or 4 sf</i>	1	[2]
[Total: 15]				

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
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Question	Sections	Indicative material	Mark	Total
2 (a)	MMO collection	I The masses of FA 4 used by candidate were between 2.6 – 3.4 g and 1.6 – 2.4 g <i>Award this mark based on candidate's recorded mass of FA 4</i>	1	
	PDO display	II Headings for a 3 × 2 table in parallel columns or rows and the three weighings from at least one experiment must be entered in the table to qualify for this mark	1	
	PDO recording	III All weighings (for at least one experiment) recorded to same number of decimal places and unit, g, is given correctly	1	
	Examiner calculates candidate's ratio $\frac{\text{mass loss}}{\text{mass of hydrated FA 4}}$ to 2 dp (expected ratio is 0.15)			
	MMO quality	Award IV if $0.14 \leq \text{ratio} \leq 0.16$ in expt 1	1	
		Award V If $0.14 \leq \text{ratio} \leq 0.16$ in expt 2	1	
		Award VI If the ratio in both of experiments 1 and 2 is between 0.12 and 0.18, inclusive	1	[6]
(b) (i) (iii)	PDO display	Correct working shown in parts (i) and (iii), for experiment 1 <i>In (i), there must be correct subtraction to give mass of water lost and then divided by $M_r = 18$</i> <i>In (iii), the answer given in (i) must be divided by 2 (the mole ratio)</i> <i>If data from experiment 2 were used, mark ecf for <u>this</u> mark</i>	1	
(ii)	ACE conclusion	$\text{MX}_2 \cdot 2\text{H}_2\text{O}(\text{s}) \rightarrow \text{MX}_2(\text{s}) + 2\text{H}_2\text{O}(\text{g})$.	1	
(iv) (v)	ACE interpretation	Correct subtraction to obtain mass of anhydrous residue. <i>Do not award this mark if data from experiment 2 were used at any point in the calculation.</i>	1	
	PDO display	Correct use of expression: $M_r = \frac{\text{mass of residue in (iv)}}{\text{no of moles in (iii)}}$ (expected answer = 208)	1	[4]
(c) (i)	ACE Improvements	Heat the residue again and check that mass remains (almost) constant after doing so <i>Allow "heat to constant mass"</i>	1	

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Question	Sections	Indicative material	Mark	Total
(ii)	ACE Improvements	Cool in a desiccator or cool in (closed) container with a (named) drying agent	1	[2]
[Total: 12]				

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Question	Sections	Indicative material	Mark	Total
FA 4 is BaCl_2 ; FA 5 is $\text{ZnSO}_4 + \text{KI}$				
3 (a) (i)	PDO layout	Clear table headings and observations recorded in single table <i>Attempts at conclusions must also be made, but they do not need to be shown in the table</i>	1	
	MMO collection	Mark horizontally or vertically: AgNO_3 NH_3 FA 4 White precipitate (ppt) soluble (in excess) FA 5 Yellow precipitate (ppt) insoluble (in excess)	1 1	
(ii)	ACE conclusion	$\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$	1	
(iii)	ACE interpretation	Correct calculation of A_r: $A_r = 222 - M_r \text{ of } \text{X}_2 = 151$ (if FA 4 was identified as chloride) <i>Candidate may use 222 [or answer in 2(b)(v)] and $2 \times A_r$ of the halide identified.</i> <i>Mark ecf if bromide was identified in FA4 from a “cream” precipitate in (i)</i>	1	
(iv)	ACE conclusion	Identification of M and explanation that the calculated A_r value is closest	1	
(v)	ACE conclusion	Formula of FA 4 would be MCl_3 if Cr or Al were present or Cr and Al show oxidation state +3 (or have +3 ions) (whereas M is 2+). Both ions must be discussed to earn this mark (“they” is sufficient): <i>“no green colour” of FA 4 is acceptable to eliminate Cr^{3+}</i>	1	[7]
(b) (i)	MMO collection	FA 4 gives no change/no precipitate with NH_3 FA 5 gives a white precipitate, soluble in excess ammonia	1 1	
	ACE conclusion	FA 4 is any two of	1	
(iv)	MMO decision	Add sulfuric acid or potassium (di)chromate(VI) to FA 4 or suitable reagent for distinguishing between ions given in (ii)	1	
	MMO collection	Observation for FA 4 in the test recorded correct for Ba^{2+} and conclusion that barium ion is present or logical conclusion from result of selected test (Expected results: White precipitate obtained with sulfuric acid or [pale] yellow precipitate with (di)chromate(VI) ions	1	

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
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Question	Sections	Indicative material	Mark	Total
(v)	MMO collection	White precipitate, insoluble in HCl and conclusion that FA 5 contains sulfate ion	1	[6]
				[Total 13]