UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/33 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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UNIVERSITY of CAMBRIDGE
International Examinations

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 *Minimum of 2×2 "boxes"*	1	
	PDO Recording	**IV** Correct headings and units in weighing table and accurate titration table(s) *Acceptable headings:* *mass of tube + FA 4;* *mass of tube + residue/mass of empty tube (mass of FA 4 used);* *initial/final or 1st/2nd (burette)(reading)/ (volume)/ (reading at)/(volume at) start/finish;* *volume added/used/ titre; or wtte,* ***not** "difference" or "total volume"* *Acceptable units are solidus:/cm^3; brackets: (cm^3); in words: volume in cubic centimeters, volume in cm^3. Similarly for mass in g, etc.* 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 *Do **not** award this mark 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.(00)*	1	
	MMO Decisions	**VI** Two uncorrected accurate titres within 0.10 cm^3 in both steps *Do not allow the Rough even if ticked.* *Do **not** award this mark if having performed two titres within 0.10 cm^3 a further titration is performed which is more than 0.10 cm^3 from the closer of the initial **two** titres, unless a fourth titration, within 0.1 cm^3 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*	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 $\delta \leq 0.1$ cm^3	1	
		Award **VII**, **VIII** if $0.10 < \delta \leq 0.20$ cm^3	1	
		Award **VII** if $0.20 < \delta \leq 0.40$ cm^3	1	
		***Spread penalty** (see below)*		

Question	Sections	Indicative material	Mark	Total
	Step 3: Examiner calculates corrected candidate titre × candidate mass added supervisor mass added and subtracts the corrected value from the supervisor's titre. *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**)*			
(a) cont.	MMO Quality	Award **X**, **XI**, **XII** if $\delta \leq 1.00$ cm^3 Award **X**, **XI** if $1.00 < \delta \leq 2.00$ cm^3 Award **X** only if $2.00 < \delta \leq 4.00$ cm^3 If Supervisor's $t_3 < 10.00$ cm^3 then halve the tolerances. *Apply **spread penalty** to each of steps 2 & 3 as follows: titres selected (by examiner) differ by* *> 0.50 cm^3 = –1;* *Apply a spread penalty of –1 if only one accurate titration is performed.*	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 {**(b)(i)** x 0.10}/1000 **and** **(iii)** as **(ii)** *If no working shown then answer must be correct* **(iv)** Expression **(b)(iii)** × 2 × 10 *If no working shown then answer must be correct*	1 1	[2]

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 cm^3 of each other. Working must be shown or ticks must be put next to the two (or more) accurate readings selected. *The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67.* *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.* *Do **not** award this mark if:* *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 (eg 21.1, 21.2, 21.4, 21.5 should have a mean of 21.3);* *the rough titre was used to calculate the mean;* *the candidate carried out only 1 accurate titration in **both** steps 2 and 3;* *burette readings were incorrectly subtracted to obtain any of the accurate titre values.*	1	
		II (ii) **(c)(i)** × 0.1/1000 **and** **(iii)** as **(c)(ii)** *If no working shown then answer must be correct*	1	
		III (iv) **(c)(iii)** × 10 *If no working shown then answer must be correct*	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 *Working must be a step in the right direction*	1	[4]

Question	Sections	Indicative material	Mark	Total
(d)	ACE Conclusion	**I** **(i)** $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$ *Allow* H_2CO_3	1	
	PDO Display	**II** **(iii)** {**(d)(ii)**/2} × 100.1 *If the balancing is incorrect then the value of **(d)(ii)** must be correct for ecf to be allowed.*	1	
	ACE Conclusion	**III** **(iv)** expression {**(d)(iii)**/mass in **(a)**} × 100 *If no working shown then answer must be correct*	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	[4]
(e)	ACE Interpretation	**(i)** (±)0.05 cm^3	1	
		(ii) {0.1/one of the **titre values** in step 3} × 100 (*ecf **(i)** × 2 for error)*	1	[2]
(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]

Question	Sections	Indicative material	Mark	Total
FA 6 = $KMnO_4(aq)$; **FA 7** = $MnSO_4(aq)$; **FA 8** = MnO_2; **FA 9** = KI(aq); **FA 10** = NaC*l*(aq)				
2 (a)	MMO Collection	**I (ii)** (purple) turns colourless **and** effervescence/fizzing/bubbling **or** solution turns colourless/ solution remains colourless *Note: positive O_2 test may be reported here*	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** <u>gas</u> reignites glowing splint	1	
		VI (viii) (gas) bleaches (damp) litmus paper		[6]
(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** *allow: white/cream ppt darkening in both NaOH and NH_3/white/cream ppt turning brown and insoluble in excess of either* **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	[3]

Question	Sections	Indicative material	Mark	Total
(c)	MMO Decisions	**I** **(i)** $AgNO_3$(aq), then NH_3(aq) (ignore HNO_3)	1	
	PDO Layout	**II** **(ii)** Tabulated with no repeated headings *Allow from incorrect reagents but withhold if extra reagent introduced (unless HNO_3).*	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 *Allow correct obs for Ag^+ and Pb^{2+}*	1	
	ACE Conclusions	**IV** **(iii)** **FA9** = iodide/I^- **and FA10** = chloride/Cl^- *Allow from correct colour of Ag^+ ppt provided AgI not soluble/$AgCl$ not insoluble in NH_3*	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	[6]
				[Total: 15]