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

9701/35 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.

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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 *Minimum of 2 × 2 "boxes"* *Acceptable headings:* *initial/final or 1st/2nd (burette)* *(reading)/(volume)//(reading at)/(volume at) start/finish;* *volume added/used/titre;* ***not** "difference", "total volume" or "volume of FA 2"* *Acceptable units are solidus: /cm³; brackets: (cm³); in words: volume in cubic centimeters, volume in cm³.* *If cm³ units are not given in the heading, every entry in the table must have the correct unit.*	1	
	PDO recording	**III** All accurate burette readings to 0.05 cm³ *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 decision	**IV** Two uncorrected accurate titres within 0.10 cm³ *Do not allow the Rough even if ticked.* *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.* *Mark **not** awarded if any accurate reading is given to **zero** dp apart from initial '0'.*	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 δ ≤ 0.20 cm³ Award **V** and **VI** if 0.20 < δ ≤ 0.40 cm³ Award **V**, only, if 0.40 < δ ≤ 0.80 cm³ *Apply **spread penalty** as follows: titres selected (by examiner) differ by > 0.50 cm³ = –1;* *Apply a spread penalty of –1 if only one accurate titration is performed.*	1 1 1	[7]

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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. *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;* *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 × $^{mean\ volume}/_{1000}$* *In **(ii)**, mass of pure H_3PO_4 = 0.084 × 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)**: $\frac{\textbf{(ii)}}{98.0} \div 10$	1	
(iv)	ACE interpretation	Ratio of moles NaOH:H_3PO_4 **correctly calculated**, to nearest integer: $\frac{\textbf{(i)}}{\textbf{(ii)}}$ *ecf for 1:3 with mol NaOH = 0.33* *Enough working must be shown to indicate that the answer was obtained by a correct method.*	1	
(v)	ACE conclusions	**Correctly balanced equation**, corresponding to the ratio (***n***) given in part **(iv)** *If calculated value of **n** was not 1, 2 or 3 (when rounded to the nearest integer), then this mark cannot be awarded* *ecf for 1:3 "corrected" to mol NaOH = 3* *If n = 1; then $NaOH + H_3PO_4 \rightarrow NaH_2PO_4 + H_2O$* *If n = 2; then $2NaOH + H_3PO_4 \rightarrow Na_2HPO_4 + 2H_2O$* *If n = 3; then $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$*	1	[5]

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

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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 *Award this mark based on candidate's recorded mass of **FA 4***	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 $^{\text{mass loss}}/_{\text{mass of hydrated FA 4}}$ to 2 dp (expected ratio is 0.15)			
	MMO quality	Award **IV** if 0.14 ≤ ratio ≤ 0.16 in expt **1** Award **V** If 0.14 ≤ ratio ≤ 0.16 in expt **2** Award **VI** If the ratio in **both** of experiments **1** and **2** is between 0.12 and 0.18, inclusive	1 1 1	[6]
(b) (i) (iii)	PDO display	Correct working shown in parts **(i) and (iii)**, for experiment 1 *In **(i)**, there must be correct subtraction to give mass of water lost **and** then divided by M_r = 18* *In **(iii)**, the answer given in **(i)** must be divided by 2 (the mole ratio)* *If data from experiment 2 were used, mark ecf for <u>this</u> mark*	1	
(ii)	ACE conclusion	$MX_2.2H_2O(s) \rightarrow MX_2(s) + 2H_2O(g)$.	1	
(iv)	ACE interpretation	Correct subtraction to obtain mass of anhydrous residue. *Do **not** award this mark if data from experiment 2 were used at **any** point in the calculation.*	1	
(v)	PDO display	Correct use of expression: $M_r = {}^{\text{mass of residue in (iv)}}/_{\text{no of moles in (iii)}}$ *(expected answer = 208)*	1	[4]
(c) (i)	ACE Improvements	Heat the residue again **and** check that mass remains (almost) constant after doing so *Allow "heat to constant mass"*	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 $ZnSO_4$ + KI				
3 (a) (i)	PDO layout	Clear table headings **and** observations recorded in single table *Attempts at conclusions must also be made, but they do **not** need to be shown in the table*	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	$Ag^+ + Co^- \rightarrow AgCl$	1	
(iii)	ACE interpretation	**Correct calculation of A_r**: A_r = 222 – M_r of X_2 = 151 (if **FA 4** was identified as chloride) *Candidate may use 222 [**or** answer in **2(b)(v)**]* ***and** $2 \times A_r$ of the halide identified.* *Mark ecf if bromide was identified in FA4 from a "cream" precipitate in **(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):* *"no green colour" of **FA 4** is acceptable to eliminate Cr^{3+}*	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	
(ii) **(iii)**	ACE conclusion	**FA 4** is any **two** of	1	
(iv)	MMO decision MMO collection	Add sulfuric acid **or** potassium (di)chromate(VI) to **FA 4** **or** suitable reagent for distinguishing between ions given in **(ii)** 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 1	

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Question	Sections	Indicative material	Mark	Total
(v)	MMO collection	White precipitate, insoluble in HC*l* **and** conclusion that **FA 5** contains sulfate ion	1	[6]
				[Total 13]

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