UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2010 question paper for the guidance of teachers

9701 CHEMISTRY

9701/35 Paper 3 (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.

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Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	**I** Volume given for Rough titre. **and** accurate titre details tabulated.	1	
	MMO Collection	**II** Follows instructions – initial and final burette readings recorded for Rough titre **and** initial and final burette readings **and** volume of **FA 2** added recorded for each accurate titre **and** headings should match readings. *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	**III** Has two uncorrected, accurate titres within 0.1 cm^3 *Do not consider the Rough even if ticked. Do **not** award this mark if having performed two titres within 0.1 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 the third titration has also been carried out.*	1	
	PDO Recording	**IV** All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3 *Assess this mark on burette readings only*	1	
	MMO Quality	**V**, **VI** and **VII** Round any burette readings to the nearest 0.05 cm^3. Check and correct subtractions in the titre table. **Select the "best" titre using the hierarchy:** two identical; titres within 0.05 cm^3; titres within 0.1 cm^3; etc. Award **V**, **VI** and **VII** for a difference from Supervisor within 0.20 cm^3 Award **V** and **VI** only for a difference of 0.20+ cm^3 – 0.30 cm^3 Award **V** only for a difference of 0.30+ - 0.50 cm^3 *If the "best" titres are ≥ 0.50 cm^3 apart cancel one of the Q marks.*	3	[7]

(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places from any accurate titres within 0.20 cm^3. *The third decimal place may be rounded to the nearest 0.05 cm^3.* *A mean of exactly .x25 or .x75 is allowed but the candidate may round up or down to the nearest 0.05 cm^3.* *If **ALL** burette readings are given to 1 decimal place then the mean can be given to 1 decimal place* if numerically correct without rounding. *Mean of 24.3 and 24.4 = 24.35 (✓)* *Mean of 24.3 and 24.4 = 24.4 (×)* ***Titres to be used in calculating the mean must be clearly shown – in an expression or ticked in the titration table.***	1	[1]
(c)	ACE Interpretation	**I** Correctly evaluates $\frac{10.00}{40}$ = 0.25(0) **II** Uses **answer (i)** × $\frac{\text{mean titre}}{1000}$ in step **(ii)** **and** **answer (ii)** x $\frac{1000}{10}$ in step **(iii)** *If an answer, with no working, is given in any section allow if correct.*	1 1	[2]
	Total			**[Total: 10]**

2 (a)	PDO Recording	**I** Has correct headings (minimum three) and units in the weighing table in **(2)(a)** and correct units in the titration table in **(2)(b)** *Acceptable units are /g, (g), mass in grams, mass in g; similarly /cm^3,* **II** All three balance reading are read with constant precision (same no of decimal places) and to at least 1 decimal place	1 1	[2]
On Supervisor script scale the titre for 3.00 g of **FA 3** added to the acid. Calculate **8** × **(3.00 – mass of FA 3 used)** and **subtract** from the titre obtained. Mass of **FA 3** used = (mass tube + **FA 3**) – (mass tube + residue) *If (mass tube + residue) < mass of empty tube then use (mass tube + **FA 3**) – (mass tube).*				
(b)	MMO Quality	Award **I** and **II** if the difference between candidate and Supervisor scaled titres is within 0.40 cm^3 Award **I** only if the difference is between 0.50+ cm^3 and 0.80 cm^3	1 1	[2]
(c)	**There is no mark available for this section.**			
(d)	ACE Interpretation	**I** Uses $\frac{\text{mean titre}}{1000} \times 0.280$ in step **(i)** **and** uses **answer (i)** × $\frac{250}{25}$ in step **(ii)**	1	
		II Correctly evaluates $\frac{0.5 \times 250}{1000} = 0.125$ in step	1	
	PDO Display	**III** Uses **answer (iv)** × 0.5 × 100 in step **(v)**	1	
		IV Working shown in a minimum of **three** sections *Working should be a step in the right direction:* *step (i) 0.28 × titre volume (in cm^3/dm^3)* *step (ii) Use of 25 & 250 or 10* *step (iii) 0.5 and 250* *step (iv) the correct two numbers* *step (v) would need to include 2 (0.5) and 100* *step (vi) must be correct*	1	
		V 3 to 5 significant figures in final answers to **all sections attempted** – minimum of **three** final answers required	1	[5]

(e)	ACE Conclusions	Explains one of the following: If 5.5 g of $CaCO_3$ had been used the titre would be too small/not enough HC*l* remains for the titration (**not** 'all the acid has reacted') **or** Difficult/takes too long to dissolve 5.5 g of solid/it will not all dissolve in 150 cm^3 (of acid) **or** Excessive/too fast effervescence/fizzing/rate of gas evolved **or** Acid spray	1	[1]
(f)	ACE Interpretation	**(i)** **If balance displays to 1 decimal place:** error in balance reading is ±0.05 g ***or*** ±0.1(0) g error in mass of **FA 3** is ±0.1 g ***or*** ±0.2 g **If balance displays to 2 decimal places:** error in balance reading is ±0.005 g ***or*** ±0.01 g error in mass of **FA 3** is ±0.01 g ***or*** ±0.02 g **If balance displays to 3 decimal places:** error in balance reading is ±0.0005 g ***or*** 0.001g error in mass of **FA 3** is ±0.001 g ***or*** ±0.002 g **(ii)** Correctly evaluates to at least 2 significant figures: $\frac{\textbf{candidate's error in mass of FA 3}}{\textbf{mass of FA 3 used}} \times \textbf{100}$	1 1	[2]
(g)	ACE Conclusions ACE Improvements	**(i)** Gives correct equation for the thermal decomposition of calcium carbonate including state symbols **(ii)** Outlines: weigh container weigh container + solid (heating and) weighing again repeated (heating and) weighing to constant mass **or** weigh container weighing container + solid (heating and) measuring gas volume when no further increase **and** cooled to room temperature / use of pV = nRT / $\frac{PV}{T}$ = constant	1 1	[2]
	Total			**[14]**

FA 7 is $Fe_2(SO_4)_3$(aq); **FA 8** is $CrCl_3$(aq); **FA 9** is ZnI_2(aq) [$ZnCl_2$ + KI]				
3 (a)	PDO Layout	**I** (Tabulates) observations clearly, showing: observation when each reagent is first added **and** observation when reagent added to <u>excess</u> (if there is a ppt)	1	
	MMO Collection	**II, III** and **IV** 1 mark for correct observations in **each** of the columns or rows representing **FA 7**, **FA 8** and **FA 9** **or** 1 mark for correct observations in the row or column representing a reagent added (initial and excess count as one row/column)	3	
	ACE Conclusions	**Award <u>V</u>** only if **one ion only** is correctly identified	1	
		Award <u>V</u> and **<u>VI</u>** if **all three ions** are correctly identified from candidate's observations. Allow ecf*	1	[6]

<u>Minimum for observations marks:</u>

Solution	FA 7	FA 8	FA 9
NaOH	red-brown/brown/rust ppt insoluble (in excess)	grey-green ppt <u>soluble</u>/dissolves (in excess) giving a dark green solution	White/milky white ppt soluble/dissolves (in excess)
NH_3	red-brown ppt insoluble (in excess) *(suitable qualified brown)*	grey-green ppt insoluble (in excess)	White/milky white ppt soluble/dissolves (in excess)

<u>Minimum for conclusions marks: (</u>*with incomplete but not CON observations)*

FA 7 red-brown ppt with either;
FA 8 grey-green ppt with either/(dark) green solution with excess NaOH;
FA 9 white ppt soluble in excess NH_3.

<u>* ecfs allowed</u>

FA 8 allow Fe^{2+} if green ppt insoluble in excess NaOH (no grey-green ppts)
FA 9 allow Al^{3+} **and** Pb^{2+} if white ppt insoluble in excess NH_3
FA 9 allow Ba^{2+} **and** NH_4^+ if no ppt with either
FA 9 allow Mg^{2+} if white ppt insoluble in excess of both

(b)	MMO Decisions	**I** Selects barium chloride or barium nitrate for the test in step **(i)** *Do not allow Ba^{2+} alone* *$Ba^{2+}(aq)$ or soln containing Ba^{2+} (ions) is acceptable*	1	
	MMO Collection	**II** Records white/off-white precipitate with <u>only</u> **FA 7**	1	
	MMO Decisions	**III** Selects silver nitrate or lead nitrate in **(ii)** to add to the solutions (that do not contain sulfate) *Do not allow Ag^+ or Pb^{2+} alone* *Aqueous ions or solutions containing the ion are acceptable as above*	1	
	MMO Collection	**IV** Appropriate observations **FA 8** white ppt with Ag^+/white ppt or no ppt with Pb^{2+} **FA 9** yellow ppt with either *Ignore observations with any solution candidate has identified as sulfate*	1	
	ACE Conclusions	**V** **FA 8** is chloride, **FA 9** is iodide Credit if the supporting evidence fits the ion identified and the practical performed for **FA 8** and **FA 9** provided there is no CON observation in **(i)** *Do not credit if Ag^+ gives a ppt with **FA 7*** Marks **IV** and **V** may be awarded from **FA 8** white ppt chloride (**IV**) **FA 9** yellow ppt iodide (**V**)	1	[5]

<u>Other possibilities:</u>

Two white ppts with aqueous Ba^{2+} then remaining solution tested with aqueous Ag^+/Pb^{2+}
This would score marks **I**, **III** and may score one of **IV** or **V**

Aqueous Ba^{2+} gives positive result with solution other than **FA 7** and tests with aqueous Ag^+/Pb^{2+} performed
(This would score marks **I** and **III**)
Ignore observation and conclusion with **FA 7**
Award correct observation and valid conclusion for third ion thus scoring one of **IV** or **V**

Aqueous Ba^{2+} gives positive result with all three solutions
Award mark **I**, and mark **III** may be awarded for selection of aqueous Ag^+/Pb^{2+} **or** statement that no further testing is required **but no other marks can be awarded** in this section.

FA 10 is $NaNO_3(s)$; FA **11** is $NaNO_2(s)$				
(c) (i)	MMO Collection	**I** Solid/**FA 10** melts/to a liquid/solution (on heating)	1	
		II Observes <u>bubbles</u> of gas in liquid/solution **or** Liquid/solution turns yellow/pale yellow	1	
	MMO Decisions	**III** Describes an appropriate test <u>in either **(i)** or **(ii)**</u> for any of the following <u>gas</u>es: O_2, CO_2, NH_3 or SO_2 *There must be a reference to gas being evolved before this mark can be awarded.*	1	
	MMO Collection	**IV** Positive identification of oxygen gas in **(i)**: glowing splint rekindles/relights/glows brighter *(gas evolved rekindles a glowing splint would gain marks* **III** ***and*** **IV***)* *('glowing splint rekindles' would gain mark* **III** *not* **IV***)*	1	
(ii)		**V** On adding acid to residue to **FA 11**, observes brown/yellow-brown gas *(not yellow, orange or red-brown)* **or** blue solution *(allow greenish blue)*	1	[5]
	Total			**[16]**