CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/31 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 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 October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO Layout	**I** The following data must be given • mass of solid used (**or** both weighings) • volume for rough titre (**or** both readings) • initial **and** final readings for two (or more) accurate titrations.	1	
	PDO Recording	**II** Appropriate headings for **all** data given in weighing **and** accurate titration tables **and** g and cm^3 units. • mass/weight (of) beaker (empty) • mass/weight (of) beaker + **FA 1**/solid • initial/start (burette) reading/volume • final/end (burette) reading/volume • titre **or** volume/**FA 2** used/added • unit: /cm^3 **or** (cm^3) **or** in cm^3 **or** cm^3 for **each** volume *If g and/or cm^3 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 (including 0.00) are to the nearest 0.05 cm^3. *The need to record to 0.05 applies only to the burette readings and **not** to the recorded titres.* *Do **not** award this mark if:* • *50(.00) is used as an initial burette reading **or*** • *more than one final burette reading is 50.(00) **or*** • *any burette reading is greater than 50.(00).*	1	
	MMO Decision	**IV** There are two uncorrected **accurate** titres within 0.10 cm^3. *Do **not** include a reading if it is labelled "rough".* *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 further titration, within 0.1 cm^3 of any other, has also been carried out.* *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0) are given to **zero** dp.*	1	

Question	Sections	Indicative material	Mark	Total
(a) (cont)	MMO Quality	Award **V**, **VI** and **VII** if $\delta \leq 0.03$ ($cm^3\ g^{-1}$) *i.e. three Q marks.* Award **V** and **VI** if $0.03 < \delta \leq 0.06$ *i.e. two Q marks.* Award **V**, only, if $0.06 < \delta \leq 0.10$ *i.e. one Q mark.* ***Spread penalty**: if the two "best" (corrected) titres used by the Examiner were ≥ 0.50 cm^3 apart, cancel **one** Q mark.*	1 1 1	[7]
(b)	MMO Decision	Check mean titre is correctly calculated from clearly selected values (ticks or working). • Candidate must average two (or more) titres where the **total** spread is ≤ 0.20 cm^3. • 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. [*e.g. 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 (*ignoring initial given as 0*) 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: • 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; • **all** burette readings (resulting in titre values used in calculation of mean) are integers.	1	[1]
(c) (i)	ACE Interpretation	**I** Correctly calculates No. of moles of $KMnO_4 = 0.0200 \times {}^{(b)}/_{1000}$	1	
(ii)	ACE Conclusion	**II** $Fe^{2+} \rightarrow Fe^{3+} + e^-$ / $5Fe^{2+} \rightarrow 5Fe^{3+} + 5e^-$	1	
(iii) + (iv)	PDO Display	**III** Correct working shown in **(iii)** and **(iv)**. *The answer to **(i)** should be multiplied by 5 to give **(iii)**.* *The answer to **(iii)** should be multiplied by 10 to give **(iv)**.*	1	
(v)	ACE Interpretation	**IV** Correct calculation of relative formula mass. $M_r = {}^{\textbf{correct}\ \text{mass of}\ \textbf{FA 1}\ \text{used}}/_{\text{answer to}\ \textbf{(iv)}}$	1	

Question	Sections	Indicative material	Mark	Total
(v) (cont)	PDO Display	**V** All answers are quoted to 3 or 4 significant figures. A minimum of three answers is needed to qualify.	1	[5]
(d) (i)	ACE Interpretation	% error for pipette = $^{0.06}/_{25} \times 100 = 0.24\%$ (or 0.240%)	1	
(ii) + (iii)	ACE Interpretation	*If balance displays to 1 decimal place: error in balance reading is ±0.05 g or ±0.1(0) g.* *If balance displays to 2 decimal places: error in balance reading is ±0.005 g or ±0.01 g.* *If balance displays to 3 decimal places: error in balance reading is ±0.0005 g or ±0.001 g.* % error = $2 \times {}^{\text{balance error (above)}}/_{\text{mass of FA 1 used}} \times 100$ *Correct answer is **not** required, but if the "× 100" factor was omitted, a correctly calculated % error answer scores the mark.*	1	[2]
				[Total: 15]
2 (a)	MMO Collection	**I** The masses of **FA 5** used by the candidate were between 2.0–2.4 g (expt 1) and 1.5–1.9 g (expt 2).	1	
	PDO Display	**II** Suitable headings for a table or list, shown completely for at least one experiment carried out. If 2 experiments, all headings must be correct. • (mass of) empty crucible • (mass of) crucible + **FA 5** • (mass of) crucible + residue / **FA 5** after heating • (mass of) residue *(owtte)* • mass lost **or** (mass of) water lost. **and** unit was given "covering" every weighing; *Unit: /g **or** (g) **or** in grams **or** g following **each** weighing*	1	
	PDO Recording	**III** Records **all** weighings **consistently** to at least 1 dp. *A minimum of **three** weighings are needed.*	1	
	Accuracy (Q) marks for gravimetric experiment – 3 marks available Examiner checks working for mass of residue **and** mass of water and expresses the ratio $^{\text{mass of hydrated solid}}/_{\text{mass of water}}$ to 2 dp for **each** experiment. The expected ratio = $^{244}/_{36} = 6.78$.			

Question	Sections	Indicative material	Mark	Total
(a) (cont)	MMO Quality	Award **IV** if the ratio in expt **1** is between 6.30 and 7.25. Award **V** If the ratio in expt **2** is between 6.30 and 7.25. Award **VI** If the ratio in **both** of experiments **1** and **2** is between 5.90 and 7.65, inclusive.	1 1 1	[6]
(b) (i)	MMO Display	Correct expression for the number of moles of water lost (from mass as recorded) **or** correct answer.	1	
(ii)	ACE Interpretation	Correct expression for the number of moles of residue with **correct** masses of anhydrous salt **and** 208 **and** answer expressed to 2–4 sf **or** correct answer **and** 2–4 sf If only **one** expt carried out then **correct calculation** for number of moles of residue expressed to 2–4 sig fig.	1	
(iii)	ACE Interpretation	Correct calculation of **(i)** ÷ **(ii)** to give answer as an integer. (should be **x** = 2)	1	[3]
(c) (i)	ACE Improvements	Heat to constant **mass** (owtte)	1	
(ii)	ACE Interpretation	An **attempt** to "**scale**" mass loss to the mass of **FA 5** used **or** to calculate **x** separately for the two experiments.	1	
	ACE Conclusion	Uses calculated values to comment sensibly on the consistency the results.	1	[3]
				[Total: 12]
FA 6 is $(NH_4)_2Fe(SO_4)_2(s)$; **FA 7** is $Na_2CO_3(aq)$; **FA 8** is $Pb(NO_3)_2(aq)$; **FA 9** is $K_2CrO_4(aq)$				
3 (a) (i)	MMO Collection	Green precipitate **and** ppt insoluble in excess NaOH**/**ppt turning brown (in air / on standing).	1	
	MMO Decision	(When heated with NaOH) **gas** / NH_3 turns red litmus to blue.	1	
	MMO Collection	(With $BaCl_2$), white precipitate forms **and** insoluble in HCl.	1	
(ii)	ACE Conclusion	**FA 6** contains ammonium ions **and** sulfate ions. *(correct evidence needed for each ion in the observations table).*	1	
(iii)	ACE conclusion	$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$	1	

Question	Sections	Indicative material	Mark	Total
(iv)	MMO collection	**Any two** of • Solid goes paler / loses green colour (at first) **and then** becomes brown (on strong heating) • Condensation / water vapour / steam produced • (Gas/NH_3) turns red litmus blue.	1 1	[7]
(b)	MMO collection	**FA 7 + FA 3** : Fizzing/effervescence **and** limewater goes milky.	1	
		FA 8 + FA 3 and **FA 8 + FA 7** : white precipitate obtained in **both** cases	1	
		FA 9 + FA 3: (solution) turns orange **FA 9 + FA 7**: statement of no change/yellow solution **FA 9 + FA 8**: (bright) yellow precipitate/solid (formed). *All three observations in the third column must be correct.*	1	
	ACE Conclusion	**FA 7** contains carbonate ions (evidence needed) / CO_3^{2-}	1	
		FA 8 contains lead ions **or** barium ions (**or** both) (evidence needed) / Pb^{2+} / Ba^{2+}	1	
		FA 9 contains chromate(VI) ions / CrO_4^{2-}	1	[6]
				[Total: 13]