CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/36 Paper 3 (Advanced Practical Skills 2), 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.

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Question	Sections	Indicative material	Mark	Total
1 (a)	PDO layout	**I** The following data are given • mass of solid used (or both weighings) • volume used in rough titre (or both readings) • initial ***and*** final readings for **two** (or more) accurate titrations	1	
	PDO recording	**II** Acceptable/appropriate headings for **all** data given in weighing ***and*** accurate titration tables ***and*** g and cm^3 units. • mass/weight of beaker (empty) • mass of beaker + **FB 1**/solid • mass solid/**FB1** • initial/start/first (burette) reading/volume • final/end/second (burette) reading/volume • titre ***or*** volume used/added/**FB 5** added *(but not difference or change in volume)* • unit:/cm^3 ***or*** (cm^3) ***or*** in cm^3 ***or*** cm^3 *If g/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 are to the nearest 0.05 cm^3. *The need to record to 0.05 only applies to the burette readings, including 0.00 cm^3 (if this was the initial reading),* *but it does **not** apply to the titre.* *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** 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 further titrations, 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 zero) are given as integers.*	1	
	MMO quality	Examiner calculates mean titre × mass **FB 1** for candidate and Supervisor. Award **V**, **VI** and **VII** if $\delta \leq 2$ (g cm^3) Award **V** and **VI** if $2 < \delta \leq 3$ Award **V**, only, if $3 < \delta \leq 5$. *Spread penalty: if two best titres used by the Examiner are ≥ 0.50 cm^3 apart, cancel one Q mark.*	1 1 1	[7]

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1 (b)	MMO decision	Candidate calculates the mean correctly. Candidate must take the average two (or more) titres where the total spread is ≤ 0.2 cm^3. Working must be shown ***or*** ticks must be put next to the accurate titres selected. The mean should normally be quoted to **2 dp**, rounded to nearest 0.01 cm^3. Example 26.667 cm^3 must be rounded to 26.67 **not** 26.65 cm^3, 26.675 cm^3 must be rounded to 26.68 **not** 26.70 cm^3. Two special cases, where the mean may not be to 2 dp: Allow mean expressed to 3 dp, only for 0.025 or 0.075. Allow mean if expressed 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 wrong – should be 26.05. *Do **not** award this mark if:* • *The rough titre was used to calculate the mean.* • *The candidate did only one 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.* ***Note**: the candidate's mean will sometimes be marked correct even if it is different from the mean calculated by the Examiner for the purpose of assessing accuracy.*	1	[1]
1 (c)	ACE interpretation	**I** Correctly calculates moles of $Na_2S_2O_3$ weighed in **(i)** = $\frac{\text{mass of } \mathbf{FB1} \text{ used}}{248.2}$	1	
		II Correct expression for moles of $Na_2S_2O_3$ used in **(ii)** = $\frac{\text{answer (i)} \times \text{mean titre}}{250}$	1	
		III Correct calculations/expression in **(iii) and (iv)** **(iii) :** no moles of I_2 = 0.5 × **(ii)**	1	
	PDO display	**IV** Correct expression in **(v)** Mass = answer **(iv)** × 40 ×158(.0) *(× 40 may be shown as × 1000/25)*	1	
	PDO display	**V** **All** quoted answers are given to 3 or 4 significant figures. *(minimum of three answers)*	1	[5]

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1 (d)	ACE interpretation	error = 0.05 cm^3 in **(i)** **and** % error in volume of **FB 5** = $\frac{2 \times 0.05}{\text{vol of FB 5 used}}$ × 100 in **(ii)**	1	[1]
				[Total: 14]
2 (a)	MMO collection	**I** The masses of **FB 6** used by the candidate were between 2.0 – 2.4 g (expt 1) ***and*** 2.5 – 2.9 g (expt 2).	1	
	PDO display	**II** Suitable headings for a table or list, shown completely for at least one experiment. If 2 experiments, all headings must be correct. • (mass of) empty crucible • (mass of) crucible + **FB 6** • (mass of) crucible + residue/**FB 6** after heating • mass (water) lost or mass anhydrous remaining **and** unit covering every weighing. *Unit/g or (g) or in grams or g following each weighing.*	1	
	PDO recording	**III** Records **all** balance readings consistently to at least 1 dp *A minimum of **three** weighings are needed.*	1	
	MMO quality	Examiner calculates $\frac{\text{mass of hydrated salt}}{\text{mass of water}}$ for each experiment. Award **IV** if the ratio in expt **1** is between 0.95 and 1.15. Award **V** If the ratio in expt **2** is between 0.95 and 1.15. Award **VI** If the ratio in **both** of experiments **1** and **2** is between 0.85 and 1.25.	1 1 1	[6]
2 (b)	MMO quality	**(i)** An appropriate choice of the more accurate experiment, **and** justification of choice. Three possibilities: • *Experiment 2 uses a larger mass and has a greater **percentage** accuracy.* • *A reference to either experiment "spitting" or "frothing" during heating is a valid reason for nominating the other experiment.* • *Experiment 1 as smaller mass takes less heating.*	1	
	ACE interpretation	**(ii)** Correctly calculates number of moles of water = $\frac{\text{mass of water lost}}{18}$ *Ans to 2–4 sf* *Candidate must use the mass loss for the experiment thought to be more accurate. (If no choice is expressed in **(i)**, this should be expt 2.)*	1	
	ACE conclusion	**(iii)** **M**$SO_4.7H_2O(s) \rightarrow$ **M**$SO_4(s) + 7H_2O(g)$ *Allow (l) for water.*	1	

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	ACE interpretation	**(iv) Correct answer calculated** n(**M**SO_4) = n(water) / 7 i.e. answer **(ii)** divided by 7 *Ans to 2–4 sf*	1	
	ACE interpretation	**(v) Method mark showing the numbers for the expression** Relative formula mass = mass of residue / no of moles *Mass of residue from same expt as mass of water* Ans to 2–4 sf	1	
	ACE interpretation	**(vi) Correct answer calculated** $A_r = M_r - 96.1$. Candidates are allowed to use 126.3 as the M_r. In this case, the A_r = 30.2. *Ans 2–4 sf* *Penalise sf once only within **(b)***	1	
	ACE conclusion	**(vii)** Correct identification of **M** as magnesium **and** explanation that this A_r is closest to value calculated. *Allow alternative identity of metal as ecf from A_r value.*	1	
	ACE conclusion	**(viii)** (**M** is divalent **but**) A*l* and Cr are both trivalent **or** (**M** forms 2+ ion whereas) A*l* and Cr are 3+ **or** sulfates of Cr/A*l* are not $CrSO_4$ and A*l*SO_4 *(ora) ref to both needed*	1	[8]
2 (c)	ACE Improvements	Cool in a desiccator **or** cool in closed container with a (named) drying agent	1	[1]
				[Total: 15]

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FB 6 = $MgSO_4$; **FB 7** is H_2SO_4; **FB 8** is $Pb(NO_3)_2$; **FB 9** = KI

3 (a)	MMO collection	**(i)** White precipitate, insoluble in excess for **both** NaOH **and** NH_3	1	
	MMO decision	**(ii)** Use barium chloride/nitrate ***and*** hydrochloric/nitric acid	1	
	MMO collection	White precipitate formed, insoluble in acid.	1	
	ACE conclusion	**(iii)** $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$	1	[4]
3 (b)	MMO collection	**(i)** One mark for each column	1	
		FB 7 / **FB 8** / **FB 9** **Mg**: Fizzing or tube gets hot/heat given out or Mg dissolves **and** (gas) pops with lighted splint / Black solid/ppt formed/Mg strip turns dark / No reaction **FB 7**: / White ppt / No reaction **FB 8**: / / Yellow ppt	1 1	
	ACE conclusion	**(ii)** **FB 7** is sulfuric acid **and** it is acidic (**or** H^+ ions are present) because it fizzes/hydrogen produced with magnesium.	1	
	MMO collection	**(iii)** Red-brown/brown/orange-brown/yellow-brown colour with KI (not red or orange or yellow) **and** blue or black colour with starch	1	
	ACE conclusion	Iodine produced **and** the anion in **FB 9** is iodide.	1	
	ACE conclusion	**(iv)** PbI_2 *or* AgI (or both) *Ecf possible for CrO_4^{2-} in **(iii)** with Ba^{2+} or Pb^{2+}*	1	[7]
				[Total: 11]

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