UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2009 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/31 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.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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UNIVERSITY of CAMBRIDGE
International Examinations

Supervisor's Report

Calculate, correct to 2 dp, the titre if the Supervisor had diluted 47.25 cm^3 of **FA 2**.

This is given by the expression $\frac{\textbf{47.25}}{\textbf{volume diluted}}$ **x Examiner selected titre**

Candidate scripts

Calculate the scaled titre for 47.25 cm^3 of **FA 2**.
Record the value against the titration table and calculate the difference to Supervisor.

Question	Sections	Indicative material	Mark	
1 (a)	PDO Layout	**(i)** Tabulates initial and final burette readings and volume added in each of the tables. *Do **not** award this mark if any final and initial burette readings are inverted or 50 is used as the initial burette reading.*	1	
	PDO Recording	**(ii)** Both burette readings in the dilution table and final and initial burette readings for all accurate titres in the titration table recorded to the nearest 0.05 cm^3.	1	
	MMO Collection	**(iii)** Follows instructions: dilutes 47.00 cm^3 to 47.50 cm^3 **and** has any two titres within 0.20 cm^3	1	
	MMO Decisions	**(iv)** Has at least two uncorrected "accurate" titres within 0.1 cm^3 *Do **not** include any titre labelled "rough"/"trial" **unless** the candidate has ticked that value or used it in an expression when calculating the average in **(b)**.*	1	
	MMO Quality	**Accuracy (v) and (vi)** Give **(v) and (vi)** if difference to Supervisor is **0.3** or less Give **(vi) only** for a difference of **0.3+ to 0.5** Give **neither mark** for a difference greater than **0.5**.	2	[6]
(b)	ACE Interpretation	Candidate selects/calculates appropriate "average" from any uncorrected titre values within 0.20 cm^3. *Candidate is permitted to use a titre labelled "rough" or "trial".* *Titres to be used **must be shown**.* Where **all** titres are given to 1 decimal place the average should be calculated correct to 1 or 2 decimal places. Where any titre is recorded to 2 decimal places, the average should be calculated to 2 decimal places or rounded to the nearest 0.05 cm^3.	1	[1]

(c)	ACE Interpretation	**(i), (ii) and (iii)** Award three marks if all steps are chemically correct. Withhold 1 mark for each chemical error – no negative marks. Count non-completed steps as chemical errors. step 1 $\frac{\textbf{titre}}{\textbf{1000}} \times \textbf{0.15}$ step 2 $\times \frac{\textbf{1}}{\textbf{2}}$ step 3 $\times$ **2** step 4 $\times \frac{\textbf{1000}}{\textbf{25}}$ step 5 $\times \frac{\textbf{250}}{\textbf{volume diluted}}$ step 6 $\times$ **249.6**	3	
	PDO Display	**(iv)** Working shown in at least three of the 5 steps	1	
		(v) Answers to 3 or 4 significant figures in final answer to each step attempted **(minimum of three steps required)**	1	[5]
(d)	ACE Interpretation	Explains that the maximum error is given by + 0.05 cm^3 on one burette reading and –0.05 cm^3 on the other burette reading, **or** Individual errors are in opposite directions.	1	[1]
(e)	ACE Interpretation	Calculates $\frac{\textbf{0.1}}{\textbf{titre}} \times \textbf{100}$ % Answer must be correct to 2 or 3 decimal places.	1	[1]
				[Total: 14]

Supervisor's Report
From the Supervisor's experimental results **round times to the nearest second** and calculate the average of (volume of sodium thiosulfate x time) for 50 cm^3 and for 25 cm^3 of sodium thiosulfate.

Candidate's scripts
From the candidate's experimental results **round times to the nearest second** and calculate (volume of sodium thiosulfate x time) as above.
Record values of (V x t) on script and use in assessing accuracy marks.

Question	Sections	Indicative material	Mark	
2 (a)	PDO Layout	**(i)** Tabulates all experimental readings: volumes of sodium thiosulfate and water, time and rate ($^1/_t$)	1	
	PDO Recording	**(ii)** Single table covering all three experiments *A single table has no repetition of column headings.*	1	
		(iii) Table has correct labels and units: e.g. /cm^3, /cubic centimetres, **or** (cm^3), (cubic centimetres) **or** volume in cubic centimetres; **Similarly** for time (s or seconds but **not** sec) **and** rate (s^{-1}, rate (in) per second; $^1/_s$ etc.) **At least two different units are required.** *Where units have not been included in the column or row header there should be the appropriate unit for <u>each entry</u> in the table.*	1	
	MMO Collection	**(iv)** All times of reaction are recorded to the nearest second (**no** decimal places).	1	
	MMO Quality	**(v) and (vi)** Give **(v) and (vi)** if difference between candidate's (V x t) values (**50 & 25 cm^3 FA 1)**, is within 5% of the larger value. *Give **(vi) only** if the difference is > 5% but ≤10% of the larger value.*	2	
		(vii) and (viii) Compare the closer of the candidate's (V x t) values with the Supervisor's average Vt. Give **(vii) and (viii)** if difference is within 10% of the <u>Supervisor's value</u>. *Give **(viii) only** if the difference is > 10% but ≤20% of the <u>Supervisor's value</u>.*	2	
	MMO Decisions	**(ix)** Selects (10–15) **or** (35–40) cm^3 sodium thiosulfate and an appropriate volume of water to give a total volume of 50 cm^3 (or 55 cm^3 if the volume of acid is tabulated).	1	[9]

(b)	ACE Interpretation	Candidate shows by calculation or by mathematical expression that $[Na_2S_2O_3] \propto$ volume of $Na_2S_2O_3(aq)$ in 50/55 cm^3 of solution. *Reference to ($^{50}/_{50}$ or $^{50}/_{55}$) and ($^{25}/_{50}$ or $^{25}/_{55}$)*	1	[1]
(c)	ACE Conclusions	Explains that rate is given by the inverse of time **or** is inversely proportional to time; **or** Rate $\propto {}^{1}/_{\text{time}}$ *Allow Rate = $^{1}/_{time}$*	1	[1]
(d)	ACE Interpretation	(i) **Correctly** evaluates all Vt values (using times given by candidate, including decimal places where appropriate – ***or*** (ii) gives an appropriate qualitative statement relating (rate or time) and concentration. *Award this mark if **either** is correct.*	1	
	ACE Conclusions	Gives a quantitative description of relationship. *Vt values are required but do not have to be correctly evaluated.* *Where no pattern is obvious accept an appropriate statement to that effect.*	1	[2]
(e)	ACE Improvements	Explains that volumes of reactants or concentration (of thiosulfate and acid) must be kept constant **and** describes <u>how</u> the temperature will be varied.	1	[1]
				[Total: 14]

Question	Sections	Indicative material	Mark	
FA 5 is K_2CrO_4(aq); FA 6 is $NaNO_2$(aq); FA 7 is $Pb(NO_3)_2$(aq), FA 8 is $MgSO_4$(aq)				
3 (a)	MMO Collection	**(i)** Records no reaction, no change or no precipitate on adding NaOH and NH_3(aq) to **FA 5** and **FA 6**.	1	
		(ii) Records white ppt soluble (in excess NaOH) and white ppt insoluble (in excess NH_3) with **FA 7**	1	
		(iii) Records white ppt insoluble (in excess for both NaOH and NH_3) with **FA 8**	1	
	ACE Conclusion	**(iv)** Conclusion is marked **consequentially** from the observations for a single cation and a pair of cations. *Mg^{2+}/magnesium from white ppt insoluble in an excess of NaOH(aq) and in an excess of NH_3(aq)* *Ca^{2+}/calcium from white ppt insoluble in an excess of NaOH(aq) no ppt in NH_3(aq)* *Pb^{2+}/Al^{3+} from white ppt soluble in an excess of NaOH(aq) and insoluble in an excess of NH_3(aq)* *Ba^{2+}/NH_4^+ from no ppt with NaOH(aq) or NH_3(aq)* **FA 6 only**	1	[4]
(b)	MMO Decisions	(Warms) with NaOH and Al(s) and records appropriate test for ammonia. **<u>Gas</u>** must be tested in at least one test. *This is a mark for the method not the observation.*	1	
	ACE Conclusion	Must have indication that the test has been performed with **FA 6**, **FA 7** and **FA 8**. In awarding the conclusion mark, assume, **in this section only**, that a blank box indicates no reaction (no ammonia detected). Award this mark for any of the following: (i) a conclusion, from correct observations, that **FA 6** and **FA 7** contain nitrate or nitrite (ii) correct observations for NH_3 – only with **FA 6** and **FA 7**, but no conclusion given (iii) a statement that NH_3 is evolved – only with **FA 6** and **FA 7** (iv) observation that red litmus turns blue (gas not needed) – only with **FA 6** and **FA 7**	1	[2]

(c)	MMO Collection	**(i)** Observes a change in colour (from yellow) to yellow/orange or orange (solution), **no ppt**, with **FA 5 and** a white ppt with **FA 7**.	1	
		(ii) Observes a brown gas formed with only **FA 6**.	1	
	ACE Conclusions	**Mark (iii) and (iv) consequentially to observations**		
		(iii) Give this mark for **one** conclusion providing it is supported by an acceptable explanation.	2	
		(iv) Give this mark for **two** further conclusions supported by acceptable explanations.		
		Minimum acceptable supporting evidence: CrO_4^{2-} from yellow soln **or** soln turning orange in acid NO_2^- from brown gas **or** from effervescence/fizzing/bubbling with acid, **if** named soln has yielded ammonia or an alkaline gas in **(b)** NO_3^- no brown gas etc with acid, but ammonia evolved in **(b)** Pb^{2+} white ppt with HC*l* if Pb^{2+} in **(a) (iv)** A*l*$^{3+}$ no white ppt with HC*l* if A*l*$^{3+}$ in **(a) (iv)**		[4]
(d)	MMO Collection	Mixes **FA 5** and **FA 7** and observes a yellow ppt. If this section has not been attempted, the correct <u>observation</u> on mixing **FA 5** and **FA 7** can be carried forward from the conclusions in **(c)**.	1	
	ACE Conclusions	Concludes that **FA 5** contains CrO_4^{2-} and **FA 7** contains Pb^{2+} providing the ions have been previously mentioned in **(a)** or **(c)**.	1	[2]
				[Total: 12]