UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/31 Paper 31 (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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International Examinations

Question 1 Round all thermometer readings to the nearest 0.5°C.

Question	Sections	Indicative material	Mark	
1 (a)	PDO Recording	**(i)** Presents data in single table of results – *to include volume of **FA 2**, initial and final temperatures and temperature change.*	1	
		(ii) All columns correctly labelled with appropriate unit shown. *Must use solidus, brackets or describe unit fully in words. If units not included in column headings every entry must have the correct unit shown.*	1	
	MMO Collection	**(iii)** All thermometer readings recorded to 0.5°C	1	
		(iv) Follows instructions – uses 10, 20, 30, 40, 50 cm^3 of **FA 2** + two additional volumes	1	
	MMO Decisions	**(v)** One extra volume of **FA 2** on either side of the maximum for the first five expts. **or** Two extra volumes between identical values for the first five expts. **or** Two extra volumes the same side as the next highest reading.	1	
	MMO Quality	**(vi)** and **(vii)** Check and correct ΔT where necessary. *(If multiple readings for max. T then apply hierarchy: take value of consistent readings; take average and correct to nearest 0.5°C)* Compare temp rise with that obtained by the Supervisor *(Expected value is 14.0°C)* For 30 cm^3 **FA 2**: Award **(vi)** and **(vii)** for a temp rise of 0.0°, 0.5°, 1.0°C *Award **(vi) only** for a difference of 1.5°C*	2	
	MMO Quality	**(viii)** and **(ix)** Check and correct ΔT where necessary. Compare temp rise with that obtained by the Supervisor *(Expected value is 13.5°C)* For 40 cm^3 **FA 2**: Award **(viii)** and **(ix)** for a temp rise of 0.0°, 0.5°, 1.0°C *Award **(viii) only** for a difference of 1.5°C*	2	[9]

Question	Sections	Indicative material	Mark	
(b)	PDO Layout	**(i)** Temperature (rise) plotted on *y-axis* against volume (of **FA 2**) **or FA 2** added /cm^3 on *x-axis*. Clearly labelled axes (ignore units unless T, ΔT or V used as labels)	1	
		(ii) Uniform and sensible scales that allow points to be plotted in at least half of the squares on each axis. (6 × 4 big squares). (0,0) may be considered – as an additional point or with a line going through it	1	
		(iii) Visual check the "sweep" of **all** points, for all experiments recorded. Check the plotting of points for 10, 30 and 50 cm^3 of **FA 2** (and any other "suspect" point) If any point is missing **and** that experiment was not carried out, check adjacent point *Points should be within ½ of a small square, in the correct square* **Do not award if T plotted instead of ΔT**	1	
		(iv) Appropriate lines drawn through the ascending and descending points. *(Ignore any deviation through rounding at the maximum temperature rise)* **Do not award** if both straight lines and curves drawn **or** there is any forced change in gradient.	1	[4]
(c)	ACE Interpretation	Reads from the graph *(to within ½ small square)* the volume of **FA 2** at the **intersection** of two lines. Allow rounding to the closest cm^3 ***Do not award this mark if the lines/curves have been rounded at the maximum ΔT.***	1	[1]
(d)	PDO Layout	Explains that the **temperature rise** is the dependent variable **or** **Volume of FA 2** is the independent variable/one that is controlled/one that you vary *(or words to that effect)*	1	[1]
(e)	ACE Conclusion	Gives correct equation for the reaction *(ignore state symbols)* $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ **or** $NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$	1	[1]
(f)	PDO Display	Working is shown in **(f)(i)** (involves volumes and concentration, 2.0 mol dm^{-3}) **and (f)(ii)** *(any clear mole ratio)*	1	
	ACE Interpretation	Has correct expression for $\frac{10.00}{1000} \times 2.0$ **or** an answer of **0.02(00)** in **(f)(i) and 0.04(00)** in **(f)(ii)** *There is no ecf within **(f)***	1	[2]
(g)	PDO Display	Expression given in the question paper is **correctly** evaluated to 2 or 3 significant figures. *Allow a volume, read from rounded curves to be used in this expression. Normal rounding rules apply to the sig fig.*	1	[1]

Question	Sections	Indicative material	Mark	
(h)	ACE Interpretation	Uses the expression: (answer from **(c)** + 10) × 4.3 × ΔT read from graph Divides the answer above by answer to **(f)(i) and** gives answer in kJ mol^{-1} with –ve sign *Do not award this second mark unless candidate has calculated (a volume of soln × 4.3 × ΔT)*	1 1	[2]
(i)	ACE Improvements	Advantage of burette: Lower % error **or** more accurately calibrated *(must refer to or infer scale/graduations/markings/divisions)* Disadvantage of burette: Takes longer to add the **FA 2**	1 1	[2]
(j)	ACE Interpretation	Candidate gives **two** of the following as significant sources of error. Heat loss (to the surroundings) Thermometer graduated at 1°C intervals Drying of cup/thermometer Initial temps of both solutions should be taken *Other acceptable sources of error may be seen.*	1	[1]
(k)	ACE Interpretation	**(i)** Maximum error in reading a 1°C graduated thermometer is given as 0.5°C **(iii)** Calculates answer in $\frac{\text{answer in (k)(i)} \times 2}{\text{answer in (k)(ii)}} \times 100\%$	1 1	[2]
	Total			**[26]**

Question 2

Question	Sections	Indicative material	Mark	
FA 3 is $BaCl_2$(aq); **FA 4** is $MgBr_2$(aq) *[$MgCl_2$ + NaBr]*; **FA 5** is CaI_2(aq) *[$CaCl_2$ + NaI]*; **FA 6** is K_2CrO_4(aq)				
2 (a)	MMO Decisions	Chooses silver nitrate/Ag^+(aq)/solution containing Ag^+ ions followed by (aqueous) ammonia.	1	[1]
(b)	PDO Recording	Results for three solutions and the two reagents from **(a)** (or three reagents if **(a)**: 'Ag^++ NH_3', Pb^{2+}) if recorded in a single table *(no repetition of solutions or reagents)*	1	
	MMO Collection	Give one mark for correct observations with **FA 3**, **FA 4** and **FA 5**. **FA 3** – white ppt with Ag^+, soluble in NH3(aq) **FA 4** – cream ppt with Ag^+, partially soluble or insoluble in NH_3(aq) (allow "creamy" not "creamy white") **FA 5** – yellow ppt with Ag^+, insoluble in NH_3(aq) If Ag^+ and Pb^{2+} in **(a)**, all observations must be correct (ignore any 'extra' NH_3 if not in **(a)**) (Pb^{2+}: white, white, yellow ppts respectively)	1	[2]
(c)	ACE Conclusion	Mark consequentially on observations in **(b)** Expected conclusion Identifies **FA 3** as solution containing Cl^- from "white ppt with Ag^+ (soluble in NH_3(aq)) given as evidence. *Mark consequentially – ecf allowed here.* *(No retrospective to observations)*	1	[1]
(d)	MMO Collection	Mark each of the boxes and see whether correct columns or rows give the better mark. Award the better mark. See table below for the expected observations	1 1 1	[3]

	FA 3	FA 4	FA 5
+ NaOH(aq)	**ignore**	white ppt	white ppt **or** "cloudiness"
+ NH_3(aq)	no ppt *(allow reference to "cloudiness"/"slight white ppt")*	white ppt	no ppt/no change/ no reaction
+ **FA 6**	yellow ppt	no ppt/no change/ no reaction/yellow soln	no ppt/no change/ no reaction/yellow soln

(e)	MMO Collection	Records (yellow) <u>solution turning orange</u> (*or wtte*, e.g. orange solution forms)	1	[1]
(f)	ACE Conclusions	Mark consequentially on observations in **(d)** and **(e)** Expected conclusions: Anion in **FA 6** is chromate, CrO_4^{2-}, from yellow soln turning orange in **(e)** or yellow ppt with **FA 3** in **(d)** *provided **FA 3** not also identified from **(d)*** **<u>and</u>** **FA 3** contains Ba^{2+} from observations with NaOH and NH_3 (or just NaOH if obs with **FA 4** and **FA 5** are correct with it) or **FA 6** in **(d)**	1	[1]
FA 7 is a tertiary alcohol; **FA 8** is an aldehyde; **FA 9** is a ketone; **FA 10** is a primary alcohol				
(g)	MMO Collection	One mark for two correct observations with **FA 7** One mark for correct observations with **FA 8** and **FA 9** One mark for two correct observations with **FA 10** See table below for expected observations	1 1 1	[3]

reagent	**observations**			
	FA 7	**FA 8**	**FA 9**	**FA 10**
acidified dichromate	no reaction		no reaction	(colour change to) green/blue-green/ cyan/turquoise (solution **not** ppt)
2,4-DNPH	~~no reaction~~	~~yellow ppt~~	~~yellow ppt~~	
Tollens' reagent	no reaction	silver mirror **or** black/grey solution or ppt		no reaction

(h)	ACE Conclusions	**No ecf from (g)** **FA 7** contains the tertiary alcohol from <u>no reaction with all three reagents</u> **or** <u>no reaction</u> with dichromate **and** 2,4-DNPH **provided** there is no CON in the observation with Tollens' **FA 8** contains the aldehyde from the silver (mirror), black or grey precipitate or solution with ammoniacal silver nitrate Allow from brown ppt if it is the only positive result with Tollens'.	1 1	[2]
	Total			**[14]**