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

9701/31 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 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** In the correct spaces, records Initial and final burette readings for Rough titre **and**; Initial and final burette readings **and**, volume of **FB 2** added recorded for each accurate titre *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** 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 or of the first two titres has also been carried out.*	1	
	PDO Recording	**IV** All accurate burette readings (initial and final) recorded to nearest 0.05 cm^3. *Assessed 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 0.10 cm^3 etc. Award **V**, **VI** and **VII** for a difference to Supervisor within 0.20 cm^3 Award **V** and **VI** only for a difference of 0.20+ cm^3 – 0.40 cm^3 Award **V** only for a difference of 0.40+ cm^3 - 0.80 cm^3 *If the selected "best" titres are > 0.50 cm^3 apart, cancel one of the Q marks awarded.*	3	[7]

(b)	ACE Interpretation	Calculates the mean, correct to 2 decimal places (third decimal place maybe rounded to the nearest 0.05 cm^3) from any accurate titres within 0.20 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 (✗)* *Mean of 24.3 and 24.5 = 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)		**No additional factor/expression is allowed in any step** *If an answer, with no working, is given in any section allow if correct.*	1	
	ACE Interpretation	**I** Uses $^{15.0}/_{248.2}$ only in step **(i)** *If no working shown accept only the following evaluated answers:* *(0.060, 0.0604 or 0.06044)*		
		II Uses **answer (i)** × $^{\text{cand average titre}}/_{1000}$ in step **(ii)** and **answer (iv)** × $^{1000}/_{25}$ in step **(v)**	1 1	
		III Uses **answer (ii)** × ½ in step **(iii)**, and **answer (iii)** × 2 in step **(iv)**	1	
	PDO Display	**IV** Appropriate working shown in a minimum of **three** sections. To include equations as steps for the working mark; *In **(iii)** must see **x2** or **x0.5**.* *In **(iv)** must see **multiplication or division** by **6**, **1.2** or **2**.* *1:6 for $IO_3^-/6H^+$,* *1:1.2 for $5I^-/6H^+$,* *1:2 for $6H^+/3I_2$*	1	
		V 3 to 5 significant figures in final answers to <u>all sections attempted</u> – *minimum of **three** final answers required to qualify for the award of this mark.*	1	[5]

(d)	ACE Interpretation	Gives 0.1(0) cm^3 as the maximum error in **(i)**. *Ignore any sign* **and** the expression $^{0.1}/_{\text{cand titre in (b)}} \times 100$ in **(ii)** Evaluates $^{0.06}/_{25.0} \times 100$ in step **(iii)** *Accept only 0.240 or 0.24,* ***or*** *rounded to 0.2* ***provided*** *0.24 has been seen in the working.*	1 1	[2]
				[Total: 15]

2	**(a)**	PDO Layout	**I**	Records at least **four** different balance readings and at least one mass of solid/gas *Accept 0.0(0X) g as the mass of the empty tube or a statement that the tube is tared.*	1	
		PDO Recording	**II**	Gives all appropriate headings and units when recording results. *Do **not** accept mass of empty tube as 0.0(00)g here unless tube is described as tared.* *(minimum of three pieces of information)*	1	
			III	All recorded balance readings consistent to at least 1 decimal place. *(minimum of **three** balance readings)*	1	
		MMO Decisions	**IV**	Evidence of reheating to "constant" mass. For balances reading to 1 d.p. two masses must be identical For 2 or 3 d.p.balances, two masses must be within 0.05 g	1	
		MMO Quality	**V and VI**	Check and correct all subtractions in the results table. Calculate $\frac{\text{mass heated}}{\text{mass of residue}}$ to 3 significant figures. Compare to **Supervisor standard or standard value of 1.45**. Award **V and VI** for a difference up to 0.15 Award **V only** for a difference of 0.15+ to 0.30 *Where a candidate repeats the experiment use cumulative masses of **FA 3** and residue.* *Where masses of **FA 3** and residue cannot be checked, accept candidate values to calculate the ratio.*	2	[6]
	(b)	ACE Interpretation		Evaluates $\frac{\text{cand mass loss from (a)}}{\text{cand mass of FA 3}}$ correct to 2–4 significant figures. *Where mass loss or mass of **FA 3** is not given in **(a)**, check, from balance readings, the values.* *A candidate who incorrectly describes the mass of the residue as the mass loss in tabulated results in **(a)** may "correct" the error and use the correct mass loss here.*	1	[1]

(c)	ACE Conclusions	Uses M_r (values) of CO_2 or H_2O to justify how the ratio of $CuCO_3$ to $Cu(OH)_2$ affects the mass loss. If % loss is too high – more $CuCO_3$ If % loss is too low – more $Cu(OH)_2$	1	[1]
(d)	ACE Improvements	Draws apparatus showing the collection of carbon dioxide in a syringe or in a burette or measuring cylinder inverted over water. *Allow use of an inverted tube if graduations are shown or it is suitably labelled.* *All apparatus should be recognisable from the drawing or appropriately labelled.* Shows, in the diagram, an effective method of removing water vapour. *Named reagent; e.g. (concentrated H_2SO_4, $CaCl_2$, silica gel, (CaO), anhydrous $CuSO_4$.* **or** *stated purpose of an un-named reagent given.* *Allow also a suitable reflux arrangement, returning water to the heated tube.* ***or*** *a **statement** that water vapour condenses in a water bath. Do **not** accept a diagram showing the gas bubbling through water without some written indication that the water is a condenser.*	1 1	[2]
				[Total: 10]

FA 4 is $Al_2(SO_4)_3$(aq); **FA 5** is $ZnSO_4$(aq); **FA 6** is $Pb(NO_3)_2$(aq); **FA 7** is $MgSO_4$(aq)				
3 (a)	MMO Collection	1 mark for correct observations in **each** of the vertical columns. **or** 1 mark for correct observations in **each** of the horizontal rows **(i)**, **(ii)** and **(iii)**. **3 mark maximum** ***Mark the section by the method which gives the better mark.***	4	[4]

test		*observations*			
		FA 4	**FA 5**	**FA 6**	**FA 7**
(i)	addition of NaOH	white ppt	white ppt	white ppt	white ppt
	further addition of NaOH	ppt soluble	ppt soluble	ppt soluble	ppt insoluble
(ii)	addition of NH_3	white ppt	white ppt	white ppt	white ppt
	further addition of NH_3	ppt insoluble	ppt soluble	ppt insoluble	ppt insoluble
(iii)	addition of KI	no ppt, no reaction, colourless or yellow solution	no ppt, no reaction, colourless or yellow solution	yellow ppt	no ppt, no reaction, colourless or yellow solution

Minimum evidence required in observations for the ion identity marks **I, II and III** in **(b)**

In some cases, identification may be allowed from incomplete observations. There must, however, be no observations that are contrary to those expected with any "correctly" identified ion.

The same criteria will be applied to "candidate's supporting evidence in awarding mark **IV**. Candidates are not permitted to introduce (from the Qualitative Analysis Notes) supporting evidence that is not given in the observations. Precipitate colour need not be mentioned in supporting evidence.

Al^{3+}	(white) precipitate, soluble in (excess) NaOH, if yellow ppt with KI
Zn^{2+}	(white) precipitate, soluble in (excess) NH_3(aq)
Pb^{2+}	Yellow precipitate with KI
Mg^{2+}	(white) precipitate, insoluble in (excess) NaOH

FA 4 is $Al_2(SO_4)_3(aq)$; **FA 5** is $ZnSO_4(aq)$; **FA 6** is $Pb(NO_3)_2(aq)$; **FA 7** is $MgSO_4(aq)$				
(b)		**Do not accept any ion other than Al^{3+}, Zn^{2+}, Pb^{2+} or Mg^{2+} in any section.** **Marks I to III** **Ions must be correct, including charge, if a symbol has been given. – <u>no ecf in this section</u>.**	1	
	ACE Conclusions	Award **<u>I only</u>** if **one ion only** is identified from correct observations.	1	
		Award **<u>I and II</u>** if **two ions only** are identified from correct observations.	1	
		Award **<u>I, II and III</u>** if **all four cations** are identified from correct observations. *The 4th cation may be identified by elimination from incomplete supporting evidence.*	1	
		Award mark **<u>IV</u>** if the supporting evidence fits the ion identified and the practical performed for at least three of the four ions. Allow ecf on ion order on mark **<u>IV</u>**.	1	[4]
(c)	MMO Decisions	Selects sodium or potassium chromate(VI), sulfuric acid or hydrochloric acid soln containing one of the following named ions or formula given followed by (aq): CrO_4^{2-}, SO_4^{2-}, Cl^-, Br^- but **not** I^-, soln containing CrO_4^{2-} ions, H_2SO_4, HCl,		[1]

FA 8 is $CuSO_4(aq)$				
(d)	MMO Collection	**I** Records blue colour of solution fading/disappearing on adding zinc powder in **(i)** *If no reaction with Zn(s) is reported **do not allow** blue to light blue solution.*	1	
		II Records a temperature rise in **(i)** *Accept reaction is exothermic/produces heat*	1	
		III Records a red-brown, orange-brown, brown or black solid in **(i)**	1	
		IV Observes a green, lime green, fluorescent green or yellow-green **solution** in **(ii)**	1	
		V Observes **solution** turning blue, **or** blue solution in **(iii)** if solution green in **(ii)** **or** solution going towards blue in colour on adding water in **(iii)** If **solution** is not mentioned in **(ii)** or **(iii)** but colours are correct – award point **V only**.	1	[5]
(e)	ACE Conclusions	Completes the equation: $\rightarrow$ Cu(s) + Zn^{2+}(aq) State symbols required	1	[1]
				[Total: 15]