UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9701 CHEMISTRY

9701/52 Paper 52 (Planning, Analysis and Evaluation), maximum raw mark 30

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.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Predicts that all strong acids should have a constant ΔH_{neut}. Any attempt at 'grading' is incorrect. Explains that ΔH_{neut} for a weak acid should be less exothermic (ΔH is more positive or less negative) than a strong acid because some of the energy is absorbed in dissociation into ions.	[1] [1]
(b)	PLAN Problem	**(i)** Nature of the acid as independent variable (not concentration). **(ii)** Temperature (ignore increase/decrease) / enthalpy change / heat exchange as dependent variable.	[1] [1]
(c)	PLAN Methods PLAN Problem	The diagram and/or the statements give **(i)** an insulated container or a lid used in an insulating context and the thermometer bulb in or touching the liquid **(ii)** constant volume/constant volume of acid mentioned/constant amount (ignore all the rest).	[1] [1]
(d)	PLAN Methods	**(i)** Moles of all monobasic acids must be $<$ 6 x 10^{-2} mol. (constant volume needed) **(ii)** [dibasic acids] = ½ [monobasic acids] These marks should be treated as separate.	[1] [1]
(e)	PLAN Methods	**(i)** Calculates the mass needed 31.5 g of $(CO_2H)_2.2H_2O$ for 1M solution or 63.0 g for 2M solution. (or in proportion to the tabled information) **(ii)** Solid dissolved in $<$ 250 cm^3 of distilled water (in beaker) and transferred to flask along with the rinsings. **(iii)** Volume made up to 250 cm^3. **(iv)** Inversion/shaking/swirling of flask to mix the <u>solution</u>.	[1] [1] [1] [1]
(f)	PLAN Methods	Shows the correct numerator $$\frac{\textbf{(vol of HC}l + \textbf{vol of NaOH)} \times \textbf{temp rise} \times \textbf{4.3}}{\textbf{moles of HC}l}$$ shows the correct denominator *numbers should be given for the volumes and moles of HCl*	[1] [1]
(h)	PLAN Methods	Use of gloves / protective clothing / eye or face protection / goggles suggested (anything relevant).	[1]
Qn 1	**Total**		**[15]**

2 (a)	ACE Data	Correctly completes $(M_r)^2$ to 3 sig fig and $\sqrt{M_r}$ column to 4 sig. fig. except the square of 2 which should be accepted as 4. *See appendix*	[1]
(b)	ACE Data ACE Data	Selects horizontal scales for all three graphs such that the plotted points cover at least half the graph (the first two graphs need to be of an appropriate curved shape, any line negates this mark). Check 'visually' that the points for $\sqrt{M_r}$ graph are on a diagonal straight line) (allow plotting errors up to one small square). Draws straight line through points and origin for $\sqrt{M_r}$ graph. If the line stops short of the origin do not award the third mark.	[1] [1] [1]
(c)	ACE Conclusions	Effusion time has a proportional relationship/is directly related to the M_r *(This is a soft mark – directly proportional not required) (give this mark even if subsequently the effusion time is stated as proportional to M_r rather than $\sqrt{M_r}$ or is stated as such initially.)* Reference to directly proportional **or** effusion time $\propto \sqrt{M_r}$ <u>gains both marks</u>.	[1] [1]
(d)	ACE Evaluation	Non-dry gas would also contain **water <u>vapour</u>**.	[1]
(e)	ACE Evaluation	Damp hydrogen would have a longer effusion time as M_r of H_2O greater than M_r of H_2.	[1]
Qn 2	**Total**		**[8]**
3 (a)	ACE Data	Correctly calculates the mass of copper and the mass of oxygen in each sample. *Allow up to 2 computational/s.f. errors across both columns without penalty.* ***All masses must be shown to 2 decimal places.*** Correctly calculates the ratio: (ignore s.f. errors) $^{\text{mass of copper}}/_{\text{mass of oxygen}}$ for each sample. Allow one computational/s.f. error. Apply ecf if necessary. Calculations must be to 2 decimal places. ***See appendix***	[1] [1]
(b)	ACE Evaluation	Explains <u>either</u> anomaly. Student 1 – (ratio of Cu/O is too <u>low</u>) – powder carried away in stream of hydrogen. Student 4 - (ratio of Cu/O is too <u>high</u>) – incomplete reduction/reoxidation. Only award this mark if students 1 and 4 are selected correctly.	[1]

(c)	ACE Evaluation ACE Data	Omits the results of students 1 and 4 (or the declared anomalies) from those used to obtain the mean/average. Calculates a mean for remaining values. *Mark ecf for any values selected by the candidate – see appendix.*	[1] [1]
(d)	ACE Data ACE Conclusion	Uses answer to **(c)** to correctly calculate molar ratio/calculates combining moles. Accept any answer from **(c)**. Calculates a formula compatible with calculation. *Must be integral values for Cu and O*	[1] [1]
Qn 3	**Total**		**[7]**

Appendix

2 (a)

		M_r	effusion time / s	$(M_r)^2$	$\sqrt{M_r}$
				3 sig fig	4 sig fig
hydrogen	H_2	2	19	**4.00**	**1.414**
oxygen	O_2	32	76	**1020**	**5.657**
carbon dioxide	CO_2	44	89	**1940**	**6.633**
butane	C_4H_{10}	58	102	**3360**	**7.616**
chlorine	Cl_2	71	113	**5040**	**8.426**

Allow 3 dp here

3 (a)

student	mass of boat / g	mass of boat + oxide / g	mass of boat + copper / g	**mass of copper / g**	**mass of oxygen / g**	**Mass ratio Cu/O / g**	mass of oxide / g
1	5.55	7.71	7.11	**1.56**	**0.60**	**2.600**	2.16
2	5.18	8.07	7.49	**2.31**	**0.58**	**3.983**	2.89
3	5.17	10.05	9.07	**3.90**	**0.98**	**3.980**	4.88
4	5.39	10.91	10.06	**4.67**	**0.85**	**5.494**	5.52
5	5.46	11.64	10.40	**4.94**	**1.24**	**3.984**	6.18
6	4.99	12.02	10.61	**5.62**	**1.41**	**3.986**	7.03

Av 4.81.

3 (c) Mean/Average for ratio Cu/O – omitting the following results

	Mass ratio Cu/O	**Mole Cu / 1 mol O**
Student 1 and Student 4	**3.983**	**1.004**
Student 1 only	**4.285**	**1.080**
Student 4 only	**3.707**	**0.934**
None	**4.005**	**1.009**