

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**

**9701/52**

**9701 CHEMISTRY**

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.

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

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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. <i>See appendix</i>	[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 $M_r$ <i>(This is a soft mark – directly proportional not required) (give this mark even if subsequently the effusion time is stated as proportional to <math>M_r</math> rather than <math>\sqrt{M_r}</math> or is stated as such initially.)</i> Reference to directly proportional <b>or</b> effusion time $\propto \sqrt{M_r}$ <u>gains both marks</u> .	[1] [1]
	(d)	ACE Evaluation	Non-dry gas would also contain <b>water vapour</b> .	[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]
<b>Qn 2</b>	<b>Total</b>			<b>[8]</b>
3	(a)	ACE Data	Correctly calculates the mass of copper and the mass of oxygen in each sample. <i>Allow up to 2 computational/s.f. errors across both columns without penalty.</i> <b>All masses must be shown to 2 decimal places.</b> Correctly calculates the ratio: (ignore s.f. errors) $\frac{\text{mass of copper}}{\text{mass of oxygen}}$ for each sample. Allow one computational/s.f. error. Apply ecf if necessary. Calculations must be to 2 decimal places. <b>See appendix</b>	[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]

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

## Appendix

### 2 (a)

		$M_r$	effusion time / s	$(M_r)^2$	$\sqrt{M_r}$
				<b>3 sig fig</b>	<b>4 sig fig</b>
hydrogen	H <sub>2</sub>	2	19	<b>4.00</b>	<b>1.414</b>
oxygen	O <sub>2</sub>	32	76	<b>1020</b>	<b>5.657</b>
carbon dioxide	CO <sub>2</sub>	44	89	<b>1940</b>	<b>6.633</b>
butane	C <sub>4</sub> H <sub>10</sub>	58	102	<b>3360</b>	<b>7.616</b>
chlorine	Cl <sub>2</sub>	71	113	<b>5040</b>	<b>8.426</b>

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	<u>1.56</u>	0.60	<b>2.600</b>	2.16
2	5.18	8.07	7.49	<u>2.31</u>	0.58	<b>3.983</b>	2.89
3	5.17	10.05	9.07	<u>3.90</u>	0.98	<b>3.980</b>	4.88
4	5.39	10.91	10.06	<u>4.67</u>	0.85	<b>5.494</b>	5.52
5	5.46	11.64	10.40	<u>4.94</u>	1.24	<b>3.984</b>	6.18
6	4.99	12.02	10.61	<u>5.62</u>	1.41	<b>3.986</b>	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
<b>Student 1 <u>and</u> Student 4</b>	<b>3.983</b>	<b>1.004</b>
<b>Student 1 <u>only</u></b>	<b>4.285</b>	<b>1.080</b>
<b>Student 4 <u>only</u></b>	<b>3.707</b>	<b>0.934</b>
<b>None</b>	<b>4.005</b>	<b>1.009</b>