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

9701/51 Paper 5 (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.

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Question	Sections	Indicative material	Mark
1 (a)	PLAN Methods PLAN Problem	Selects a volume of 3 mol dm ^{3} NaOH between 10 and 80 cm^{3}. Calculates the volume of 2 mol dm ^{3} H_2SO_4 that reacts with the volume of NaOH given. Ignore decimal places or significant figures. (ecf from **(a)** and accept 0.75x). Sketches a graph showing increasing temperature, reaching a maximum, then decreasing (or staying on plateau). AND indicating the neutralisation point at the maximum or the volume calculated above, Accept straight lines or curves with a maximum.	[1] [1] [1]
(b)	PLAN Problem	**(i)** volume of acid. **(ii)** temperature / temperature increase / temperature change. **(iii)** heat loss (given as being controlled) / use of same cup / apparatus. or same initial temperatures of both start solutions.	[1] [1] [1]
(c)	PLAN Methods	Burette / pipette to add acid.	[1]
(d)	PLAN Methods	The acid is added in successive volume portions (not dropwise). or adding the calculated acid volume in **(a)** slowly or gradually.	[1]
(e)	PLAN Methods	Risks or hazards identified **(i)** <u>apparatus</u> unstable (chemical spills on persons) or getting very hot / high heat / burns. Do not accept just temperature increase. Melting plastic is neutral. Do not accept irritant / harmful or itching or damage to clothing. **(ii)** NaOH is corrosive / burns / damage to skin. BOTH needed for mark. Do not accept burns twice.	[1]
(f)	PLAN Methods	Mark here is dependent on correct responses in **(e)**. BOTH needed for mark. **(i)** plastic cup put in beaker / clamp for stability or appropriate handling of hot plastic cup. **(ii)** **two of**: gloves, face shield / goggles or lab coat in handling corrosive liquid. *Where only 1 risk and the associated way of minimising that risk are given – award one mark maximum for **(e)** and **(f)***	[1]

(g)	PLAN Methods	**EITHER** A column for volume of acid added (in portions) with units and provision for an initial temperature at 0 cm^3 acid, or a separate statement of initial temperature or a separate column of initial temperature. WITH Columns for temperature and temperature change, both with units. **OR** Table indicates in some way multiple repeats of the same experiment. Must have a statement or column of acid volume. WITH Column for initial temperature, final temperature and temperature change, all with units. Only penalise unit error once.	[1] [1] **OR** [1] [1]
(h)	PLAN Methods	(vol/mass NaOH + vol/mass H_2SO_4) × 4.3 × ΔT Added numerical values from **(a)** are required. Units not required. Conversion to kJ may be here.	[1]
(i)	PLAN Methods	Divides answer to **(h)** by moles of NaOH or water. Use of "n" or "moles" allowed if related to NaOH / H_2O Allow moles of H_2SO_4 only if 2 × moles H_2SO_4 used or 2 × value of moles H_2SO_4 from part **(a)**. Converts J to kJ in **(h)** or **(i)** AND gives –ve sign for an exothermic reaction. If values are used, calculations must be correct.	[1] [1]
	Total		**[15]**

2 (a)	ACE Evaluation	Accept anomalous values 90.6 / 97.8 only. Accept these indicated in the table. *(Column 2 at 60% and column 4 at 100%)*	[1]
(b)	ACE Data	Correctly calculates the % composition for each mixture. Ignore d.p. or s.f. Correctly calculates a mean boiling temperature for each mixture. Also accept if any / all anomalies are included. Values to at least 1 decimal place. *(See appendix)*	[1] [1]
(c)	ACE Data	Selects suitable scales for both graphs (at least half grid and linear, axes to be labelled). Check points for both graphs. *All points to be plotted within ½ small square in either direction* Draws straight line through points for the alcohols graph and suitable curve for ethanol / cyclohexane. If points are incorrectly plotted these may become 'lines of best fit'. For the second plot accept a line that includes the 50% point or runs smoothly below it. Mark the 3 points on each graph and award marks All 6 points correct max 3 marks 4, 5 points correct max 2 marks 2, 3 points correct max 1 mark	[1] [1] [1]
(d)	ACE Conclusions	Endothermic AND More energy required to break intermolecular forces than is released by making new ones. OR Solution has fewer / weaker intermolecular forces. OR Solution has lower boiling-point (than expected) OR Solution is a more volatile liquid. OR Reduced forces holding molecules together. Accept bonds between molecules, but not bonds alone. Bonds alone is neutral (no CON). Refers correctly to hydrogen bonds in ethanol and Van der Waals forces in cyclohexane. (Van der Waals forces in ethanol neutral). Refers to Van der Waals forces only between cyclohexane and ethanol in the mixture. Accept induced dipole / dipole. Not induced (single) dipole.	[1] [1] [1]
	Total		**[9]**

3 (a)	ACE Data	Correctly computes (to a minimum of 2 decimal places) the table values for student 1, student 4 and student 7. *See appendix*	[1]
(b)	ACE Data	Correctly reads from the graph (to within ½ small square) the mass of magnesium and corresponding mass of MgO for any point on the printed line.	[1]
(c)	ACE Data	Shows by calculation that the coordinates do fit the formula of MgO. Evidence of two mole calculations needed. These could be the calculation of two mole values or the calculation of a theoretical mass from moles. A mole ratio that fits the formula of MgO OR the comparison of a theoretical mass with that measured from the plot, OR calculation of an M_r that fits MgO. Accept 1sf+ in mole values. Candidate may find any of the following ratios: Mg:O; Mg:MgO; MgO:O	[1]
(d)	ACE Evaluation	(The mass of MgO is too low for the mass of magnesium taken). There needs to be a reason as to why the mass is low. Suggests that there has been loss of magnesium oxide as smoke or some has escaped with the lid off. Do not accept just "MgO too low or lost or spilled" OR Not all of the Mg has reacted.	[1]
(e)	ACE Evaluation	Suggests the crucible lid has been omitted when weighing the magnesium oxide, OR different lid. Not loss of oxide since end mass < start mass.	[1]
(f)	ACE Evaluation	Magnesium must have reacted with nitrogen. Accept forms magnesium nitride.	[1]
	Total		**[6]**

Appendix

2 (a)

volume / cm^3		temperature of boiling mixture / °C				**% (by volume) of propan-1-ol in mixture**	**mean boiling temperature / °C**
propan-1-ol	propan-2-ol	1	2	3	4		
0	20.00	82.1	82.6	82.7	82.2	**0**	**82.4**
4.00	16.00	85.3	85.4	85.5	85.4	**20.0**	**85.4**
8.00	12.00	88.5	88.4	88.1	88.2	**40.0**	**88.3**
12.00	8.00	91.3	90.6	91.2	91.4	**60.0**	**91.3 (91.125)**
16.00	4.00	94.2	94.0	94.3	94.3	**80.0**	**94.2**
20.00	0	97.1	97.3	97.2	97.8	**100.0**	**97.2 (97.35)**

Shaded cells are those most likely to be omitted when calculating mean.

3 (a)

student	mass of crucible and lid / g	mass of crucible and lid + magnesium / g	mass of crucible and lid + magnesium oxide / g	mass of magnesium / g	mass of magnesium oxide / g
1	25.37	26.62	27.50	**1.25**	**2.13**
2	25.18	27.01	28.19	1.83	3.01
3	25.44	27.73	29.19	2.29	3.75
4	25.26	27.71	24.96	**2.45**	**–0.30**
5	25.39	28.11	29.84	2.72	4.45
6	25.04	27.89	28.54	2.85	3.50
7	25.13	28.08	29.93	**2.95**	**4.80**