

**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

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	GCE AS/A LEVEL – May/June 2010	9701	51

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 .	[1]
		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).	[1]
		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]
(b)	PLAN Problem	(i) volume of acid.	[1]
		(ii) temperature / temperature increase / temperature change.	[1]
		(iii) heat loss (given as being controlled) / use of same cup / apparatus. or same initial temperatures of both start solutions.	[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. <i>Where only 1 risk and the associated way of minimising that risk are given – award one mark maximum for (e) and (f)</i>	[1]

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(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.	[1]
		WITH Columns for temperature and temperature change, both with units.	[1]
		OR Table indicates in some way multiple repeats of the same experiment. Must have a statement or column of acid volume.	OR [1]
		WITH Column for initial temperature, final temperature and temperature change, all with units. Only penalise unit error once.	[1]
(h)	PLAN Methods	$(\text{vol/mass NaOH} + \text{vol/mass H}_2\text{SO}_4) \times 4.3 \times \Delta T$ 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 ₂ O Allow moles of H ₂ SO ₄ only if 2 × moles H ₂ SO ₄ used or 2 × value of moles H ₂ SO 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]

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	GCE AS/A LEVEL – May/June 2010	9701	51

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.	[1]
		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]
(c)	ACE Data	Selects suitable scales for both graphs (at least half grid and linear, axes to be labelled).	[1]
		Check points for both graphs. <i>All points to be plotted within ½ small square in either direction</i>	[1]
		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.	[1]
		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	
(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).	[1]
		Refers correctly to hydrogen bonds in ethanol and Van der Waals forces in cyclohexane. (Van der Waals forces in ethanol neutral).	[1]
		Refers to Van der Waals forces only between cyclohexane and ethanol in the mixture. Accept induced dipole / dipole. Not induced (single) dipole.	[1]
	Total		[9]

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3 (a)	ACE Data	Correctly computes (to a minimum of 2 decimal places) the table values for student 1, student 4 and student 7. <i>See appendix</i>	[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	<u>4.80</u>

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1 (a) (i)	PLAN Problem	States that the boiling point increases with concentration because the lowered vapour pressure means that the temperature has to be raised in order to raise the vapour pressure to that of the ambient value. (Accept boiling point is proportional to concentration or reverse).	[1]
		Straight-line or curve showing a gradual increase. (This line may start anywhere). Ignore any plateau but any line which shows a boiling point decrease is wrong.	[1]
		Line or extrapolated line to begin on the y-axis with the value 100°C labelled. [there is no ecf here from (i) to (ii)]	[1]
(b)	PLAN Problem	Mass / weight / concentration of potassium chloride.	[1]
		Temperature / temperature change. Accept boiling point or change in boiling point. (Ignore any reference to water but boiling point of potassium chloride is wrong).	[1]
(c)	PLAN Method	Give one mark for a diagram which shows some form of heating (not a water bath, but allow oil-bath or heating mantle) of an apparatus containing water. (No mark if the apparatus is sealed). (If the apparatus is 'obvious' labels are not necessary).	[1]
		Give one mark for showing the thermometer bulb at the interface between liquid and vapour (bulb half in and half out of the liquid).	[1]
		Give one mark for showing an appropriate temperature range for the thermometer (must cover 100°C).	[1]

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(d)	PLAN Method	Give one mark for a method, which gives details / a list of the masses / volumes / weights of water to be used along with the need to have masses of the potassium chloride to produce a solution, provided that the total mass of water does not exceed 100g.	[1]
		Give one mark if at least five different concentrations are indicated. (Allow a method based on adding increasing portions of the solute to one initial mass of water. First mark for a mass of water 100g or less; second mark for adding at least five portions of solute, table in (g) will require the same four headings). These details may be shown in the expression detailed below.	[1]
		Give one mark for the following correct expression. Mass of chloride / 74.6×1000 / mass or vol. of water. (Any or all these marks may be covered in the table in (g) . If there is a correct calculation of molality but the candidate refers to molarity give the mark, but if then molarity appears in the table in (g) count this second use as an error.)	[1]
(e)	PLAN methods	Give one mark for identifying 'boiling water' / boiling solution / hot apparatus / steam or equivalent (ignore risks). Accept any sensible suggestion that might produce burns. (Reference to hot potassium chloride or its corrosive nature are wrong).	[1]
(f)	PLAN Methods	Any statement which clearly indicates that the experiment is limited by the solution becoming saturated gains one mark. (Reference to solubility alone is not enough.) Accept reference to limited volume of water.	[1]
(g)	PLAN Methods	A minimum of four columns is required: Boiling point; mass / volume / weight (not amount) of water; mass of potassium chloride; (all with correct units); molality (ignore units here). If all four are fully correct give two marks; if only three are correct give one mark; otherwise zero.	[2]
	Total		[15]

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Question	Sections	Indicative material	Mark
2 (a)	ACE Data	The required two M _r s are correct. (249.6 and 97.5)	[1]
(b)	ACE Data	The required two column headings are correct. (A / 249.6, moles of CuSO₄.5H₂O: B / 97.5, moles of Cu(OH)₂) [If moles are given as shown separate units are not needed.] (the expressions need a number not just M^r) The first two calculations are correct and both columns are fully completed to the correct number of significant figures. [0.010; 0.025 and 0.008; 0.020] If only one column is fully correct give a salvage one mark.	[1] [1]
(c)	ACE Data	Give the mark if excess sodium hydroxide is identified	[1]
(d)	ACE Data	Give one mark for labelling the x-axis copper sulfate and the y-axis copper hydroxide provided all the plotted points cover at least half the grid in both directions. [moles of or / moles or (moles) are acceptable as units. (all points must be on the given grid). Give one mark for correctly plotting the nine points, which must include both anomalous points. Give one mark for drawing a 'straight-line of best fit' passing through the origin. (allow 'ecf' here from incorrectly plotted points – the line may of course now not pass through the origin).	[1] [1] [1]
(e)	ACE Data	Give one mark if all the anomalous points are circled. There should be one each side of the line if the plotting is correct. (If points are misplotted there may be either one or more than two anomalies. If there are points close to the line judgement will be needed as to whether these are anomalies or not). For each of the two different anomalies an appropriate explanation gains one mark. Point 4 (not enough Cu(OH)₂): loss of the sulfate solution / not an excess of NaOH / loss of precipitate / recorded mass of the sulfate more than the actual value. Point 8 (too much Cu(OH)₂): Cu(OH)₂ still wet / contamination with other chemicals / excess sulfate weighed out / recorded mass of the sulfate less than the actual value. There may be other acceptable reasons. (If there are two correct comments which are not 'tied' to a particular anomaly give a salvage one mark).	[1] [2]

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		For a value of the slope within ± 0.05 of the 'correct value'.	[1]
		This should be in the order of 0.80. If the axes have been reversed the value will be 1.25.	
		If the slope is significantly different due to earlier errors the answer should be within ± 0.05 of their 'actual' value.	
(g)	ACE Data	For the correct statement that the equation is not confirmed. Allow ecf.	[1]
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