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

9701/51 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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UNIVERSITY of CAMBRIDGE International Examinations

Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Predicts a direct proportionality. Accept statements such as 'no. of moles of the precipitate/$PbCl_2$ will increase (as the number of moles of $NaCl$ increases'). Equation shows a 1 to 2 molar ratio or wtte. (If a 'plateau' graph is described for the first mark allow a correctly explanation for the second mark i.e. all the lead nitrate has been used up)	[1] [1]
(b)	PLAN Method & Problem & ACE	All the lead nitrate was used up; moles or concentration of lead nitrate; **total** volume of lead nitrate. **NOT** amount A diagonal straight-line going through the origin. The line will abruptly change to a horizontal line Possible alternatives: • Diagonal line only, with +ve slope from the origin – 1 mark • Diagonal line not starting at the origin with a horizontal line – 1 mark • Curve from the origin with decreasing gradient and horizontal straight-line – 1 mark • Curve not from the origin with decreasing gradient and horizontal straight-line – 0 marks • Any lines showing an increase in gradient – 0 marks	[1] [1] [1]
(c)	PLAN Problem	Independent variable – volume/mass/moles of $NaCl$ Dependent variable – moles/mass of $PbCl_2$ / ppt Other variables – temperature. **NOT** amount and **NOT** concentration of the $NaCl$. Three points correct – 2 marks Two points correct – 1 mark Any incorrect suggestions cancel correct suggestions	[2]

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Question	Sections	Indicative material	Mark
(d) (i)	PLAN Method	Calculating an appropriate mass of lead nitrate; this should be 8.275(8.3)g	[1]
		Dissolving the solid in water (or stirring) in a beaker or other appropriate vessel (volumetric/graduated/dilution flask) using less than 250 cm^3	[1]
		Adding to the volumetric/graduated/dilution flask and adding water to the 250 cm^3 mark (if 250 cm^3 of water are added directly to a volumetric/ graduated/dilution flask (containing the solid of course) allow 1 mark)	[1]
		Any dilution from a 'given' solution of lead nitrate gets 0 marks out of 3. Synthesis of the lead nitrate from lead and nitric acid scores zero.	
(ii)		A student who uses 33.1 grams of lead nitrate to make up correctly 1 dm^3 of solution can gain the first two marks, but to gain the third mark a measured 250 cm^3 needs to be taken using an appropriate measuring vessel.	[1]
		Apparatus for volume measurement (burette/pipette/measuring cylinder)(not a syringe) used to measure 50 cm^3 or less of lead nitrate and 100 cm^3 or less of sodium chloride (mention of only one measuring vessel is enough for this mark)	
		Method for drying the precipitate (adding propanone and allowing to evaporate/pressing with filter paper/warm oven/sun leaving out to dry. **NOT** heat or the use of a Bunsen or microwave.	[1]
(e)	PLAN Method	Table needs • volumes of lead nitrate, sodium chloride and mass/weight of lead chloride/ppt with appropriate data (volumes must total no more than 250 cm^3 in each case)	[1]
		• moles of sodium chloride and lead chloride/ppt	[1]
		• correct units throughout (/cm^3, /cm^3 and /g [accept grams]; accept ( ) instead of /) (these are for the items in bullet point one)	[1]
		Normally there will be 5 sets of volumes with the volume of lead nitrate being constant. (no figures are required for the mass of the ppt) (allow 4 sets if the volumes are different to those in **(d)**). **Ignore;** volumes of water; units in the mole columns; items such as filter paper; numbers in the mole columns. **Do not allow;** n for the number of moles; zero for the volume of lead nitrate or sodium chloride.	
(f)	PLAN Method	The drying process should be repeated to constant mass Allow heat/reheat to constant mass/weight.	[1]
	Total		**[16]**

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Question	Sections	Indicative material	Mark
2 (a)	ACE Data	The required M_r is correct (180) (allow if given in the table.) Ignore units.	[1]
(b)	ACE Data	The required two column headings are correct. • Moles of glucose/solute; B/180; B/M_r; mass of glucose/M_r etc. IGNORE units. • Molality; D × 10; D/(A × 10^{-3}) or equivalent; units mol kg^{-1} (allow Cm instead of molality) The calculations are correct and both columns are fully completed to 3 s.f. (allow ecf for the calculations, only if the calculation is absolutely clear) If only one column is given with correct header and numbers give one mark. If the molality column is given and it is fully correct give both marks (the formula in the heading needs to be something like (B × D × 10)/180 or D × 10 if the D column heading is correct as B/180 / or equivalent), if only the heading or the numbers are correct give one mark (even if column D is incorrect in some way, this means that a correct set of values for the molality, to 3sf could be worth a mark). If the first two values for the molality are 0.555 and 0.677 and the remainder are all correct award the mark. Table values at the end.	[1] [1]
(c)	ACE Data	Give one mark for labelling the x-axis molality and the y-axis freezing point depression provided the plotted points and the origin if used cover at least half the scalings in both directions. Scales must allow all the points to be plotted; if less than nine points are plotted allow plotting for those actually plotted. (in other cases where correct scales are used all 9 points must be plotted, allow plotting to the nearest half a square in each direction) (If either of the axes have non-linear scales do not award the first two marks) Freezing point depression must have units /°C; ignore any molality units Give one mark for correctly plotting all the points plotted. Give one mark for drawing a 'line of best fit' passing through the origin. (again allow a half square accuracy) (If the origin is not used do not give this mark) These three points can stand alone as far as possible while allowing for ecf. Even if the axes are unlikely to access the mark, allow the other two marks.	[1] [1] [1]

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Question	Sections	Indicative material	Mark
(d)	ACE Data	One mark if the two anomalous points furthest from the line (one on each side) are circled. Allow only one anomaly if there is only one or all the anomalies are on the same side. In plotting the points, it is possible that some points will be a little way from the correctly drawn line. These in many cases are likely not to be 'ringed'. If 5 or more points are 'ringed' do not award this mark but allow any subsequent correct discussion. For each of the two different anomalies an appropriate explanation gains one mark. If the graph is plotted correctly point 3 will be above the line and point 7 below the line. **POINT 3;** temperature measured after freezing was complete (i.e. late); too much glucose added; reduced amount of water. **POINT 7;** temperature recorded before freezing was complete; not all glucose dissolved; too much water. If two correct suggestions are given but not 'tied' to a particular point award one mark. If the comments are assigned to the wrong points NO marks.	[1] [2]
(e) (i) **(ii)**	ACE data	Appropriately drawn lines on the graph with correctly deduced intercepts. For a correct calculation from the candidates figures with correct units (°C kg mol^{-1}) Since the results produce a good linear graph, the procedure is OK. Accept 'constant gradient', and references such as 'most of the points are close to the drawn line' etc. 'Line passing through the origin' is irrelevant.	[1] [1] [1]
(f)	ACE Data	The NaC*l* produces twice the number of **particles**. Allow the statement that NaC*l* produces Na^+ and Cl^-.	[1]
(g)	ACE Data	Between answers to **(a)** and **(f)**.	[1]
	Total		**[14]**

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A	B	C	D	E	F
mass of water /g	mass of glucose /g	freezing point depression ΔT_f /°C	moles of glucose $\frac{B}{180}$	molality D × 10 mol/kg	
100	10.0	1.03	0.0556	0.556	
100	12.2	1.26	0.0678	0.678	
100	18.0	2.09	0.100	1.00	
100	23.3	2.40	0.129	1.29	
100	27.7	2.86	0.154	1.54	
100	30.9	3.22	0.172	1.72	
100	33.1	3.31	0.184	1.84	
100	38.6	3.98	0.214	2.14	
100	42.3	4.37	0.235	2.35	

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