

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2014 series

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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Page 2	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9701	51

Question	Expected Answer	Mark
1 (a) (i)	$2\text{Mg}(\text{NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2$ allow correct multiples	[1]
(ii)	40.3g MgO, 48.0 dm ³ NO ₂ , 12.0 dm ³ O ₂ Units must be given allow ecf from equation in (i)	[1]
(b) (i)	Directly heated vessel labelled (magnesium) nitrate(V) with tube at exit Gas stream led into a liquid labelled alkali which will absorb the nitrogen(IV) oxide/NO ₂ Collects a gas in a syringe or over a liquid, provided it is properly connected All parts of the apparatus are connected and air-tight AND nitrogen(IV) oxide absorption precedes oxygen collection.	[1] [1] [1] [1]
(ii)	States a collector volume with unit AND Correct calculation of mass of magnesium nitrate(V) to a volume that would fit the stated volume of collector. allow ecf on (a)(i) Units of volume and mass required.	[1]
(c)	Mass of magnesium nitrate(V) (at start) and mass of magnesium oxide (at end). Or Mass of heated tube and contents before and after heating and mass of empty tube Mass of container (+ alkali) at start and mass at end Volume of oxygen	[1] [1] [1] [1]
(d) (i)	Heat to constant mass OR heat to constant volume	[1]
(ii)	Let the apparatus cool (to room temperature)	[1]
(e)	Use experimental results to produce moles of magnesium nitrate(V) AND moles of one of the three products. compare with molar ratio in equation as given in (a)(i)	[1] [1]
(f)	Make sure all apparatus is airtight/no leakage before heating allow other sensible suggestions regarding exposure to nitrogen(IV) oxide or use of apparatus	[1]

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	GCE A LEVEL – May/June 2014	9701	51

2 (a)	$[M^{n+}(aq)] / \text{mol dm}^{-3}$	EMF / V	$\log[M^{n+}(aq)]$	
	5.00×10^{-1}	0.94	–0.30	
	1.00×10^{-1}	0.96	–1.00	
	4.00×10^{-2}	0.97	–1.40	
	1.00×10^{-2}	0.99	–2.00	
	5.00×10^{-3}	1.00	–2.30	
	2.00×10^{-3}	1.01	–2.70	
	8.00×10^{-4}	1.02	–3.10	
	2.00×10^{-4}	1.04	–3.70	
	Correctly calculated values			[1]
	All data to 2 decimal places			[1]
(b)	All 8 points present and plotted correctly			[1]
	Best fit continuous straight line			[1]
(c)	There are no anomalous points			[1]
	Variations in points due to rounding.			[1]
	OR			
	Variations arise from being to just 2dp.			
(d) (i)	Appropriately drawn lines on graph			[1]
	Calculates correctly gradient of the graph			[1]
	Uses $-0.06/n = \text{gradient}$ to calculate $n = 2$			[1]
	Correct working must be shown			
(ii)	Extrapolates graph to obtain intercept on y-axis and deduces $E^\ominus$ for the cell to a minimum of 2 dp e.g. (+)0.93(V)			[1]
	OR			
	Calculates a value for $E^\ominus$ using the electrode potential expression and candidate's final value for n calculated in (d)(i) or candidate's gradient and a data point on the candidate's line.			
(e)	$E^\ominus$ for M, $(0.80 - 0.93) = -0.13$ AND Metal is Pb (allow Sn on -0.14) allow ecf from (d)(ii)			[1]

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(f)	$2\text{Ag}^+ + \text{Pb} \rightarrow 2\text{Ag} + \text{Pb}^{2+}$	[1]
(g) (i)	To allow movement of ions OR to maintain charge / ion <u>balance</u>	[1]
(ii)	If lead given in (e) then only potassium nitrate is suitable If potassium chloride given as unsuitable, then accept precipitations with silver OR lead (ions) If potassium sulfate given as unsuitable, then accept precipitations with lead (ions) ONLY If tin given in (e) potassium sulfate or potassium nitrate are suitable precipitation would occur just with potassium chloride with silver (ions) ONLY	[1] [1]

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Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2014	9701	52

Question	Expected Answer	Mark	
1 (a)	Water can hydrogen bond with ammonia (ORA for trichloromethane) Water/oxygen/ammonia/nitrogen has a lone pair (of electrons) (ORA for trichloromethane) OR trichloromethane has dipole-dipole interactions only	[1] [1]	[2]
(b)	$(K_{\text{partition}} =) \frac{[\text{NH}_3(\text{water})]}{[\text{NH}_3(\text{trichloromethane})]}$ AND $(K_{\text{partition}}) > 1$ ORA	[1]	[1]
(c)	It is not important as the concentration is independent of volume	[1]	[1]
(d)	$2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$	[1]	[1]
(e) (i)	Calculates the concentration of ammonia (in the aqueous layer) is (approximately) 1 mol dm^{-3} OR between 0.96 mol dm^{-3} and 1.04 mol dm^{-3} ecf from (d) Should be diluted by 5	[1] [1]	[2]
(e) (ii)	Pipette 50 cm^3 of the 5.00 mol dm^{-3} aqueous ammonia into a 250 cm^3 volumetric (graduated) flask ecf from (e)(i) other flask sizes and methods of accurate volume measurement allowed Make up to the mark with water. Shake OR invert the flask OR mix.	[1] [1]	[2]
(f)	Allow suitable methods for avoiding the inhalation of ammonia AND/OR trichloromethane fumes	[1]	[1]
(g)	methyl orange/screened methyl orange Allow other indicators with suitable pH range As it is weak base-strong acid titration	[1] [1]	[2]
(h)	The concentration/solubility in the aqueous layer is much larger so determination of its concentration would be less prone to error Allow sulfuric acid immiscible with trichloromethane layer	[1]	[1]
(i)	Calculates the moles of ammonia in the aqueous layer ecf from (d) Subtracts from the original to obtain moles in the trichloromethane	[1] [1]	[2]

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2	(a)	2 marks awarded unless: (i) The curve is clearly not smooth or has a point of inflexion or is in the wrong position (ii) A point is clearly not in the correct position	[2]	[2]
	(b)	Point at 120 s is the most anomalous Difficult to measure very small concentrations / volume OR concentration / volume measured before the recorded time OR time recorded later than the measured concentration	[1] [1]	[2]
	(c)	EITHER Draws appropriate construction lines Read two half-lives from graph as between 95 and 105 s Because half-lives are equal, identifies the reaction as first order OR Draws tangents to the curve at the points Correctly calculates gradients of the two lines OR the ratio of gradients Because shallower gradient is half of the steeper gradient, the reaction is first order	[1] [1] [1] [1] [1] [1]	[3]
	(d) (i)	Draws suitable tangent at $t = 0$ Calculates gradient correctly for any line drawn at $t = 0$.	[1] [1]	[2]
	(ii)	Calculates correctly a value for: $k = \text{ans(d(i))} / (27 \times 10^8)(4 \times 10^{11})$ gives units as $\text{cm}^3 \text{ molecules}^{-1} \text{ s}^{-1}$	[1] [1]	[2]
	(e)	Gives initial rate (gradient) as $\text{ans(d(i))} / (6.02 \times 10^{23})$ Completes calculation correctly	[1] [1]	[2]
	(f)	The ozone concentration should remain (nearly) constant during the experiment So that the rate depends only on the concentration of NO	[1] [1]	[2]

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