UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Specimen for 2007

GCE A/AS LEVEL

MARK SCHEME
MAXIMUM MARK: 40
SYLLABUS/COMPONENT: 9701/31 ADVANCED PRACTICAL SKILLS

Skill	Total marks	Breakdown of marks/expectations		Question 1	Question 2
Manipulation, measurement and observation	16 marks	Successful collection of data and observations	8 marks	2	6
		Decisions relating to measurements or observations	8 marks	5	3
Presentation of data and observations	12 marks	Recording data and observations	5 marks	3	1
		Display of calculation and reasoning	3 marks	3	0
		Data layout	4 marks	4	0
Analysis, conclusions and evaluation	12 marks	Interpretation of data or observations and identifying sources of error	6 marks	2	4
		Drawing conclusions	5 marks	3	1
		Suggesting improvements	3 marks	1	1

MMO = Manipulation, measurement and observation
Collection = Successful collection of data and observations
Decisions = Decisions relating to measurements or observations
PDO = Presentation of data and observations
Recording = Recording data and observations
Display = Display of calculation and reasoning
Layout = Data layout
ACE = Analysis, conclusions and evaluation
Interpretation = Interpretation of data or observations and identifying sources of error
Conclusions = Drawing conclusions
Improvements = Suggesting Improvements

Question		Sections	Learning outcomes	Indicative material	mark
1	**(a)**	PDO Display	• show their working in calculations, and the key steps in their reasoning	correct working for volume of H_2SO_4	1
	(b)	MMO decisions	• decide how many tests or observations to perform	appropriate volume of acid added each time (between 2 and 4 cm^3) volumes spanning a sufficient range each side of calculated end point (between 20 and 30 cm^3 below end point and 10 and 20 cm^3 above end point)	1 1
	(c)	PDO Recording	• draw up table in advance of taking readings so that they do not have to copy results • use column headings that include both the quantity and the unit and that conform to accepted scientific conventions • record raw readings of a quantity to the same degree of precision	no evidence on script of table having been produced or added to after measurements made; volume, temperature and ΔT columns correctly labelled volumes and temperatures recorded to consistent significant figures	1 1 1
		MMO collection	• making measurements using burettes and thermometers	all volumes recorded to 0.05 cm^3; all temperatures recorded to 0.5 °C;	1 1
		MMO decisions	• make and record sufficient, accurate measurements	volume at which max temp rise recorded within 5 cm^3 of Supervisor; ΔT for highest temp within 1 °C of that obtained by Supervisor (1 of these two marks if in range +1 °C to 3 °C)	1 2

	(d)	PDO Layout	• plot appropriate variables on clearly labelled x- and y-axes • choose suitable scales for graph axes • plot all points to an appropriate accuracy. follow the ASE recommendations for putting lines on graphs	ΔT plotted on y-axis and volume of acid on x-axis, correctly labelled including units; suitable scales selected; points plotted as fine cross or encircled dot within ½ small square in either direction; two smooth intersecting curves drawn	1 1 1 1
	(e)	ACE Interpretation	• find an unknown value by using intercept on a graph	reading the volume of H_2SO_4 at the end-point from the intercept of the graph	1
	(f)	PDO Display	• show working in calculations, and the key steps in reasoning • use the correct number of significant figures for calculated quantities	shows working and explains the steps in the calculation; calculates concentration to same sf as titre/volume information recorded	1 1
	(g)	ACE Conclusions	• draw conclusions from an experiment, giving an outline description of the main features of the data, considering whether experimental data supports a given hypothesis.	first part of hypothesis not supported as the graph is not a straight line. (hypothesis supported is acceptable if the graph **is** a straight line) shape of graph described second part of hypothesis is supported as temperature falls after the end-point	1 1 1
	(h)	ACE Interpretation	• identify the most significant sources of error in an experiment	comments on the closer spacing of temperatures at higher values or curve with decreasing gradient; explains that heat loss is greater/more rapid at higher temperatures	1 1
	(i)	ACE Interpretation	• estimate, quantitatively, the uncertainty in quantitative measurements • express such uncertainty as an actual or percentage error	calculates 0.05 or 0.10 as a % of the end-point volume	1
	(j)	ACE Improvements	• suggest modifications that will improve the accuracy of the experiment	calculates (total volume x ΔT x 4.3)	1

2	**(a)**	MMO Decisions	• selecting a suitable reagent	use of $Pb(NO_3)_2$ or $AgNO_3/NH_3(aq)$ as reagent;	1
		MMO Collection	• use apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour, solubility or quantity of materials	records appropriate observation for selected reagent	1
	(b)	MMO Decisions	• selecting a suitable reagent	use of $Pb(NO_3)_2$ or $AgNO_3/NH_3(aq)$ as reagent;	1
		MMO Collection	• use apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour, solubility or quantity of materials	records appropriate observation for selected reagent	1
		ACE conclusions	• draw conclusions from interpretations of observations	draws a conclusion appropriate to the observations in (a) and (b)	1
	(c)-(f)	MMO collection	follow instructions given in the form of written instructions	all tests attempted and some observation recorded	1
			use apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour, solubility or quantity of materials	at least three initial precipitates correctly recorded	1
				colours of precipitates correctly described	1
				solubility of precipitates in excess $NaOH/NH_3$ correctly described	1
		MMO decisions	make appropriate qualitative observations	appropriate test for ammonia gas recorded	1
		PDO recording	record observations to the same level of detail	consistent standard in recording observations i.e. all precipitates and their solubilities in excess recorded	1

	(g)	ACE Interpretation	• describes and summarises the key points of a set of observations.	explains how the observations identify and confirm the presence of Ba^{2+}. explains how the reaction with sodium hydroxide and ammonia identifies Al^{3+} or Pb^{2+} as the unknown cation explains which tests eliminate Pb^{2+}	1 1 1
	(h)	ACE Improvements	• suggest ways in which to extend the investigation	suggests dilute acid to liberate NO	1