**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**Specimen for 2007**

**GCE A/AS LEVEL**

| MARK SCHEME |
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| MAXIMUM MARK: 40 |
| SYLLABUS/COMPONENT: 9701/31<br><br>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 $cm^3$)<br>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<br>1 |
| | **(c)** | PDO Recording | • draw up table in advance of taking readings so that they do not have to copy results<br>• use column headings that include both the quantity and the unit and that conform to accepted scientific conventions<br>• 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;<br>volume, temperature and $\Delta T$ columns correctly labelled<br>volumes and temperatures recorded to consistent significant figures | 1<br>1<br>1 |
| | | MMO collection | • making measurements using burettes and thermometers | all volumes recorded to 0.05 $cm^3$;<br>all temperatures recorded to 0.5 °C; | 1<br>1 |
| | | MMO decisions | • make and record sufficient, accurate measurements | volume at which max temp rise recorded within 5 $cm^3$ of Supervisor;<br>$\Delta T$ for highest temp within 1 °C of that obtained by Supervisor<br>(1 of these two marks if in range +1 °C to 3 °C) | 1<br>2 |

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| | **(d)** | PDO Layout | • plot appropriate variables on clearly labelled x- and y-axes<br>• choose suitable scales for graph axes<br>• plot all points to an appropriate accuracy.<br>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;<br>suitable scales selected;<br>points plotted as fine cross or encircled dot within ½ small square in either direction;<br>two smooth intersecting curves drawn | 1<br>1<br>1<br>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<br>• use the correct number of significant figures for calculated quantities | shows working and explains the steps in the calculation;<br>calculates concentration to same sf as titre/volume information recorded | 1<br>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)<br>shape of graph described<br>second part of hypothesis is supported as temperature falls after the end-point | 1<br>1<br>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;<br>explains that heat loss is greater/more rapid at higher temperatures | 1<br>1 |
| | **(i)** | ACE Interpretation | • estimate, quantitatively, the uncertainty in quantitative measurements<br>• 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 |

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| **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 |

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