

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

## **MARK SCHEME for the May/June 2008 question paper**

### **9701 CHEMISTRY**

**9701/31**

Paper 31 (Advanced Practical Skills 1), maximum raw mark 40

Mark schemes must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



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## Generic Mark Scheme for Papers 31 and 32

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

### Statement Bank

#### MANIPULATION, MEASUREMENT AND OBSERVATION (MMO)

Successful collection of data and observations (Collection)

<b>C1</b>	Set up apparatus correctly
<b>C2</b>	Follow instructions given in the form of written instructions or diagrams
<b>C3</b>	Use apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour, solubility or quantity of materials
<b>C4</b>	Make measurements using pipettes, burettes, measuring cylinders, thermometers, and other common laboratory apparatus

Quality of measurements or observations (Quality)

<b>Q1</b>	Make accurate and consistent measurements and observations
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Decisions relating to measurements or observations (Decisions)

<b>De1</b>	Decide how many tests or observations to perform
<b>De2</b>	Make measurements that span a range and have a distribution appropriate to the experiment
<b>De3</b>	Decide how long to leave experiments running before making readings
<b>De4</b>	Identify where repeated readings or observations are appropriate
<b>De5</b>	Replicate readings or observations as necessary
<b>De6</b>	Identify where confirmatory tests are appropriate and the nature of such tests

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## PRESENTATION OF DATA AND OBSERVATIONS (PDO)

### Recording of data and observations (Recording)

<b>R1</b>	Present numerical data, values or observations in a single table of results
<b>R2</b>	Draw up the table in advance of taking readings/making observations so that they do not have to copy up their results
<b>R3</b>	Include in the table of results, if necessary, columns for raw data, for calculated values and for analyses or conclusions
<b>R4</b>	Use column headings that include both the quantity and the unit and that conform to accepted scientific conventions
<b>R5</b>	Record raw readings of a quantity to the same degree of precision and observations to the same level of data

### Display of calculation and reasoning (Display)

<b>Di1</b>	Show their working in calculations, and the key steps in their reasoning
<b>Di2</b>	Use the correct number of significant figures for calculated quantities

### Data layout (Layout)

<b>L1</b>	Choose a suitable and clear method of presenting the data, e.g. tabulations, graph or mixture of methods of presentation
<b>L2</b>	Use the appropriate presentation medium to produce a clear presentation of the data
<b>L3</b>	Select which variables to plot against which and decide whether the graph should be drawn as a straight line or a curve
<b>L4</b>	Plot appropriate variables on clearly labelled x- and y-axes
<b>L5</b>	Choose suitable scales for graph axes
<b>L6</b>	Plot all points or bars to an appropriate accuracy
<b>L7</b>	Follow the ASE recommendations for putting lines on graphs

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## ANALYSIS, CONCLUSIONS AND EVALUATION (ACE)

Interpretation of data or observations and identify sources of error (Interpretation)

<b>I1</b>	Describe the patterns and trends shown by tables and graphs
<b>I2</b>	Describe and summarise the key points of a set of observations
<b>I3</b>	Find an unknown value by using co-ordinates or intercepts on a graph
<b>I4</b>	Calculate other quantities from data, or calculate the mean from replicate values, or make other appropriate calculations
<b>I5</b>	Determine the gradient of a straight line
<b>I6</b>	Evaluate the effectiveness of control variables
<b>I7</b>	Identify the most significant sources of error in an experiment
<b>I8</b>	Estimate, quantitatively, the uncertainty in quantitative measurements
<b>I9</b>	Express such uncertainty in a measurement as an actual or percentage error
<b>I10</b>	Show an understanding of the distinction between systematic errors and random errors

Drawing conclusions (Conclusions)

<b>Con1</b>	Draw conclusions from an experiment, giving an outline description of the main features of the data, considering whether experimental data supports a given hypothesis, and making further predictions
<b>Con2</b>	Draw conclusions from interpretations of observations, data and calculated values
<b>Con3</b>	Make scientific explanations of the data, observations and conclusions that they have described

Suggesting Improvements (Improvements)

<b>Imp1</b>	Suggest modifications to an experimental arrangement that will improve the accuracy of the experiment or the accuracy of the observations that can be made
<b>Imp2</b>	Suggest ways in which to extend the investigation to answer a new question
<b>Imp3</b>	Describe such modifications clearly in words or diagrams

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<i>Skill</i>	<i>Total marks</i>	<i>Breakdown of marks</i>			<i>Question 1</i>	<i>Question 2</i>
		<i>Statement</i>	<i>Marks</i>			
Manipulation, measurement and observation (MMO)	16 marks	Successful <u>collection</u> of data and observations	C	8	2	6
		<u>Quality</u> of measurements and observations	Q	4	4	0
		<u>Decisions</u> relating to measurements of observations	De	4	2	2
Presentation of data and observations (PDO)	12 marks	<u>Recording</u> data or observations	R	5	3	2
		<u>Display</u> of calculation and reasoning	Di	3	3	0
		Data <u>layout</u>	L	4	4	0
Analysis, conclusions and evaluation (ACE)	12 marks	<u>Interpretation</u> of data or observations and identifying sources of error	I	6	6	0
		Drawing <u>conclusions</u>	Con	5	0	5
		Suggesting <u>improvements</u>	Imp	1	0	1
Total					24	16

The Examiner is to check all subtractions on Supervisor and candidate scripts.

Record Supervisor values for titres in **(a)** and **(b)** on the front cover of the Supervisor's script.

Where a Supervisor has not provided titre information or where the Supervisor value is suspect (more than half the candidates in the Centre scoring zero marks in **(a)** or **(b)**) list the candidate values and attempt to obtain a suitable "average/mean" from these values.

### Correct units

One of three forms acceptable.

Use of solidus, e.g. / cm<sup>3</sup>

Unit in brackets, e.g. (cm<sup>3</sup>)

In words, e.g. volume in cubic centimetres

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Question	Sections	Statement	Indicative material	Mark	
1 (a)	MMO Quality	Q	<p>Cross out any titration labelled as rough unless only titration recorded.</p> <p>Give <b>two marks</b> if the titre in (a) within 0.2 cm<sup>3</sup> of the Supervisor.</p> <p>Give <b>one of these marks</b> for a titre of 0.20+ to 0.50 cm<sup>3</sup>.</p> <p><i>If titres are repeated – assess the value closer to that obtained by the Supervisor.</i></p>	2	[2]
(b)	MMO Quality	Q	<p>Titre in (b) within 0.2 cm<sup>3</sup> of Supervisor.</p> <p><i>Treat repeated titres as in (a)</i></p>	1	[1]
(c)	ACE Interpretation	I4	<p>Correctly calculates (to 3 or 4 significant figures) the predicted end-point from titres (a) and (b)</p> $\frac{\text{titre (a)}}{\text{titre (a) - titre (b)}} \times 12$	1	[1]
(d)	PDO Recording	R1	<p>Results incorporated into a single table (volume of <b>FA 3</b>, burette readings, and titre)</p> <p>(a) and (b) need not be included if titration data fully included in those sections.</p>	1	
		R2	<p>Table drawn up in advance of taking readings. Selected volumes of <b>FA 3</b> must be sequential.</p> <p><i>Must include (a) and (b) which can be at beginning, at end or entered sequentially.</i></p>	1	
	MMO Collection	R4	<p>Correct column or row headings <u>and units</u> (see page 1 for acceptable form of units).</p> <p><i>Minimum – volume of <b>FA 3</b> and titre.</i></p>	1	
		C2	<p>Selects four additional volumes of <b>FA 3</b> to add.</p>	1	
	MMO Decisions	C4	<p>Makes all volume measurements of <b>FA 2</b> and <b>FA 3</b> with a burette.</p> <p><i>(all burette readings and/or volumes/titres recorded to 2 dp or to nearest 0.05 cm<sup>3</sup>).</i></p>	1	
		De2	<p>Candidate selects four points around the predicted “end-point” (or 20 cm<sup>3</sup>), either</p> <p>(i) one value to left and three to right, or</p> <p>(ii) two values to each side.</p> <p><i>If there are only three additional points give this mark if one value to left and two values to right.</i></p> <p><b><i>The C2 and De2 marks can be awarded if volumes of FA 3 have been selected but the titration not performed.</i></b></p>	1	[6]

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(e)	PDO Layout	L4	Clearly and correctly labelled axes. <i>Accept volume of FA 2 or FA 2 / cm<sup>3</sup> or FA 2 / ml, etc. as a label. Units not required.</i>	1	
		L5	Suitable scales selected. More than ½ of each axis used. <i>Allow “difficult” scale on x-axis but only if it easily fits the selected values of FA 3.</i>	1	
		L6	All points (including values from (a) and (b)) plotted to within ½ small square in either direction and in the correct square.	1	
		L7	2 continuous straight lines drawn, each passing close to the majority of points. (Minimum of 2 points on either side of the end-point) – meeting on x-axis.	1	
	ACE Interpretation	I3	Reads, to nearest small square, the x-axis value of the intersection of the two lines. <i>Intersection need not be on the x-axis.</i>  <i>Where the left-hand line only has been drawn (or there is a right hand line with no plotted points) allow the intersection of the left-hand line with the x-axis providing there are at least 3 points close to the line drawn.</i>	1	
	MMO Quality	Q	Not more than one anomalous point (off Examiner selected “best-fit” left-hand line) on plotted graph. <i>Minimum – three well-spaced points on or close to line.</i> <i>Do not award this mark if the points are “bunched” in a small area of the paper.</i>	1	[6]
(f)	MMO	De5	Identifies valid titre to be repeated or states correctly that no titre needs repeating. <i>Only award this mark if two lines (allow curves) have been drawn using plotted data for each line.</i> <i>If lenient in awarding L7 mark in (e) be tighter in this section.</i>	1	[1]
Calcs	PDO Display	Di1	Shows working in all sections attempted.	1	
		Di2	3 or 4 significant figures in final section answers to (g) / (h) – if attempted.	1	[2]

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(g)	ACE Interpretation	I4	Calculates $M_r = 392$ (stated or used). <i>Check any expression, adding <math>A_r</math> values to confirm that the values add up to 392 if no total given.</i>	1	[2]
		I4	Expression or calculated value: $\frac{15.68}{\text{cand } M_r} \times \frac{25.0}{1000} \quad \text{or}$ $0.04 \times \frac{25}{1000} \quad \text{or}$ $1(.00) \times 10^{-3}$ <i>Do not penalise incorrect evaluation of a correct expression.</i>	1	
(h)	ACE Interpretation	I4	Calculates: $\frac{\text{intercept from graph}}{1000} \times 0.025$	1	[1]
(i)	ACE Interpretation	I4	Expression or calculation: $\frac{\text{ans(g)}}{\text{ans(h)}}$	1	[2]
	PDO Display	Di2	candidate values evaluated correctly to 3 significant figures. <i>Candidate must <u>use</u> an answer to (g) and (h) for the award of this mark (expression may be inverted).</i>	1	
				[Total: 24]	



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FA 4 (0.1 mol dm <sup>-3</sup> ) NH <sub>4</sub> I (actually NaI), FA 5 (0.1 mol dm <sup>-3</sup> ) Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> , FA 6 (0.1 mol dm <sup>-3</sup> ) Zn(NO <sub>3</sub> ) <sub>2</sub>					
2 (a)	PDO Recording	R1	Data in single table. <i>No repeat of reagents or reactants.</i> <i>Allow for single reagent and three solutions.</i>	1	
	MMO Decisions	De1	Selects silver nitrate, Ag <sup>+</sup> (aq) or solution containing Ag <sup>+</sup> as one reagent.	1	
		De1	Select (aqueous) ammonia as 2 <sup>nd</sup> reagent to use with AgNO <sub>3</sub> or selects soluble lead salt or Pb <sup>2+</sup> (aq) or solution containing Pb <sup>2+</sup> as separate reagent.  <i>If ion is given with no state symbol or reference to the ion being in solution - penalise once only.</i>  <i>Ignore incorrect formulae for reagents if intention is clear.</i>	1	
	MMO Collection	C3	Records correct observations for <b>both</b> reagents selected ( <b>FA 4</b> contains the iodide). <i>Ignore observations for FA 5/FA 6 – unless observations for iodide in these solutions.</i>  <i>Where all three reagents have been selected allow two out of three correct observations.</i>	1	
	ACE Conclusions	Con2	Correct conclusion (from <b>one piece</b> of evidence) that <b>FA 4</b> contains iodide ion. <i>Allow this conclusion if AgNO<sub>3</sub> or Pb(NO<sub>3</sub>)<sub>2</sub> used as a single reagent.</i>	1	[5]
(b)	PDO Recording	R5	Observations to show degree of precision – addition of NaOH to excess where a precipitate has been observed on addition of NaOH. <i>A precipitate must be recorded with FA 5 <u>and/or</u> FA 6.</i>	1	
	MMO Collection	C3	Records white ppt soluble in excess with <b>FA 5</b> white ppt soluble in excess with <b>FA 6</b> <i>Ignore FA 4 column.</i>	1	[2]
(c)	MMO Collection	C3	Records white ppt insoluble in excess with <b>FA 5</b> white ppt soluble in excess with <b>FA 6</b>  <i>Ignore FA 4 column.</i>	1	[1]

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(d)	MMO Collection	C3	Records white ppt with <b>FA 5</b> insoluble in acid no ppt with <b>FA 6</b>	1	[2]
	MMO Collection	C3	Records no ppt or no reaction for <b>FA 4</b> with reagent in <b>each</b> of tests <b>(b)</b> , <b>(c)</b> and <b>(d)(i)</b> – addition of $\text{BaCl}_2$ . <i>Accept blank boxes as no reaction</i>	1	
(e)	MMO Collection	C3	Records yellow ppt with <b>FA 4</b> , soluble/partially soluble on heating <b>or</b> yellow ppt with <b>FA 4</b> and forming crystals or (more) precipitate on cooling. <i>Accept precipitate forms as an acceptable observation when cooling the solution.</i> <i>Accept shiny precipitate/sparkly solid/spangles as equivalent to observing crystal formation.</i> <b>and</b> no ppt with <b>FA 6</b>  <i>Ignore <b>FA 5</b>, unless yellow ppt formed.</i>	1	[1]
(f)	ACE Conclusions		<b>Marks in this section must be based on evidence from the tests performed.</b>  <b>All formulae used in this section must be correct</b> ( <i>identified ions or reagents</i> ). <i>It is acceptable to refer back to (e.g. test (a)) providing the observation mark was awarded for that test.</i> <i>Allow named compounds or chemically correct formulae as well as ions .</i>	1	[4]
		Con3	Identifies $\text{I}^-$ as the anion in <b>FA 4</b> and explains <b>two</b> observations leading to that conclusion. <i>Minimum observation for <math>\text{I}^-</math> is yellow precipitate with silver ions, soluble in ammonia.</i> <b>or</b> <i>yellow precipitate with silver ions and with lead ions.</i>	1	
		Con3	Identifies $\text{Al}^{3+}$ <b>and</b> $\text{SO}_4^{2-}$ as the ions in <b>FA 5</b> and explains the observations leading to that conclusion. <i>Minimum observation for <math>\text{Al}^{3+}</math> is white precipitate insoluble in excess ammonia.</i> <i>Minimum observation for <math>\text{SO}_4^{2-}</math> is white precipitate with barium chloride.</i>	1	
		Con3	Identifies $\text{Zn}^{2+}$ as the cation in <b>FA 6</b> and explains the observations leading to that conclusion. <i>Minimum observation for <math>\text{Zn}^{2+}</math> is white precipitate soluble in excess ammonia.</i>	1	
		Con3	States that $\text{NH}_4^+$ and $\text{NO}_3^-$ have not been identified. <i>This may be recorded at any point in (f).</i>		

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(g)	ACE Improve	Imp2	NaOH, Al and heat used to test for $\text{NO}_3^-$ would also liberate ammonia from $\text{NH}_4^+$ so would not be specific to $\text{NO}_3^-$ . <i>Candidates must show clear understanding of why the solution must be tested for ammonium ion before being tested for nitrate.</i>	1	[1]
					[Total: 16]