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.

UNIVERSITY of CAMBRIDGE
International Examinations

Generic Mark Scheme for Papers 31 and 32

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

Statement Bank

MANIPULATION, MEASUREMENT AND OBSERVATION (MMO)

Successful collection of data and observations (Collection)

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

Quality of measurements or observations (Quality)

Q1	Make accurate and consistent measurements and observations

Decisions relating to measurements or observations (Decisions)

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

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

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

Data layout (Layout)

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

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

Drawing conclusions (Conclusions)

Con1	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
Con2	Draw conclusions from interpretations of observations, data and calculated values
Con3	Make scientific explanations of the data, observations and conclusions that they have described

Suggesting Improvements (Improvements)

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

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

Unit in brackets, e.g. (cm^3)

In words, e.g. volume in cubic centimetres

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

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(e)	PDO Layout	L4	Clearly and correctly labelled axes. *Accept volume of* **FA 2** or **FA 2** / *cm*^{3} *or* **FA 2** / *ml, etc. as a label. Units not required.*	1	
		L5	Suitable scales selected. More than ½ of each axis used. *Allow "difficult" scale on x-axis but only if it easily fits the selected values of* **FA 3**.	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. *Intersection need not be on the x-axis.* *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.*	1	
	MMO Quality	Q	Not more than one anomalous point (off Examiner selected "best-fit" left-hand line) on plotted graph. *Minimum – three well-spaced points on or close to line.* *Do not award this mark if the points are "bunched" in a small area of the paper*.	1	[6]
(f)	MMO	De5	Identifies valid titre to be repeated or states correctly that no titre needs repeating. *Only award this mark if two lines (allow curves) have been drawn using plotted data for each line.* *If lenient in awarding* ***L7*** *mark in* ***(e)*** *be tighter in this section.*	1	[1]
Calcs	PDO Display	Di1 Di2	Shows working in all sections attempted. 3 or 4 significant figures in final section answers to **(g)** / **(h)** – if attempted.	1 1	[2]

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

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FA 4 (0.1 mol dm^{-3}) NH_4I (actually NaI), FA 5 (0.1 mol dm^{-3}) $Al_2(SO_4)_3$, FA 6 (0.1 mol dm^{-3}) $Zn(NO_3)_2$					
2 (a)	PDO Recording	R1	Data in single table. *No repeat of reagents or reactants.* *Allow for single reagent and three solutions.*	1	
	MMO Decisions	De1	Selects silver nitrate, $Ag^+(aq)$ or solution containing Ag^+ as one reagent.	1	
		De1	Select (aqueous) ammonia as 2nd reagent to use with $AgNO_3$ or selects soluble lead salt or $Pb^{2+}(aq)$ or solution containing Pb^{2+} as separate reagent. *If ion is given with no state symbol or reference to the ion being in solution - penalise once only.* *Ignore incorrect formulae for reagents if intention is clear.*	1	
	MMO Collection	C3	Records correct observations for **both** reagents selected (**FA 4** contains the iodide). *Ignore observations for* **FA 5/FA 6** *– unless observations for iodide in these solutions.* *Where all three reagents have been selected allow two out of three correct observations.*	1	
	ACE Conclusions	Con2	Correct conclusion (from **one piece** of evidence) that **FA 4** contains iodide ion. *Allow this conclusion if $AgNO_3$ or $Pb(NO_3)_2$ used as a single reagent.*	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.		
	MMO Collection	C3	*A precipitate must be recorded with* **FA 5** *and/or* **FA 6**. Records white ppt soluble in excess with **FA 5** white ppt soluble in excess with **FA 6** *Ignore* **FA 4** *column.*	1 1	[2]
(c)	MMO Collection	C3	Records white ppt insoluble in excess with **FA 5** white ppt soluble in excess with **FA 6** *Ignore* **FA 4** *column.*	1	[1]

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(d)	MMO Collection	C3	Records white ppt with **FA 5** insoluble in acid no ppt with **FA 6**	1	
	MMO Collection	C3	Records no ppt or no reaction for **FA 4** with reagent in **each** of tests **(b)**, **(c)** and **(d)(i)** – addition of $BaCl_2$. *Accept blank boxes as no reaction*	1	[2]
(e)	MMO Collection	C3	Records yellow ppt with **FA 4**, soluble/partially soluble on heating **or** yellow ppt with **FA 4** and forming crystals or (more) precipitate on cooling. *Accept precipitate forms as an acceptable observation when cooling the solution.* *Accept shiny precipitate/sparkly solid/spangles as equivalent to observing crystal formation.* **and** no ppt with **FA 6** *Ignore* **FA 5**, *unless yellow ppt formed.*	1	[1]
(f)			**Marks in this section must be based on evidence from the tests performed.** **All formulae used in this section must be correct** *(identified ions or reagents).* *It is acceptable to refer back to (e.g. test **(a)**) providing the observation mark was awarded for that test.* *Allow named compounds or chemically correct formulae as well as ions .*	1	
	ACE Conclusions	Con3	Identifies I^- as the anion in **FA 4** and explains **two** observations leading to that conclusion. *Minimum observation for I^- is yellow precipitate with silver ions, soluble in ammonia.* ***or*** *yellow precipitate with silver ions and with lead ions.*	1	
		Con3	Identifies Al^{3+} **and** SO_4^{2-} as the ions in **FA 5** and explains the observations leading to that conclusion. *Minimum observation for Al^{3+} is white precipitate insoluble in excess ammonia.* *Minimum observation for SO_4^{2-} is white precipitate with barium chloride.*	1	
		Con3	Identifies Zn^{2+} as the cation in **FA 6** and explains the observations leading to that conclusion. *Minimum observation for Zn^{2+} is white precipitate soluble in excess ammonia.*	1	
		Con3	States that NH_4^+ and NO_3^- have not been identified. *This may be recorded at any point in* **(f)**.		[4]

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(g)	ACE Improve	Imp2	NaOH, A*l* and heat used to test for NO_3^- would also liberate ammonia from NH_4^+ so would not be specific to NO_3^-. *Candidates must show clear understanding of why the solution must be tested for ammonium ion before being tested for nitrate.*	1	[1]
					[Total: 16]

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