UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2008 question paper

9701 CHEMISTRY

9701/31 Paper 31 (Practical 1), maximum raw mark 40

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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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 October/November 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY of CAMBRIDGE
International Examinations

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

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Supervisor's Report
Check all subtractions in **(a)**. Use the titres, corrected where necessary, to select the "best average" titre to be used as an accuracy standard using the following hierarchy.

- value of 2 identical titres
- average of titres within 0.05 cm^3
- average of titres within 0.10 cm^3, etc.

Calculate, **correct to 2 dp**, the titre if the Supervisor had diluted 38.50 cm^3 of **FA 1**.
Do not round calculated averages to nearest 0.05 cm^3.

This is given by the expression $\frac{\text{vol of FA 1 diluted}}{38.5} \times \text{titre}$

Record this value on the Supervisor's script and on all candidate scripts against the titration table.

Candidate scripts
Check and correct all subtractions as above.
Examiner is to select best titre as above, (**do not include values labelled rough unless rought is crossed out or ticked/used by candidate**) and calculate the scaled titre for 38.50 cm^3 of **FA 1**.
If no volume of **FA 1** diluted has been given, assume candidate has used 38.50 cm^3.
Record the value against the titration table and calculate the difference to Supervisor.

Question	Sections	Statement	Indicative material	Mark	
1 (a)	PDO Layout	L1	**(i)** Records initial and final burette readings in each of the tables. *(If 50.00 cm^3 is used as initial burette reading, treat as 0.00 cm^3. Do **not** award **(i)** in this case or if 50.00 is given as a repeated final titre in the 2nd table.)*	1	
	PDO Recording	R5	**(ii)** All accurate burette readings in the titration table recorded to nearest 0.05 cm^3.	1	
	MMO Collection	C2	**(iii)** Follows instructions – dilutes 38.00 cm^3 to 39.00 cm^3 (uncorrected) of **FA 1**.	1	
	MMO Decisions	De5	**(iv)** Has at least two uncorrected titres within 0.1 cm^3. *Titres labelled "rough" may be included.*	1	
	MMO Quality	Q1 Q1	**Accuracy** Award **(v) and (vi)** if difference from Supervisor is 0.3 cm^3 or less. Award **(v) only** if difference from Supervisor is 0.3+ cm^3 to 0.6 cm^3.	2	[6]
(b)	ACE Interpretation	I4	Candidate selects/calculates correct "average" from titre values within 0.2 cm^3. *Average must be calculated correct to 2 dp or nearest 0.05 cm^3 if burette read to 2 dp/0.05 cm^3. For burette readings, consistent to 1 dp the average may be correct to 1 or 2 dp).*	1	[1]

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(c)	ACE Interpretation	I4	**Award (i)** for $\frac{\mathbf{25}}{\mathbf{1000}} \times \frac{\mathbf{3.40}}{\mathbf{40}}$ in 1st step.	1	
		I4	**Award (ii)** for correct 2nd step $\times \frac{\mathbf{1}}{\mathbf{1}} \times \frac{\mathbf{250}}{\mathbf{titre}}$ **and** correct 3rd step $\times \frac{\mathbf{1000}}{\mathbf{vol\ diluted}}$.	1	
	PDO Display	Di1	**(iii)** Working shown in the first three steps.	1	
		Di2	**(iv)** 3 or 4 significant figures given in **each answer attempted** for sections 1–3. A **minimum** of two sections attempted is required before this mark can be awarded.	1	
		Di2	**(v)** Award one mark for $M_r = \frac{\mathbf{38.68}}{\mathbf{answer\ to\ previous\ section}}$ **correctly evaluated to 3 sig fig.** (Examiner to check) *Allow ±1 in 3rd sig fig.* *It may be necessary to check any calculation in which numbers have been "carried" in a calculator.*	1	[5]
				[Total: 12]	

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2 (a)	PDO Layout	L1	**(i)** Three (or four) weighings, *mass of empty tube* *mass of tube* + **FA 4** *mass of tube after heating* *mass tube* + **FA 4** *mass of tube + residual* **FA 4** *mass of empty tube* *mass of tube after heating* mass of residue**,** **and** mass of water clearly shown.	1	
	MMO Collection	C2	**(ii)** Give one mark for evidence from results of reheating and reweighing.	1	
	MMO Decisions	De1	**(iii)** Give one mark for repeating heating and reweighing until final masses are within 0.1 g.	1	
	PDO Recording	R5	**(iv)** Correct headings and units for each weighing/mass recorded. (Watch out for reversed residue and water.) *Accept only:* */ g; (g); or mass of …… in grams.* *If not included in heading every entry must be followed by g.*	1	
		R5	**(v)** All of the balance readings recorded are consistent to 1 dp, 2 dp, etc. *showing the precision of the balance used.*	1	
	On each candidate's script check all subtractions in **(a)**. Use the masses, corrected where necessary, to calculate $\frac{\text{mass of water}}{\text{mass of anhydrous solid}}$. Work to 2 dp. Record this value on page 4 and calculate the difference to the theoretical value of **1.05** for $MgSO_4.7H_2O$.				
	MMO Quality	Q1 Q1	**Accuracy** Award **(vi)** and **(vii)** for a difference up to 0.15. Award **(vi) only** for a difference of 0.15+ to 0.25. *Award no Q marks if either the mass of water or the mass of residue is negative* ***or*** *mass of water driven off > mass of crystals taken.*	2	[7]
(b)	ACE Interpretation	I4	Give one mark for calculating $\frac{\text{candidate's mass of water}}{\text{candidate's mass of crystals}} \times 100$ *This mark is for the method of calculation not for evaluation of the expression.*	1	[1]

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(c)	ACE Interpretation	I4	Give one mark for correctly calculating, to within 1 dp, the two missing % of water of crystallisation. *Answers given to 2 dp are acceptable.* **x** = 3 % = 31.0 **x** = 9 % = 57.4	1	
	ACE Conclusions	Con2	Give one mark if candidate selects a value of **x** consistent with the % of water calculated from experiment. *Accept:* *the closest integer from the table;* *a calculated (or estimated) non-integral value between appropriate integers.*	1	[2]
(d)	ACE Improvements	Imp1	Give one mark if the candidate explains how repetition of the whole experiment can: (i) show consistent results, **or** (ii) display reproducibility, **or** (iii) eliminate anomalous results *Accept reference to <u>accuracy</u> only if there is reference to consistent results.* *Accept reference to <u>average</u> only if there is reference to "leaving out" erroneous or inconsistent results.*	1	[1]
(e)	ACE Interpretation	I9	Give one mark for calculating 250 g as being the mass giving 0.04% error when weighed on a 1 dp balance.	1	[1]
				[Total: 12]	

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FA 5 is solid manganese(IV) oxide, FA 6 is aqueous iron(II) sulphate, FA 7 is aqueous hydrogen peroxide					
3 (a)	MMO Decisions	De2	**(i)** Give one mark if candidate explains that H_2 should be tested first as less dense/lighter than air or the least dense/lightest gas.	1	
	PDO Recording	R1	**(ii)** Give one mark for a single table showing tests and observations up to a positive test for one of the three gases **<u>and</u>** starting with the gas selected in **(i)** above.	1	
	MMO Collection	C3	**(iii)** Give one mark if correct observations are made for correct tests. Only oxygen giving positive result.	1	
	ACE Conclusion	Con2	**(iv)** Give one mark for conclusion (from evidence) that oxygen is the gas given off. **No e.c.f. from (iii).**	1	[4]
(b)	PDO Layout	L1	Give one mark for clear presentation of both tests and of at least one observation.	1	
	MMP Collection	C3	Give one mark for observing: yellow / yellow-green / green solution when **FA 5** is added to KI **or** a blue / black / blue-black / purple colour **<u>in the solution</u>** when starch is added.	1	[2]
(c)			**FA 5**	1	
	ACE Conclusions	Con2	Give one mark for **catalyst** in test **(a)**.		
		Con2	***If the first mark in this section has been given or*** **FA 5** ***acts as an oxidant / oxidising agent in*** **(b)*:*** Give one mark for suggesting element is in **transition block or d-block**. *Accept also:* *Groups (3-12), B-subgroups.*	1	[2]

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(d)	MMO Collection	C3	**(i)** Give one mark for an initial precipitate formed in each box on addition of NaOH or $NH_3(aq)$.	1	
	PDO Recording	R5	**(ii)** Give one mark for reporting the solubility/insolubility of any initial precipitate on adding excess reagent.	1	
	MMO Collection	C3	**(iii)** Give one mark for green, (dark, dirty or muddy green acceptable but not grey-green) ppt. with **FA 6**.	1	
		C3	**(iv)** Give one mark for brown, orange-brown, red-brown or rust coloured ppt. with mixture **FA 6/FA 7**.	1	
	ACE Conclusions	Con2	**(v)** Identifies Fe^{2+} as cation in **FA 6**, Fe^{3+} as the cation in the mixture of **FA 6** with **FA 7** and that **FA 7** has acted as an oxidant / oxidising agent / oxidiser. **(No e.c.f.)** *Conclusions must be supported by a minimum of a correct observation with one reagent for each ion and no contra observations.*	1	[5]
(e)	PDO Layout	L1	Give one mark for clear presentation of observations and conclusion.	1	

Selection of reagents *– Accept any of the following:*
- *a named compound or a recognisable (but not necessarily correct) formula for the compound*
- *aqueous ions, e.g. $Ba^{2+}(aq)$*
- *a solution containing a named ion*

Identification of unknowns *– Accept either of the following:*
- *a named compound (or ion)*
- *a **fully correct** formula for the compound or ion*

	MMO Decisions	De6	Give one mark for choosing barium chloride or nitrate and HC*l* or HNO_3 as reagents **or** lead nitrate / lead ethanoate and HNO_3 as reagents **or** barium chloride and (acidified) dichromate(VI) in separate tests. *(Acid could be added and dichromate used to test for SO_2.)*	1	

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	MMO Collection	C3	Give one mark for recording a white ppt. with Ba^{2+} or Pb^{2+} insoluble in presence/excess of the appropriate acid **or** white ppt. with Ba^{2+} and no change in orange colour of dichromate(VI) *(in solution or gas from acid).*	1	[3]
				[Total: 16]	

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