UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2007 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.

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UNIVERSITY of CAMBRIDGE
International Examinations

Generic Mark Scheme

Skill		***Breakdown of marks***	
Manipulation, measurement and observation	16 marks	Successful collection of data and observations	8 marks
		Decisions relating to measurements or observations	8 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

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Question	Sections	Indicative material	Mark	
Round all recorded times in Supervisor and candidate scripts to the nearest second. List on the Supervisor's script the rounded times for expts. 1 & 2 for each candidate.				
1 (a)	MMO Collection	Performs experiments and records times for each reaction. Follows instructions. Award this mark if the reaction time for experiment 2 is within 20% of that obtained for experiment 2 by the Supervisor (or the majority of candidates in the Centre).	1 1	[2]
1(b)	PDO Recording	**(i)** Single table for all experiments performed. *(Expts 1&2 must be included; minimum for table is volume and time for expts 1&2)* *A single table has no repetition of headings.*	1	
		(ii) Table has been drawn up in advance. *(must have minimum of 4 expts tabulated – does not have to include expts 1&2)* – volumes of **FA 1** are sequential. Expts 1 and 2 may be entered first or last.	1	
		(iii) Table includes columns for volume of **FA 1** or log(volume of **FA 1**), time, $^1/_t$ or log($^1/_t$). *Ignore other columns* *or if total volume in expt ≠ 55*	1	
		(iv) Ignore log columns All other columns correctly labelled with <u>appropriate unit</u> (2007 syllabus). Accept t but not T for time heading Accept cm^3, dm^3, s, s^{-1}, $^1/_s$ as units for units accept: *unit after solidus, unit in bracket or <u>in</u> words e.g. / cm^3; (cm^3) or volume in cubic centimetres* ***but not*** *volume cm^3* *If the unit is not included in the column heading every entry in the column must have a unit.*	1	
		(v) All times recorded to nearest second	1	
	MMO Decisions	**(vi)** At least 3 mixtures – in addition to expt 1 and expt 2.	1	
		(vii) Volumes of **FA 1** chosen are uniformly spaced over the whole range	1	

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Question	Sections	Indicative material	Mark	
	Accuracy Calculate (vol of **FA 1** x time) for expt 1 and the two additional expts with greatest volume of **FA 1**. *(Round all times to the nearest second)* Record the Vt values against the appropriate expt on the candidate's script.			
1 (b) contd.	MMO Decisions	**(viii) and (ix)** Award both of these marks if two of the Vt values are within 10% of the larger of the closest pair. *[Award point **(ix)** but **not** point **(viii)** for a difference of 10+% to 20%]* **(x) and (xi)** Award both of these marks if candidate's time for expt 1 is within 10% of that obtained by the Supervisor. *[Award point **(xi)** but **not** point **(x)** for a difference of 10+% to 20%]*	2 2	[11]
	Where experiment 1 has been repeated, assess accuracy using the time on page 3. Use the value on page 4 when checking the graph.			
1 (c)	PDO Layout	**Ignore labels** – check which numerical values have been plotted **Ignore** omission of negative signs; direction of numbers on axes etc. Plots ***a rate*** ($^1/_t$ or (log $^1/_t$)) on *y*-axis and ***a concentration*** (volume of **FA 1** or (log volume of **FA 1**)) on *x*-axis *If labels correct but numbers on scale indicate a different quantity do **not** award this mark* Easy to use scales chosen with plotted points covering more than ½ of each available axis A point must be plotted for each experiment performed – *take care where expts 1&2 have been omitted from the main results table)* All points plotted to within ½ small square and in the correct half of a small square	 1 1 1	

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Question	Sections	Indicative material	Mark	
1 (c) contd		Appropriate straight line drawn through the points. (*This does not have to be a "best-fit" line but must show correlation to the points plotted. Do **not** award this mark if there is clearly a better line that could have been drawn through the points))* A minimum of three points that lie close to the line are required – n*o anomalous point is permitted where three points only have been plotted.* Do **not** award this mark if the line is drawn through points "bunched" in less than 20 x 20 small squares.	1	[4]
	If a candidate has only performed experiments 1&2 or if data has only been plotted for 2 experiments, points L4, L5 and L6 but **not** L7 can be awarded.			
1 (d)	PDO Display	Construction lines drawn on the graph. *The hypotenuse of the constructed "triangle" should cover at least half of the length of the line drawn by the candidate.* Correctly reads (to nearest ½ small square) the coordinates from the graph *Accept values from the table if the line is drawn through the point.* *Do **not** penalise reuse of values for an incorrectly plotted point*	1 1	[3]
	ACE Interpretation	Calculates gradient correctly to at least 1 decimal place using the values read from the graph by the candidate.	1	
	Where data for two experiments **only** has been plotted, the Display marks **only** may be awarded. Do **not** award the Display mark for reading coordinates if either value is taken from the table.			

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Question	Sections	Indicative material	Mark	
1 (e)	ACE Interpretation	Explains that uncertainty is less when change is rapid (or converse) Estimated errors expt 1 number of seconds ≤ 3 s. expt 2 number of seconds ≥ 3 s, up to a maximum of 10 s. error for expt 2 > error for expt 1 Candidate's uncertainties correctly expressed as % of reaction time. Error may be carried forward.	1 1 1	[3]
1 (f)	ACE Improvements	Has: constant volumes of **FA 1**, variable volume of **FA 2**, water to keep total volume constant at 55 cm^3 Record the total volume for each experiment to the left of the table.	1	[1]
1 (g)	PDO Display	Uses experimental data to make appropriate comment, from experimental results, as to how **rate** varies with acid concentration. *[Do not give this mark where mixtures selected in **(f)** are not appropriate]* *Little change in reaction time is expected. The rate increases slightly as the concentration of acid is doubled etc.* *Where an acceptable qualitative statement has been given ignore any incorrect attempt at a quantitative/mathematical expression.*	1	[1]
			Qn 1 Total 25	

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Question	Sections	Indicative material	Mark	
FA 3 is aqueous ammonium sulphite (*ammonium chloride* + *sodium sulphite*), FA 4 is aqueous sodium nitrite, FA 5 is aqueous barium nitrate, FA 6 is aqueous manganese(II) sulphate,				
2 (a)	MMO Decisions	Chooses named dilute acid as single reagent for identifying nitrite **and** chooses $BaCl_2$/ $Ba(NO_3)_2$ (Ba^{2+}(aq) or aqueous solution containing Ba^{2+} acceptable) together with HCl/HNO_3 (not H_2SO_4) as reagents for identifying sulphate/sulphite	1	[1]
2 (b)	 MMO Collection	Award the C3 marks only from observations in the table. No retrospective marks. Give one mark for a brown gas evolved from **FA 4** with any acid Give one mark for one of the following for **FA 6**: 1. a white ppt with Ba^{2+} **insoluble** in hydrochloric or nitric acid, 2. a white ppt with Ba^{2+} **insoluble** in unnamed acid, 3. precipitate whose colour has not been described **insoluble** in named acid other than H_2SO_4 Give one mark for one of the following for **FA 3**: 1. a white ppt with Ba^{2+} **soluble** in hydrochloric or nitric acid, 2. a white ppt with Ba^{2+} **soluble** in unnamed acid, 3. precipitate whose colour has not been described **soluble** in named acid other than H_2SO_4 ***If sulphuric acid is <u>stated in the table in (b)</u> award one observation mark only, if the barium salt is added <u>before</u> the acid and a white ppt is obtained with FA 6 and with FA3.*** **OR** Give one mark for adding HCl/HNO_3 and <u>detecting SO_2</u> (dichromate turning green) from **FA 3** Give one mark for adding Ba^{2+}(aq) and observing a white ppt with **FA 6** and no ppt with **FA 3**. *Do **not** give the first of these marks if dichromate is added to the acidified mixture (additional reagent) but allow conclusions from that test)*	 1 1 1 (1) (1)	

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Question	Sections	Indicative material	Mark	
2 (b) contd	ACE Conclusions	Give one mark **each** if the ions are correctly identified (No evidence is required in this section for the identification of the ions) Mark conclusions consequentially to observations **FA 4** – nitrite **FA 6** – sulphate **FA 3** – sulphite		 1 1 1
	ACE Interpretation	Gives appropriate evidence for identification of two of the ions. This mark can be awarded for <u>correct</u> anions where no observations are tabulated.		1 [7]
2 (c)	MMO Collection	**FA 6** – observes off-white ppt insoluble in excess with both NaOH and NH_3(aq)	1	
		FA 5 – observes white ppt in **(iii)** and white ppt soluble in HC*l* in **(iv)** *Ignore any ppt with NaOH/NH_3.*	1	
		FA 3 – positive test for alkaline **<u>gas</u>** described with **FA 3 only**.	1	[3]
2 (d)	ACE Conclusions	Give two marks if **all** ions are correctly identified. **FA 6** – Mn^{2+} (from off-white ppt with NaOH and NH_3(aq) **or** off white ppt with NaOH or NH_3(aq) soluble in excess) **FA 5** – Ba^{2+} (if observation mark given in **(c) or** white ppt with H_2SO_4 and no ppt with NH_3(aq)) **FA 3** – NH_4^+ (from ammonia/alkaline gas on warming with NaOH) *Give one of these two marks for 2 correct ions* *Mark conclusions consequentially to observations, e.g. Fe^{3+} from brown ppt for **FA 6**.* *Do **<u>not</u>** allow Ca^{2+} or Mg^{2+} in place of Ba^{2+}.*	1 1	
	ACE Interpretation	Gives appropriate evidence (minimum – as above) for identification of two of the ions. Evidence for Ca^{2+} (from reaction with OH^-) may be allowed here	1	[3]
	If a candidate does not record any practical work for sections **(iii)** and **(iv)**, ions such as Ca^{2+}, Mg^{2+}or Zn^{2+} may be credited from appropriate observations with NaOH and NH_3(aq)			
2 (e)	MMO Decisions	Selects CrO_4^{2-} or $Cr_2O_7^{2-}$ as additional reagent *(No cation or "aqueous ion" required)*	1	[1]
			Qn 2 Total 15	

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