UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper for the guidance of teachers

9701 CHEMISTRY

9701/51 Paper 51 (Planning, Analysis and Evaluation), maximum raw mark 30

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, which would have considered the acceptability of alternative answers.

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

Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Treat section **(a)** as one answer. From preliminary expt – predicts that rate of reaction will be proportional to [persulfate] / accept 'doubling the concentration doubles the rate'/increasing concentration increases rate. Explains that doubling the concentration doubles the number of collisions/increasing the concentration increases the number of collisions. The use of frequency alone is incorrect but if used with other correct comments regard it as neutral.	[1] [1]
(b)	PLAN Problem	**(i)** [Persulfate] as independent variable. Accept the correct ion instead of the correct name. Do not accept volume or amount. **(ii)** Elapsed time identified as dependent variable / rate (of reaction) or equivalent. Time alone scores zero but rate alone is OK.	[1] [1]
(c)	PLAN Problem	Explains that [iodide] remains constant – (controlled variable)/so that the iodide does not run out/continuous supply of iodide ions (for reaction with persulfate). NOT allowed are reformed/regenerated alone – rubric.	[1]
(d)	PLAN Methods	**(i)** Has at least 3 more appropriate experiments of lower concentration. (inappropriate experiments negate this mark) **(ii)** At least one of the diluted (varying water or persulphate) solutions half or less of original correct concentration / uses 20 cm^3 or less of persulphate at least once. (if concentration is used alone it must be correct but if used in conjunction with volumes regard the concentration as neutral). **(iii)** Total volume, volumes of potassium iodide, thiosulfate and starch all constant. **(allow drops of starch) (use of the exemplar experiment is not mandatory)** If **all** volumes stated, then the same procedure (with different persulfate concentrations) repeated could suffice. **(iv)** Burette or measuring cylinder used to measure volumes of persulfate **and** distilled water. **(v)** 'Minimum' is persulfate and iodide kept apart until reaction stated as started. **(vi)** Clock stopped when blue colour appears / elapsed time to blue colour is noted / measure time to the appearance of the blue colour. Not in a (timed) titration procedure. Also look at the table in **(f)** for possible answers to the first three marks.	[1] [1] [1] [1] [1] [1]
(e)	PLAN Methods	Explains that the volume / amount of thiosulfate defines the extent of the reaction ("finishing line") to enable comparison – or equivalent statement. Relate the constant volume of thiosulphate to the end / finishing point. Any reference to 'accuracy' should be regarded as neutral'.	[1]

Question	Sections	Indicative material	Mark
(f)	PLAN Methods	Tabulates volumes or concentrations of persulfate. *(Accept concentration if volumes used in text to show diluted solution)* **and** elapsed time. Include unit Includes a column for rate or Vt and unit (cm^3s), or concentration x t and unit. *(Penalise error or omission in units once only across the three relevant columns)* Units for rate (or 1/t) should be $/s^{-1}$ or $/moldm^{-3}s^{-1}$. allow 'brackets instead of /. (NOT M seconds minutes)	[1] [1]
(g)	PLAN Methods	Must have the first mark in **(a)**. Mark "justification" consequently. 'If the rate increases/time decreases/Vt is constant as the concentration of persulfate increases then the rate is proportional to the concentration of the persulfate'. Check the trend in **(f)** from time/rate and conc/vol data that may be provided. Accept a plot of rate against concentration having a line of positive slope/or going through the origin, OR a plot of time against concentration having a line of negative slope.	[1]
Qn 1	**Total**		**[15]**

2 (a)	ACE Data	Mass of zinc **used**, B-D, / g and full column. Mass of iodine, C-B, / g and full column. Check first 3 subtractions correct in the column **labelled** iodine. These must also be to 2dp. All 3 must be totally correct. ECF incorrect equation in calculation only.	[1] [1] [1]
(b)	ACE Data ACE Data	Correctly converts the first three masses of zinc to moles of zinc. (to 2 s.f.) Correctly converts the first three masses of iodine to moles of iodine. (to 2 s.f.) For these two marks, allow ecf from incorrect masses in (a). This ecf refers to the masses the candidate believes to be Zn and/or I. (Allow 1 computational/s.f error for the first 3 values in each column.) So 1 error is allowed in these 6 values. If an incorrect A_r has been used to calculate moles in all 3 values in one column then count this as just 1 computational error, not 3. For example 254 being used for iodine. A similar error in the Zn column would also count as 1 error only. Has calculated the ratio of I:Zn (to 2 dp.) (do not allow the inverse) (this can be done by simple visual checking) (e.g. 2.08 or 2.08:1). No ecf for calculations that have used < 2 sf in moles. Experiments 3 and 8 calculations correct (to 2 dp.) No ecf for calculations that have used < 2sf in moles In the 3rd and 4th marks ecf can operate in the ratio calculation from incorrect values of moles but 2 dp required. If the calculations are evaluated to more then 2 s.f. they should approximate to the 2. s.f. answers. If a value is quoted to 3 sf then allow +/- 1 in the 3rd figure.	[1] [1] [1] [1]
(c)	ACE Evaluation	Both experiments 3 and 8 only. (other values are neutral if they are there as a consequence of errors in **(b)** or **(a)**.) These must have some numerical justification in **(b)**.	[1]
(d)	ACE Evaluation ACE Data	Suggests taking an average / plotting a graph. Leaving out the anomalies (when calculating an average) / calculate the gradient/measure the slope.	[1] [1]
(e)	ACE Evaluation	(If experimental ratio of I: Zn is too high (Expt 3)) zinc has been oxidised during drying/ zinc not dried enough/ reaction is incomplete/ not all ZnI_2 washed away. If experimental ratio of I: Zn is too low (Expt 8) zinc has been blown out of the tube; **or** Zn lost on pouring out liquid. The reasoning must relate clearly to the correct anomaly. Allow correct reason for an anomaly (other than 3 or 8) stated in **(c)** provided evidenced in data in **(b)**.	[1] [1]

(f)	ACE Conclusions	Must refer in some way to the general agreement of the calculated/stated ratio being approximately 2 or 1:2 (in **(b)** or **(d)**. May have something written below the table in **(b)**. OR The slope of the graph is approximately 2. OR The moles/atoms/ions of iodine is about double that of zinc. Not references to molecules/mass/weight/I_2	[1]
(g)	ACE Conclusions	Identifies a single point of weakness in method. Possibly: Small masses weighed / large % error in mass. Not if large % error is related to balance dp or accuracy.	[1]
(h)	ACE Conclusion	Suggests titration of iodine with (sodium) thiosulfate.	[1]
Qn 2	**Total**		**[15]**