



General Certificate of Education

Applied Science **8771/8773/8776/8779**

SC11 Controlling Chemical Processes

Mark Scheme

2010 examination – January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question 1

(a)	Change in concentration (of product/reactant) Over time	(1) AO1 (1) AO1	2
(b)(i)	Rate constant	(1) AO1	1
(ii)	6.4×10^{-2} 0.5	(1) AO2 (1) AO2	1 1
(iii)	2	(1) AO2	1
(c)(i)	Zero Rate does not increase when conc increases	(1) AO2 (1) AO2	1 1
(ii)	Rate = $k[(\text{CH}_3)_3\text{CBr}]$ 1 mark for correct order with respect to $(\text{CH}_3)_3\text{CBr}$ 1 mark for rest of equation correctly written	(1) AO2 (1) AO2	1 1
(d)(i)	Bonds broken = $8 \times 413 + 612 + 2 \times 347 + 366$ Bonds made = $9 \times 413 + 3 \times 347 + 290 = 5048$ Bonds broken – bonds made (1 mark for this or for numerical answer) = $4976 - 5048 = -72$. 1 mark if negative sign correct as well as numerical answer	(1) AO2 (1) AO2 (1) AO2 (1) AO2	4
(ii)	Incomplete reaction/ other products formed	(1) AO2	1

Total Mark: 15**Question 2**

(a)(i)	Starts at origin Skewed to left and general shape correct Does not touch x axis but approaches close to it	(1) AO1 (1) AO1 (1) AO1	3
(ii)	Minimum energy Required for a reaction to occur/ for a successful collision	(1) AO1 (1) AO1	2
(iii)	All of area under curve to the right of E_a	(1) AO2	1
(b)(i)	No effect	(1) AO1	1
(ii)	decrease in temp means particles possess less energy less collisions less particles with energy greater than or equal to E_a	(1) AO2 (1) AO2 (1) AO2	3
(c)(i)	$9 \times 12 + 4 \times 16 + 8 \times 1 = 180$ $2 \times 12 + 2 \times 16 + 4 \times 1 = 60$	(1) AO2 (1) AO2	2
(ii)	$16 \times 0.3 = 4.8\text{g}$ aspirin in total Moles of aspirin = $4.8/180 = 0.027$ Reaction is 1:1 so 0.027 moles ethanoic acid formed = $0.027 \times 60 = 1.6\text{g}$ Only 24% decomposed so $1.6 \times 24/100 = 0.384\text{g}$ $180\text{mg aspirin} \rightarrow 60\text{mg ethanoic}$ $4800\text{mg} \rightarrow \frac{60}{180} \times 4800\text{mg}$ $= 1600\text{mg}$	(1) AO2 (1) AO2 (1) AO2 (1) AO2	4
(d)	Any acceptable spectroscopic method titration	(1) AO1	1

Total Mark: 17

Question 3

(a)(i)	Insulated cup/lid Thermometer Measuring cylinder/bulb pipette/burette Answers can be derived from a diagram	(3) AO3	3															
(ii)	<table><tr><td colspan="3">The mark scheme for this part of the question includes an assessment of the Quality of Written Communication (QWC). There are no discrete marks for the assessment of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level.</td></tr><tr><td>Level</td><td>Mark</td><td>Descriptor an answer will be expected to meet most of the criteria in the level descriptor</td></tr><tr><td>3</td><td>4-5</td><td>-The answer:<ul style="list-style-type: none">Is full and detailed and is supported by an appropriate range of relevant points such as those given in the example below.Is well structured with minimal repetition or irrelevant points. There is an accurate, fluent and clear expression of ideas.Contains only minor errors in the use of technical terms, spelling, punctuation and grammar.</td></tr><tr><td>2</td><td>2-3</td><td>The answer:<ul style="list-style-type: none">Has some omissions but is generally supported by some of the relevant points given in the example below.Shows some attempt at structuring, the ideas are expressed with reasonable fluency and clarity.Contains a few errors in the use of technical terms spelling, punctuation and grammar.</td></tr><tr><td>1</td><td>0-1</td><td>The answer:<ul style="list-style-type: none">Is largely incomplete, it may contain some valid points which are not clearly structured.Is unstructured with a lack of fluency and/or clarity.Contains errors in the use of technical terms, spelling, punctuation and grammar.</td></tr></table>	The mark scheme for this part of the question includes an assessment of the Quality of Written Communication (QWC). There are no discrete marks for the assessment of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level.			Level	Mark	Descriptor an answer will be expected to meet most of the criteria in the level descriptor	3	4-5	-The answer: <ul style="list-style-type: none">Is full and detailed and is supported by an appropriate range of relevant points such as those given in the example below.Is well structured with minimal repetition or irrelevant points. There is an accurate, fluent and clear expression of ideas.Contains only minor errors in the use of technical terms, spelling, punctuation and grammar.	2	2-3	The answer: <ul style="list-style-type: none">Has some omissions but is generally supported by some of the relevant points given in the example below.Shows some attempt at structuring, the ideas are expressed with reasonable fluency and clarity.Contains a few errors in the use of technical terms spelling, punctuation and grammar.	1	0-1	The answer: <ul style="list-style-type: none">Is largely incomplete, it may contain some valid points which are not clearly structured.Is unstructured with a lack of fluency and/or clarity.Contains errors in the use of technical terms, spelling, punctuation and grammar.	(5) A03	5
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(ii)	QWC – an example of a level 3 type of answer that may be produced would be: Carry out the experiment in a fume cupboard. Measure out known volumes (25cm ³ or more) of nitric acid and ammonia solutions using measuring cylinders. Measure temperature of each solution for several minutes to ensure that both are at the same temperature. Mix the solutions thoroughly in an insulated container, stir continuously and measure the temperature of the resultant mixture every minute for several minutes. Determine maximum temperature rise by plotting temperatures and extending the graph to time of mixing.		
(b)	Repeat	(1) AO3	1
(c)	$Q = mc\Delta T$ gives energy released in experiment 2 nd mark only awarded if state that m = total mass of water/solutions	(1) AO1 (1) AO1	2
(d)	Reactants and products labelled General shape Products lower than reactants	(1) AO1 (1) AO1 (1) AO2	3

Total Mark: 14

Question 4

(a)(i)	Products are removed at same time as reactants are added Process never stops	(1) AO1 (1) AO1	2
(ii)	Lower labour cost/faster/can give purer product/lower energy cost/savings on rent, etc	(1) AO1	1
(iii)	Process easily modified for a different product	(1) AO1	1
(b)(i)	One of the Earth's resources Used to provide a reactant	(1) AO1 (1) AO1	2
(ii)	Capital Direct Indirect Indirect	(1) AO1 (1) AO1 (1) AO1 (1) AO1	4
(c)	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 3\text{CO}_2 + 2\text{Fe}$	(2) AO2	2
(d)	(+) ³ 0	(1) AO2 (1) AO2	2

Total Mark: 14

Question 5

(a)	$\Sigma\Delta H_f(\text{products}) - \Sigma\Delta H_f(\text{reactants})$ /appropriate Hess's cycle $\Sigma\Delta H_f(\text{products}) = -826.2$ $\Sigma\Delta H_f(\text{reactants}) = -721.5$ $-826.2 - (-721.5) = -104.7$ (ignore units)	(1) AO2 (1) AO2 (1) AO2 (1) AO2	4
(b)	Closed system	(1) AO1	1
(c)	Both forward and reverse reactions occur	(1) AO1	1

(d)	The mark scheme for this part of the question includes an assessment of the Quality of Written Communication (QWC). There are no discrete marks for the assessment of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level.		(2) A01 (3) A02	5
	Level	Mark	Descriptor an answer will be expected to meet most of the criteria in the level descriptor	
	3	4-5	-The answer: <ul style="list-style-type: none">Is full and detailed and is supported by an appropriate range of relevant points such as those given in the example below.Is well structured with minimal repetition or irrelevant points. There is an accurate, fluent and clear expression of ideas.Contains only minor errors in the use of technical terms, spelling, punctuation and grammar.	
	2	2-3	The answer: <ul style="list-style-type: none">Has some omissions but is generally supported by some of the relevant points given in the example below.Shows some attempt at structuring, the ideas are expressed with reasonable fluency and clarity.Contains a few errors in the use of technical terms spelling, punctuation and grammar.	
	1	0-1	The answer: <ul style="list-style-type: none">Is largely incomplete, it may contain some valid points which are not clearly structured.Is unstructured with a lack of fluency and/or clarity.Contains errors in the use of technical terms, spelling, punctuation and grammar.	
QWC – an example of a level 3 type of answer that may be produced would be: LeChatelier's principle states that a system in equilibrium will oppose any change imposed upon it. If the pressure is increased less phosphorus pentachloride will dissociate. There are fewer gaseous mole (which occupy less volume) on the left hand side. When pressure is increased the equilibrium will shift to the left hand side to relieve pressure.				
(e)(i)	[Cl ₂][PCl ₃] / [PCl ₅] Correct terms Correct indices Square brackets		(1) AO2 (1) AO2 (1) AO1	3
(ii)	Divided by 2 Substituted numbers 0.05 × 0.098/0.6 = 8.17 × 10 ⁻³		(1) AO2 (1) AO2 (1) AO2	3
(iii)	Mol dm ⁻³		(1) AO2	1

(f)	Reactants and products / all substances Are in more than one state	(1) AO1 (1) AO1	2
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Total Mark: 20