



General Certificate of Education

Applied Science
8771/8773/8776/8779

SC11 Controlling Chemical Processes

Mark Scheme

Specimen Paper

2010 examinations onward

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Copyright © 2009 AQA and its licensors. All rights reserved.

COPYRIGHT

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

Question 1

(a)(i)	Cost of each unit has direct effect on unit cost of product	(1) (AO1)	1
(ii)	Maintenance of plant / insurance / rent / depreciation etc	(1) (AO1)	1
(iii)	Capital	(1) (AO1)	1
(b)	Measure change in pH	(1) (AO3)	1
(c)	First Rate halves as concentration halves	(1) (AO2) (1) (AO2)	2
(d)(i)	Rate = $k[\text{CH}_3\text{COOCH}_3][\text{NaOH}]$	(1) (AO2)	1
(ii)	2.6×10^{-2}	(1) (AO2)	1
(e)	Rate does not depend on the concentration of sodium hydroxide	(1) (AO1)	1
(f)	Increase energies of particles Increase number of (successful) collisions Increase proportion / number of particles that possess energy greater than the activation energy	(1) (AO1) (1) (AO1) (1) (AO1)	3
(g)	Sodium hydroxide Corrosive (allow irritant as this applies at lower concs) OR methyl ethanoate – flammable/irritant	(1) (AO1)	1

Total Mark: 13**Question 2**

(a)	$\text{H}_3\text{PO}_4 + 3\text{NaOH} \rightarrow \text{Na}_3\text{PO}_4 + 3\text{H}_2\text{O}$		(1) (AO2)	1
(b)(i)	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.			5
	Level	Marks	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	<p>The answer:</p> <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. 	(AO3) X 5	
			<p>An example of a Level 3 type of answer that may be produced would be:</p> <p>Measure out known volumes (e.g. 50cm³) of phosphoric acid and sodium hydroxide solutions using measuring cylinders (50cm³ capacity)</p> <p>Have ensured that concentrations of the two solutions so that the sodium hydroxide is in excess</p> <p>All solutions to equilibrate and record temperatures using a thermometer (+/- 0.1°C)</p> <p>Mix the solutions, stir continuously and record highest temperature</p>		
			Max 5		
(b)(ii)	Any 3 from		Reasonable concentration of acid suggested	(1) (AO3)	3
			Any method of reduction of heat loss	(1) (AO3)	
			Any reference to precision of the measuring equipment used	(1) (AO3)	
			Repeat	(1) (AO3)	
(c)			Stir	(1) (AO3)	
(d)(i)	Volumetric analysis or titration			(1) (AO3)	1
(ii)	11.5°C	11.4 → 11.6 °C		(1) (AO2)	1
	2898 / ecf			(1) (AO2)	2
	J			(1) (AO1)	

Total Mark: 13

Question 3

(a)	Enthalpy or Heat Energy required / released to <u>break/form</u> (one mole of a particular covalent) bond	(1) (AO1)	1
(b)	290 + 413 = 703 347 + 366 = 713 Bonds broken – Σ bonds made Mark is for numerical answer (10)	(1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2)	4
(c)	15.5-36.4 – (-90.5 +108.9) / appropriate cycle / $\Sigma \Delta H_f$ prods - $\Sigma \Delta H_f$ reactions =-20.9 -18.4 =-39.3	(1) (AO2) (1) (AO2) (1) (AO2)	3
(d)	Mean bond enthalpy values are an <u>average</u> for large range of molecules / not specific to these molecules	(1) (AO1)	1

Total Mark: 9**Question 4**

(a)	Oxidation accept REDOX	(1) (AO2)	1	
(b)	Divide no of moles by volume Substitute numbers into expression 1.62 (to 3s.f)	(1) (AO2) (1) (AO2) (1) (AO2)	3	
(c)(i)	Decreases	(1) (AO2)	1	
(c)(ii)	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.		5	
	Level	Marks		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	<p>The answer:</p> <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. 		
			<p>An example of a Level 3 type of answer that may be produced would be:</p> <p>Forward reaction is exothermic and when temperature is raised the reverse endothermic reaction is favoured since this removes the added heat energy. This opposes the change to temperature and the yield decreases.</p> <p>Yield decreases as temperature increases but this also results in a lower rate of reaction. The use of 450°C produced a reasonable rate of reaction and a reasonable yield.</p>	(1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2) (1) (AO1)	

Total Mark: 10**Question 5**

(a)	If slow, candidate must qualify answer Exothermic reaction/product unstable	(1) (AO2)	1
(b)(i)	Number of particles	(1) (AO1)	1
(ii)	<u>Total</u> number of particles present	(1) (AO1)	1
(iii)	Curve skewed to left of original <u>and</u> starting at 0 Peak higher than original and crosses original curve	(1) (AO1) (1) (AO1)	2
(c)(i)	Products have higher energy than reactant Positive – accept endothermic	(1) (AO2) (1) (AO1)	2
(ii)	Peak higher Require start and finish to be the same as original curve	(1) (AO1)	1
(d)(i)	Minimum energy particles must possess for a collision to be successful / to react	(1) (AO1) (1) (AO1)	2
(ii)	Provides alternative route/pathway requiring lower energy	(1) (AO1) (1) (AO1)	2

Total Mark: 12

Question 6

(a)(i)	109 151	(1) (AO2) (1) (AO2)	2
(ii)	$\frac{302}{151} \times 109$ (mk is for $\frac{302}{151} = 2$) = 218 kg	(1) (AO2) (1) (AO2) (1) (AO2)	3
(iii)	$\frac{80}{100} \times 302 = 241.6$ or 242	(1) (AO2)	1
(b)(i)	batch process reactants added (at start), reaction occurs + reaction stops whereas continuous process reactants added as products removed 2 marks for comparison, 1 mark for individual/relevant statement batch process reaction stops products removed /vessel washed / reaction started again whereas continuous process reaction is not stopped and restarted 2 marks for comparison, 1 mark for individual/relevant statement Accept other relevant points (1 mark) or direct comparisons (2 marks)	(1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1)	4
(ii)	Advantage: low set-up / capital costs / simple technology / suitable for small scale production Disadvantage: higher labour costs / time consuming	(1) (AO1) (1) (AO1)	2

Total Mark: 12

Question 7

(a)(i)	The products can re-form the reactants / the reaction can take place in both directions	(1) (AO1)	1
(ii)	The forward and reverse reactions occur at the same rate	(1) (AO1)	1
(b)	Homogeneous	(1) (AO1)	1
(c)	Increase Less moles / particles of gas on RHS (or converse) Equilibrium shifts to RHS to relieve/counteract increase in pressure	(1) (AO2) (1) (AO2) (1) (AO2)	3
(d)(i)	$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]}$ Correct fraction Correct indices	(1) (AO1) (1) (AO1)	2
(ii)	Decrease	(1) (AO2)	1
(e)	Increase surface area So increase collisions / increase the number of particles available for collision	(1) (AO2) (1) (AO2)	2

Total Mark: 11

Mark Breakdown

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	TOTAL
AO1	8	1	2	1	9	6	5	32
AO2	4	3	7	9	3	6	6	38
AO3	1	9	0	0	0	0	0	10
TOTAL	13	13	9	10	12	12	11	80