AQA Qualifications

A-LEVEL
APPLIED SCIENCE

SC11 – Controlling Chemical Processes
Mark scheme

8770
June 2014

Version: 1.0 Final

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

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' 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 from aqa.org.uk

Question	Part	Sub-part	Marking guidance	AOs	Mark	Comment
1	a	i	Reactants are added as products are removed Process is non-stop	(1)AO1 (1)AO1	2	
1	a	ii	Reactants are added, reaction occurs Then products are removed (and vessel is cleaned)	(1)AO1 (1)AO1	2	
1	a	iii	E.g. research laboratory/pharmaceutical/food manufacture Need to change product being made Any acceptable alternative scores	(1)AO2 (1)AO2	2	
1	b		Using electrical energy / electricity To split a compound / electrolyte into its constituent elements	(1)AO1 (1)AO1	2	
1	c	i	Cost per unit is Directly proportional to this cost	(1)AO1 (1)AO1	2	
1	c	ii	Insurance / rent / sales and marketing/maintenance Electrolysis cell/construction of plant	(1)AO2 (1)AO2	2	
1	d	i	$C(s) + 2O^{2-}$ $CO_2 + 4e^-$	(1)AO2 (1)AO2	2	

1	d	ii	Heterogeneous	(1)AO1	1	
1	d	iii	Solid being converted to gas owtte	(1)AO2	1	Accept 'electrodes burn away'
1	d	iv	+4 0	(1)AO2 (1)AO2	2	
1	d	v	Redox (allow reduction)	(1)AO2	1	Accept 'electrolysis'

Total 19

2	a	i	78.5 73	(2)AO2	2	

2	a	ii	Mass of N-methylethanamide = 50 × 73 / 78.5 = 46.5 kg Or Moles ethanoyl chloride = 50 000 / 78.5 = 636.9 Reaction ratio is 1 : 1 therefore 636.9 moles of N-methylethanamide is formed Mass of N-methylethanamide = 636.9 × 73 = 46500 g or 46.5 kg Units required for all 3 marks ecf from 2(a)(i)	(3)AO2 or (1)AO2 (2)AO2	3	

2	b		Fume cupboard / breathing apparatus	(1)AO2	1	

2	c		Broken = (6 × 413) + 346 + 740 + 339 + (2 × 390) + 305 = 4988 Made = (6 × 413) + 346 + 740 + (2 × 305) + 390 + 431 = 4995 Bonds broken − bonds made = −7 kJ mol^{-1} Correct answer scores 4 marks	(1)AO2 (1)AO2 (1)AO1 (1)AO2	4	

2	d	i	Energy / enthalpy / *H* Reactants and products both labelled correctly Activation energy	(1)AO1 (1)AO1 (1)AO1	3	

2	d	ii	Endothermic	(1)AO2	1	

Total 14

3	a	i	58	(1)AO2	1	

3	a	ii	Heat energy = 150 × 4.2 × 58 = 36 540 J or 36.54 kJ 1 mark for general equation (ie Q=mc∆T) 1 mark for correct mass of water = 150 36 540 or 36.54 scores 3 marks Correct units required for all 4 marks ecf from 3(a)(i)	(4)AO2	4	

3	a	iii	1.93 / 32 = 0.0603 Correct answer alone gets 2 marks	(1)AO2 (1)AO2	2	Accept 0.06 but not 0.1

3	a	iv	Enthalpy change = Q/n =36.54 kJ / 0.0603 (can score mark from equation or with substituted numbers) = 606 (kJ mol^{-1}) Allow ecf from parts (a) (ii) and (a) (iii)	(1)AO2 (1)AO2	2	Correct answer alone gains full marks Accept 609 if 0.06 answer in 2(a)(iii)

3	b	i	Reactants form products <u>and</u> products form reactants owtte	(1)AO1	1	

3	b	ii	<u>Closed</u> system / container	(1)AO1	1	

3	b	iii	$[CO][H_2]^3$ / $[CH_4][H_2O]$ Correct terms (including square brackets) Correct indices and correct way around	(1)AO2 (1)AO2	2	

<table>
<tr>
<td>3</td>
<td>b</td>
<td>iv</td>
<td colspan="3">The marking 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 below.
<table>
<tr><th>Level</th><th>Marks</th><th>Descriptor
An answer will be expected to meet most of the criteria in the level descriptor</th></tr>
<tr><td>3</td><td>4-5</td><td>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:
- argument is well structured with minimal repetition or irrelevant points
- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling, punctuation and grammar.</td></tr>
<tr><td>2</td><td>2-3</td><td>-answer has some omissions but is generally supported by some of the relevant points below:
-the argument shows some attempt at structure
-the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar.</td></tr>
<tr><td>1</td><td>0-1</td><td>-answer is largely incomplete. It may contain some valid points which are</td></tr>
</table></td>
<td>(2)AO1

(3)AO2</td>
<td>5</td>
<td></td>
</tr>
</table>

					not clearly linked to an argument structure -unstructured answer -errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency			
			A good answer might include: *Le Chatelier's principle states that 'A system at equilibrium will oppose any change imposed.'* *The yield will increase when the temperature is increased. This is because an increase in temperature will cause the rate of the forward reaction to increase for a short time. Application of Le Chatelier's principle indicates that the overall temperature must be reduced. Heat energy will be absorbed as the forward reaction is endothermic. The overall position of equilibrium will therefore shift to the right.*					

3	c	i	The enthalpy / heat energy change When 1 mole of the compound is burnt completely	(1)AO1 (1)AO1	2	

3	c	ii	Evidence of correct Hess's cycle $-283 - (286 \times 2) - \Delta H_c$(methanol) = −91 $\Delta H_c = 91 - 283 - (286 \times 2)$ ie correct rearrangement = −764	(1)AO2 (1)AO2 (1)AO2 (1)AO2	4	

Total 24

4	a	i	Rate = $k[Br^-][BrO_3^-][H^+]^2$ complete answer gains 3 marks Inclusion of *k* $[Br^-][BrO_3^-]$ $[H^+]^2$	 (1)AO1 (1)AO2 (1)AO2	3	
4	a	ii	4	(1)AO2	1	
4	a	iii	When the <u>concentration</u> is doubled The <u>rate</u> will be quadrupled	(1)AO1 (1)AO1	2	
4	a	iv	Rate would halve	(1)AO2	1	
4	b	i	A substance that <u>reacts</u> to form product	(1)AO1	1	
4	b	ii	A substance that alters the rate of a reaction But is not used up itself; no mark for 'does not take part'	(1)AO1 (1)AO1	2	
4	c		A catalyst lowers the activation energy This allows a greater proportion of particles to have sufficient energy to react When they <u>collide</u>	(1)AO1 (1)AO2 (1)AO1	3	

Total 13

5	a		Any three of : insulated / polystyrene cup thermometer measuring cylinder/ bulb pipette/ burette stopclock	(3)AO3	3	

5	b		The marking 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 below.			(5) AO3	5	
			Level	**Marks**	**Descriptor** An answer will be expected to meet most of the criteria in the level descriptor			
			3	4-5	Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below: - argument is well structured with minimal repetition or irrelevant points - accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling, punctuation and grammar.			
			2	2-3	-answer has some omissions but is generally supported by some of the relevant points below: -the argument shows some attempt at structure -the ideas are expressed with			

					reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar.			
			1	0-1	-answer is largely incomplete. It may contain some valid points which are not clearly linked to an argument structure -unstructured answer -errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency			
			A good answer might include: *25 cm^3 of 1.0 mol dm^{-3} hydrochloric acid would be measured into a polystyrene cup using a bulb pipette. The temperature of the acid would be measured every minute for 4 minutes before 25 cm^3 of 1.0 mol dm^{-3} sodium hydroxide (also measured with a bulb pipette) is added at 4.5 minutes.* *The reaction mixture would be thoroughly stirred and the temperature would be measured after 5 minutes, and then after each minute until 10 minutes had passed.* *A graph would then be plotted with time on the horizontal axis and temperature on the vertical axis. Two lines of best fit should be drawn, one for the hydrochloric acid, the other for the reaction mixture. Each of these should be extended to 4.5 minutes and the temperature rise would then be determined.*						

5	c		• Insulate container / lid • Measure temperature of sodium hydroxide before reaction to ensure it is the same as that of the acid before reaction • stir	(1)AO3 (1)AO3	2	

Total 10

	1	2	3	4	5	Total
AO1	9	6		4	8	**27**
AO2	10	18		10	5	**43**
AO3			10			**10**
Total	**19**	**24**	**10**	**14**	**13**	**80**