AQA

A-LEVEL
Applied Science
SC11 Controlling Chemical Processes
Mark scheme

8770
June 2015

V1 Final Mark Scheme

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.

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Question	Answers	Additional Comments/Guidance	Mark	ID details
1(a)	• Change in concentration (of products/reactants) • Over time/in a given time		1 1	
1(b)	• Order = 1; when the concentration of **A** is halved; the rate halves • Order = 2; when the concentration of **B** is doubled; the rate quadruples		2 2	
1(c)(i)	• Vertical: Number of particles • Horizontal: Energy		1 1	
1(c)(ii)	• Peak moves to the left • and higher		1 1	
1(c)(iii)	• At a lower temperature, the particles will move more slowly and will collide less frequently • The proportion of particles that possess an energy greater than or equal to the activation energy will decrease • There will be fewer successful collisions per second		1 1 1	
Total			**13**	

Question	Answers	Additional Comments	Mark	ID details
2(a)(i)	Toxic/irritant		1	
2(a)(ii)	Gas mask	Ignore 'goggles'	1	
2(a)(iii)	Bleach/polymer production		1	
2(b)	E.g. making soap	Accept any correct use	1	
2(c)(i)	• Direct • Indirect • Capital • Indirect		1 1 1 1	
2(c)(ii)	• The cost per unit of the product • is not directly proportional to this cost		1 1	
2(d)(i)	• Products are removed at same time as new reactants are added • Process may never stop		1 1	
2(d)(ii)	Accept any two of: • Faster • Purer product • Labour costs lower	 More easily automated	1 1	
2(e)(i)	58.5		1	
2(e)(ii)	• Moles of NaCl = 740 × 1000 ÷ 58.5 = 12 650 • Moles of Cl_2 = moles of NaCl ÷ 2 =12 650 ÷ 2 = 6325 • Mass of Cl_2 = 6325 × 71 = 449 100 (g) or 449.1 (kg)	2 : 1 ratio needs to be stated/implied for this mark Correct answer alone gains 3 marks.	1 1 1	

2(e)(iii)	740 × 100 ÷ 85 = 871(kg)		1	
Total			**19**	

Question	Answers	Additional Comments/Guidance	Mark	ID details
3(a)	So the concentration of iodine remains the same until analysis is carried out	Accept to remove H^+	1	
3(b)(i)	$I_2 + 2S_2O_3^{2-}$ $2I^- + S_4O_6^{2-}$		1 1	
3(b)(ii)	+2		1	
3(b)(iii)	Redox		1	
3(c)(i)	Any three of: • burette • bulb pipette • conical flask • stopclock • suitable reaction vessel, e.g. round bottomed/conical flask		3	
3(c)(ii)	Both reactant solutions would be measured using a bulb pipette and placed in a large conical flask. This mixture would be swirled to ensure efficient mixing. After 1 minute, 10 cm^3 of the mixture is removed using a bulb pipette and delivered into a clean conical flask that contains an excess of sodium hydrogen carbonate solution. A few drops of starch solution are added and the mixture is titrated. 0.1 $mol\,dm^{-3}$ sodium thiosulphate solution would be delivered from the burette. The mixture is swirled as the sodium thiosulphate is delivered. When near to the endpoint, the sodium thiosulphate is added dropwise. The endpoint occurs when no blue black colouration can be seen. The volume of sodium thiosulphate added is then recorded. 10 cm^3 portions are taken after every subsequent minute and the titration procedure repeated.		5	

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.
Level 1 (0—1 marks)
Answer is largely incomplete. It may contain 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.
Level 2 (2—3 marks)
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.
Level 3 (4—5 marks)
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 minimum repetition or irrelevant points - accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling, punctuation and grammar.

3(c)(iii)	• Vertical = concentration of I_2 • Horizontal = time If quantities correct, one mark out of two		1 1	
3(c)(iv)	Gradient (owtte) = reaction rate		1	
3(d)	Colorimetry		1	
Total			**17**	

Question	Answers	Additional Comments/Guidance	Mark	ID details
4(a)	Homogeneous		1	
4(b)(i)	$[NO]^4[H_2O]^6 \div [O_2]^5[NH_3]^4$ • correct terms (including square brackets) • correct indices and correct way around		 1 1	
4(b)(ii)	mol dm^{-3}		1	
4(c)(i)	• A system at equilibrium will alter the position of equilibrium • to oppose the change imposed		1 1	
4(c)(ii)	• Decrease • Position of equilibrium will shift to the left hand side to <u>lower</u> the temperature • The forward reaction is exothermic so the rate of the reverse reaction will be increased	No mark for simply 'oppose the change'	1 1 1	
4(c)(iii)	There are 10 moles of gaseous molecules on the right-hand side and 9 moles of gaseous molecules on the left-hand side. If the pressure in the vessel is increased, the position of equilibrium will shift to decrease the pressure. This is achieved by moving to the side with the smaller number of <u>gaseous</u> molecules. Therefore the position of equilibrium will move to the left-hand side and there will be a decreased yield of nitrogen monoxide. However, an increase in pressure will increase the number of particles in a given volume. There will therefore be more collisions per second and a consequent increase in the overall rate of reaction. Equilibrium will be established in a shorter time.		5	
Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.				

Level 1 (0-1 marks)
Answer is largely incomplete. It may contain 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.
Level 2 (2-3 marks)
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.
Level 3 (4-5 marks)
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 minimum repetition or irrelevant points - accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling, punctuation and grammar.

4(d)	• [Y] = 3.74 ÷ 2.3 = 1.63 mol dm^{-3} • $K_c = 0.57^2 \div (1.63 \times 0.84^2)$ • = 0.3249 ÷ 1.150 = 0.28	Divide by volume Mark is for substituting numbers Mark is for final value Correct answer alone gains 3 marks	1 1 1	
Total			**17**	

Question	Answers	Additional Comments/Guidance	Mark	ID details
5(a)	Correct Hess's cycle or ΔH(reaction) = $\Sigma\Delta H_f$ (products) − $\Sigma\Delta H_f$ (reactants) $\Sigma\Delta H_f$ (p) = (2×+147.2) + (6×−241.8) = −1156.4 $\Sigma\Delta H_f$ (r) = (2×+20.2) + (2×−394.4) + 0 = −748.4 ΔH(reaction) = (−1156.4) − (−748.4) = −408 ΔH(reaction per mole) = −408 kJ mol^{-1} ÷ 2 = −204 kJ mol^{-1}	Correct answer alone gains 4 marks	1 1 1 1	
5(b)	• Average enthalpy required to break one mole of a particular covalent bond • in different environments / compounds		1 1	
5(c)	• Bond breaking = (12×413) + (2×346) + (2×610) + (6×390) + (3×497) =4956 + 692 + 1220 + 2340 + 1491 = +10 699 • Bond making =(6×413) + (2×610) + (2×346) + (2×887) + (12×463) =2478 + 1220 + 692 + 1774 + 5556 = 11 720 • Bond breaking – bond making = 10 699 – 11 720 = −1021 kJ mol^{-1} ΔH = −1021 ÷ 2 = −510.5 kJ mol^{-1}	Bond breaking = (6×413) +(6×390)+ (3×497) = 6309 Bond making = (2×887) + (12×463) =7330 Bond breaking – bond making = 6309 – 7330 = −1021 kJ mol^{-1} ΔH = −1021 ÷ 2 = −510.5 kJ mol^{-1} Correct answer alone gains 4 marks.	1 1 1 1	
5(d)	5(a) because values for specific compounds not averaged over many different compounds		1	
5(e)	• Correct shape		1	

	• Reactants and products labels correct • Products lower than reactants	ecf from 5(a) and 5(c)	1 1	
Total			**14**	