

Version 1.0: 0810



**General Certificate of Education  
June 2010**

**APPLIED SCIENCE**

**SC11**

**Unit 11      Controlling Chemical Processes**

***Mark Scheme***

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**Question 1**

(a)	Heterogeneous	(1) (AO1)	<b>1</b>
(b)(i)	Incomplete reaction 2 other products formed	(1) (AO2) (1) (AO2)	<b>2</b>
(b)(ii)	63 80	(1) (AO2) (1) (AO2)	<b>2</b>
(b)(iii)	If 100% yield: mass = $100/80 \times 63 = 78.75\text{kg}$ (or molar calculation acceptable) As yield only 90% mass needed = $78.75 \times 100/90 = 87.5\text{kg}$	(2) (AO2) (1) (AO2)	<b>3</b>
(c)	Increase rate at which it dissolves	(1) (AO2)	<b>1</b>
(d)(i)	Direct	(1) (AO1)	<b>1</b>
(d)(ii)	Indirect	(1) (AO1)	<b>1</b>
(d)(iii)	Indirect	(1) (AO1)	<b>1</b>
(d)(iv)	Capital	(1) (AO1)	<b>1</b>
(e)(i)	- 3 + 5	(1) (AO2) (1) (AO2)	<b>2</b>
(e)(ii)	oxidation	(1) (AO2)	<b>1</b>

**Total Mark: 16****Question 2**

(a)	The enthalpy/heat energy change When <b>one mole</b> of a compound undergoes <b>complete</b> combustion	(1) (AO1) (1) (AO1)	<b>2</b>
(b)(i)	Any <b>three</b> from Balance Measuring cylinder/ bulb pipette/ burette Calorimeter/ copper can Thermometer Answers can be derived from a <b>diagram</b>	(3) (AO3)	<b>3</b>

(b)(ii)	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)	<b>5</b>
	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		
An ideal answer might read: Before the experiment measure the mass of the spirit burner (which contains the ethanol) using a balance. Measure the volume of water to be used accurately using a burette. The temperature of the water is also measured before the experiment starts. Light the spirit burner and heat the calorimeter. After heating ensure that both the temperature of the water and the mass of the spirit burner are measured again. Calculate the temperature rise in the experiment. Use $Q = mc\Delta T$ to calculate the energy released in experiment, where m= mass of the water used. Then use Q/No of moles of ethanol used in experiment (calculated using moles = mass/ $M_r$ ) to calculate the enthalpy of combustion					
(b)(iii)	<b>Any 2 from</b> Lid on calorimeter Reduce draughts Stir water consistently Allow insulate calorimeter			(1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3)	<b>2</b>

(c)(i)	Bonds broken = $5 \times 413 + 348 + 360 + 463 + 3 \times 498 = 4730$ Bonds made = $4 \times 743 + 6 \times 463 = 5750$ Bonds broken – bonds made (1 mark for this or for numerical answer) = $4730 - 5750 = -1020$ mark if negative sign correct as well as numerical answer	(1) (AO2) (1) (AO2) (1) (AO2)  (1) (AO2)	<b>4</b>
(c)(ii)	Higher Heat loss in experiment	(1) (AO2) (1) (AO1)	<b>2</b>

**Total Mark: 18****Question 3**

(a)(i)	Forward <b>and</b> reverse reactions occur At same rate (concentrations of reactants and products remain constant)	(1) (AO1)  (1) (AO1)	<b>2</b>																
(a)	Closed/sealed	(1) (AO1)	<b>1</b>																
(b)(i)	$[\text{SO}_3]^2 / [\text{SO}_2]^2 [\text{O}_2]$ Correct terms Correct indices	(1) (AO2) (1) (AO2)	<b>2</b>																
(b)(ii)	Rearranged Kc expression Substituted numbers $\sqrt{(1.2 \times 10^5 \times 24 \times 24 \times 18.5)} = \sqrt{1.27872 \times 10^9} = 3.576 \times 10^4 \text{ moldm}^{-3}$	(1) (AO2) (1) (AO2)  (1) (AO2)	<b>3</b>																
(c)(i)	<p>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.</p> <table border="1"> <thead> <tr> <th>Level</th> <th>Marks</th> <th>Descriptor</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td>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>-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 not clearly linked to an argument structure -unstructured answer -errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency</td> </tr> </tbody> </table>		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	(2) (AO1) (3) (AO2)	<b>5</b>
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(c)(i) cont	Quality of written Communication An ideal answer might read: Le Chatelier's principle states that a system in equilibrium will oppose any change imposed upon it. Yield of sulphur trioxide will <b>decrease</b> as the reverse (endothermic) reaction will be favoured in order to reduce the temperature of the system.		
(c)(ii)	High pressure = hazardous/ cost not outweighed by benefit	(1) (AO2)	<b>1</b>
(d)(i)	A substance that alters the rate of a reaction But remains unchanged itself	(1) (AO1) (1) (AO1)	<b>2</b>
(d)(ii)	Reactants and products labelled General shape Products lower than reactants	(1) (AO1) (1) (AO1) (1) (AO2)	<b>3</b>
(d)(iii)	Peak lower than original Curve joins original at reactants and products	(1) (AO2) (1) (AO1)	<b>2</b>

**Total Mark: 21****Question 4**

(a)	Zero order as rate is unaltered when concentration of B is altered	(1) (AO2) (1) (AO2)	<b>4</b>
	second order as rate is quadrupled when concentration of C is doubled	(1) (AO2) (1) (AO2)	
(b)	Rate = $k [A][C]^2$ inclusion of k order of A overall equation	(1) AO1 (1) AO2 (1) AO2	<b>3</b>
(c)	temperature	(1) AO2	<b>1</b>
(d)	$\text{Mol}^{-2}\text{dm}^6\text{s}^{-1}$	(1) AO2	<b>1</b>

**Total Mark: 9****Question 5**

(a)(i)	Vertical – no. of particles Horizontal – energy Activation energy shown at some point on the x-axis	(1) (AO1) (1) (AO1) (1) (AO1)	<b>3</b>
(a)(ii)	Starts at origin Peak of drawn curve is higher than original At no point does the drawn curve cross the original	(1) (AO1) (1) (AO2) (1) (AO2)	<b>3</b>
(b)	More particles therefore there will be <b>more collisions</b> More particles will have <b>energy greater than the activation energy</b> There will be more <b>successful</b> collisions	(1) (AO2) (1) (AO2) (1) (AO2)	<b>3</b>
(c)	More collisions	(1) (AO1)	<b>1</b>
(d)(i)	Reactants are added, reaction occurs then products are removed Vessel cleaned and then fresh reactants added	(1) (AO1) (1) (AO1)	<b>2</b>
(d)(ii)	Products are removed at same time as reactants are added Process never stops	(1) (AO1) (1) (AO1)	<b>2</b>

(d)(iii)	Lower labour cost/faster/can give purer product/lower energy cost/savings on rent, etc	(1) (AO1) (1) (AO1)	<b>2</b>
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**Total Mark: 16**