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General Certificate of Education (A-level)
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Applied Science SC11

(Specification 8771/8773/8776/8777/8779)

Unit 11: Controlling Chemical Processes

Mark Scheme

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Question	Part	Sub-part	Marking guidance	AO	Mark	Comment
1	(a)		Products are removed at same time as reactants are added Process never stops / continuously	1(AO1) 1(AO1)	**2**	
1	(b)		Reactants are added and reaction occurs And then products are removed	1(AO1) 1(AO1)	**2**	
1	(c)		Any **two** of: Lower labour cost/faster/can give purer product/lower energy cost/savings on rent, no downtime i.e. start-up/shut-down costs	2(AO1)	**2**	
1	(d)	(i)	Closed container	1(AO1)	**1**	
1	(d)	(ii)	Correct substitution 7.8(4) answer = 2 marks	1(AO2) 1(AO2)	**2**	
1	(d)	(iii)	$mol^{-1}dm^{3}$	1(AO2)	**1**	
2	(a)	(i)	Neutralisation/exothermic	1(AO2)	**1**	
2	(a)	(ii)	**2**HNO_3	1(AO2)	**1**	
2	(a)	(iii)	Heterogeneous	1(AO2)	**1**	
2	(b)	(i)	Change in concentration (of product/reactant) Over time	1(AO1) 1(AO1)	**2**	
2	(b)	(ii)	If measure mass loss: Top-pan balance Any **two** of: Weigh boat Conical flask Cotton wool Measuring cylinder/bulb pipette/burette	 1(AO3) 2(AO3)	**3**	

			Thermometer Stopclock **OR** If measure volume of gas produced: Gas syringe = 1 mark Any two of: Conical flask/ round bottomed flask Rubber bung to ensure airtight seal Measuring cylinder/bulb pipette/burette Thermometer Stopclock (list principle applies)			

2	(b)	(iii)	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	Mark	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, and 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: Approximately 3g of limestone pieces would be measured accurately in a weigh boat using a top-pan balance. 50cm^3 of 1.0 mol dm^{-3} nitric acid would be measured using a bulb pipette and placed in the conical flask (reasonable quantities required). The temperature of the acid is then measured. The conical flask would then be placed on the top-pan balance and the balance zeroed. The limestone pieces would then be added to the conical flask and the stopclock started at the same time. The initial mass reading (the starting mass of the limestone pieces) should be noted and then mass readings recorded every 20 seconds.			

2	(b)	(iv)	Any two of: Same **mass** of limestone pieces Same **size** of limestone pieces Same **volume** of nitric acid Same **concentration** of nitric acid Same **temperature** of nitric acid	1(AO3) 1(AO3)	**2**	

2	(c)		Smaller pieces have an increased surface area And so a greater number of particles available for collision Therefore more successful collisions per second will occur	1(AO2) 1(AO2) 1(AO2)	**3**	

3	(a)	(i)	78.5 74	1(AO2) 1(AO2)	**2**	
3	(a)	(ii)	Moles ethanoyl chloride = 10/78.5 = 0.1274 1:1 therefore moles methyl ethanoate = 0.1274 Mass of methyl ethanoate = 0.1274 x 74 = 9.4(3)g	1(AO2) 1(AO2) 1(AO2)	**3**	
3	(a)	(iii)	Incomplete reaction/side reactions occur/impure reactant/transfer losses	1(AO1)	**1**	
3	(b)		$\Sigma\Delta H_f$(products) $-\Sigma\Delta H_f$(reactants) /appropriate Hess's cycle $\Sigma\Delta H_f$(products)= –538.1 $\Sigma\Delta H_f$(reactants = –512.0 (–538.1) – (–512.0) = –26.1 (ignore units unless wrong)	1(AO2) 1(AO2) 1(AO2) 1(AO2)	**4**	
3	(c)		Average enthalpy required to break one mole of a particular covalent bond in different environments.	1(AO1) 1(AO1)	**2**	
3	(d)		Σbonds broken = 4858 Σbonds formed = 4816 Enthalpy change = Σbonds broken − ΣBonds formed =4858 – 4816 = (+)42 $kJmol^{-1}$ (ignore units unless wrong)	1(AO2) 1(AO2) 1(AO1) 1(AO2)	**4**	
3	(e)		Bond enthalpies are averages and not specific to methyl ethanoate	1(AO2)	**1**	
4	(a)	(i)	The <u>rate</u> of the forward reaction is <u>Equal</u> to the <u>rate</u> of the backward reaction	1(AO1) 1(AO1)	**2**	
4	(a)	(ii)	Sketch has a peak which is <u>above</u> level of reactants and products <u>and</u> general shape correct Products are <u>lower</u> than reactants	1(AO1) 1(AO2)	**2**	
4	(b)		A system at <u>equilibrium</u> Shifts to oppose any change imposed on it	1(AO2) 1(AO2)	**2**	

<table>
<tr><td rowspan="6">4</td><td rowspan="6">(c)</td><td rowspan="6"></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.</td><td rowspan="6">2(AO1)
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The increase in pressure will mean that there are more particles in any given volume. The number of successful collisions per second will therefore increase and so will the rate of the reaction.</td></tr>
</table>

				There is a smaller number of gaseous molecules on the RHS (or converse). Therefore if the pressure is increased the equilibrium will shift to the RHS to reduce the presssure of the system and so the yield of ammonia will increase.			
4	(d)	(i)		Yield of ammonia decreases As the <u>forward reaction is exothermic</u> The reverse reaction is favoured to <u>reduce the temperature</u>, or converse	1(AO2) 1(AO2) 1(AO2)	**3**	
4	(d)	(ii)		Even though higher temperature reduces yield it <u>increases rate</u> at which equilibrium is established (owtte)	1(AO1)	**1**	
5	(a)			A substance which alters the rate of a reaction Without being <u>used up</u> itself	1(AO1)	**1**	
5	(b)	(i)		The <u>minimum</u> amount of energy Particles require to react when they collide	1(AO1) 1(AO1)	**2**	
5	(b)	(ii)		Starts at origin and skewed to left Does not touch *x*-axis but approaches close to it	1(AO1) 1(AO1)	**2**	
5	(b)	(iii)		E_a on *x*-axis E_a(cat) to left of E_a	1(AO1) 1(AO2)	**2**	
5	(b)	(iv)		A catalyst reduces the activation energy for a reaction and So increases the proportion of particles that possess an energy greater than or equal to the E_a There will therefore be more successful collisions per second	1(AO1) 1(AO2) 1(AO2)	**3**	
6	(a)	(i)		First As concentration of A is tripled rate also triples Second As concentration of B is multiplied by 4 rate is multiplied by 16	1(AO2) 1(AO2) 1(AO2) 1(AO2)	**4**	

6	(a)	(ii)	Temperature	1(AO1)	**1**	

6	(b)	(i)	When the concentration of Y increases the rate is unaltered	1(AO1)	**1**	

6	(b)	(ii)	3	1(AO2)	**1**	

6	(b)	(iii)	Rate = k[**X**]^2[**Z**] Rate = k [**X**]^2 [**Z**]	 1(AO1) 1(AO2) 1(AO2)	**3**	