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General Certificate of Education (A-level) Applied
January 2012

Applied Science SC11

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

Unit 11: Controlling Chemical Processes

Final

Mark Scheme

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 events which all examiners 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 examiner understands and applies it in the same correct way. As preparation for standardisation each examiner 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, examiners encounter unusual answers which have not been raised 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 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	Part	Sub-part	Marking guidance	AO	Mark	Comment
1	(a)	(i)	Products are removed at same time <u>as</u> reactants are added Process never stops	1(AO1) 1(AO1)	**2**	
1	(a)	(ii)	Faster Purer product	1(AO1) 1(AO1)	**2**	
1	(b)	(i)	$TiO_2 + 2\ Cl_2 + 2\ C \rightarrow TiCl_4 + 2\ CO$	1(AO2) 1(AO2)	**2**	
1	(b)	(ii)	Reactants are added, reaction occurs Then products are removed (and vessel is cleaned)	1(AO1) 1(AO1)	**2**	
1	(b)	(iii)	(+)4 0	1(AO2) 1(AO2)	**2**	
1	(b)	(iv)	Reduction/redox	1(AO2)	**1**	
1	(c)	(i)	The **cost (per unit) of the product** is **directly influenced by** this cost. (OWTTE)	1(AO1) 1(AO1)	**2**	
1	(c)	(ii)	Direct Indirect Capital	1(AO2) 1(AO2) 1(AO2)	**3**	

Total Marks: 16

2	(a)		Enthalpy/heat energy change when **<u>One mole</u>** of a compound undergoes <u>complete</u> combustion	1(AO1) 1(AO1)	**2**	

2	(b)	(i)	Any three from: 1 - Thermometer 2 - Burette/pipette/measuring cylinder 3 - Calorimeter/copper can 4 - Balance	1(AO3) 1(AO3) 1(AO3)	**3**	

2	(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)	**5**	

Level	Marks	Descriptor An answer will be expected to meet most of the criteria.
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.

2	(b)	(ii)	<table><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></table> QWC *A good answer might include:* A small camping stove could be used. The mass of the stove with butane would be measured and recorded before the experiment. A known volume of water (100cm^3) would be accurately measured using a burette and placed in a copper calorimeter. The temperature of the water would be measured for a few minutes to allow the thermometer to equilibrate. The stove would then be lit and used to heat the water in the calorimeter until the temperature had risen by 10^{o}C. The flame would then be extinguished and the mass of the burner, once cool, measured again. Q=mcΔT would then be used to calculate the enthalpy change for the experiment. The molar enthalpy change for butane would then be calculated using Q/no of moles.			

2	(b)	(iii)	Any two of: Insulate container/lid Reduce draughts (i.e. use heat shield) Stir consistently Repeat	1(AO3) 1(AO3)	**2**	

2	(c)		Use Q = mcΔT Q = 3000 × 4.2 × 95 = 1197 kJ Number of moles = 1197/2876.5 = 0.416(1) Assumption is that the water will boil at 100 ^{o}C Density of water = 1g/cm^{3} All heat is transferred to container (OWTTE) 100% efficiency	1(AO1) 1(AO2) 1(AO2) 1(AO1)	**4**	
2	(d)	(i)	0.732 x 100/80 = 0.915 If used alternative answer will be 0.915	1(AO2)	**1**	
2	(d)	(ii)	0.915 x 22.4 = 20.5 If used alternative answer will be 20.5 dm^{3}	1(AO2)	**1**	

Total Marks: 18

3	(a)	(i)	**Reactants and products** are in the **same** state	1(AO1) 1(AO1)	**2**	
3	(a)	(ii)	Both forward and reverse reactions occur OR When products can be turned back into reactants OWTTE	1(AO1)	**1**	
3	(b)	(i)	A system in **equilibrium** Will **oppose** any change imposed upon it	1(AO1) 1(AO1)	**2**	
3	(b)	(ii)	Number of moles of NO present will **increase** The forward reaction is **endothermic** The equilibrium will therefore shift to the right to **oppose the increase in temperature/reduce the temperature**	1(AO2) 1(AO2) 1(AO2)	**3**	
3	(b)	(iii)	None LCP states that increase in pressure will shift the equilibrium to side with the least gas molecules the number of gaseous reactant molecules is the **same** as the number of gaseous product molecules.	1(AO2) 1(AO2) 1(AO2)	**3**	

3	(c)	(i)	0.12 × 0.12 / 0.8 × 0.05 mark is for substituting numbers correctly = 0.0144 / 0.04 = 0.36	1(AO2) 1(AO2) 1(AO2)	**3**	
3	(c)	(ii)	Top and bottom **cancel** each other out	1(AO2)	**1**	

Total Marks: 15

4	(a)	(i)	$\Sigma\Delta H_f$(products) - $\Sigma\Delta H_f$(reactants) / appropriate Hess's cycle –77.6 – 52.3 = −129.9 (ignore units)	1(AO2) 1(AO2)	**2**	
4	(a)	(ii)	Enthalpy of formation for oxygen is zero because it is an element	1(AO1)	**1**	
4	(a)	(iii)	Σ Bonds broken = 612 + 496/2 = 860 Σ Bonds formed = 348 + 2 × 360 = 1068 Bonds broken – bonds formed = −208	1(AO2) 1(AO2) 1(AO2)	**3**	
4	(a)	(iv)	Mean bond enthalpies are an average for that bond in several **different environments** whereas Enthalpy of formation data are for those **specific** compounds	1(AO1) 1(AO1)	**2**	
4	(b)		No naked flames Breathing apparatus / contain fumes	1(AO2)	**1**	
4	(c)	(i)	Horizontal axis = Energy Vertical axis = number of molecules	1(AO1) 1(AO1)	**2**	
4	(c)	(ii)	Curve skewed to left of original Peak higher than original	1(AO2) 1(AO2)	**2**	

<table>
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<td>4</td>
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<td></td>
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Total Marks: 18

5	(a)		4	1(AO1)	**1**	
5	(b)	(i)	4.4×10^{-3} 0.3	1(AO2) 1(AO2)	**2**	
5	(b)	(ii)	Rate constant	1(AO2)	**1**	
5	(b)	(iii)	11	1(AO2)	**1**	
5	(b)	(iv)	$mol^{-3}\ dm^{+9}\ s^{-1}$	1(AO2)	**1**	
5	(c)	(i)	A substance which **alters the rate of a reaction** But is **itself not used up**	1(AO1) 1(AO1)	**2**	

5	(c)	(ii)	Reactants and products labelled General shape Products lower than reactants	1(AO1) 1(AO1) 1(AO2)	**3**	

5	(c)	(iii)	Peak lower Joins original at reactants and products	1(AO2) 1(AO1)	**2**	

Total Marks: 13