Version 1.0: 0209

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Applied Science 8771/8773/8776/8779

SC11 Controlling Chemical Processes

Mark Scheme

2009 examination – January series

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Question 1

(a)	Any two of (Both) forward and reverse reactions occur At same rate Constant concentrations of reactants and products	 (1) (AO1) (1) (AO1) (1) (AO1)	**2**
(b)(i)	Correct terms – i.e. correct formulae & square bracket Correct indices	(1) (AO2) (1) (AO2)	**2**
(ii)	0.9 x 1.2 / 0.5 x 0.6 = 3.6 OR 0.6 x 0.8 / 0.333 x 0.4 = 3.6 (if concentrations were calculated) 1 mark for correct concentrations 1 mark for correct substitution, 1 mark answer 3 marks if 3.6 given	 (1) (AO2) (1) (AO2) (1) (AO2)	**3**
(c)(i)	Any sensible suggestion as long as closed	(1) (AO3)	**1**
(ii)	Cool the mixture/flood/quench	(1) (AO3)	**1**
(iii)	(Titrate) using a (strong) alkali Of known concentration / standard Max 4 for description of titration - pipette - swirling flask constantly - burette - adding dropwise near endpoint - repeat until concordant Any 2 standard precautions to ensure accuracy	(1) (AO3) (1) (AO3) (4) (AO3)	**6**
(iv)	More than one mixture at each temperature	(1) (AO3)	**1**
(v)	Hydrochloric acid was a catalyst	(1) (AO2)	**1**
(vi)	No effect Increases rate of both forward and reverse reactions equally	(1) (AO1) (1) (AO1)	**2**

Total Mark: 19

Question 2

(a)(i)	$\Sigma\Delta H_f$(products) - $\Sigma\Delta H_f$(reactants) /appropriate Hess's cycle = 2 x (-394) + 3 x (-286) – (-278) = -1368 (kJ mol^{-1})	(1) (AO1) (1) (AO2) (1) (AO2)	**3**
(ii)	(It is an) element	(1) (AO1)	**1**
(b)(i)	21(^oC)	(1) (AO3)	**1**
(ii)	Q = mcΔt = 150 x 4.2 x 21 (mark is for using 150) = 13230J or 13.23kJ Correct units Mark consequentially on b(i)	(1) (AO1) (1) (AO2) (1) (AO2) (1) (AO2)	**4**
(iii)	62.09 – 61.26 = 0.83 0.83/46 = 0.018	(1) (AO2) (1) (AO2)	**2**
(iv)	13.23kJ / 0.018 735(kJ mol^{-1}) Mark consequentially on b(ii)	(1) (AO2) (1) (AO2)	**2**
(v)	Heat loss in experimental results Incomplete combustion	(1) (AO3) (1) (AO3)	**2**

Total Mark: 15

Question 3

(a)	Homogeneous	(1) (AO1)	**1**
(b)(i)	Rate = $k[H_2][I_2]$	(1) (AO2)	**1**
(ii)	Doubled	(1) (AO2)	**1**
(c)(i)	Reactants and products labelled General shape Products lower than reactants	(1) (AO1) (1) (AO1) (1) (AO2)	**3**
(ii)	Activation energy correctly labelled	(1) (AO1)	**1**
(d)	3	(1) (AO2)	**1**
(e)	In table each line needs following adding: 0.2 0.4 1.8 x 10-1	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(f)(i)	Rate constant	(1) (AO1)	**1**
(ii)	mol $^{-2}$ dm^6s^{-1}	(1) (AO2)	**1**
(iii)	Temperature increase	(1) (AO1)	**1**

Total Mark: 14

Question 4

(a)(i)	Indirect	(1) (AO1)	**1**
(ii)	Capital	(1) (AO1)	**1**
(iii)	Direct	(1) (AO1)	**1**
(iv)	Indirect	(1) (AO1)	**1**
(b)(i)	A system in equilibrium Will oppose any change imposed upon it	(1) (AO1) (1) (AO1)	**2**
(ii)	Increase Equilibrium will shift to RHS to relieve pressure Fewer gaseous moles on RHS/4 on LHS, 2 on RHS	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(iii)	Decrease Therefore equilibrium will shift to LHS to reduce Forward reaction is exothermic temperature	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(c)	Minimum energy Required for a reaction to occur/ for a successful collision	(1) (AO1) (1) (AO1)	**2**
(d)(i)	Starts at origin Skewed to right Does not touch x axis but approaches close to it E_a shown on x axis	(1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1)	**4**
(ii)	(Increase in temp gives) particles more energy More effective / successful collisions More particles with energy greater than or equal to E_a	(1) (AO2) (1) (AO2) (1) (AO2)	**3**

Total Mark: 21

Question 5

(a)(i)	Reactants added as products removed Not stopped and restarted / process is non-stop	(1) (AO1) (1) (AO1)	**2**
(ii)	Cost savings – must state what i.e. energy, labour cost. rent, insurance, etc	(2) (AO1)	**2**
(iii)	When process is still in the pre-production stages/ when only small quantities required/ product not very stable Any sensible product suggestion eg. Pharmaceuticals	(1) (AO1)	**1**
(b)(i)	80 44	(1) (AO2) (1) (AO2)	**2**
(ii)	Moles of nitrous oxide = 132/44 = 3 Reaction is 1:1 therefore 3 moles of ammonium nitrate required Mass of ammonium nitrate = moles x M_r = 3 x 80 = 240 kg 44 – 80 scores 1 mark Mark consequentially on b(i)	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(iii)	103/132 x 100 = 78%	(1) (AO2)	**1**

Total Mark: 11