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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Applied Science 8771/8773/8776/8779

SC11 Controlling Chemical Processes

Mark Scheme

2008 examination – June series

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Question 1

(a)(i)	Cost of each unit has direct effect on unit cost of product	(1) (AO1)	**1**
(ii)	Maintenance of plant / insurance / rent / depreciation etc	(1) (AO1)	**1**
(iii)	Capital	(1) (AO1)	**1**
(b)	Measure change in pH	(1) (AO3)	**1**
(c)	First Rate halves as concentration halves	(1) (AO2) (1) (AO2)	**2**
(d)(i)	Rate = $k[CH_3COOCH_3][NaOH]$	(1) (AO2)	**1**
(ii)	2.6×10^{-2}	(1) (AO3)	**1**
(e)	Rate does not depend on the concentration of sodium hydroxide	(1) (AO1)	**1**
(f)	Increase energies of particles Increase number of (successful) collisions Increase proportion / number of particles that possess energy greater than the activation energy	(1) (AO1) (1) (AO1) (1) (AO1)	**3**
(g)	Sodium hydroxide Corrosive (allow irritant as this applies at lower concs) OR methyl ethanoate – flammable/irritant	(1) (AO1)	**1**

Total Mark: 13

Question 2

(a)	H_3PO_4 + **3**NaOH → Na_3PO_4 + **3**H_2O	(1) (AO2)	**1**
(b)(i)	NB – credit any other appropriate techniques attempted Acid and alkali Stabilise reagent temps Reasonable volume of acid / alkali selected (e.g. 50 cm^3) Temp of acid measured before mixing Temp of alkali measured before mixing Complete mixing of reagents ensured Temp taken for several minutes to account for cooling / warming Temp rise measured **Max 5**	 (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3)	**5**
(ii)	Use q = mcΔT or H =Δq/n	(1) (AO3)	**1**
(c)	**Any 2 from** Reasonable concentration of acid suggested Any method of reduction of heat loss Any reference to precision of the measuring equipment used Repeat Stir	 (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3)	**2**
(d)(i)	11.5°C 11.4 → 11.6 °C	(1) (AO2)	**1**
(ii)	2898 / ecf J	(1) (AO2) (1) (AO1)	**2**

Total Mark: 12

Question 3

(a)	Enthalpy or Heat Energy required / released to <u>break/form</u> (one mole of a particular covalent) bond	(1) (AO1)	**1**
(b)	290 + 413 = 703 347 + 366 = 713 Bonds broken – Σ bonds made Mark is for numerical answer (10)	(1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2)	**4**
(c)	15.5-36.4 – (-90.5 +108.9) / appropriate cycle / $\Sigma\triangle H_f$ prods - $\Sigma\triangle H_f$ reactions =-20.9 -18.4 =-39.3	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(d)	Mean bond enthalpy values are an <u>average</u> for large range of molecules / not specific to these molecules	(1) (AO1)	**1**

Total Mark: 9

Question 4

(a)	Oxidation accept REDOX	(1) (AO2)	**1**
(b)(i)	Divide no of moles by volume Substitute numbers into expression 1.62 (to 3s.f)	(1) (AO1) (1) (AO2) (1) (AO2)	**3**
(ii)	$mol^{-2}\ dm^6$	(1) (AO2)	**1**
(c)(i)	Decreases Forward reaction is exothermic (or converse) Eqm shifts to left To reduce temperature / absorb heat / opposes change imposed	(1) (AO2) (1) (AO2) (1) (AO2) (1) (AO1)	**4**
(ii)	Lower yield But faster rate	(1) (AO2) (1) (AO2)	**2**

Total Mark: 11

Question 5

(a)	If slow, candidate must qualify answer Exothermic reaction/product unstable	(1) (AO2)	**1**
(b)(i)	Number of particles	(1) (AO1)	**1**
(ii)	<u>Total</u> number of particles present	(1) (AO1)	**1**
(iii)	Curve skewed to left of original <u>and</u> starting at 0 Peak higher than original and crosses original curve	(1) (AO1) (1) (AO1)	**2**
(c)(i)	Products have higher energy than reactant Positive – accept endothermic	(1) (AO2) (1) (AO1)	**2**
(ii)	Peak higher Require start and finish to be the same as original curve	(1) (AO1)	**1**
(d)(i)	Minimum energy particles must possess for a collision to be successful / to react	(1) (AO1) (1) (AO1)	**2**
(ii)	Provides alternative route/pathway requiring lower energy	(1) (AO1) (1) (AO1)	**2**

Total Mark: 12

Question 6

(a)(i)	Reactants added (at start), reaction occurs + reaction stops Reaction stops products removed /vessel washed / reaction started again	(1) (AO1) (1) (AO1)	**2**
(ii)	Advantage: low set-up / capital costs / simple technology / suitable for small scale production Disadvantage: higher labour costs / time consuming	(1) (AO1) (1) (AO1)	**2**
(iii)	Reactants added as products removed (2 marks) Not stopped and restarted (alternative for 1 mark)	(1) (AO1) (1) (AO1)	**2**
(b)(i)	109 151	(1) (AO2) (1) (AO2)	**2**
(ii)	$\frac{302}{151}$ x 109 (mk is for $\frac{302}{151}$ = 2) = 218 kg	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(iii)	$\frac{80}{100}$ x 302 = 241.6 or 242	(1) (AO2)	**1**

Total Mark: 12

Question 7

(a)(i)	The products can re-form the reactants / the reaction can take place in both directions	(1) (AO1)	**1**
(ii)	The forward and reverse reactions occur at the same rate	(1) (AO1)	**1**
(b)	Homogeneous	(1) (AO1)	**1**
(c)	Increase Less moles / particles of gas on RHS (or converse) Equilibrium shifts to RHS to relieve/counteract increase in pressure	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(d)(i)	$K_c = [SO_3]^2/[SO_2]^2[O_2]$ Correct fraction Correct indices	(1) (AO1) (1) (AO1)	**2**
(ii)	Decrease	(1) (AO2)	**1**
(e)	Increase surface area So increase collisions / increase the number of particles available for collision	(1) (AO2) (1) (AO2)	**2**

Total Mark: 11