UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

9791 CHEMISTRY

9791/03 Paper 3 (Part B Written), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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UNIVERSITY of CAMBRIDGE
International Examinations

Question Number	Expected Answer	Max Marks	Rationale
1 (a) (i)	If the conditions of an equilibrium are changed then the system will adjust in such a manner as to oppose the change	1	**ALLOW** alternatives for 'oppose' e.g. 'minimise', 'counteract'
1 (a) (ii)	$K_p = \frac{pNO^2}{pN_2 \times pO_2}$	2	1 mark if no 'squared' or if square brackets used
1 (a) (iii)	K_p increases with increasing T Increasing T favours endothermic reaction **OR** inc T favours forward reaction **OR** inc T favours NO production (so forward reaction must be endothermic)	1 1	
1 (a) (iv)	No change in equilibrium position Equal number of moles of gas on each side	1 1	
1 (b) (i)	T_2 curve must have its peak to the right and lower than T_1 T_2 curve must start at '0,0' only cross T_1 once and not touch T_1 curve at RHS *Number of molecules* labelled on vertical axis *Energy* labelled on horizontal axis	1 1 1 1	**IGNORE** 'kinetic'
1 (b) (ii)	Labelled E_a on horizontal axis with line up to top curve **AND** reference to greater area under curve above E_a for T_2 curve More molecules with $E>E_a$ at higher T Greater proportion of collisions successful	1 1 1	
Total		**[14]**	

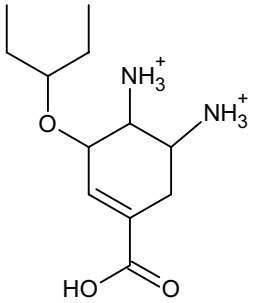
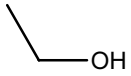
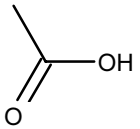
Question Number	Expected Answer	Max Marks	Rationale
2 (a)	$V \alpha T$ or V/T = Constant	1	**ALLOW** $V_1/T_1 = V_2/T_2$
2 (b) (i)	Forces of attraction and repulsion between particles **OR** intermolecular forces Particles have volume	1 1	Both needed if just 'forces' 'Particle' owtte must be seen at least once
2 (b) (ii)	$V = nRT/p = \frac{1 \times 8.31 \times 273}{1 \times 10^5} = 0.0227\ m^3 = 22.7\ (dm^3)$ **(1) (1)**	2	
2 (b) (iii)	At high pressures the molecular size **OR** the forces of repulsion become increasingly significant Increase in pressure is accompanied by a less than ideal decrease in volume	1 1	
2 (b) (iv)	Volume effect is greater the bigger the particles	1	**DO NOT ALLOW** 'mass'
2 (c)	Intermolecular forces of attraction (are significant when KE of molecules is relatively low hence) Increase in pressure causes greater than ideal decrease in volume	1 1	
Total		**[10]**	

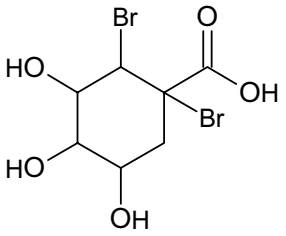
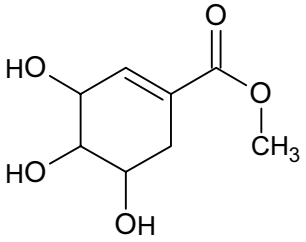
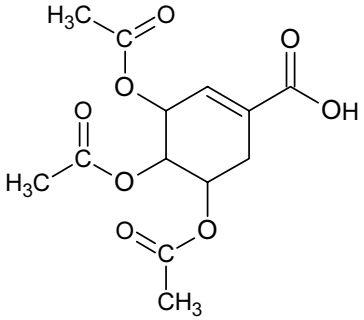
Question Number	Expected Answer	Max Mark	Rationale
3 (a)	**A:** Electrons **B:** Protons/Hydrogen ions/H^+	1 1	
3 (b)	platinum (palladium/nickel/metal hydrides)	1	
3 (c)	Cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ Anode: $H_2 \rightarrow 2H^+ + 2e^-$	1 1	**ALLOW** one mark if correct equations but wrong way round **ALLOW** 'multiples'
3 (d) (i)	Any two from: • eliminates/reduces greenhouse gases if hydrogen comes from electrolysis of water • have higher efficiency (than diesel or gas engines) • much quieter operation (than internal combustion engines) • maintenance simple/few moving parts	Max 2	Advantages must relate directly to context of use in motor vehicles
3 (d) (ii)	Any two from: • reforming is technically challenging and not environmentally friendly • 'refuelling' and starting times are longer • driving range of cars is shorter • fuel cells generally bigger/heavier than comparable batteries or engines	Max 2	Disadvantages must relate directly to context of use in motor vehicles

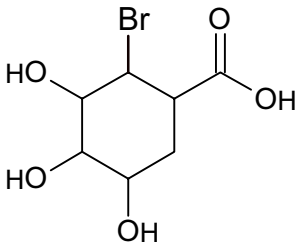
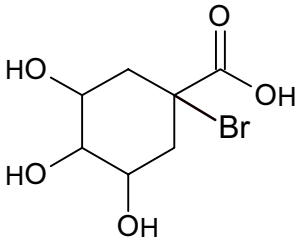
Question Number	Expected Answer	Max Mark	Rationale
3 (e) (i)	Zn**(s)**$\|Zn^{2+}$**(aq)**	1	State symbols required
3 (e) (ii)	being oxidised = Zn being reduced = Ag_2O (or Ag in the Ag_2O)	1 1	**DO NOT ALLOW** Ag^+
3 (e) (iii)	$Zn + Ag_2O + H_2O \rightarrow Zn^{2+} + 2OH^- + 2Ag$	1	**ALLOW** $Zn(OH)_2$ state symbols NOT required
3 (e) (iv)	+0.34 – (–0.76) = +1.10 V	1	
3 (e) (v)	$\Delta G = -nFE = -2 \times 96.5 \times 1.10 = -212(.30)$ kJmol^{-1}	1	**ALLOW** ecf from **3(e)(iv)**
3 (e) (vi)	$\Delta G = -RT\ln K$ $-212300 = -8.31 \times 298 \times \ln K$ $\ln K = 212300/(8.31 \times 298) = 85.73$ $K = e^{85.73} = 1.7(1) \times 10^{37}$	1 1	**ALLOW** ecf from **3(e)(v)**
Total		**[17]**	

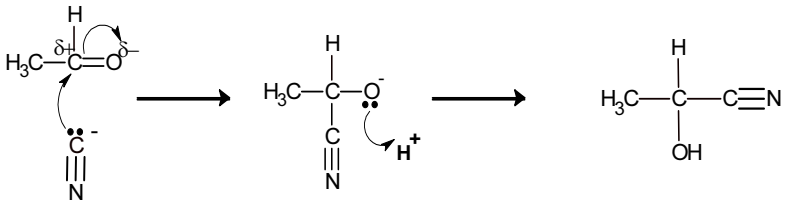
Question Number	Expected Answer	Max Marks	Rationale
4 (a)	12	1	
4 (b)	HCP = ABA(B) FCC/CCP = ABC(ABC)	1 + 1 1 + 1	**ALLOW** 'hexagonal' **ALLOW** 'cubic' Names are 'free-standing'; layers marks depend on names
4 (c) (i)	octahedral	1	
4 (c) (ii)	calcium; fluoride/fluorine; tetrahedral	1 1	calcium **AND** fluoride/fluorine both needed for first mark
4 (d) (i)	(Good agreement indicates a) high level of ionic character/low level of covalency in the ionic halides As electronegativities of Na and X are very different	1 1	
4 (d) (ii)	Difference increases from AgF to AgI with decreasing difference in electronegativity so least covalency in AgF/greatest covalency in AgI as small anion least easily polarised/large anion most easily polarised	1 1 1	

Question Number	Expected Answer	Max Marks	Rationale
4 (e) (i)	haemoglobin	1	
4 (e) (ii)	(apo)Ferritin binds to Fe(II) and stores it as Fe(III) so it stores/controls release of iron	1 1	
4 (f)	(negative $E^{\ominus}$ in) 4.1 (indicates) equilibrium lies further left (than in 4.2)/tendency to produce electrons greater/$Fe(OH)_2$ stronger reducing agent In acid conditions $[OH^-]$ falls so equilibrium moves right/ tendency to produce electrons falls. $Fe(OH)_2$ reducing power falls So Fe(II) stabilised wrt Fe(III)/chance of Fe(II) oxidation reduced	1 1 1	ora
Total		**[19]**	

Question Number	Expected Answer	Max Marks	Rationale
5 (a)	Carbon 1 = Alcohol Level Carbon 2 = Carboxylic Acid Level	1 1	
5 (b)	Hydrolysis Functional Group Level (of Carbons 3 and 4) is the same	1 1	
5 (c)	   	2 1 1	**ALLOW** $-NH_2$ in place of both $-NH_3^+$ groups for 1 mark in first structure **ALLOW** one –OH (from amide link) and one $-NH_3^+$ for 1 mark in first structure
5 (d)	$C_7H_{10}O_5$	1	

Question Number	Expected Answer	Max Marks	Rationale
5 (e) (i)		1	
5 (e) (ii)		1	
5 (e) (iii)		2	**ALLOW** 1 mark if only one or two acyl groups attached **ALLOW** 1 mark if –COOH acylated <u>as well as</u> all 3 –OH groups
5 (f)	From left to right: 1; 2 and 7; 4; 5 and 6; 3	3	4 = 3; 2 = 2; 1 = 1
5 (g) (i)	Electrophilic Addition	1	both needed

Question Number	Expected Answer	Max Marks	Rationale
5 (g) (ii)	 	1 1	
5 (g) (iii)	relative stability of intermediate (carbo)cations lower charge density of C+ = greater stability/lower E_a to form	1 1	
Total		**[21]**	

Question Number	Expected Answer	Max Marks	Rationale
6 (a)	Nucleophilic Addition	1	both needed
6 (b) (i)			
	lone pair, - charge and curly arrow on C in CN	1	
	polarity of C=O	1	
	curly arrow from C=O to delta –ve O	1	
	lone pair on O^- and curly arrow to H^+	1	**ALLOW** H-OSO_3H or H-OH for H^+
6 (b) (ii)	(product is a) racemate / <u>equimolar</u> mix of enantiomers	1	
6 (c) (i)	$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$	1	
6 (c) (ii)	$pK_a = -\log K_a$	1	
6 (c) (iii)	decreasing pK_a means increasing acid strength	1	**ALLOW** pattern identification by reference to number of chlorines
	<u>increasing</u> electron-withdrawing character from $-CH_2Cl$ (to $-CHCl_2$) to $-CCl_3$	1	
	reduces charge density on COO^- **OR** stabilises anion **OR** weakens O-H bond	1	
	so moves equilibrium to right/increases dissociation	1	**DO NOT ALLOW** 'easier' for 4th mark

Question Number	Expected Answer	Max Marks	Rationale
6 (d) (i)	non-superimposable mirror images	1	
6 (d) (ii)	higher <u>atomic number</u> = higher priority 'view' chiral centre from opposite lowest priority group **OR** reference to moving –H to the back R = clockwise order of priority (high to low) of remaining groups	1 1 1	**DO NOT ALLOW** reference to 'atomic mass' or 'size'
6 (d) (iii)	The <u>rotation of plane-polarised light</u>	1	
6 (d) (iv)	+/- notation + = clockwise / - = anticlockwise	1 1	
Total		**[19]**	