

RIVER VALLEY HIGH SCHOOL YEAR 6 PRELIMINARY EXAMINATION II

CANDIDATE NAME						
CLASS						
CENTRE NUMBER	S 3 0	4 4	INDEX NUMBER	0	0	
H2 CHEN	IISTRY			9	729/02	_
Paper 2 Structu	red Questions			13 Sep 2017		
					2 hours	
Additional Materials: Data Bookle						

READ THESE INSTRUCTIONS FIRST.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Write your name, class and index number in the spaces at the top of this page. Write in dark blue or black pen. You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper. The use of an approved scientific calculator is expected, where appropriate. A Data Booklet is provided.

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [] at the end of each question or part question.

	For Examiner's Use							
	Paper 2							
	1	2	3	4	5	SF	UNITS	Total (P2)
P2	17	14	14	15	15			75
P1	30	P3	80	Total	185	P4	55	Grade

This paper consists of **XX** printed pages.

2 Answer all questions in the spaces provided.



	3	
(c)	In the laboratory, Compound C can be converted to ibuprofen using a 3-step synthesis route.	
	Suggest reagents and conditions for each step, and draw the structures of all intermediates.	
	$\begin{array}{c} OH \\ & PCl_5 \\ \end{array} \end{array} \xrightarrow{Cl} \\ \end{array}$	
	ethanolic KCN, heat under reflux	
	dilute HC <i>l</i> heat under reflux	
		[5]
(d)	Young children often find it difficult to swallow tablets. Thus, ibuprofen is supplied as an "infant formula" emulsion.	
	Given that ibuprofen and water are immiscible, an emulsifier such as polysorbate 80 is used to create a homogeneous mixture.	
	$CH_3(-CH_2)_7$ $(CH_2)_6$ C'_{O-C} O_{O-C} OCH_2CH_2OH	
	OCH ₂ CH ₂ OH	
	polysorbate 80	
	Explain why this molecule is able to act as an emulsifier.	
	The <u>-OH polar groups</u> allow the molecule to be soluble in water, while the non-polar hydrocarbon groups allow the molecule to be soluble in oil / non-polar liquids.	[1]
(e)	A certain pharmaceutical brand claims that the ibuprofen tablets it manufactures are 95.0% pure by mass.	

	4	
	To investigate this claim, 5.00 g of a sample was crushed and dissolved in 250 cm ³ of 0.450 mol dm ⁻³ aqueous KOH. 25.0 cm ³ of this solution was withdrawn and titrated against sulfuric acid. The unreacted KOH in this solution required 25.50 cm ³ of 0.180 mol dm ⁻³ of sulfuric acid for complete neutralisation.	
	Showing relevant calculations, deduce if the claim is valid.	
	Amount of $H_2SO_4 = \frac{25.50}{1000} \times 0.180$	
	= 0.00459 mol	
	Amount of unreacted KOH = 0.00459×2	
	= 0.00918 mol	
	Amount of unreacted KOH (in 250 cm ³) = 0.0918 mol	
	Amount of KOH reacted with ibuprofen sample = $\frac{2500}{1000} \times 0.450 - 0.0918$	
	= 0.0207 mol	
	Since ibuprofen ≡ KOH,	
	Amount of ibuprofen = 0.0207 mol	
	Mass of ibuprofen = $0.0207 \times [13(12.0) + 18(1.0) + 2(16.0)]$	
	= 4.26 g	
	Percentage purity = $\frac{420}{5.00} \times 100\%$	
	= 85.2%	
	Hence, the claim is invalid.	
		[3]
(f)	Compare the acidity of ibuprofen and aspirin. Explain your answer.	
	Aspirin is a stronger acid than ibuprofen.	
	The anion of aspirin, $\overset{\circ}{\leftarrow} \overset{\circ}{\leftarrow} \overset{\circ}{\leftarrow}$, is <u>more stable</u> than the anion of ibuprofen, <u>ibuprofen</u> , as the <u>negative charge is delocalised over</u> the COO ⁻ group and into the benzene ring.	[2]
 (a)	Describe two simple chemical tests to distinguish between its sector	
(g)	paracetamol and aspirin.	
	Test: Add neutral FeC/ ₃ (aq)	[4]

5	
Observations: Violet colouration forms for paracetamol. No violet colouration forms for ibuprofen and aspirin.	
Test: Heat with acidified KMnO₄(aq)	
Observations: Purple KMnO ₄ turns colourless for ibuprofen. KMnO ₄ remains purple for paracetamol and aspirin.	
[Total	l: 17]

2	(a)	Gaseous ethane can be used as a fuel for campers. A company manufactures compressed gaseous ethane in 400 cm ³ metal canisters. A typical metal canister at room temperature contains compressed gaseous ethane at a pressure of 4.00 atm.				
		(i)	Suggest a reason why gaseous ethane in the metal canister does not behave like an ideal gas.			
			Due to <u>high pressure in the canister, volume of the ethane</u> molecules is not negligible compared to volume of the metal canister / intermolecular forces of attraction between ethane molecules are not negligible.	[1]		
		(ii)	One metal canister is used for heating water and the pressure decreases from 4.00 atm to 1.50 atm. Assuming that the compressed ethane behaves ideally, calculate the mass of water at room temperature that could be brought to boiling if the process is 80% efficient. The enthalpy change of combustion of ethane is -1420 kJ mol ⁻¹ .			
			Using pV = nRT, (2.50 x 101325)(400 x 10 ⁻⁶) = n (8.31)(293) n = amount of ethane used = 0.0416 mol Heat evolved from combustion of ethane = 0.0416 x 1420 = 59.1 kJ 0.80 x 59.1 x 10 ³ = Mass of water x 4.18 x (100 - 20) Mass of water = 141 g	[3]		
		(iii)	Suggest a reason why butane is a better fuel for campers compared to ethane.			



	7	
1	$N_{2}H_{4}(I) + O_{2}(g) \longrightarrow N_{2}(g) + 2H_{2}O(g)$ $\downarrow \qquad \qquad$	
(i) Given +58.0 Bookle hydraz	that the enthalpy change of vapourisation of hydrazine is kJ mol ⁻¹ , use appropriate bond energies from the <i>Data et</i> to calculate the enthalpy change of reaction between liquid tine and oxygen.	
$\Delta H_r = 2$	∆ <i>H</i> _{vap} (N₂H₄) + [BE(N–N) + 4BE(N–H) + BE(O=O)] – [BE(N≡N) + 4BE(O–H)] ⊦58 + [(+160) + 4(+390) + (+496)] – [(+944) + 4(+460)] -510 kJ mol ⁻¹	[2]
(ii) The re signific	action shown above has a positive ΔS value. Account for its cance.	
There gaseou procee	is an <u>increase in disorder</u> of the system. The <u>amount of</u> us molecules increases from 1 mol to 3 mol as the reaction eds.	[1]
(iii) Hence sponta	e, under what conditions of temperature will the reaction be ineous?	
$\Delta G = \Delta$ $\frac{\text{Since } \Delta}{\text{is negative}}$ $\frac{\text{Since } \Delta}{\text{tempe}}$	$\Delta H - T\Delta S$ ΔS is positive, $-T\Delta S$ is negative. Given that the calculated ΔH ative, ΔG is negative and the reaction is spontaneous at all ratures.	[2]
	[Tota	l: 14]



9				
		(i)	Use your graph to determine the gradient and the charge, n, of the M^{n+} ions.	
			Gradient = −0.0300	
			<mark>– 0.06 / n = -0.0300</mark>	
			<mark>n = 2</mark>	[2]
		(ii)	Use your graph to determine the $E^{\Theta_{cell}}$, showing your working clearly.	
			<mark>log₁₀1 = 0</mark>	
			y-intercept = 0.93 V or uses equation to calculate	[2]
		(iii)	In the determination of standard electrode potential of a half-cell, the polarity of standard hydrogen electrode can either be positive or negative.	
			The standard electrode potential for Cl^- , ClO^- in alkaline conditions is +0.80 V.	
			Hence, calculate the standard electrode potential of the metal, M, and suggest its identity.	
			E^{\ominus} for M = 0.80 – 0.93	
			= -0.13 V	[2]
				[2]
		(iv)	Suggest one purpose of a salt bridge in a galvanic cell.	
			To allow movement of ions / complete the circuit	
			OR	
			To maintain electrical neutrality / charge or ion balance	[1]
		(v)	A student suggested the use of aqueous potassium sulfate in the salt bridge. Do you think his choice is wise? Explain your reasoning.	
			Not wise	
			PbSO ₄ is insoluble/ is a ppt. Will affect <i>E</i> values.	[2]
	(c)	Using is sol	Le Chatelier's Principle and relevant equations, explain why AgC <i>l</i> uble in excess aqueous ammonia.	
		AgC <i>l</i>	(s) ≓ Ag⁺(aq) + C <i>l⁻</i> (aq) (1)	
		<mark>Ag+(a</mark>	$(q) + 2NH_3(aq) \rightleftharpoons [Ag(NH_3)_2]^+(aq)$	
		Wher	n excess NH ₃ is added, diammine silver complex is formed.	[2]

	10		
	POE in (1) is shifted to the right as [Ag ⁺] decreases.		
	AgC <i>l</i> dissolves.		
		[Tota	l: 14]

4	Viric glas Cr2C Alun 2O3) harc	Viridian is a blue-green pigment used commonly in paints, inks, and stained glasses. The major constituent of viridian is the compound chromium(III) oxide, Cr_2O_3 , that gives its characteristic colour. Alumina, which is the common name for the chemical aluminium oxide (A <i>l</i> -2O ₃), is a white solid which is commonly used as abrasive owing to its high hardness rating.				
	(a)	Define the term transition element.				
		A transition element is a d-block element which forms at least one stable ion (compound) with a partially filled d subshell.	[1]			
	(b)	In terms of structure and bonding, explain why alumina has a high hardness rating.				
		Alumina has a <u>giant ionic structure</u> . Strong <u>electrostatic forces of</u> attractions between Al ³⁺ and O ²⁻ ions which is difficult to overcome.	[2]			
	(c)	Both Cr_2O_3 and Al_2O_3 are amphoteric oxides. Describe the observations and write balanced equations when Cr_2O_3 is dissolved in $HCl(aq)$ and NaOH(aq). You can assume that the coordination number of chromium in NaOH(aq) is 6.				
		In HC <i>l</i> (aq)				
		Equation:				
		$Cr_2O_3 + 6HCl \rightarrow 2CrCl_3 + 3H_2O$				
		Observation:				
		(Blue)-green solid dissolves in HC/(aq) to give a <u>green solution</u>				
		In NaOH(aq)				
		Equation:				
		$Cr_2O_3 + 6NaOH + 3H_2O \rightarrow 2Na_3[Cr(OH)_6]$				
		Observation:				
		(Blue)-green solid dissolves in NaOH(aq) to give a <u>dark green solution</u>	[4]			
	(d)	Explain why the resultant solution is coloured when Cr_2O_3 is dissolved in acid.				
		The solution contains Cr^{3+} which has a partially filled 3d subshell. In the presence of H ₂ O ligands, the 3d orbitals are split into 2 sets of orbitals with	[3]			

		11	
	differ sets o regio prom orbita colou	ent energy level. The difference in energies (ΔE) between these 2 of non-degenerate 3d orbitals is small and radiation from the visible n of the electromagnetic spectrum is absorbed when an electron is oted from a lower energy d-orbital to another unfilled/partially-filled d al of higher energy. The colour observed is the complement of the rabsorbed.	
(e)	Anoth prope Predi	ner chromium-containing compound, $CrCl_3$, also exhibits similar erties to $AlCl_3$. ct the pH of the solution when a solid sample of $CrCl_3$ is dissolved in	
	water	. Use equations to justify your answer where possible.	
	<mark>pH of</mark>	solution = 3.0	
	CrCl3	$_{3}$ + 6H ₂ O \rightarrow [Cr(H ₂ O) ₆] ³⁺ + 3C l^{-}	
	[Cr(H	² O)6] ³⁺	
	OR		
	[Cr(H	$_{2}O)_{6}]^{3+}$ + H ₂ O \rightleftharpoons [Cr(H ₂ O) ₅ (OH)] ²⁺ + H ₃ O ⁺	[2]
(f)	Use	of the Data Booklet is relevant to this question.	
	The e 3 rd and differ	element chromium shows a relatively similar increase in the 1 st , 2 nd , nd 4 th ionisation energy. Aluminium however, shows a significant ence between its 3 rd and 4 th ionisation energy.	
	(i)	By means of an equation, express the 2 nd ionisation energy of chromium.	
		$Cr^+(g) \rightarrow Cr^{2+}(g) + e^- \qquad \Delta H = 2^{nd} IE$	[1]
	(ii)	Explain fully why the 4 th ionisation energy of aluminium has a significantly larger magnitude compared to its 3 rd ionisation energy.	
		$Al^{2+}: 1s^2 2s^2 2p^6 3s^1$	
		A/ ³⁺ : 1s ² 2s ² 2p ⁶	
		Fourth electron is removed from an <u>inner principal quantum shell</u> which is closer to the nucleus while the 3 rd electron is removed from the outermost shell. The fourth electron in the inner shell (2p subshell) also experiences a <u>greater effective nuclear charge/ less</u> <u>shielding effect</u> compared to the electron in the outermost shell (3p subshells).	[2]
		[Tota	l: 15]

5	Caftaric acid is a compound found in grapes and is responsible for the yellowish-gold colour seen in some white wines.					
	caftaric acid					
	(a)	Deduce the molecular formula of caftaric acid.				
		C13H12O9				
	(b)	(i)	State the type(s) of stereoisomerism exhibited by caftaric acid.			
			Enantiomerism and cis-trans isomerism	[1]		
		(ii)	Hence, state the total number of stereoisomers of caftaric acid.			
			8 (2 ² enantiomers × 2 cis-trans)	[1]		
	 (c) The level of caftaric acid can be used to estimate the oxidation levels that a wine has undergone. Wines that undergo a high degree of oxidation, such as pressed wine, will have little to no caftaric acid in them. Suggest the carbon-containing products formed when caftaric acid is heated with excess acidified KMnO₄(aq). 					
	HO OH OH OH AND CO2			[3]		



River Valley High School 2017 Preliminary Examinations II 9729/02

[Turn over

14							
		(i)	State the type of reaction undergone by B above.				
			Condensation	[1]			
		(ii)	Suggest the reagents and conditions for the above reaction.				
			Methanol, (a few drops of) concentrated H ₂ SO ₄ , heat (under reflux)	[1]			
	(f)	Anoth involv solve This Sugg	her method for conversion of carboxylic acids to their methyl esters ves the reaction with diazomethane, $:\overline{CH_2} \longrightarrow N$, in an inert nt. $RCO_2H + CH_2N_2 \rightarrow RCO_2CH_3 + N_2$ reaction occurs via a two-step mechanism. The carboxylic acid reacts with diazomethane to form a carboxylate ion intermediate in the first step. N_2 is formed in the second step.				
		R	es and charges, and indicate the movement of electron pairs with arrows.	[4]			
		[Total: 15]					

END OF PAPER