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PRELIMINARY EXAM 2008	
CHEMISTRY Higher 2	9746/02
Paper 2 Structured Questions	26 August 2008
Candidates answer on the Question Paper. Additional Materials: Data Booklet	1 hour 30 mins

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page. Write in dark blue or black pen. You may use a soft pencil for any diagrams, graphs or rough working. Do not use correction fluid.

Answer all questions.

You are advised to show all working in calculations. You may use a calculator. A Data Booklet is provided.

The number of marks is given in brackets [] at the end of each question or part question.

For Exam	niner's Use
1	
2	
3	
4	
5	
6	
Total	60

This document consists of <u>9</u> printed pages and <u>1</u> blank page.

- **1** Explain the following observations:
 - (a) Sulphur has a lower first ionisation energy than phosphorus.

(b) Carbon dioxide and silicon dioxide have widely different melting points.
(c) 2-Nitrophenol has a lower melting point than 4-nitrophenol.

2

(d) The boiling points of hydrogen halides are of the following order.

	Compound	HF	HCI	HBr	HI]
	Boiling point/ °C	19.4	-85.1	-66.4	-35.6	
						-
						[2]
						[-]
(e)	The bond angle in PC	l₃ is larger tha	an that in As(Cl₃.		
						[2]
					[T(otal: 10]

- 2 A 1.00 g sample of steel was dissolved in excess nitric acid. The resulting solution was found to contain manganese(II) ions. On addition of sodium bismuthate, NaBiO₃, all the manganese(II) ions were oxidised to manganate(VII) ions. After removing any excess bismuthate ions, the resulting purple solution was titrated with a solution containing iron(II) ions of concentration 0.10 mol dm⁻³. 36.00 cm³ of this solution was required to reach the endpoint, in which iron(II) ions were oxidised to iron(III) ions. (a) What is the oxidation state of bismuth in NaBiO₃?[1] Given that the bismuthate ion is reduced to Bi³⁺, write the half-equation for (b) (i) this reduction reaction. Hence, write an overall balanced equation for the oxidation of (ii) manganese(II) to manganate(VII) by bismuthate ions in acidic solution. [2]
 - (c) Calculate the percentage by mass of manganese in the steel sample.

[3]

(d) (i) Calculate the E_{cell}^{θ} for each of the following reactions in the table below and hence deduce whether each reaction can occur under standard conditions.

Reactants	Products	E ^θ _{cell} / V	Can reaction occur? (Y/N)
Mn & SO ₄ ²⁻	Mn ²⁺ & SO ₂		
Mn ²⁺ & SO ₄ ²⁻	MnO_4^- & SO_2		
Fe ²⁺ & SO ₄ ²⁻	Fe ³⁺ & SO ₂		

(ii) Using your answers from (d)(i), state and explain whether sulphuric acid is a suitable replacement for nitric acid in this experiment.

- **3** (a) *Paracetamol* is a common analgesic drug often used as a painkiller and for treating mild fever. In a study carried out to determine the rate of removal of *paracetamol* from the body, the reaction was found to have a constant *half-life* of 2.7 h.
 - (i) Sketch a graph to show how the concentration of *paracetamol* changes with time.



time / h

(ii) A boy took a dose of *paracetamol* (two 500 mg tablet) for his fever. How long does it take for the *paracetamol* in his body to decrease to 125 mg?

- (iii) An independent study shows that the removal of *paracetamol* from the body could be accelerated by using enzymes. On the same axes in (a)(i), sketch and label clearly the graph expected for the enzyme-catalysed reaction.
- (iv) The enzyme-catalyst only works well under certain conditions in the body. Suggest one condition which would affect the action of the enzyme-catalyst.

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(b) The following reaction scheme involved a halogeno compound **V**.

$$CI \xrightarrow{\frown} CH_2CH_3 \xrightarrow{\text{step I}} V \xleftarrow{HCI} CI \xrightarrow{\frown} CH=CH_2$$

(i) Draw the structural formula of **V**.

(ii) Suggest reagents and conditions required for step I.

(iii) Draw diagrams to illustrate the type of stereoisomerism exhibited by V.

(iv) When V is boiled under reflux with excess ethanolic silver nitrate, a white precipitate is formed. What is the mass of the precipitate formed if 1.75 g of V is used in the reaction?

> [5] [Total: 10]

- **4** (a) A hydrocarbon **W** contains 92.3 % carbon. On complete combustion, 0.005 mol of **W** produced 1.76 g of CO₂.
 - (i) Determine the molecular formula of **W**.

- (ii) Given that W forms a white precipitate on heating with acidified potassium manganate(VII) and 1 mol of W reacts with 1 mol of bromine gas in tetrachloromethane, draw the displayed formula of W.
- (iii) State the type of hybridisation shown by the carbon atoms of **W** and draw the hybrid orbitals.

W forms a monochlorinated product **X** that is able to exhibit stereoisomerism.

- (iv) State the type of stereoisomerism shown by **X**.
- (v) Draw and clearly label the two stereoisomers of **X**.

 (b) Nickel metal, used in the reaction described in (a)(ii), is a transition metal. Explain the data given below.

	Atomic Size/nm	Melting Point / °C	
Ni	0.115	1453	
Са	0.197	842	

[2] [Total: 10] $SO_2CI_2(g) \Longrightarrow SO_2(g) + CI_2(g)$

(a) 6.7 g of gaseous SO₂Cl₂ was placed into a 1 dm³ vessel and the temperature was held constant at 375 K. What is the initial pressure of SO₂Cl₂ (in atm) in the vessel before dissociation? (1 atm = 1.01×10^5 Pa)

[1]

(b) Using your answer in (a), write a K_p expression in terms of the partial pressure of SO₂, p_{SO_2} , only. Hence, determine the partial pressures of SO₂, Cl₂, and SO₂Cl₂ at equilibrium.

[3]

(c) If 1.0 atm of Cl₂ was initially present along with the 6.7 g of SO₂Cl₂, give the partial pressure terms of Cl₂ and SO₂Cl₂ in terms of the partial pressure of SO₂, p_{SO_2} , only and hence determine the corresponding equilibrium partial pressures of the gases.

6 (a) (i) An organic compound **Y** has the molecular formula $C_9H_{12}O_2$. The following tests were conducted to deduce the structure of **Y**.

 ${\bf Y}$ burns with a sooty flame and reacts with aqueous NaOH but not Na₂CO₃. Deduction:

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Y rotates plane polarised light. Deduction:

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Y gives a yellow precipitate when warmed with aqueous alkaline I_2 . Deduction:

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Y decolourises 2 mol of aqueous Br_2 to give steamy fumes and a white precipitate. Deduction:

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Y reacts with hot excess concentrated sulphuric acid to give **Z**, $C_9H_{10}O$, which can exist as stereoisomers. Deduction:

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Deduce the structural formulae of compounds Y and Z.

Y:

Z:

(b) (i) Compound **Y** can undergo chlorination with hot thionyl chloride, SOCl₂ in the presence of pyridine. What is the advantage of this method for organic synthesis as compared to using PCl₅?

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(ii) By considering the reaction in b(i), predict and explain the sign of ΔS . (Assume all the organic compounds are in liquid state.)

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(iii) How will ΔG^{θ} for this reaction change with increasing temperature, given that it is an endothermic reaction? Hence predict the effect of temperature on the spontaneity of this reaction.

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[5] [Total: 11]

END OF PAPER