Centre Number	Index Number	Name and Class

ANGLO-CHINESE JUNIOR COLLEGE
PRELIMINARY EXAMINATIONS
Advanced Level

CHEMISTRY **9746/03**
Higher 2

Paper 3 Free response **18 August 2008**

2 hours

Candidates answer on separate paper.
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagram, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer any **four** questions.
A Data Booklet is provided.
You are reminded of the need for good English and clear presentation in your answers.
The number of marks is given in brackets [ ] at the end of each question or part question.
At the end of the examination, fasten all your work securely together including the cover page.

Write down the question numbers that you have attempted in the table below.

For Examiner's Use	
Question no.	**Marks**
TOTAL	

This question paper consists of **8** printed pages including the cover page.

Paper 3 (80 marks)
Answer any **four** questions

1 (a) When aqueous bromine reacts with methanoic acid, carbon dioxide gas is produced.

$$Br_2\,(aq) + HCOOH\,(aq) \longrightarrow 2\,Br^-\,(aq) + 2\,H^+\,(aq) + CO_2\,(g)$$

The rate of the reaction can be determined by measuring the rate of formation of carbon dioxide gas. In investigations of this reaction, the following results were obtained.

Experiment	Initial concentrations / mol dm^{-3}		Initial rate of formation of CO_2 (g) / mol dm^{-3} s^{-1}
	$[Br_2]$	[HCOOH]	
1	0.01	0.02	2.0×10^{-6}
2	0.02	0.04	8.0×10^{-6}
3	0.03	0.02	6.0×10^{-6}

(i) Deduce the order of the reaction with respect to Br_2 and HCOOH. Hence, write a rate equation for the reaction. [3]

(ii) Using the data from **Experiment 3**, calculate the rate constant for the reaction, stating its units. [2]

(iii) What conclusions about the mechanism of the reaction can you draw from the rate equation? [2]

(iv) In another experiment, equal volumes of 0.01 mol dm^{-3} of Br_2 and 0.02 mol dm^{-3} of HCOOH were mixed. What is the initial rate of this experiment? [2]

(b) The relative molecular mass and the boiling point of methanal, methanol and methanoic acid are given in the table below.

Compounds	Relative Molecular Mass	Boiling Point / °C
Methanal	30.0	-21.0
Methanol	32.0	64.7
Methanoic Acid	46.0	100.7

(i) Explain the differences in their boiling points. [3]

(ii) In benzene solution, the measured relative molecular mass of methanoic acid is approximately 92.0. Explain the observation and include relevant diagram in your answer. [2]

(c) Suggest a simple chemical test to distinguish the following pairs of compounds. You should include the reagent, conditions, observations and relevant balanced equations for each test. [6]

(i) Methanal and methanoic acid

(ii) Methanoic acid and ethanoic acid

[Total: 20]

2 **(a)** A cell consisting of a Cu^{2+} (aq) | Cu (s) half-cell and a Fe^{3+} (aq), Fe^{2+} (aq) | Pt (s) half cell is shown below, using conventional notation.

Cu (s) | Cu^{2+} (aq) || Fe^{3+} (aq), Fe^{2+} (aq) | Pt (s)

(i) What do you understand by the term *standard electrode potential*? [2]

(ii) Calculate the standard cell potential, E^{θ}, of this cell [1]

(iii) Write the equation for the reaction occurring in each half cell, and hence write a balanced equation for the overall reaction which takes place when current flows. [2]

(iv) If a current is drawn from the cell, what will happen to the concentration of the ions in the solution of Fe^{3+} (aq), Fe^{2+} (aq) | Pt (s) half cell? [1]

(v) What is the change in mass of the copper electrode if a current of 1 ampere is drawn from the cell for 30 seconds? [2]

(vi) State with reason what you expect to happen if the Cu^{2+} (aq) | Cu (s) half cell connected to Fe^{3+} (aq), Fe^{2+} (aq) | Pt (s) half cell is replaced by Co^{3+} (aq), Co^{2+} (aq) | Pt (s) half cell. [2]

(b) An Fe/Fe_2O_3 catalyst is used in the synthesis of ammonia in the Haber Process

$N_2\,(g) + 2\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$ $\quad \Delta H^{\ominus}$ negative

But no catalyst was used in the synthesis of nitrogen monoxide

$N_2\,(g) + O_2\,(g) \rightleftharpoons 2\,NO\,(g)$ $\quad \Delta H^{\ominus}$ positive

Explain the observation of the usage of catalyst in one synthesis and not in the other. [4]

(c) One substance which is responsible for the fragrance of roses is 2-phenylethanol, $C_6H_5CH_2CH_2OH$. It can be synthesized from methylbenzene by the following series of reactions

$$C_6H_5CH_3 \xrightarrow{Cl_2} C_6H_5CH_2Cl \xrightarrow{\textbf{II}} C_6H_5CH_2CN \xrightarrow{\textbf{III}} \textbf{P} \xrightarrow{\textbf{IV}} C_6H_5CH_2CH_2OH$$

(i) Suggest reagents and conditions for steps **II** and **III**. [2]

(ii) Describe the mechanism of the reaction that will take place when methylbenzene is subjected to excess chlorine in the presence of iron filing. [2]

(iii) Suggest an identity for compound **P**. [1]

(iv) What types of reaction are steps **III** and **IV**? [2]

[Total: 20]

3 Hydrogen halides result from the chemical reaction of hydrogen with one of the halogen elements (fluorine, chlorine, bromine, iodine). They are hydrohalic acids because of their ability to release hydronium (H_3O^+) ions in aqueous solution.

(a) HC*l*, HBr and HI form acidic white fumes in moist air under room temperature and pressure conditions.

The addition of concentrated sulfuric acid to these three hydrogen halides separately can be used as a distinguishing test. You should state what you would observe for **each** compound when concentrated sulfuric acid is added. Write balanced equations with state symbols for any reactions that occur. [3]

(b) Describe what is happening in the following phenomena. Write balanced equations with state symbols for the reactions that occur in each of the following phenomena.

(i) Chlorine gas turns moist starch-iodide paper blue. [2]

(ii) Reaction of chlorine with aqueous potassium hydroxide at different temperatures will produce different products. [2]

(c) **(i)** **X** and **Y** are Period III elements.

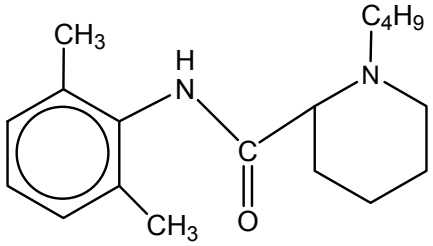
Element **X** forms a white oxide that is slightly soluble in cold water. Its chloride dissolves in water to form a weakly acidic solution.

Element **Y** forms two oxides. 0.03 mol of one of the two oxides produces 6.99 g of white precipitate when shaken with excess barium chloride solution. A solution containing 0.05 mol of the oxide of Element **Y** forms a neutral solution when the same amount of the oxide of the Element **X** is added to it.

Identify the element **X**, **Y** and the oxide of **Y** in the above reaction. Explain the observations with the help of relevant equations. [6]

(ii) Compare and explain the difference in the melting points of elements **X** and **Y**. [2]

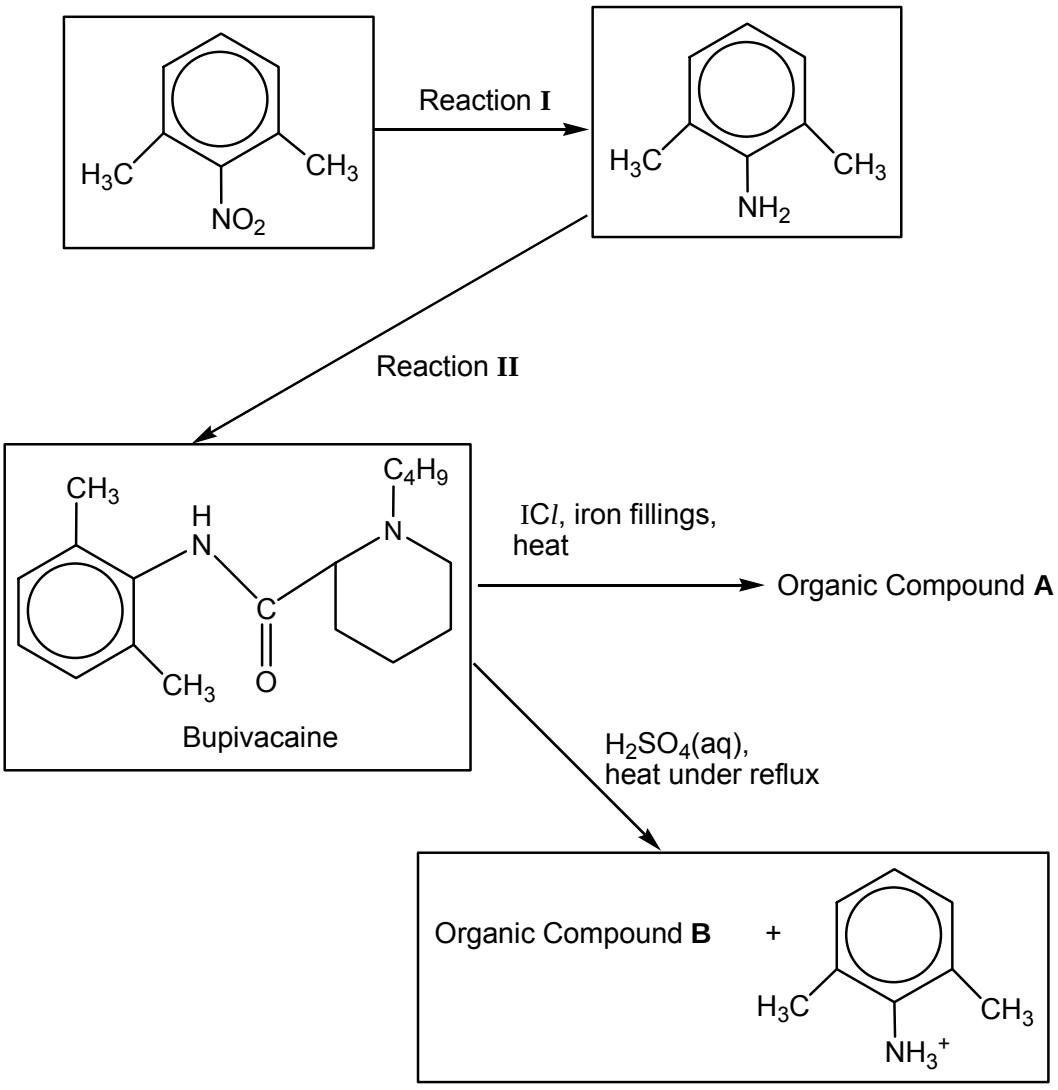
(d) Bupivacaine is a local anaesthetic drug is commonly injected to surgical wound sites to reduce pain for up to 20 hours after the surgery. It has the structural formula shown below.



Bupivacaine

(i) Copy the structure of Bupivacaine and circle the chiral C atom(s) in the structure. [1]

3 (d) (ii) For the reaction scheme below involving Bupivacaine, state the reagents and conditions for Reactions **I** and **II** and draw the structures of the organic compounds **A** and **B**. [4]



[Total: 20]

4 (a) The atomisation reaction of 1-chlorobutane, with molecular formula C_4H_9Cl, is

$CH_3CH_2CH_2CH_2Cl\ (l) \longrightarrow 4C\ (g) + 9H\ (g) + Cl\ (g)$

The enthalpy change of formation of 1-chlorobutane is -188 kJ mol^{-1} and the enthalpy change of atomisation of carbon is +716 kJ mol^{-1}.

(i) What is meant by the term *standard enthalpy change of formation*? [1]

(ii) Using the above data and suitable data from the *Data Booklet,* construct a **labelled energy level diagram** and calculate the enthalpy change of atomisation of $CH_3CH_2CH_2CH_2Cl$. [3]

(iii) Calculate another value for the enthalpy change of atomisation of $CH_3CH_2CH_2CH_2Cl$ using **only bond energies** from the *Data Booklet*. [1]

(iv) State **two** reasons for the difference in the values calculated in **(ii)** and **(iii)**. [2]

(b) (i) Draw the **displayed** formulae of the other isomers of C_4H_9Cl. [2]

(ii) Comparing the isomers you have drawn in **(b)(i)**, which compound has the highest boiling point? Explain. [2]

(c) $CH_3CH_2CH_2CH_2Cl$ can be hydrolysed to $CH_3CH_2CH_2CH_2OH$.

(i) State the reagent and condition for this hydrolysis. [1]

(ii) Name and describe the mechanism of this reaction. [3]

(iii) Would you expect this reaction to be exothermic or endothermic? Justify your answer with an appropriate calculation. [2]

(iv) Propose a synthetic pathway to convert $CH_3CH_2CH_2CH_2OH$ to $CH_3CH_2CH_2CH(OH)CN$, indicating any reagent(s) and condition(s) used. [3]

[Total: 20]

5 (a) A polypeptide chain of keratin, was digested with leucine carboxypeptidase (digesting at the carboxyl end of leucine). A particular section of this polypeptide was found to yield the following:

glu-ala
val-leu
glu-asp-thr-leu
ala-glu-leu

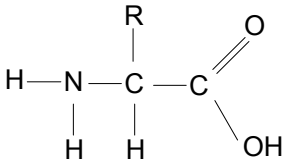
Another enzyme, a carboxypeptidase digests glutamic acid at the carboxyl end and the following peptides were obtained:

ala
val-leu-glu
asp-thr-leu-ala-glu
leu-glu

(i) What is the sequence of amino acids in this section of the polypeptide chain? [1]

(ii) Calculate the M_r of the molecular peptide, glu-asp-thr-leu .

The general formula of amino acids is



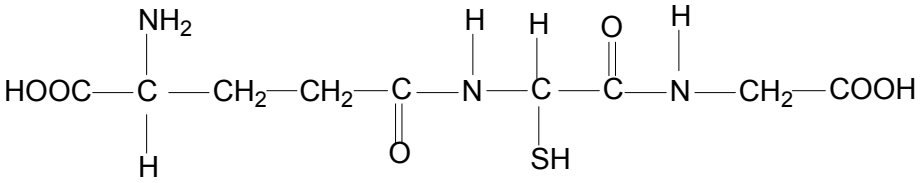
The R groups of the following amino acids are as follows:

	asp	glu	leu	thr
R	$-CH_2CO_2H$	$-(CH_2)_2CO_2H$	$-CH_2CH(CH_3)_2$	$-CH(OH)CH_3$

[2]

(iii) Name and draw the secondary structure of keratin found in finger nails. You may use the general formula of amino acids given above in your diagram. [2]

(b) Glutathione, GSH, is a powerful anti-oxidant. It has the structure:



(i) Draw the structures of the amino acids obtained from GSH on hydrolysis at a pH of 11. [3]

(ii) What are the likely interactions of the R groups of the amino acids in GSH in tertiary protein structure? [2]

5 (c) A compound, **R**, $C_6H_{10}Cl_2$, exists as stereoisomers. When vigorously oxidised with hot alkaline potassium manganate (VII) followed by acidification, **R** gave **S**, $C_4H_6O_3$. **S** gave yellow crystals with alkaline aqueous iodine solution and carbon dioxide with aqueous sodium carbonate, but no reaction with Fehling's solution. **R** when reacted with hot ethanolic potassium cyanide gave **T**, $C_8H_{10}N_2$. **T** was reduced by hydrogen with nickel as a catalyst to give **U**, $C_8H_{20}N_2$. With dilute hydrochloric acid, **U**, gave a white crystalline solid, **V**, when the mixture was evaporated. **T** when heated under reflux with a dilute acid gave **W**, $C_8H_{12}O_4$. [10]

(i) Identify the compounds **R, S, T, U, V** and **W**, giving your reasons.

(ii) Write balanced equations for oxidation of **R** to give **S** and the action of a dilute acid on **T** to give **W**.

[Total: 20]

- END OF PAPER -