JURONG JUNIOR COLLEGE
PRELIMINARY EXAMINATION 2008

H2 CHEMISTRY PAPER 2
9746 / 2

Friday 22nd August 2008 1 hour 30 minutes

Name: _____ (No. _____) Class: 07_____

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, exam index number and class in the spaces at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.
Do not use highlighters or correction fluid.

Answer **all** questions.

INFORMATION FOR CANDIDATES

A *Data Booklet* is provided. Do not write anything on the *Data Booklet*.

The number of marks is given in brackets [ ] at the end of each question or part question.
You are advised to show all workings in calculations.
You may use a calculator.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
TOTAL	/ 60

This question paper consists of 13 printed pages, including this page.

[Turn over

1. Many copper minerals are found in hydrothermal deposits where they were formed by crystallisation from very hot solutions. Deep underground, it is like a giant pressure cooker and water is still in liquid form at high temperature. This means that minerals which are regarded as 'insoluble' in the laboratory can dissolve under these conditions. When the solutions cool, the minerals crystallise out.

One such copper mineral is chalcopyrite, $CuFeS_2$, which is a copper iron sulfide mineral that crystallises out in a tetragonal system. Chalcopyrite is one of the minerals referred to as 'Fool's Gold' due to its brassy yellow appearance.

(a) Chalcopyrite can be smelted in modern works by heating with air.

$$3CuFeS_2 + 8O_2 \rightarrow 3Cu + FeO + Fe_2O_3 + 6SO_2$$

A rock sample was found to contain 0.5 % by mass of chalcopyrite.

(i) Calculate the volume of sulfur dioxide gas released into the atmosphere at r.t.p. if 1 tonne of the rock sample is smelted. (1 tonne = 1000 kg)

(ii) Suggest a reason why we should try to limit the emission of sulfur dioxide into the atmosphere.

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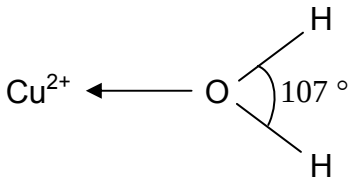
……

[4]

1. Chalcanthite, known as 'copper flower', is a water soluble copper sulfate mineral. When dissolved, aqueous copper(II) sulfate contains $[Cu(H_2O)_6]^{2+}$ ions.

(b) Water is a simple molecule. The H–O–H bond angle in an isolated water molecule is 104.5 °.

The diagram below shows part of the $[Cu(H_2O)_6]^{2+}$ ion and the H–O–H bond angle in the water ligand.



(i) Explain why the H–O–H bond angle in the water ligand is 107 ° while that in an isolated water molecule is 104.5 °.

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(ii) State the hybridisation state of the oxygen atom in the water ligand.

…… [5]

(c) Describe and explain the observations made when aqueous ammonia is added slowly to a small volume of aqueous copper(II) sulfate solution, until in excess.

Identify all of the copper-containing species formed.

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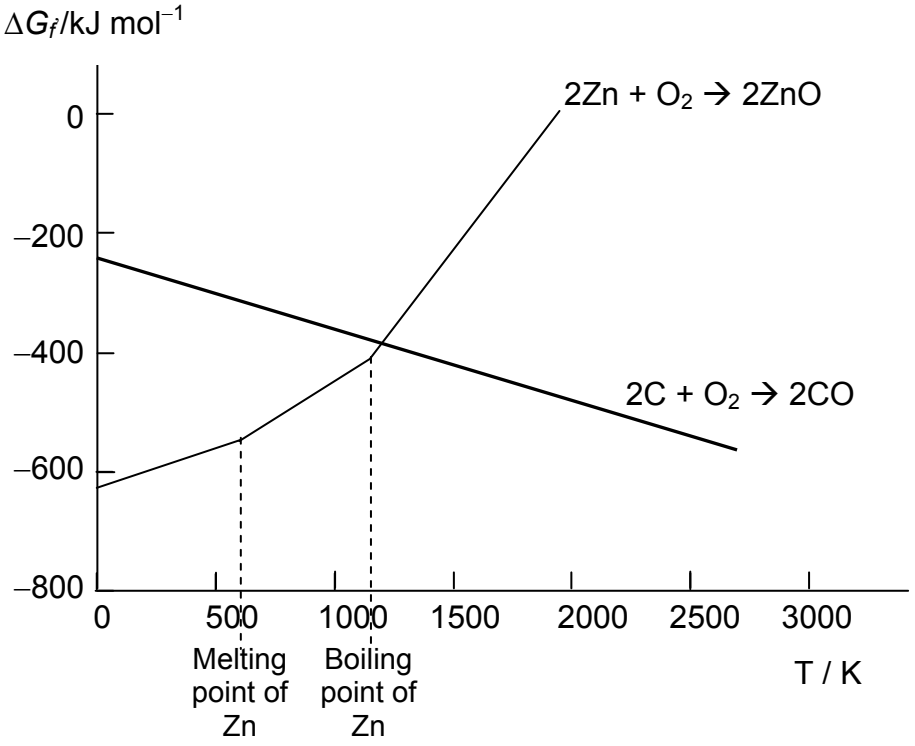
…….. [3]

[Total: 12]

2. **(a)** The graph below is an Ellingham diagram, which shows the variation in the standard free energy change of formation, $\Delta G_f^{\ominus}$, with temperature, T, for both carbon monoxide and zinc oxide.



(i) By considering the relationship between the *free energy change*, $\Delta G^{\ominus}$, the *enthalpy change*, $\Delta H^{\ominus}$, and the *entropy change* $\Delta S^{\ominus}$ for a reaction, suggest how you would obtain a value for *entropy change* from the Ellingham diagram above.

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(ii) Explain why the line for carbon monoxide in the diagram above has a negative gradient.

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(iii) Deduce, from the diagram, which oxide, CO or ZnO, is the stronger oxidising agent at 1800 K.

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[3]

(b) Explain why carbon monoxide is toxic, with reference to its interactions with haemoglobin, an important iron–containing complex in red-blood cells that transports oxygen around the body.

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…… [1]

2. **(c)** In heavily polluted air, nitrogen dioxide is often formed and it appears as a brown haze with a sharp biting odour.

Besides causing human respiratory problems and other adverse health effects, nitrogen dioxide also plays a part in destroying the ozone layer through a free radical chain mechanism, similar to that caused by the harmful chlorofluorocarbons (CFCs).

Nitrogen dioxide gas is formed by the following reaction between nitrogen oxide and oxygen gas.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H < 0$$

The following mechanism has been proposed for the reaction:

Step 1: $NO + O_2 \rightleftharpoons NO_3$ (fast)

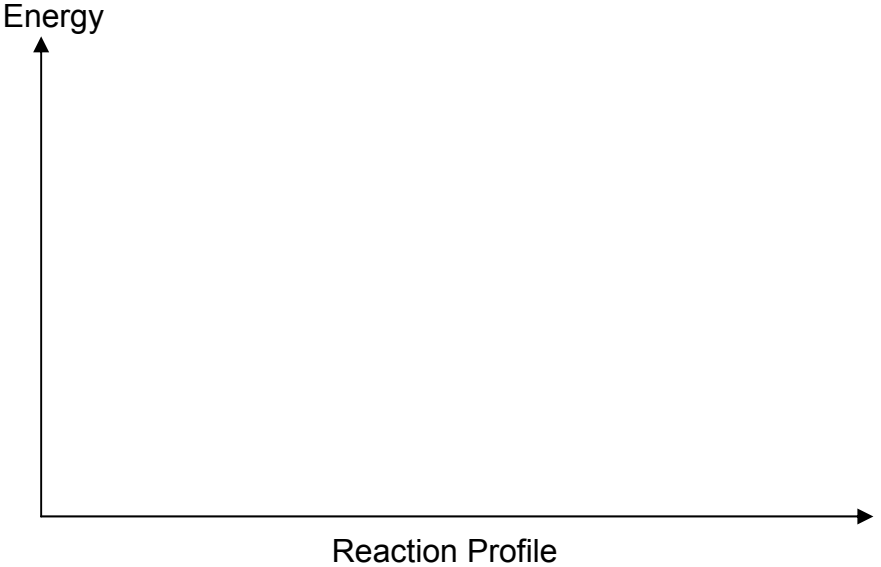
Step 2: $NO_3 + NO \rightleftharpoons 2NO_2$ (slow)

(i) Draw a dot-and-cross diagram to show the arrangement of the valence electrons in NO_2.

(ii) Based on the proposed kinetics, deduce the rate equation for the reaction.

……..

(iii) Sketch an energy profile diagram for the proposed mechanism in the space below. Label your diagram clearly, including the reactants and the products formed.



[4]

[Total: 8]

3. A cell set-up based on the magnesium-iodine system consists of a magnesium electrode dipped in magnesium nitrate electrolyte and a platinum electrode dipped in aqueous iodine-sodium iodide electrolyte.

(a) **(i)** Draw a diagram to illustrate the set up of the cell, showing the direction of the electron flow in the external circuit.

(ii) Write a balanced equation for the cell reaction.

(iii) Calculate the cell e.m.f. under standard conditions.

(iv) How would you expect the e.m.f. of this cell to change, if at all, when the concentration of magnesium ions is doubled? Explain your answer.

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[7]

3. (b) Sodium iodide occurs as colourless crystals or as white crystalline powder. The primary use for sodium iodide is in the treatment of *actinobacillosis* in cattle, where aqueous sodium iodide solution is injected intravenously into the animals.

(i) Draw an energy cycle on the grid below, using the following data, to determine the enthalpy change of solution, ΔH_{soln}, for NaI.

Enthalpy change of lattice energy of NaI	–704 kJ mol^{-1}
Enthalpy change of hydration energy of $Na^+(g)$	–390 kJ mol^{-1}
Enthalpy change of hydration energy of $I^-(g)$	–247 kJ mol^{-1}

Energy/ kJ mol^{-1}

(ii) The enthalpy change of hydration of Cl^- is –362 kJ mol^{-1}. Explain why this is more exothermic than that of I^-.

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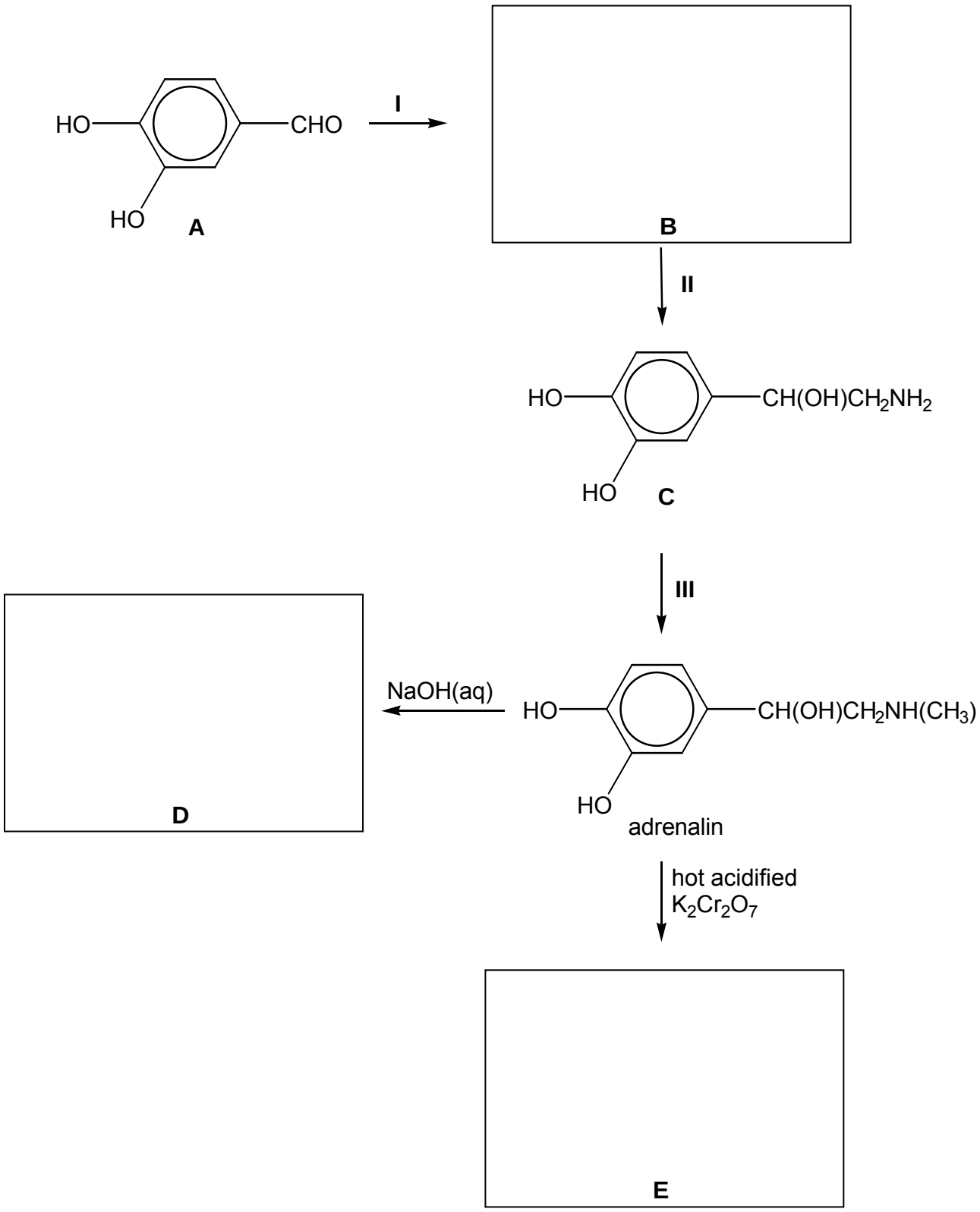
(iii) Astatine is the element below iodine in Group VII.

Identify the halogen-containing substances when concentrated sulfuric acid is added to a solid mixture of sodium chloride and sodium astatide. Write equations for the reactions that occur.

[7]

[Total: 14]

4. The reaction scheme below involves adrenalin, a hormone and neurotransmitter.



4. **(a)** **(i)** Suggest the structural formula of compound **B** and draw it in the box provided.

(ii) Suggest reagents and conditions required in steps **I** and **II**.

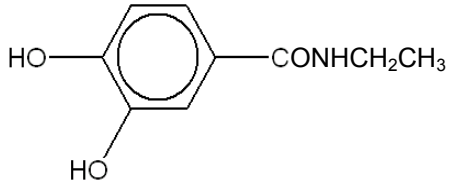
Step **I** : ……

Step **II** : ……

(iii) Draw the structural formula of the organic products **D** and **E** in the boxes provided.

[5]

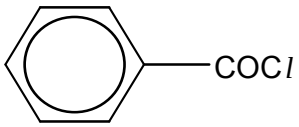
(b) Suggest a simple chemical test that can be used to distinguish between adrenalin and the following compound :



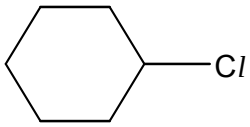
[2]

[Total: 7]

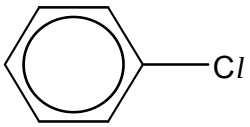
5. Compounds **R**, **S** and **T** are shown below.



R



S



T

(a) Arrange the compounds in order of increasing ease of hydrolysis. Explain your answer.

[3]

(b) Describe an experiment to determine the relative ease of hydrolysis of the compounds **R**, **S** and **T**.

[2]

5. **(c)** Compound **S** can be made by the free-radical chlorination of cyclohexane. Describe the reaction mechanism of its formation.

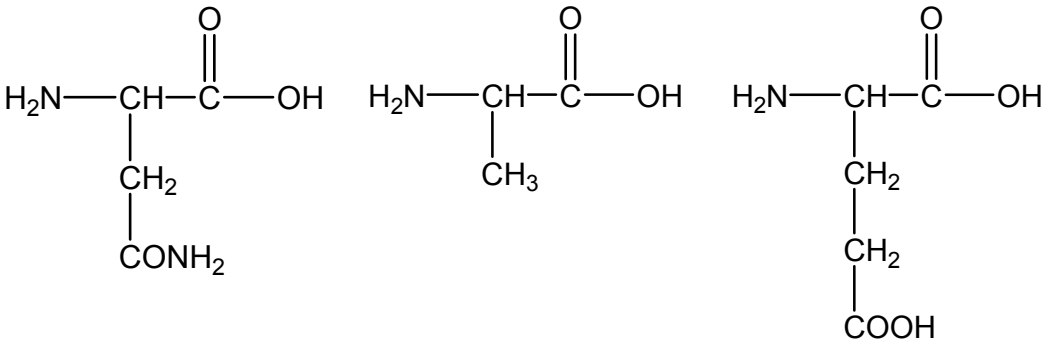
[3]

[Total: 8]

6. There are four levels of organisation found in the structure of a protein. The primary structure of a protein determines its secondary, tertiary and quaternary structures.

The formulae of three amino acids are given.

asparagine (asn) alanine (ala) glutamic acid (glu)



(a) Draw the structural formula of a portion of a protein with the sequence asn-ala-glu in its primary structure, showing the form in which it would exist at pH 12.

[2]

(b) The two main secondary structures are the α–helix and β–pleated sheet.

Describe what *β–pleated sheets* are. Illustrate your description with a diagram to show how two strands in a protein can be involved in maintaining the *β*–pleated structure, clearly indicating and labelling any bonds established between the strands.

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[3]

6. **(c)** The overall three-dimensional shape of a protein is stabilised by interactions between the side chains of the amino acid residues.

State the type of side-chain interactions that are possible for **each** of the amino acids, asparagine and glutamic acid at pH 12.

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…….. [2]

(d) Alanine is a naturally occurring amino acid that is found primarily in poultry, beef, pork and fish.

Draw the structure of the products formed when alanine is reacted with:

(i) hot propan-2-ol in the presence of concentrated sulfuric acid

(ii) ethanoyl chloride

[2]

(e) Alanine can also react with CH_3Cl in a 1:1 mole ratio. State the type of reaction involved and give the structure of the organic product.

[2]

[Total: 11]