INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2
in preparation for General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY 9746/02

Paper 2 Structured **24 September 2009**

1 hour 30 minutes

Candidates answer on the Question Paper

Additional Materials: *Data Booklet*

READ THESE INSTRUCTIONS FIRST

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

Answer **all** questions in the space provided.
A Data Booklet is provided.

You are advised to show all working in calculations.
You are reminded of the need for good English and clear presentation in your answers.
You are reminded of the need for good handwriting.
Your final answers should be in 3 significant figures.

You may use a calculator.

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.

For Examiner's Use	
1	/11
2	/11
3	/12
4	/11
5	/15
Total	/60

This document consists of **14** printed pages.

For Examiner's Use

Answer ALL questions on the space provided.

1 2 identical gas syringes **A** and **B**, each with a volume of 200 cm^3 are filled with a volatile liquid which behaves as an ideal gas in vapour state.

1 g and 2 g of the liquid is placed in gas syringes **A** and **B** respectively and warmed. When the temperature reaches 60 °C, all the liquid evaporate in gas syringe **A** and the pressure is 80 kPa.

(a) (i) Calculate the temperature in gas syringe **A** when the pressure is 120 kPa.

(ii) Calculate the temperature when all the liquid evaporates in gas syringe **B** when the pressure is 120 kPa.

(iii) Calculate the relative molecular mass of the gas.

[4]

(b) A student wrote the following in his notebook: "Potassium chloride has a very high boiling point while tetrachloromethane boils below 100 °C. This shows that ionic bond is stronger than covalent bond."

Do you agree with the above statement?

.....

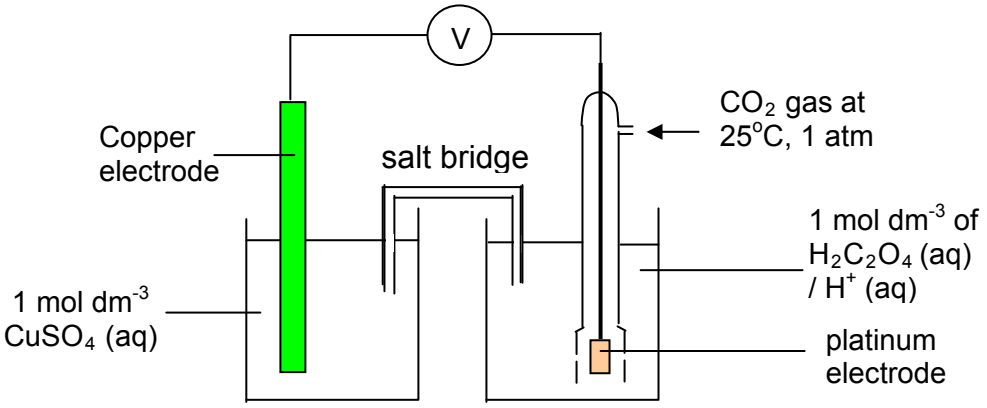
.....

.....

.....[2]

(c) A copper electrode was dipped in an aqueous solution containing 1 mol dm^{-3} $CuSO_4$. When this half cell was connected via a salt bridge to the following half cell, a voltage was registered.

$$2CO_2 + 2H^+ + 2e \rightleftharpoons H_2C_2O_4 \qquad E^\ominus = -0.49\ V$$



(i) Write the equation at the respective electrodes:

Anode.....

Cathode.....

(ii) Calculate the e.m.f of the cell.

(iii) State and explain the effect of the $E^\ominus_{cell}$ of the reaction on adding aqueous potassium hydroxide to the CO_2 / $H_2C_2O_4$ half-cell.

.....

.....

.....

.....

.....

(iv) Explain why it is not possible to use $E^\ominus$ value reliably to determine if a reaction will occur.

.....

.....

[5]

[Total: 11]

For Examiner's Use

2 **(a)** When a mixture of silicon dioxide and carbon is heated in a stream of chlorine, silicon tetrachloride and carbon monoxide are formed.

(i) Write an equation for the reaction described above in which silicon tetrachloride is formed.

.....

(ii) Melting point of silicon dioxide is 1883 K. Relate the melting point of the silicon dioxide to its structure and bonding.

.....

.....

.....

(iii) Silicon dioxide and silicon tetrachloride each behaves differently when added to water.

1. Write an equation for the reaction that occurs when separate samples of silicon dioxide and silicon tetrachloride are added to an excess of water.

Equation .....

2. What is seen when litmus solution is added to each of the resulting solution?

Silicon dioxide with water ……..……..……

Silicon tetrachloride with water ……

[4]

(b) Hydrogen sulphide, H_2S smells of rotten eggs and is highly poisonous. 1 mole of hydrogen sulphide can react with 2 moles of boron trifluroide, BF_3, to form Compound **C** only.

(i) Draw a diagram to illustrate the shape of and bonding in Compound **C**.

(ii) Gaseous hydrogen sulphide is appreciably soluble in water to give a resulting solution that turns universal indicator yellow. Write an equation, with state symbols, to illustrate the solubility of hydrogen sulphide with water.

……..

[2]

(c) **(i)** When aqueous ammonia was added to an aqueous solution of cobalt(II) sulphate, a blue precipitate **D** was formed. Identify the precipitate **D**.

Identity of **D** ……

(ii) Precipitate **D** dissolved when an excess of aqueous ammonia was added. The solution formed was pale brown due to the presence of the cobalt containing species **E**. Identify **E**.

Identity of **E** ……

(iii) On standing in air, the colour of the solution containing **E** slowly darkened as the cobalt-containing species **G** was formed.

State the type of reaction occurring when **E** changes into **G** and identify the reactant responsible for this change.

Identity of **G** ……

Type of reaction ……..

Reactant responsible ……

(iv) When potassium iodide was added to the solution containing **G** and the mixture was acidified, a dark red-brown colour due to the presence of **H** was produced. On addition of hexane, the mixture turned purple.

Write an equation to explain the formation of **H**.

Equation ……..

[5]

[Total: 11]

3 (a) Recent climate changes around the world have been attributed to the continuous depletion of ozone layer over the Antarctic. For many years, environmental scientists have been studying the role of CFCs in the thinning of ozone layer. The reaction between CFCs and ozone in the stratosphere is as follows:

$CF_2Cl_2 \rightarrow CF_2Cl\bullet + Cl\bullet$ ----------Step 1; slow

$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$ ----------Step 2; fast

$ClO\bullet + O_3 \rightarrow Cl\bullet + O_2$ ----------Step 3; fast

where $CF_2Cl\bullet$, $Cl\bullet$, $ClO\bullet$ are radicals which contain an unpaired electron.

(i) Briefly explain why fluorine radical, F•, is **not** formed in step 1.

.....

.....[1]

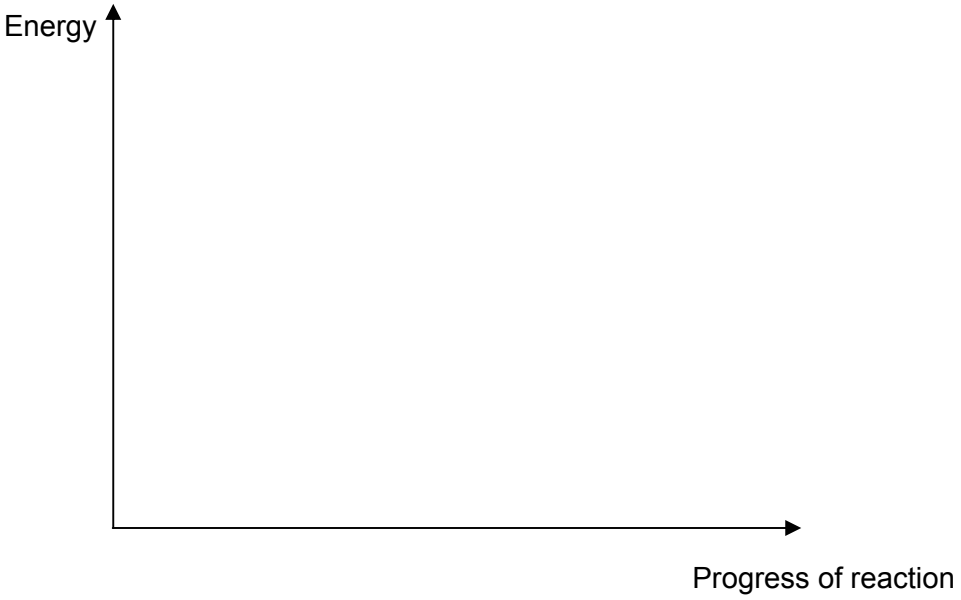
(ii) Suggest why step 1 is a slow step, while both steps 2 and 3 are fast steps.

.....

.....

.....[1]

(iii) On the axis below, draw the reaction pathway for step 1 ***only***, labeling clearly the reactants, products and activation energy and enthalpy change of the reaction. [2]



For Examiner's Use

(b) Study the following reaction scheme.

(i) Give reagent(s) and condition(s) for **each** of the steps 1 to 3.

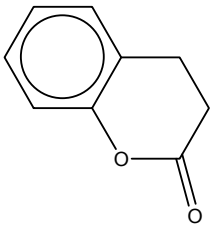
Steps	Reagent(s) and condition(s)
1	
2	
3	

(ii) Identify the intermediate compounds **K** and **L** in the boxes provided.

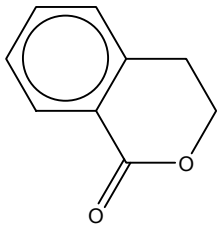
Compound **K**	$(CH_3)_2C{=}CH_2$ Compound **L**

[5]

(c) Suggest a method by which the following compounds can be distinguished from each other by simple chemical tests.



Compound **N**



Compound **P**

Reagent(s) and condition(s)

……...

Observations for Compound **N**

……...

Observations for Compound **P**

……...

[3]

[Total: 12]

For Examiner's Use

4 Morphine can be used as a relief to severe acute and chronic pain. It is used in small quantities as it is a potentially highly additive substance and can cause psychological and physical dependence.

(a) Morphine is a weak monobasic alkali in water, with K_b = 7.40 x 10^{-7} mol dm^{-3}.
A buffer solution is formed when 0.01 mol of hydrochloric acid is added to 100 cm^3 of 0.20 mol dm^{-3} morphine solution.

You may use Mor and $MorH^+$ to denote morphine and its conjugate acid respectively.

(i) Explain what is meant by the term base dissociation constant, K_b of morphine.

[1]

(ii) Calculate the pH of 0.20 mol dm^{-3} morphine solution.

[2]

(iii) Calculate the amount of salt formed in the buffer solution.

[1]

(iv) Calculate the pH of the buffer solution.

[1]

(v) Write an equation that occurs when a drop of aqueous sodium hydroxide is added to the buffer solution.

……..[1]

(vi) Suggest a suitable indicator for the titration between morphine against hydrochloric acid.

…….. [1]

(b) When the organic compound liquid morphine ($C_{17}H_{19}NO_3$) undergoes complete oxidation, it produces carbon dioxide, nitrogen dioxide and water.

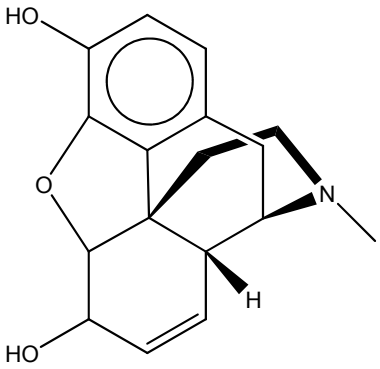
(i) Construct an equation for the complete combustion of morphine.

……...

(ii) Calculate the volume of oxygen required for complete combustion of 5.7 g of morphine at s.t.p.

[2]

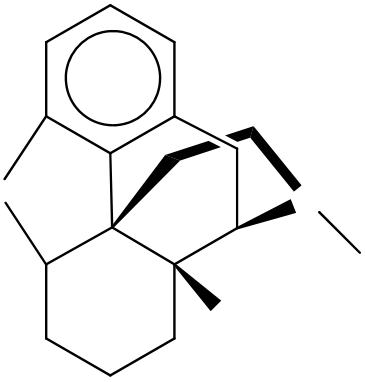
(c) Morphine has the following structure.



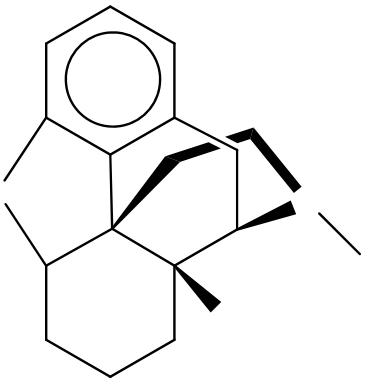
Morphine

In the spaces below, complete the outline structures of morphine thereby showing the structural formulae of substances which will be formed when morphine reacts with each of the reagents named.
(You may treat C–O–C bond as inert.)

(i) Aqueous chlorine



(ii) Refluxed with acidified potassium dichromate

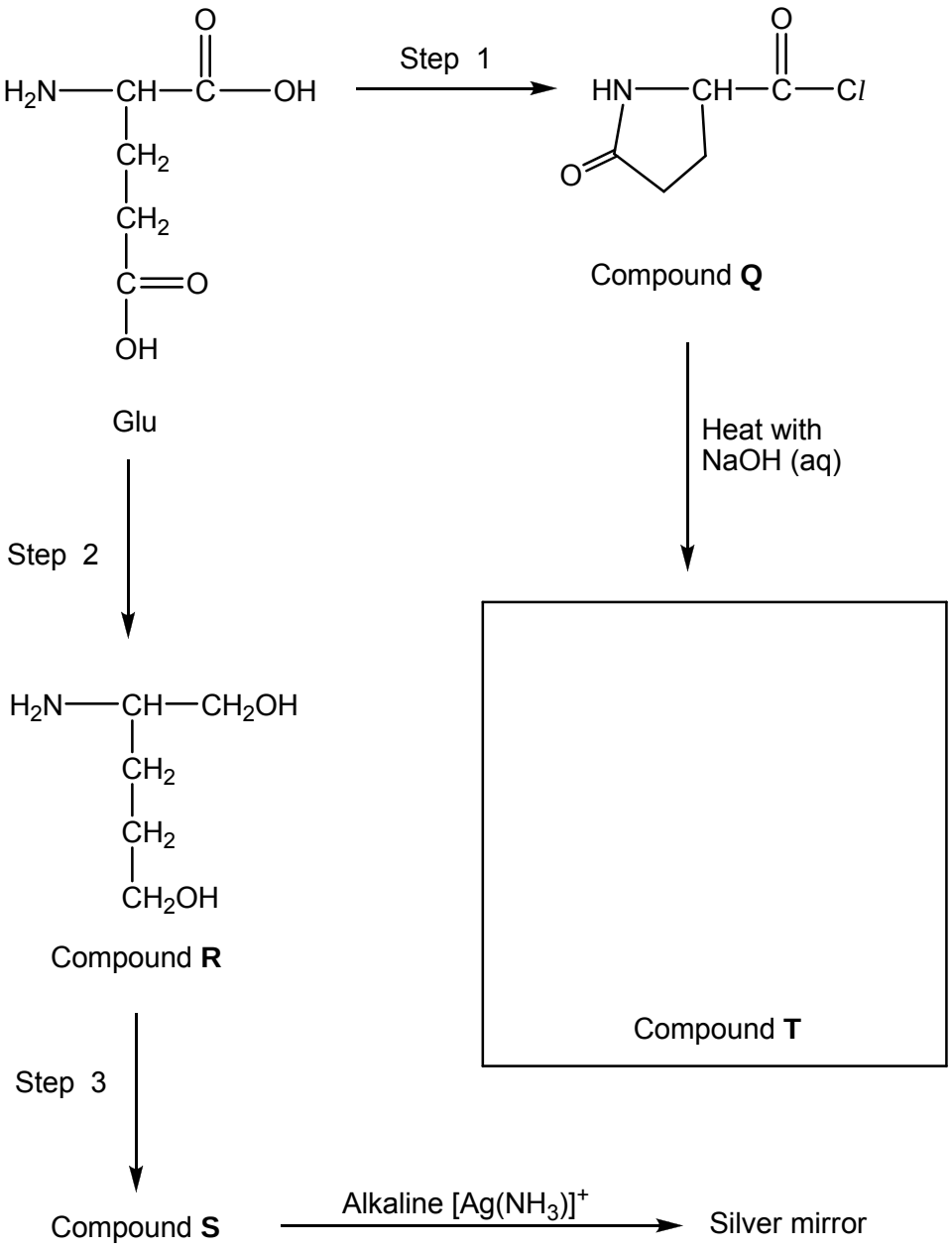


[2]

[Total: 11]

For Examiner's Use

5 Glutamic acid and its salts, called glutamates are flavour-enchancing compounds which provide a savory taste to food. The diagram below shows some possible reaction of glutamic acid (glu).



(a) Complete the reaction scheme above by writing the structural formula of the organic Compound **T** formed in the box provided. [1]

For Examiner's Use

(b) Give reagent(s) and condition(s) for **each** of the steps 1 to 3.

Step	Reagent(s) and Condition(s)
1	
2	
3	

[3]

(c) Would you expect aqueous Compound **Q** to be acidic, neutral or alkaline? Explain your answer.

……

……

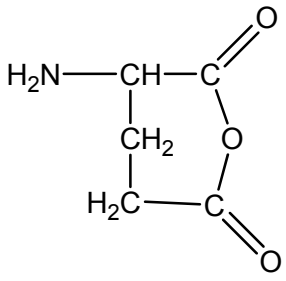
……

……[2]

(d) An isomer of Compound **R**, can be distinguished from Compound **R** itself by the tri-iodomethane test. Suggest the structural formula of this isomer of Compound **R**.

[1]

(e) When heated strongly, glutamic acid produces Compound **U**.



Compound **U**

(i) What type of reaction has occurred in the formation of Compound **U**?

…… [1]

(ii) Explain why Compound **U** is more soluble in dilute nitric acid than in water.

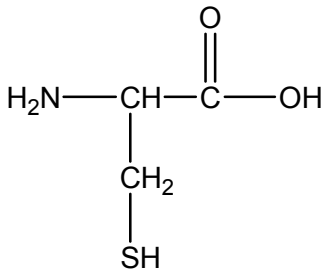
……...

……...

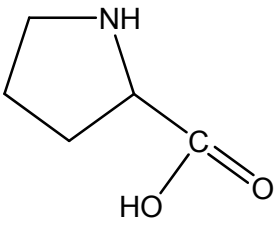
……...

……...…[2]

(f) Proteins (also known as polypeptides) are organic compounds made of amino acids arranged in a linear chain. The structures of two other amino acids are given below.



Cysteine (Cys)



Proline (Pro)

(i) Draw the structural formula for the glu-pro-cys tripeptide.

(ii) Suggest a reason why the amino acid proline is rarely found in alpha helix regions of protein.

……...

……..... [2]

(iii) State what R group interactions are possible for each of the two amino acids cysteine and proline.

Amino Acid	R group interactions
Cysteine	
Proline	

[1]

(iv) Foods are cooked to denature the proteins to make it easier for enzymes to digest them.

1. Explain the meaning of *denaturation* as applied to proteins.

……...

……...

2. State two types of R group interactions that can be disrupted during heating.

……and ……

[2]

[Total: 15]