**SERANGOON JUNIOR COLLEGE**
**General Certificate of Education Advanced Level**
**Higher 2**

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|---|---|
| **CANDIDATE NAME** | |
| **CLASS** | |

# CHEMISTRY 9647/02

**Preliminary Examination** **17 August 2012**
**Paper 2 Structured Questions (SPA)** **2 hours**

Additional Materials: Data Booklet

**READ THESE INSTRUCTIONS FIRST**

Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough work.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

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

| For Examiner's Use | |
|---|---|
| **P1** | /40 |
| **P2** | /72 |
| **P3** | /80 |
| **GRAND TOTAL** | /192 |
| **%** | |
| **GRADE** | |

| For Examiner's Use | |
|---|---|
| **1(P)** | /12 |
| **2** | /8 |
| **3** | /18 |
| **4** | /10 |
| **5** | /12 |
| **6 (P)** | /12 |
| **TOTAL P2** | /72 |

This document consist of **16** printed pages and **0** blank page

For Examiner's Use

**1 (a) Planning**

In the presence of hydrogen ions, bromate(V) ions, $BrO_3^-$, oxidise bromide ions to bromine.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

The reaction is relatively slow and can be followed by adding aqueous phenol and the indicator methyl orange to the reaction mixture. As bromine is formed, it reacts rapidly with the phenol present until the latter is used up. The free bromine in solution now bleaches the methyl orange indicator.

The initial rate of the reaction can be investigated by measuring the time taken for the methyl orange indicator to be bleached.

You are to plan a series of experiments to determine the order of reaction with respect to the bromide ion.

In addition to the standard apparatus present in a laboratory, you are provided with the following:

**FA 1** 0.01 mol $dm^{-3}$ aqueous KBr.
**FA 2** 1.0 mol $dm^{-3}$ potassium bromate(V), $KBrO_3$.
**FA 3** 1.0 mol $dm^{-3}$ sulfuric acid, $H_2SO_4$.
Aqueous phenol containing methyl orange indicator
Distilled water

**(i)** Complete the table below and outline, by means of a series of numbered steps,

- the apparatus to be used
- the experimental procedure
- the measurements to be taken to collect the required data.

| Expt. | Volume of phenol/methyl orange indicator solution / $cm^3$ | Volume of **FA1** / $cm^3$ | Volume of **FA2** / $cm^3$ | Volume of **FA3** / $cm^3$ | Volume of distilled water / $cm^3$ |
|---|---|---|---|---|---|
| 1 | 20.0 | 50.0 | 50.0 | 20.0 | 0.0 |
| 2 | 20.0 | 40.0 | | | |
| 3 | 20.0 | 30.0 | | | |
| 4 | 20.0 | 20.0 | | | |
| 5 | 20.0 | 10.0 | | | |

Outline of experiment:

For Examiner's Use

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**(ii)** In order to find the order of reaction with respect to bromide, a graph of $\log_{10}(\frac{1}{t})$ against $\log_{10}$(volume of KBr (aq)) can be plotted. Use the general rate equation to derive a relationship between $\log_{10}(\frac{1}{t})$ and $\log_{10}$(volume of KBr (aq)). Hence, explain how the order of reaction with respect to bromide can be found from the plotted graph.

**(iii)** The concentration of phenol used in the experiment is very low. Suggest why this is so.

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**[7]**

For Examiner's Use

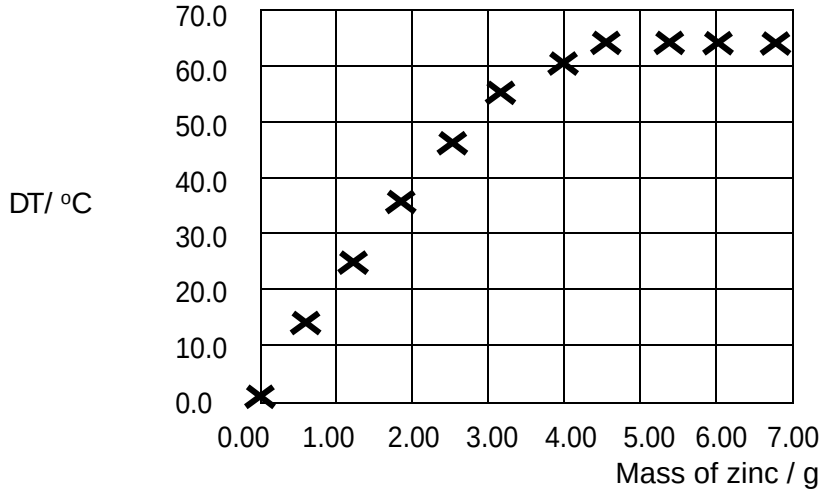
**(b)** An experiment was carried out to measure the enthalpy change for the reaction of zinc with aqueous copper(II) sulfate.

The equation for the reaction is:

$$Zn\ (s) + CuSO_4\ (aq) \rightarrow ZnSO_4\ (aq) + Cu\ (s)$$

- A measuring cylinder was used to transfer separate 50 $cm^3$ samples of 1.25 mol $dm^{-3}$ copper(II) sulfate solution into polystyrene cups.
- Different weighed amounts of zinc powder were added to each sample of copper(II) sulfate.
- Each mixture was stirred thoroughly and the temperature rise noted.

The results of the experiment is summarised on the graph below.




**(i)** Explain the shape of the graph.

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**(ii)** Using the data from the graph, calculate the $\Delta H_{reaction}$.

**(iii)** Suggest a simple practical change to the **method** that will make the experiment more accurate.

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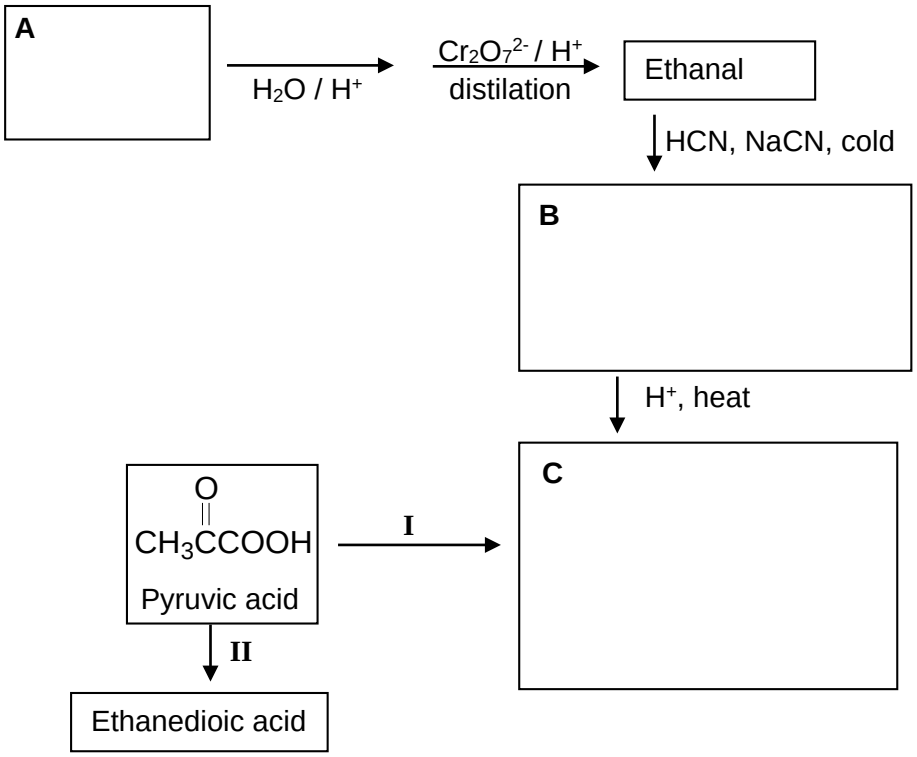
**[5]**

**Total 12 marks**

**2** **(a)** Pyruvic acid is an important component in living cells as it is involved in the aerobic process of supplying energy. The flow chart shows a series of reactions starting with compound **A**, which has an empirical formula of $CH_2$.

For Examiner's Use




**(i)** Draw the structures of compounds **A, B** and **C** in the boxes above.

**(ii)** State the reagents and conditions for steps **I** and **II**.

Step **I**: ……

Step **II:** ……

**[5]**

For Examiner's Use

**(b)** Element **D** can form two different chlorides. The two chlorides of element **D** is commonly used in Organic Chemistry qualitative analysis to test for a specific functional group. When dissolved in a solution containing methyl orange, chlorides of element **D** turn the solution red.

10 $cm^3$ of liquid organic compound **E**, $C_nH_{2n+2}O$, is vaporised and burnt in excess oxygen. After the reaction is cooled to 25$^oC$, a contraction of 20 $cm^3$ in the gas volume was observed. When the resultant gases from the combustion were passed through aqueous sodium hydroxide, the gas volume decreased a further 20 $cm^3$. The vapour of **E** is also observed to react with the same reagents and conditions of step **II** mentioned in **(a)**.

**(i)** State the identities of element **D** and organic compound **E**.

**D**: ……..

**E**: ……

**(ii)** Hence write an equation, if any, between one of the chlorides of element **D** and organic compound **E**.

……

**[3]**

**Total 8 marks**

For Examiner's Use

**3** **(a)** **(i)** Both strontium and manganese are silvery metals. Complete the electronic configurations of manganese and strontium below.

Mn: [Ar] ……

Sr: [Kr] ……

**(ii)** Manganese and strontium both contribute two electrons into the sea of delocalised electrons.

Explain if strontium or manganese has a higher melting point.

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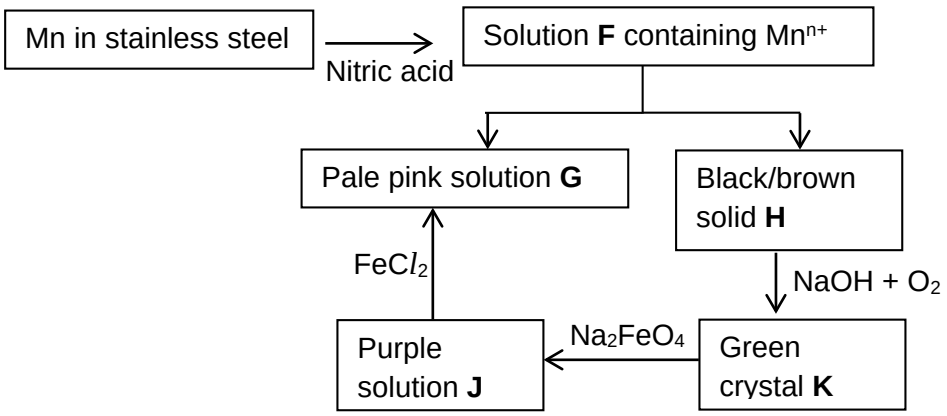
**(iii)** Manganese is particularly important in the manufacturing of stainless steel. A reaction scheme involving manganese-containing compounds is shown below. **F** undergoes a reaction to form **G** and **H**.




Using the information provided, state the oxidation number of manganese in **F** and **K**. (Manganese and its compounds have different oxidation states).

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**(iv)** Suggest a chemical formula for the purple solution **J**.

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For Examiner's Use

**(v)** Suggest the type of reaction that takes place when **F** forms **G** and **H**.
Write a balanced chemical equation, including state symbols, for this reaction.

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**[10]**

**(b)** Strontium compounds such as $SrF_2$ and $SrSO_4$ are sparingly soluble in water. Their solubility products at 298 K are given in the table below:

| **Strontium compound** | **Numerical value of $K_{sp}$** |
|---|---|
| $SrF_2$ | $2.5 \times 10^{-9}$ |
| $SrSO_4$ | $3.2 \times 10^{-7}$ |

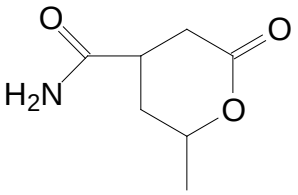
**(i)** Suggest, using quantitative calculations, which of the two compounds is less soluble in water at 298 K.

**(ii)** A sample of strontium(II) fluoride is dissolved in a solution of sodium fluoride. Predict qualitatively the effect, if any, on the solubility and solubility product of strontium(II) fluoride.

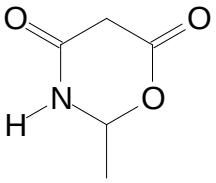
**[4]**

**(c)** Propose chemical test(s) to differentiate between the following organic compounds. You are to state clearly in your answer the reagents and conditions used and observations made. Write chemical equation(s) for any reactions that occur.

For Examiner's Use




and

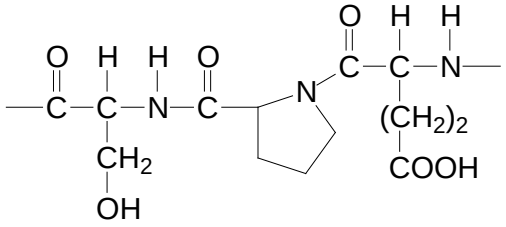



**[4]**

**Total 18 marks**

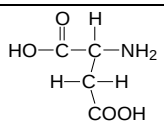
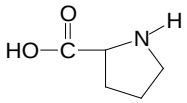
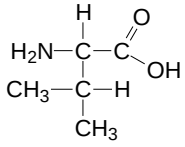
For Examiner's Use

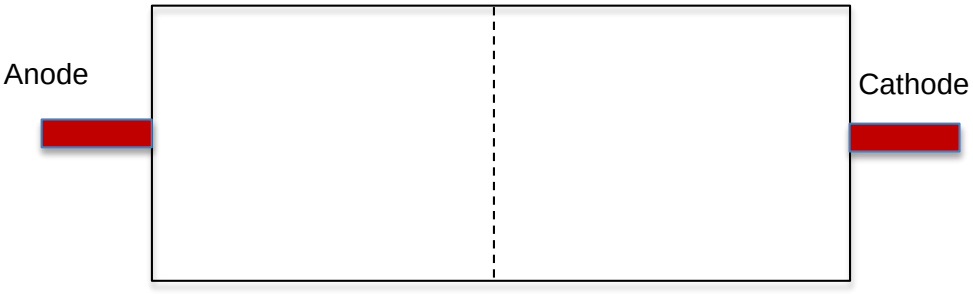
**4(a)** Amino acids serve as the building blocks of proteins. They can be linked together in varying sequences to form a vast variety of proteins. An example of a segment of a protein is shown below.



**(i)** In the space provided below, draw the structural formulae of the amino acids formed from the hydrolysis of the above protein with aqueous sodium hydroxide.

**(ii)** Amino acids can be separated using electrophoresis. With reference to the isoelectric point of the amino acids provided, indicate the positions of the amino acids on the gel at a pH of 5.96.

| **Amino acid** | **Structure** | **Isoelectric point** |
|---|---|---|
| Aspartic acid |  | 2.77 |
| Proline |  | 6.30 |
| Valine |  | 5.96 |



For Examiner's Use

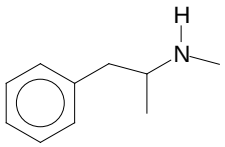
**(iii)** A common secondary structure of proteins is the alpha helix. With the aid of a diagram and your knowledge in chemical bonding, describe the alpha helix structure.

……

……

**[7]**

**(b)** **(i)** Methamphetamine, $C_{10}H_{15}N$, is a psychostimulant. It has high potential for abuse and addiction. In high doses, it can induce euphoria and anxiety. Under the Misuse of Drugs Act in Singapore, a person who carries 500 grams of methamphetamine will be sentenced to the Mandatory Death Penalty. Its structure is as shown:




Methamphetamine

A 25.0 $cm^3$ sample of 0.500 mol $dm^{-3}$ methamphetamine was titrated with aqueous hydrochloric acid of the same concentration.

Would you expect the pH at equivalence point to be above or below 7? Explain your answer.

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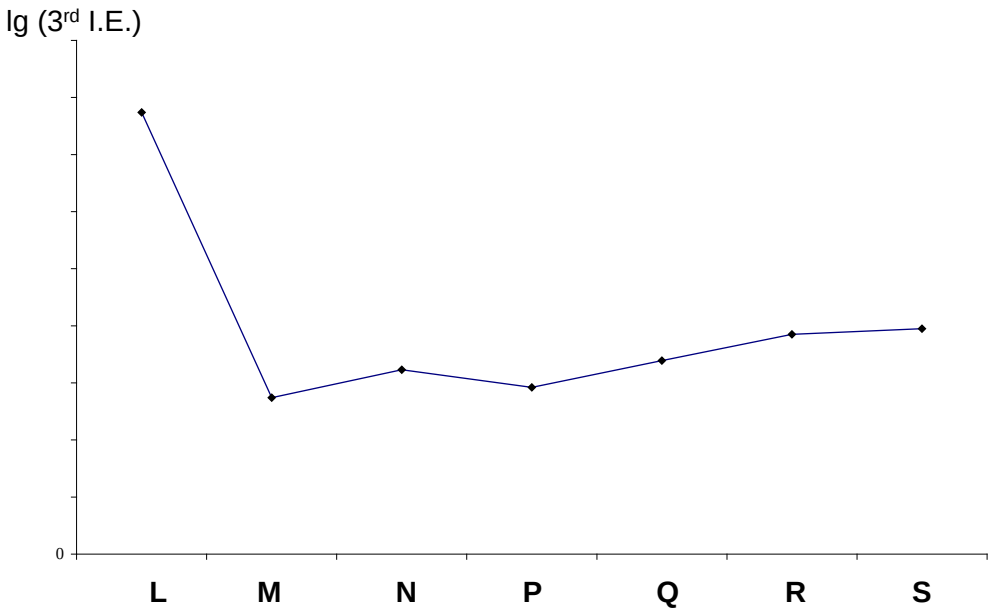
**(ii)** State the formula of the organic product formed when methamphetamine was reacted with sulfuric acid instead of hydrochloric acid.

**[3]**

**Total 10 marks**

**5** Elements **L** to **S** are consecutive Period 3 elements with proton number less than 20. The following graph shows the third ionisation energies of these elements.
[**L** to **S** are not specific elements from the Periodic Table].

For Examiner's Use




**(a)** Identify the group that element **P** belongs to.

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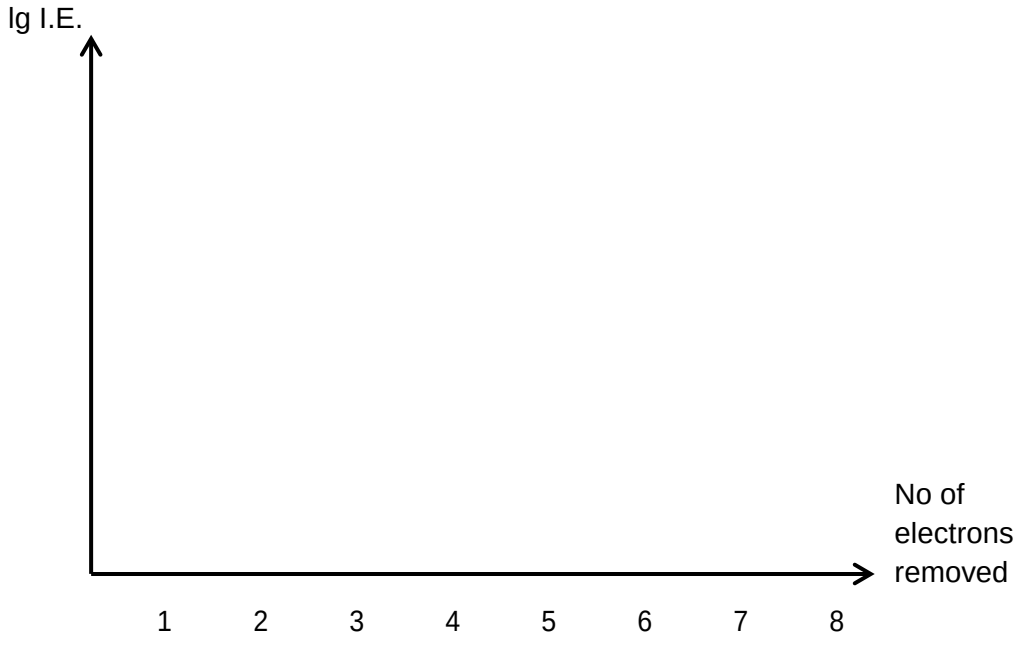
**[1]**

**(b)** Sketch a graph to show the successive ionisation energies of element **P** when the first eight electrons are removed from it.




**[1]**

**(c)** Explain the drop in the third ionisation energy from **N** to **P**.

For Examiner's Use

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**[2]**

**(d)** Write down the equations for the reactions of the oxide of **M** with aqueous hydrochloric acid and aqueous sodium hydroxides separately.

……

……

**[2]**

**(e)** Describe the reactions, if any, of the chlorides of **M** and **P** with water, suggesting the pH of the resulting solutions and writing equations where appropriate.

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**[6]**

**Total 12 marks**

**6 (a)** Nitrogen monoxide in the air can be converted to nitric acid, which results in acid rain. Both nitrogen monoxide and nitrogen dioxide participate in ozone layer depletion. One way of forming nitrogen monoxide is through the dissociation of nitrogen dioxide.

For Examiner's Use

$$2NO_2\ (g) \rightleftharpoons 2NO\ (g) + O_2\ (g)$$

At 494 $^oC$, the value of $K_p$ for the above reaction is 36.9 kPa.

When a certain partial pressure of nitrogen dioxide is put into an empty vessel at 494 $^oC$, equilibrium is reached when 45% of the original nitrogen dioxide has decomposed.

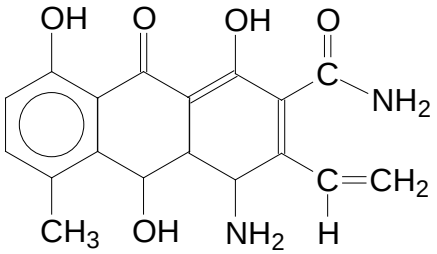
**(i)** Write an expression for the equilibrium constant, $K_p$, for the reaction.

**(ii)** Calculate the original partial pressure of nitrogen dioxide before any dissociation occurred.

**[3]**

**(b)** Draw the structural formula of the organic products formed when compound **T** reacts with the following reagents.

For Examiner's Use




Compound **T**

**(i)** Alkaline aqueous $KMnO_4$, heat

**(ii)** $Br_2$ in $CCl_4$, absence of UV light

**[5]**

**(c)** Compound **U** has the molecular formula $C_9H_{12}O$.

It reacts with chlorine gas in the presence of light to form compound **V**, $C_9H_{11}OCl$, which is optically active.

On addition of bromine water at room temperature, **U** forms a white precipitate **W**, $C_9H_{10}OBr_2$.

When treated with acidified potassium manganate(VII) under reflux, **U** forms compound **X**, $C_8H_6O_5$. 1 mol of **X** reacts with 2 mol of thionyl chloride.

Draw the structures for compounds **U** to **X.**

For Examiner's Use

**[4]**

**Total 12 marks**

**END**