YISHUN JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2014

CHEMISTRY 8872/02

HIGHER 1
Paper 2 Structured & Free Response Questions **2 hours**

Additional materials:
Writing papers, Data Booklet

INSTRUCTIONS TO CANDIDATES

Write your name and CTG 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 paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** the questions.

Section B

Answer **two** questions on separate answer paper.

You are advised to show all working in calculations.

You may use a calculator.

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

For Examiner's Use	
Paper 1	
Total	**/30**
Paper 2	
Section A	
1	/15
2	/10
3	/5
4	/10
Section B	
5	/20
6	/20
7	/20
Total	**/80**
Overall	**/110**

Section A

Answer **all** the questions in this section in the spaces provided.

1 Benzene is a commonly used chemical, especially in the production of plastics and fibres.

(a) With the aid of a diagram, explain the formation of a *pi* bond, using ethene as an example.

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[2]

(b) Compare the relative reactivity of benzene and phenylethene towards addition reactions. Explain your answer.

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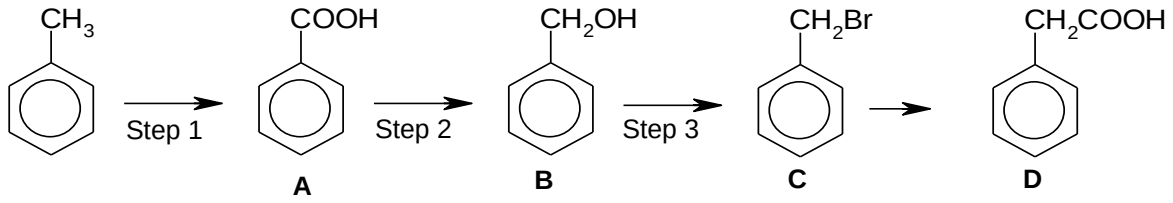
[2]

(c) The following diagram shows some reactions of methylbenzene.



(i) State the type of reaction for Step 2.

.....

(ii) There is *another* method to obtain **C** from methylbenzene in *one* step. Give the reagent and conditions for this method and explain why this method is **not** preferred.

Reagent and conditions: .....

Explanation: .....

.....

(iii) Propose a 2- step synthetic pathway for the conversion of **C** to **D**. Give the reagents and conditions for all steps, and the structure of any intermediates.

(iv) Suggest how the acidity of **A** might compare to that of **D**. Give reasons for your answers.

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.....

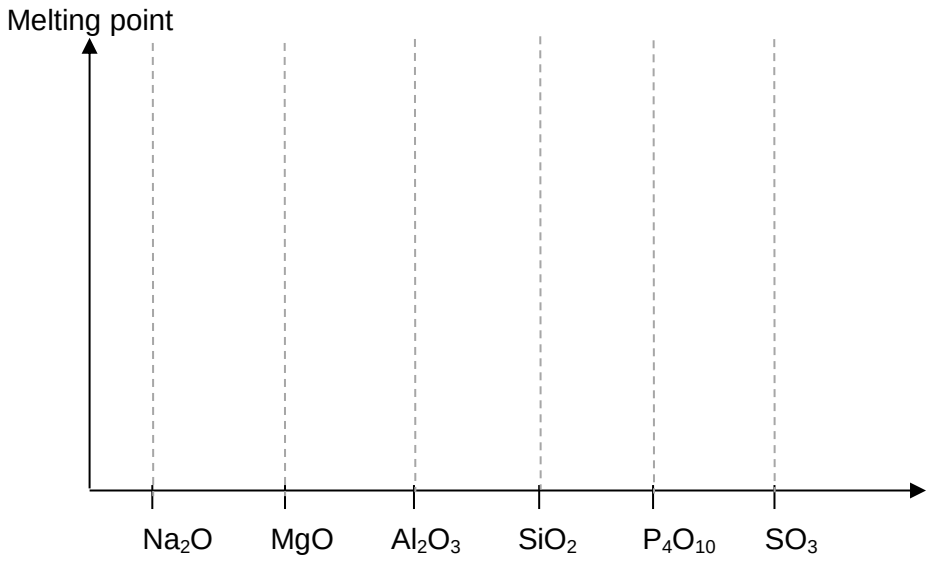
.....

[8]

(d) 5 cm^3 of methylbenzene (density = 0.87 g cm^{-3}) was completely burnt in excess oxygen. Calculate the volume of carbon dioxide produced at s.t.p.

[3]
[Total:15]

2 **(a)** Complete the sketch for elements of the third period to show how the melting points of the oxides vary.



[1]

(b) Explain, in terms of bonding and structure, the difference in melting points between:

(i) Na_2O and MgO,

.....

.....

.....

.....

(ii) SiO_2 and SO_3.

.....

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.....

.....

[4]

(c) The labels on two bottles containing aluminium oxide and silicon dioxide have been torn off. Describe a test which you could carry out in order to distinguish between these two oxides. Include the reagents, observations and equations for any reaction that occurs.

.....

.....

.....

[3]

(d) A 0.150 g sample of a Group I oxide was dissolved in water. It was then titrated with 0.200 mol dm^{-3} hydrochloric acid. 24.20 cm^3 of hydrochloric acid was needed for complete reaction. Calculate the M_r of the oxide.

[2]
[Total:10]

3 The following equation shows an equilibrium reaction for aqueous cobalt(II) chloride solution.

$$\underset{\text{pink}}{[Co(H_2O)_6]^{2+}} + 4Cl^- \rightleftharpoons \underset{\text{blue}}{[CoCl_4]^{2-}} + 6H_2O$$

(a) The reaction above can serve as a humidity sensor. State the colour when the sensor is moist.

.....

[1]

(b) When a solution of aqueous cobalt(II) chloride was placed in ice water, the solution changed from pink to blue. State the enthalpy change for the reaction and explain your answer.

.....

.....

.....

[2]

(c) Adding a few drops of hydrochloric acid causes the pink aqueous cobalt(II) chloride solution to turn blue. Explain the observations.

.....

.....

[2]

[Total:5]

4 Household bleaches contain the active ingredient sodium hypochlorite. The concentration of hypochlorite ion, ClO^- in bleaches can be determined by performing a series of redox reactions.

Under acidic conditions, ClO^- can oxidise iodide ions to iodine. The amount of iodine liberated can be found by titration with a standard solution of sodium thiosulfate, $Na_2S_2O_3$.

(a) (i) Define the term *redox.*

.....

(ii) State the oxidation state of chlorine in ClO^-.

.....

[2]

(b) A student performed the following steps to determine the concentration of ClO^- in Brand **X**'s bleach solution.

Step 1: Brand X bleach solution was first diluted by adding 20 cm^3 of Brand **X** bleach solution to 100 cm^3 of distilled water.

Step 2: An excess of potassium iodide was added to 25.0 cm^3 of the diluted bleach solution, and acidified with dilute sulfuric acid.

Step 3: The mixture obtained from **Step 2** was titrated against 0.100 mol dm^{-3} $Na_2S_2O_3$. When the solution turned pale yellow, starch was added, and the student continued titration until the reaction was completed. 23.90 cm^3 of $Na_2S_2O_3$ was required for complete reaction.

(i) State the observations upon completion of the reaction in **Step 3**.

.....

(ii) Construct balanced equations between:

1. ClO^- and I^- to form Cl^- and I_2 (in acidic medium)

2. I_2 and $S_2O_3^{2-}$ to form I^- and $S_4O_6^{2-}$

(iii) Calculate the number of moles of iodine liberated by the reaction between ClO^- and I^-.

(iv) Hence, determine the concentration of ClO^- in Brand **X** bleach.

[8]
[Total:10]

Section B

Answer **two** questions from this section on separate answer paper.

5 **(a)** Draw the 'dot-and-cross' diagrams to show the bonding in aluminium chloride and ammonia, stating their shapes. Use the diagrams to explain why the bond angle in aluminium chloride is 120° and in ammonia is 107°.

[7]

(b) Ammonia is manufactured industrially in the Haber Process. Describe this process including an equation for the reaction, the conditions used, and the reasons that these particular conditions are chosen.

[5]

(c) A student prepared two solutions.

- Solution **A** was made by mixing 25 cm^3 of 0.10 mol dm^{-3} of dilute hydrochloric acid with 50 cm^3 of 0.10 mol dm^{-3} of ammonia. Solution **A** is a buffer solution.
- Solution **B** was made by mixing 50 cm^3 of 0.10 mol dm^{-3} of dilute hydrochloric acid with 25 cm^3 of 0.10 mol dm^{-3} of ammonia. Solution **B** is **not** a buffer solution.

(i) Explain why solution **B** is **not** a buffer solution.

(ii) Write two balanced equations to show how solution **A** is able to maintain pH when small amounts of acid and base are added to it.

[3]

(d) Ammonia reacts with bromoethane. Give an equation for this reaction stating any conditions required. State the type of reaction involved.

[3]

(e) In the laboratory, bromoethane is prepared by adding HBr to ethene.

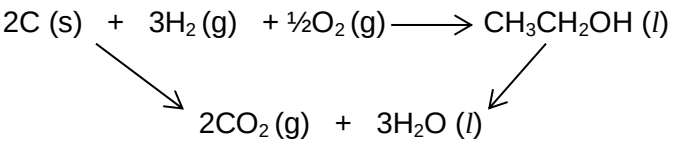
There is an alternative reaction to prepare bromoethane in the lab using a suitable alcohol. Suggest the reagents and conditions for this reaction and write a balanced equation for it.

[2]

[Total:20]

6 **(a)** **(i)** In a flame caloriometry experiment, when 1.00 g of ethanol was combusted, it heated 150 cm^3 of water from 25 °C to 70 °C. Determine the enthalpy change of combustion of ethanol. The density of water is 1.0 g cm^{-3}. Assume that the specific heat capacity of water to be 4.2 J g^{-1} K^{-1}.

(ii) Using the following data and the energy cycle below, calculate another value for the standard enthalpy change of combustion of ethanol.



$\triangle H_c^{\ominus}$carbon = −394 kJ mol^{-1}
$\triangle H_c^{\ominus}$hydrogen = −286 kJ mol^{-1}
$\triangle H_f^{\ominus}$ethanol = −277.7 kJ mol^{-1}

(iii) Suggest a reason for the difference in the answers from **a(i)** and **a(ii)**.

[6]

(b) Ethanol and ethanoic acid react together in the presence of sulfuric acid. The following equilibria is established, in which ester, ethyl ethanoate, is present.

$$CH_3CH_2OH\ (l) + CH_3COOH\ (l) \rightleftharpoons CH_3COOCH_2CH_3\ (l) + H_2O\ (l)$$

(i) Write an expression for the equilibrium constant, K_c, for the reaction between ethanol and ethanoic acid shown above.

(ii) 2.00 moles of ethanoic acid and 3.00 moles of ethanol were mixed in a closed vessel. At equilibrium, 1.50 moles of ethyl ethanoate are present. The total volume of the reaction mixture is 1 dm^3. Calculate a value for K_c.

[4]

(c) Compound **G** has the following molecular formula $C_5H_9O_2Cl$. Upon adding sodium carbonate to **G,** effervescence was observed.

Compound **G** produced a yellow precipitate with hot aqueous alkaline iodine.

Compound **G** does not decolourise hot acidified $KMnO_4$.

Compound **G** reacts with hot aqueous sodium hydroxide to give **J**.

Upon acidification, **J** forms compound **K**, $C_5H_8O_2$ in the presence of a small amount of hot concentrated sulfuric acid.

Compound **K**, $C_5H_8O_2$ has the following characteristics.

- It does not exhibit geometric isomerism.
- It does not decolourise aqueous bromine.

Draw the structures for **G**, **J**, and **K**. Show how you deduced these structures by explaining the reactions that occurred.

[10]
[Total:20]

7 **(a)** Using the oxides of magnesium, silicon and phosphorus as examples, describe the reactions of the oxides of elements in the third period of the Periodic Table with water. Include balanced equations for any reactions. [4]

(b) The reaction between **X** and **Y** is monitored by finding the time taken for **X**, a coloured reactant to decolourise. Water is added to the reaction mixture to keep the volume of the reaction mixture for experiment 1, 2 and 3 constant at 60 cm^3.

$$\mathbf{X} + \mathbf{Y} \longrightarrow \mathbf{Z}$$

The following results are obtained:

Experiment	Volume of **X** added/cm^3	Volume of **Y** added/cm^3	Volume of H_2O added/cm^3	Relative rate of reaction
1	10	20	30	1
2	15	40	5	6
3	20	20	20	2
4	60	40	20	***r***

(i) Explain why is there a need to keep the total volume of the reaction mixture constant.

(ii) Deduce, showing your working, the orders of reaction with respect to **X** and **Y**. Hence, state the overall rate equation for this reaction.

(iii) Deduce the value of ***r*** in experiment 4.

(iv) Sketch a concentration–time graph for **X** in this reaction.

(v) Sketch a Boltzmann distribution curve for the reactants and use it to explain the effect of increasing temperature on the rate of reaction.

[10]

(c) The presence of C=C bonds in unsaturated fat makes the fat turn rancid easily as it is more prone to breakdown. In food production, liquid unsaturated fats such as vegetable oils are hydrogenated to produce saturated fats such as margarine, which have higher melting point than unsaturated fat.

(i) Why is the melting point of saturated fat higher than unsaturated fat?

(ii) Suggest a synthetic route for the formation of prop-1-ene from butan-1-ol.

[6]
[Total:20]

~ END OF PAPER ~