RIVER VALLEY HIGH SCHOOL

Year 6 Preliminary Examination II

CANDIDATE NAME								
CLASS	6							
CENTRE NUMBER	S					INDEX NUMBER				

H1 CHEMISTRY 8872/02

Paper 2 **13 Sept 2016**

2 hours

Candidates answer Section A on the Question Paper.

Additional Materials: Data Booklet, graph paper, writing papers

READ THESE INSTRUCTIONS FIRST

Write your name, class, Centre number and index number 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 working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer all the questions.

Section B
Answer two questions on separate answer paper.

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									
		Paper 2									
Section A	1	2	3	4	5	6	Section B	Q7	Q8	Q9	Total (Paper 2)
	/4	/6	/6	/6	/7	/11		/20	/20	/20	/80
Paper 1	/30					Total	/110	Grade			

This paper consists of **16** printed pages and **1** blank pages

Section A (40 marks)

Answer all the questions in the space provided.

1 The oxidation number of vanadium in a complex ion was determined as follows. 0.015 mol of the complex was dissolved in water and the solution was made up to 250 cm^3. A 25.0 cm^3 portion of this solution required 11.60 cm^3 of 0.050 mol dm^{-3} $KMnO_4$ to oxidise all the V^{3+} ions.

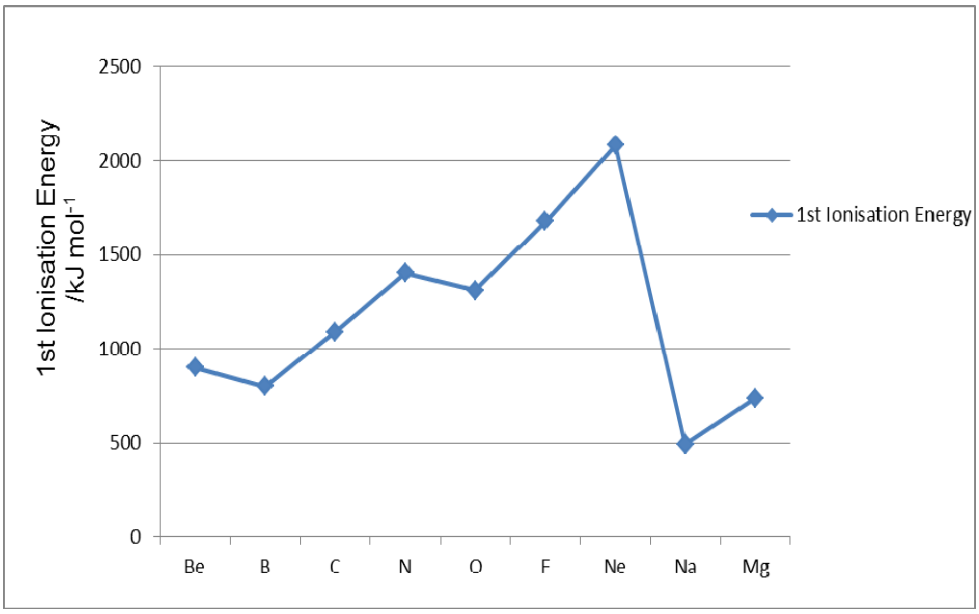
(a) Using V^{n+} to represent the final product of V and in terms of n, write an equation to show the oxidation of V^{3+} **[1]**

……

(b) Hence or otherwise, use these data to calculate the final oxidation number of the vanadium ions. **[3]**

[Total : 4]

2 The graph below shows the first ionisation energies of the elements beryllium to magnesium.



(a) Define the term *first ionisation energy*. **[1]**

……

(b) Explain why the first ionisation energy from beryllium to neon is increasing. **[2]**

……

……

……

(c) Explain why the first ionisation energy decreases from beryllium to boron and nitrogen to oxygen. **[2]**

……

……

……

……

(d) Explain why there is a sharp decrease from neon to sodium. **[1]**

……

……

[Total: 6]

3 Gallium oxide is an important material in the production of catalysts, one of which is Ga_2O_3-Al_2O_3 catalyst. The production of this catalyst involves the reaction between aqueous gallium nitrate and aluminium oxide.

(a) With reference to Ga_2O_3, explain what is meant by the following terms:

(i) standard enthalpy change of formation

……...

……..

……..

(ii) lattice energy

……...

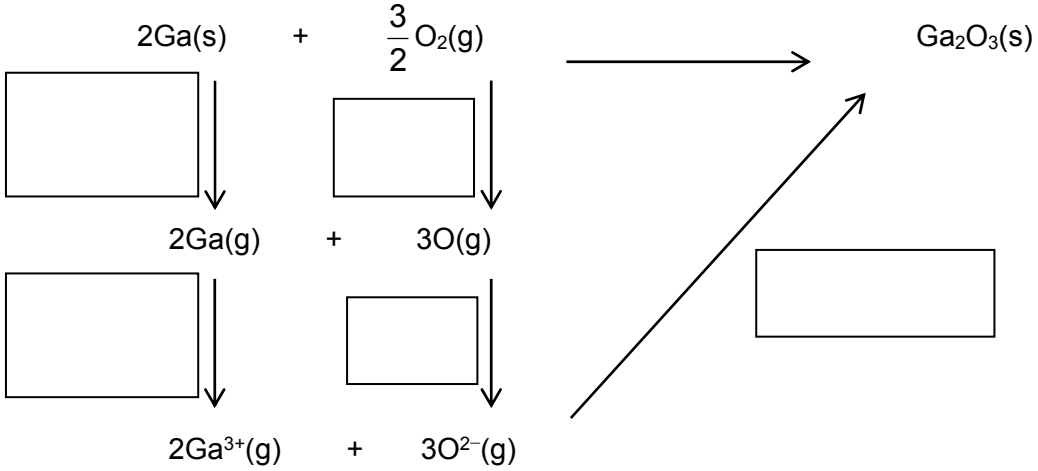
……..

……..

[2]

(b) Given the following information, as well as that from the D*ata Booklet*, fill in the missing information in the diagram and calculate the lattice energy of Ga_2O_3:

Enthalpy change of atomisation of Ga	+277 kJ mol^{-1}
Sum of first two electron affinities of O	+752 kJ mol^{-1}
Enthalpy change of formation of Ga_2O_3	−1089 kJ mol^{-1}



[2]

(c) How would you expect the magnitude of lattice energy of Ga_2O_3 to compare with that of Al_2O_3? Explain your answer.

……

……

……

…… **[2]**

[Total: 6]

4 In a reaction between nitric oxide (NO) and oxygen (O_2), the order of reaction with respect to nitric oxide is two, and the order of reaction with respect to oxygen is one.

(a) Write a rate equation for the reaction and give the units for the rate constant.

Rate equation ……

Units for rate constant …… **[2]**

Two experiments are conducted to study the effect of temperature on the rate of reaction between nitric oxide and oxygen.

Experiment **1** is carried out at T_1 °C, and the numerical value of the rate constant is found to be 3.60×10^{-4}.

Experiment **2** is carried out at T_2 °C.

The following table shows the initial concentrations of nitric oxide and oxygen, and the initial rates for Experiment **1** and **2** performed at T_1 and T_2 respectively.

Experiment	**Temperature / °C**	**Initial [O_2] / mol dm^{-3}**	**Initial [NO] / mol dm^{-3}**	**Initial rate / mol dm^{-3} s^{-1}**
1	T_1	0.12	0.64	x
2	T_2	0.48	0.64	7.80×10^{-5}

(b) **(i)** Calculate the value of the initial rate of reaction of Experiment **1**, *x*.

(ii) Calculate the value of the rate constant at T2.

Hence, deduce whether T_1 or T_2 is higher.

Explain your answer.

[4]

[Total: 6]

5 **(a)** Magnesium, phosphorus and sulfur are elements in Period 3 in the Periodic Table.

Describe what you would observe when these three elements are separately burned in oxygen.

Write equations for the reactions that occur.

Magnesium

Observation …….

……

Equation ……...

Phosphorus

Observation …….

……

Equation ……..

Sulfur

Observation …….

……

Equation ……..

[4]

(b) The oxides of phosphorus and sulfur resulting from the reactions in **(a)** both react with water.

Write equations for these two reactions and state the colour of litmus indicator in the resulting solutions.

Oxide of phosphorus

Equation ……...

Colour of litmus indicator ……...

Oxide of sulfur

Equation ……..

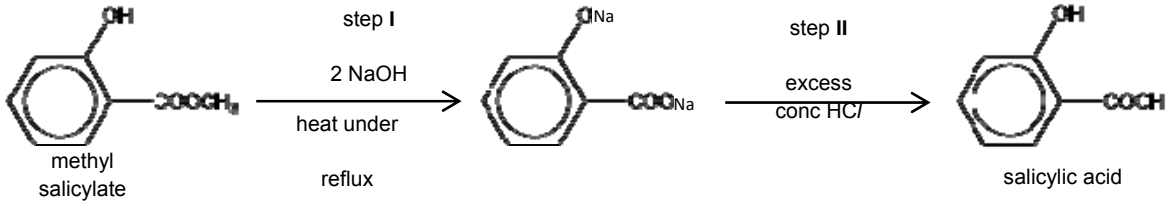
Colour of litmus indicator ……..

[3]

[Total: 7]

6 Salicylic acid is known for its ability to ease aches and pains as well as reduce fevers. Its analgesic and anti-inflammatory properties makes it one of the most important medications needed in a basic health system, placing it on the World Health Organisation Model List of Essential Medicines.

It is synthesised from a precursor known as methyl salicylate shown in the reaction scheme below:



methyl salicylate

(M_r = 152)

salicylic acid

(M_r = 138)

(a) **(i)** Name a functional group present in methyl salicylate.

……...

(ii) State the two types of reaction that occurred in step **I**.

……...

……... **[3]**

Methyl salicylate is a liquid with a density of 1.174 g cm^{-3}.

Aqueous sodium hydroxide has a concentration of 6.0 mol dm^{-3}.

The yield of most organic reactions is less than 100%. A typical yield of pure salicylic acid using the above method is 60%.

(b) Calculate the volumes of methyl salicylate and aqueous sodium hydroxide you would use to prepare 10 g of salicylic acid.

[3]

Suitable quantities of methyl salicylate and aqueous sodium hydroxide are added into a round bottom flask, and the mixture is heated under reflux for 30 minutes.

Once the reaction is completed, the reaction mixture is cooled down before the addition of concentrated hydrochloric acid. During the addition of acid, the round bottom flask is placed in an ice bath.

(c) **(i)** Explain why there is a need to heat the mixture under reflux for 30 minutes.

……...

……..

…….. **[2]**

(ii) Taking into consideration the need to place the round bottom flask in an ice bath, suggest the nature of the acidification process.

…….. **[1]**

(d) Describe a simple chemical test to distinguish between methyl salicylate and salicylic acid.

Write the expected observations for both compounds.

……..

……..

…….. **[2]**

[Total: 11]

Section B (40 marks)

Answer 2 out of 3 the questions in this section on separate answer paper.

7 **(a)** Nitrous oxide or dinitrogen oxide, N_2O, is commonly known as "laughing gas" due to the euphoric effects of inhaling it. It is used in surgery and dentistry for its anesthetic and analgesic effects. To produce N_2O, ammonium nitrate is decomposed at 170 °C. Water is produced in this reaction too.

(i) Write an equation for the production of dinitrogen oxide from ammonium nitrate **[1]**

(ii) In the manufacturing of N_2O gas, 1 kg of N_2O gas is produced for every 2.1 kg of ammonium nitrate used. Determine the percentage yield of dinitrogen oxide. **[2]**

(b) At 1200 K, in the presence of gold wire, dinitrogen oxide decomposes as shown:

$2N_2O(g) \longrightarrow 2N_2(g) + O_2(g)$.

To follow the rate of reaction, the change in concentration of a sample of N_2O is measure against time. The results are shown below:

Time, t/ s	**Concentration of N_2O / $\times 10^{-3}$ mol dm^{-3}**
0	2.50
1000	2.01
2000	1.62
3000	1.31
4000	1.05
5000	0.85
6000	0.68
7000	0.55

(i) What do you understand by the term *half-life* of N_2O? **[1]**

(ii) Plot the above data on a graph paper. **[2]**

Use the following scale:

- 2 cm to represent 1000 s on the x-axis; and
- 2 cm to represent to represent 0.25×10^{-3} mol dm^{-3} on the y-axis.

(iii) From your graph, deduce the order of the reaction with respect to N_2O. **[2]**

(iv) Calculate the rate constant for the reaction and state its units. **[2]**

(v) Define the term *catalyst*. **[1]**

(vi) With reference to the Maxwell-Boltzmann distribution curve, explain how the presence of catalyst increases the rate of reaction. **[2]**

(c) The water-gas reaction plays a central role in the chemical method for obtaining cleaner fuels from coal.

$$CO\,(g) + H_2O\,(g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H > 0$$

A mixture of carbon monoxide and steam was heated at 500 K and a pressure of 10 atm. The equilibrium mixture was found to contain the following amounts of gases in 2 dm^3 flask.

	CO	H_2O	CO_2	H_2
Amount /mol	0.260	1.12	1.24	0.86

(i) Calculate the equilibrium constant, K_C, at 500 K. **[2]**

(iii) Define *Le Chatelier's Principle* **[1]**

(iv) Describe and explain what will happen to the equilibrium position and the value of K_C if

1. the temperature is increased;

2. the pressure is increased. **[4]**

[Total: 20]

8 Pentan-1-ol is a colourless liquid with an unpleasant aroma. It is a useful intermediate in the formation of many organic compounds.

(a) **(i)** Give the structural formula of another primary alcohol which is an isomer of pentan-1-ol. **[1]**

(ii) Write a balanced equation for the preparation of 1-bromopentane from pentan-1-ol. **[1]**

(iii) During the preparation in **(a)(ii)**, 10.3 g of impure pentan-1-ol was found to produce 15.0 g of 1-bromopentane.

Determine the percentage purity of the pentan-1-ol used. **[2]**

(b) Pentan-1-ol can react to give pent-1-ene which is one of the components of gasoline.

State the type of reaction undergone and give the reagent and conditions required. **[2]**

(c) Compounds **A** and **B** are among many compounds secreted by insects to attract members of the same species. They are used in traps to control insect populations. The compounds can be prepared from pentan-1-ol.

A **B**

Give the reagents, conditions and draw the structures of intermediates involved for each synthesis. **[3]**

(d) Pentyl ethanoate is an ester with a scent similar to bananas which allows it to be used as a flavouring agent.

The following is a simple procedure for the preparation of pentyl ethanoate:

1. Add 5 cm^3 of glacial ethanoic acid and an excess of pentan-1-ol into a round bottom flask.
2. Add 0.5 cm^3 of concentrated sulfuric acid to the mixture and heat the resulting mixture under reflux for about half an hour.
3. Cool the mixture and add 25 cm^3 of aqueous sodium carbonate to it.
4. Separate the organic layer from the aqueous layer.
5. Collect the organic layer and allow it to dry in contact with anhydrous magnesium sulfate powder.

(i) What is the role of concentrated sulfuric acid in the experiment? **[1]**

(ii) At the end of the experiment, only about 20% of the ethanoic acid has reacted.

Explain why this is so. **[1]**

(iii) Suggest why pentan-1-ol is added in excess in step 1. **[1]**

(iv) Draw the displayed formula of a by-product that may be formed during the reaction if the temperature is not controlled properly. **[1]**

(v) Why is aqueous sodium carbonate added in step 3? **[1]**

(e) Magnesium sulfate is used as a drying agent in step 5 in the procedure described in (d). It is able to form favourable interactions with the small amount of water molecules still present in the organic layer after the separation process carried out in step 4.

(i) Draw a dot-cross diagram to illustrate the bonding in magnesium sulfate. **[1]**

(ii) Using the Valence Shell Electron Pair Repulsion (VSEPR) Theory, state the shape of the sulfate anion. **[1]**

(iii) Suggest the type of interactions formed between magnesium sulfate and water molecules that enable it to act as a good drying agent.

Illustrate your answer with a well-labeled diagram. **[2]**

(iv) Explain why solid magnesium sulfate is unable to conduct electricity but molten magnesium sulfate is able to. **[2]**

[Total: 20]

9 (a) In a titration experiment, 25.0 cm^3 of 1.0 mol dm^{-3} NH_3 (aq) requires 25.0 cm^3 of 0.5 mol dm^{-3} H_2SO_4 solution for complete neutralisation.

(i) Explain what is meant by a *Bronsted–Lowry acid* and a *Bronsted–Lowry base*. **[2]**

(ii) Use these *Bronsted–Lowry* definitions to describe how H_2SO_4 behaves as a Bronsted acid. Include equations where appropriate. **[2]**

(iii) Calculate the initial pH of the H_2SO_4 solution. **[1]**

(iv)

Indicator	**Working pH range**
Bromocresol green	3.5-5.4
Bromothymol blue	6.0-7.6
Phenol red	6.8-8.4

Suggest a suitable indicator, with reasoning, for the titration reaction. State the change in colour when end-point is reached. **[2]**

(v) NH_3(aq) and its salt can act as a alkaline buffer. Explain how such a buffer solution can resist changes in pH when small amount of acid or base is added to it. Write equations when needed. **[2]**

(b) Compound **A** has a molecular formula of $C_{10}H_{12}O$. It can react with Br_2 in CCl_4 to form compound **B** of molecular formula $C_{10}H_{12}OBr_2$. Reacting compound **A** with HBr will yield compound **C**. Heating compound **C** under reflux with NaOH(aq), acidification and addition of $AgNO_3$ will yield a cream precipitate. Reaction of compound **A** with acidified $KMnO_4$ will yield 2 products **D** and **E** of molecular formula $C_7H_6O_2$ and $C_3H_4O_3$ respectively. **E** reacts with 2,4 dinitrophenylhydrazine to form an orange precipitate. **E** and **F** reacts with Na_2CO_3 to produce CO_2 gas.

Deduce structure **A**- **F**. Explain your answer. **[11]**

[Total : 20]

~ END OF PAPER~

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