H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CLASS 1 5 | INDEX NO. | TUTOR

CHEMISTRY 9647/02

Paper 2 Structured **14 September 2016**

2 hours

Candidates answer on the Question Paper

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 working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces 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 brackets [ ] at the end of each question or part question.

For Examiner's Use		
1	P /12	
2	/ 15	
3	/ 6	
4	/ 13	
5	/ 6	/60
6	/ 20	

This document consists of **17** printed pages and **1** blank page.

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

1 Planning (P)

Baker's yeast is a useful enzyme which can be used to catalyse the decomposition of hydrogen peroxide.

$$H_2O_2 \rightarrow H_2O + ½\ O_2$$

You are provided with

Set-up apparatus:
- 1 x retort stand with clamp
- 1 x 100 cm^3 conical flask
- 1 x L-shape glass tube connector fitted with a rubber bung
- 1 x rubber tubing connection
- 1 x gas syringe (possible capacities of 10, 20 or 100 cm^3)

Reagents and apparatus
- 100 cm^3 of yeast suspension
- 100 cm^3 of 3% (by weight) hydrogen peroxide
- Distilled water
- Stopwatch
- All other common laboratory equipment

When 8.0 cm^3 of the yeast suspension, 4.0 cm^3 of H_2O_2 and 18.0 cm^3 of distilled water is mixed, 10 cm^3 of oxygen gas was produced in 90 s.

Use the above information and the reagents provided to design an experiment to

- prove first order reaction with respect to yeast by a graphical method
- prove first order reaction with respect to hydrogen peroxide by a graphical method

In your experiment, you should perform 4 other experimental runs (including the above run) to measure the volume of oxygen gas produced at regular intervals. The volume of yeast suspension used should be varied in all the runs while keeping volume of H_2O_2 constant at 4.0 cm^3.

In your experiment, illustrate / describe the following:

- A labelled set-up for your experiment using the set-up apparatus provided
- Table of volumes that you will be using in your experiment
- Calculations to determine the maximum volume of oxygen gas produced in each experimental run. In your calculations, assume that the density of H_2O_2 is 1.00 g cm^{-3} and conditions are at r.t.p.
- Procedure for measuring the volume of oxygen gas produced at regular intervals and use the results to find the initial rate for each run graphically
- Graphical analysis involving initial rates to deduce order with respect to yeast
- Graphical analysis involving half-lives to deduce order with respect to H_2O_2 based on one selected run

Experimental setup:

[Turn over

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[Total: 12]

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2 A solder is an alloy of metals which is used to join other metal pieces together. A specialist solder that can be used to join together pieces of aluminium is made from a mixture by mass of 65% zinc, 20% aluminium and 15% copper.

An experimental procedure can confirm the composition of a powdered sample of this solder, by adding reagents and then extracting from the mixture each of the following in sequence;

(i) copper metal,
(ii) aluminium as aluminium hydroxide,
(iii) zinc as zinc hydroxide.

You are provided with

- a sample of this solder, with approximate mass 4 g,
- 1.00 mol dm^{-3} sulfuric acid,
- 1.00 mol dm^{-3} ammonia.

No other reagents should be used. Standard laboratory equipment is available.

(a) Complete the flowchart below to show the order in which the reagents would be added to the solder to allow you to extract and separate the components as copper metal, aluminium hydroxide and zinc hydroxide in **Step 1**, **Step 2** and **Step 3** respectively.

Step 1		**Step 2**		**Step 3**
reagent(s) added		reagent(s) added		reagent(s) added
substance(s) present in solution	→	substance(s) present in solution	→	substance(s) present in solution
substance(s) removed by filtration (if any)		substance(s) removed by filtration (if any)		substance(s) removed by filtration (if any)

[3]

(b) **(i)** For some of the steps in the procedure you would need to be careful to add an appropriate quantity of a reagent.
For each step of your procedure, explain why particular quantities of reagent should be chosen.

Step 1.....

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Step 2.....

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Step 3.....

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..... [4]

(ii) Write the ionic equations for the reactions taking place in **Step 2**.

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..... [2]

(iii) State the observations for the reactions taking place in **Step 1** and **Step 3**.

Step 1.....

Step 3..... [2]

(c) Aluminium hydroxide and zinc hydroxide that have been extracted are difficult to dry so it is better to convert them to their oxides.
Describe how this could be done and how you would ensure that each hydroxide has been completely converted into its oxide.

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..... [2]

(d) If the mass of aluminium oxide obtained was 1.50 g, calculate the mass of aluminium that was present in the solder. [1]

(e) Even if the experimental difficulties of extracting all of the copper from the mixture were overcome, it would be difficult to obtain an accurate mass of copper from this experiment. Suggest why this is so.

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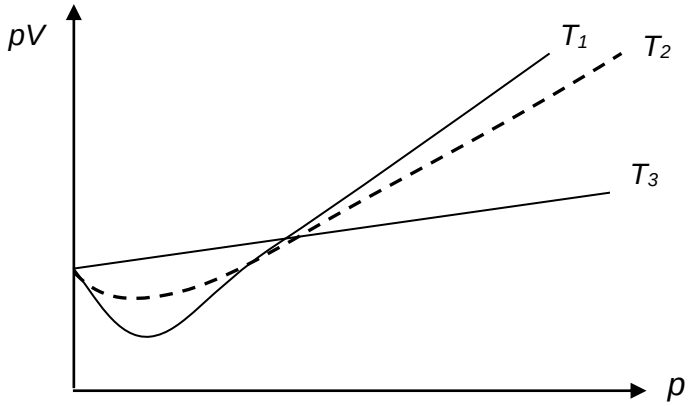
..... [1]

[Total: 15]

3 The relationship $pV=nRT$ can be derived from the laws of mechanics by assuming ideal behaviour for gases.

(a) The graph below represents the relationship between pV and p for a real gas at three different temperatures, T_1, T_2 and T_3.



(i) Draw **one** line on the graph to show what the relationship should be for the same amount of an **ideal** gas. [1]

(ii) With reference to the graph, state and explain which temperature, T_1, T_2 or T_3 is the lowest temperature.

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..... [2]

(b) A flask with a volume of 100 cm^3 was first weighed with air filling the flask, and then with another gas **Y**, filling the flask. The results, measured at 26 ^oC and 1.00 x 10^5 Pa are shown.

Mass of flask containing air	= 47.930 g
Mass of flask containing **Y**	= 47.989 g
Density of air	= 0.00118 g cm^{-3}

Calculate the relative molecular mass, M_r, of **Y**. [3]

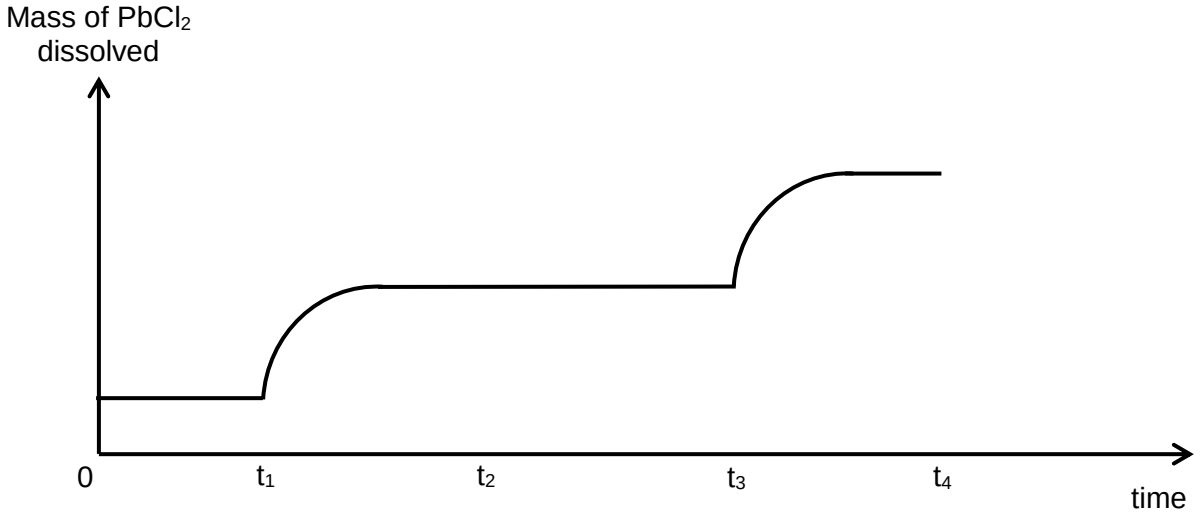
[Total: 6]

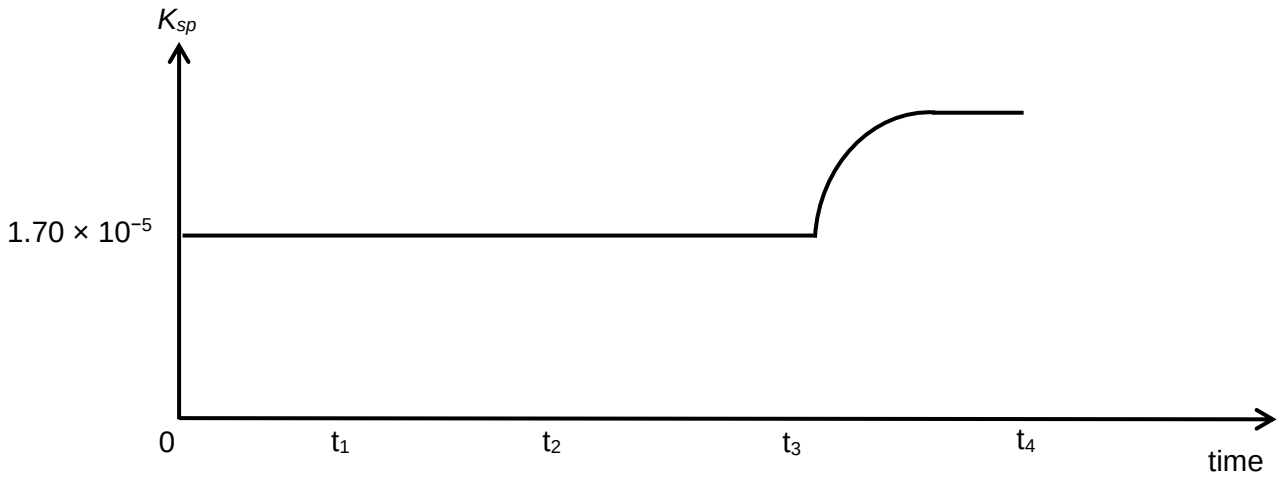
4 $PbCl_2$ is a sparingly soluble salt.

$$PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq) \qquad \Delta H > 0$$

A student investigated the solubility product and solubility of $PbCl_2$ under different conditions. He first added 0.0100 g of solid $PbCl_2$ into 120 cm^3 of an unknown concentration of HCl(aq) at 25 ^oC and subsequently made four changes at t_1, t_2, t_3 and t_4.

The graphs below show the mass of $PbCl_2$ dissolved and solubility product of $PbCl_2$ against time.





(a) Given that 0.00465 g of $PbCl_2$ remained undissolved after addition of 0.0100 g of $PbCl_2$ into HCl, deduce the unknown concentration of the HCl. [3]

(b) Determine the mass of $PbCl_2$ that can dissolve in 500 cm^3 of water at 25 ^oC. [2]

[Turn over

(c) Some possible changes listed below were made by the student at t_1, t_2 and t_3.

1. Cool reaction mixture to 10 ^oC in water bath
2. Heat reaction mixture to 50 ^oC in water bath
3. Addition of $AgNO_3(aq)$
4. Addition of $PbCl_2(s)$
5. Addition of water

With reference to both graphs, suggest and explain the changes made at t_1, t_2 and t_3.

change made at t_1 .....

explanation .....

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change made at t_2 .....

explanation .....

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change made at t_3 .....

explanation .....

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.....[6]

(d) The student added concentrated HCl at t_4. On both the graphs on **Page 10**, draw how the two graphs would look like after t_4. [2]

[Total: 13]

6 Compound **A** ($C_{12}H_{16}O_2$) exhibits optical isomerism. It does not react with hot acidified $K_2Cr_2O_7$. 1 mole of **A** reacts with 1 mole of PCl_5 to form **B**. **A** reacts with cold dilute $KMnO_4$ to form **C** ($C_{12}H_{18}O_4$). Upon heating with acidified $KMnO_4$, **A** gives **D** ($C_9H_{10}O_4$) and **E**. **D** produces effervescence when aqueous Na_2CO_3 is added. 1 mole of **D** reacts with 3 moles of aqueous bromine. **E** gives **F**, a yellow precipitate with warm alkaline aqueous iodine.

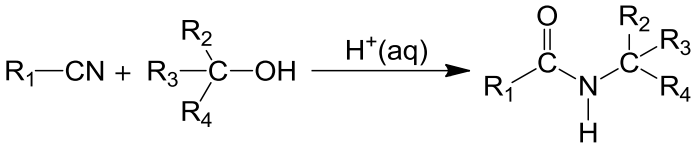
Draw the structures of **A**, **B**, **C**, **D**, **E** and **F**.

A	**B**
C	**D**
E	**F**

[Total: 6]

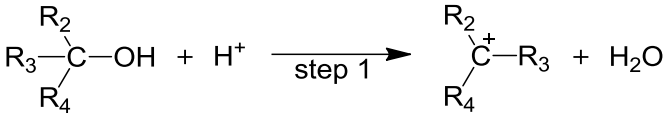
[Turn over

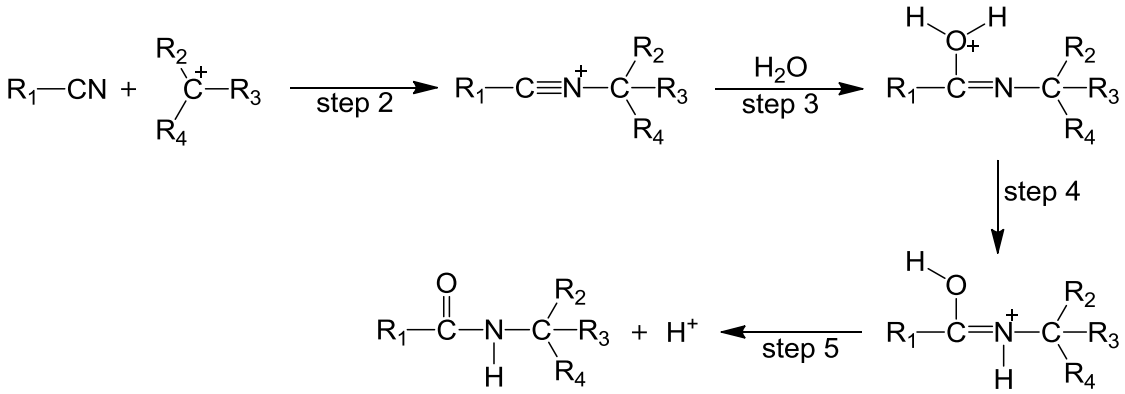
5 The Ritter reaction is an organic reaction used to convert a nitrile and a tertiary alcohol, in a second order reaction, to form an amide using strong aqueous acid as the catalyst.



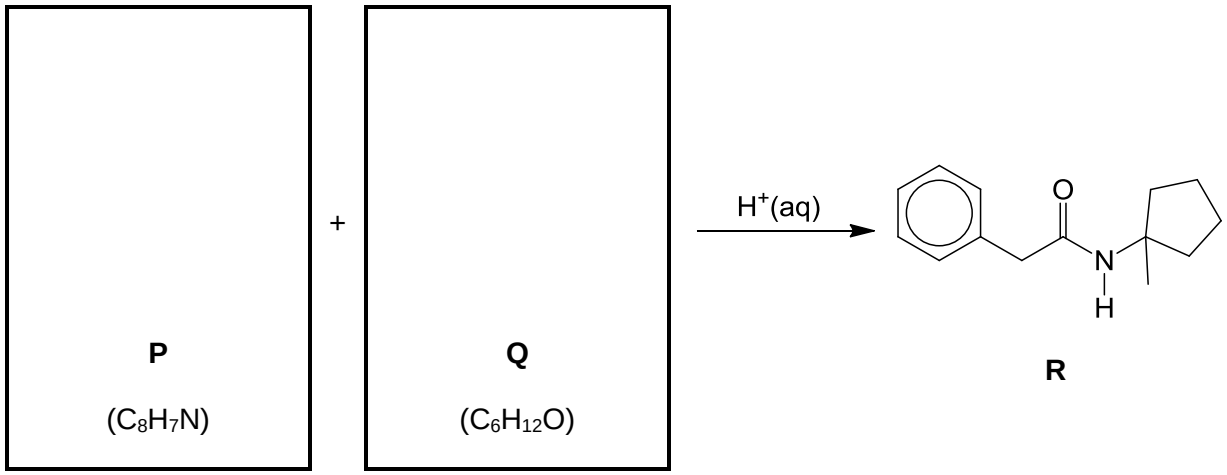
R_1, R_2, R_3 and R_4 are alkyl groups

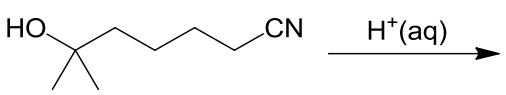
The proposed mechanism is as follows:





(a) Predict the structures of **P, Q** and **T** for each of the following Ritter reactions. [3]





S

T

($C_8H_{15}NO$)

(b) Describe a simple chemical test to distinguish compound **R** and **S**, stating clearly the observations.

Test .....

Observation .....

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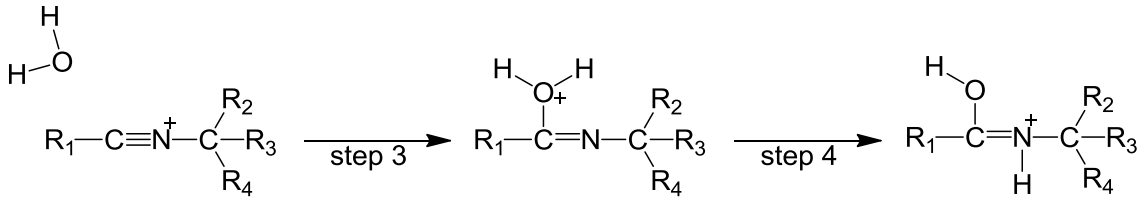
..... [2]

(c) Suggest the types of reaction occurring in steps 3 and 4.

Step 3.....

Step 4..... [2]

(d) Complete the mechanism of step 3 and 4 below with arrows, showing the lone pairs and dipole charges. [3]



(e) Suggest which step of the proposed mechanism on **Page 14** is the slowest step. Explain your reasoning.

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.....[1]

(f) Primary alcohols such as ethanol are not suitable reagents for the Ritter reaction.

(i) Draw a diagram to show the orbitals of the carbon in the carbocation in step 1 and state the type of hybridisation involved. [1]

(ii) Suggest why tertiary alcohols are used in the Ritter reaction but not primary alcohols.

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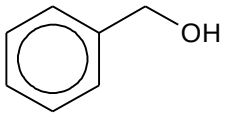
(iii) Suggest why phenylmethanol is a suitable reagent for the Ritter reaction even though it is a primary alcohol.



phenylmethanol

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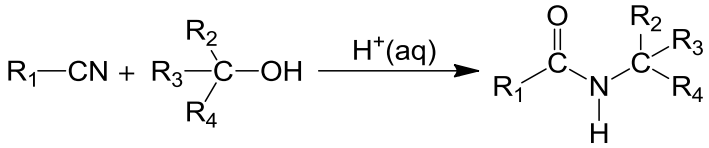
..... [1]

(g) This equation for the Ritter reaction is repeated from page **14**.



R_1, R_2, R_3 and R_4 are alkyl groups

(i) Using suitable data from the *Data Booklet*, calculate the enthalpy change of reaction. [2]

(ii) Suggest and explain if the Ritter reaction is spontaneous at high or low temperature.

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..... [3]

[Total: 20]

[End of Paper]