H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME

CLASS

TUTOR'S NAME

CHEMISTRY

9746/02

Paper 2 Structured

17 September 2008

1 hour 30 minutes

Candidates answer on the Question Paper

Additional Materials: Answer Paper
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.
A Data Booklet is provided.

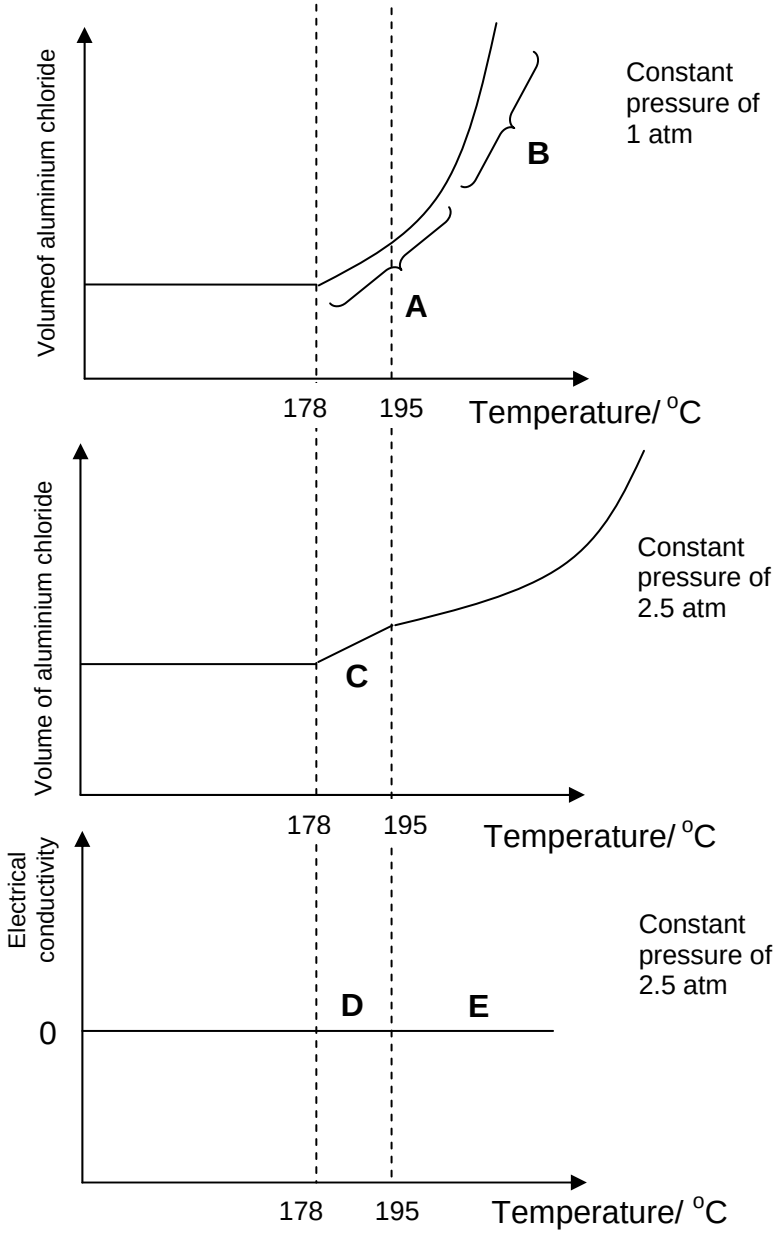
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

This document consists of **14** printed pages and **0** blank page.

Answer **all** questions.

1 Aluminium chloride sublimes at 178^{o}C at standard pressure. The diagrams below show how the volume of aluminium chloride varies with temperature as well as how its electrical conductivity varies with temperature at the stated constant pressures.



(a) Explain why aluminium chloride has zero electrical conductivity at regions **D** and **E**.

.....

.....

.....

..... [2]

(b) Draw the displayed formula of the aluminium chloride molecule at regions **A** and **B**.

Region **A**	Region **B**

[2]

(c) Suggest the physical state of the aluminium chloride at region **C**. Explain your answer and hence state the significance of 195^{o}C.

.....

.....

.....

.....[2]

[Total: 6]

2(a) The following table shows the first ionisation energies of phosphorus, sulphur and chlorine.

Element	*Ionisation Energy* / kJ mol^{-1}
P	1060
S	1000
Cl	1260

(i) Write an equation to represent the first ionization energy of chlorine.

..... [1]

(ii) Why is the ionisation energy of sulphur lower than that of phosphorus?

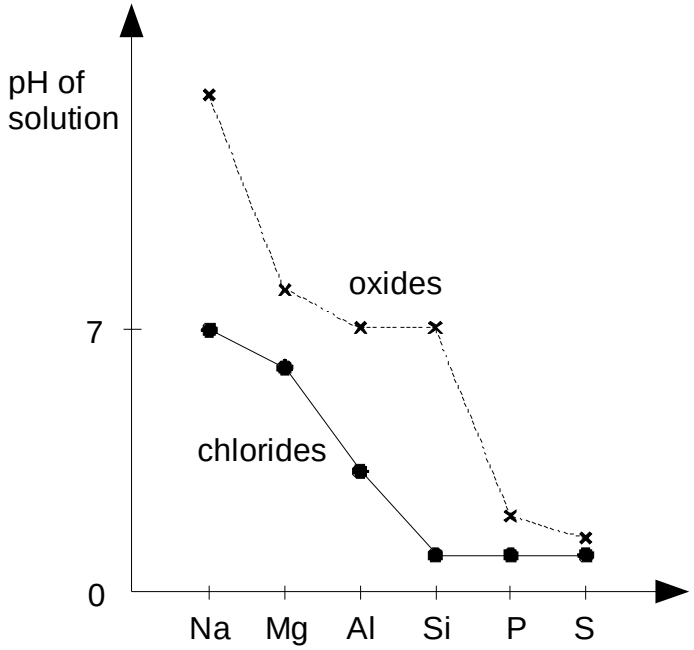
.....

.....

.....

..... [2]

(b) The graphs below show the pH of the solutions obtained after reaction (if any) of chlorides and oxides of some Period 3 elements with water.



(i) Explain why aqueous sodium chloride has a pH of 7. Include any relevant equations in your answer.

.....

.....

.....

..... [2]

(ii) Use the graph above and data from the *Data Booklet* to predict the pH of aqueous $BeCl_2$. Explain your reasoning

.....

.....

.....

..... [2]

(iii) Give the formula of an oxide of sulphur and give the oxidation state of sulphur in this oxide. Give a balanced equation to account for the pH of its aqueous solution.

Formula of oxide:.....

Oxidation state of sulphur in oxide:.....

Equation: ..... [3]

[Total: 10]

3 Silver chromate(VI), Ag_2CrO_4 is only sparingly soluble in water.

(a) Write an expression for the solubility product, K_{sp}, of silver chromate(VI).

.....[1]

(b) The solubility of silver chromate(VI) in water at 25 ^oC is 0.0302 g dm^{-3}.
For a saturated solution of silver chromate(VI) at 25 ^oC, calculate

(i) the concentration, in mol dm^{-3}, of chromate ions,

(ii) the concentration, in mol dm^{-3}, of silver ions,

(iii) the value of K_{sp} of silver chromate(VI), stating the units.

[4]

(c) Will a precipitate form when equal volumes of solutions containing 3 x 10^{-3} mol dm^{-3} silver nitrate and 5 x 10^{-3} mol dm^{-3} of potassium chromate(VI) are mixed together? Explain your answer, with the aid of relevant calculations.

[2]

[Total: 7]

4(a) **(i)** Write a balanced equation for the reaction of heat on calcium nitrate.

.....

(ii) Explain, with the help of equations including state symbols, what happens when a small amount of water is added initially to the white solid obtained after heating in **(a)(i)**, followed by an excess of water.

[3]

(b) A 4.50 g sample of a carbonate of a Group II metal, **X**, lost 1.34 g in mass when heated strongly. Identify the metal.

[3]

[Total: 6]

5 **J** ($Cr_2H_8N_2O_7$) is an orange crystalline solid that is readily soluble in water to give an orange solution. When aqueous sodium hydroxide is added to a sample of the solution, the solution turns yellow and gives off an alkaline pungent gas, **K**.

When a solution of **J** is acidified with sulphuric acid and treated with zinc powder, the solution turns green. On addition of sodium hydroxide to this green solution, a green precipitate, **L**, forms which dissolved in excess sodium hydroxide.

On heating a sample of **J**, a violent reaction takes place with the evolution of steam and a diatomic gas **M** (M_r = 28.0). The residue from the reaction is a green powder that does not dissolve in water but dissolves in sulphuric acid to give a green solution. The addition of aqueous sodium hydroxide to this green solution gives the precipitate **L** that had been produced in an earlier test.

(a) Identify **J, K** and **L**.

J is .....

K is .....

L is .....[3]

(b) The solution of **J** turns yellow when aqueous sodium hydroxide is added. Explain whether this is a redox reaction.

.....

.....[1]

(c) Write a balanced ionic equation for the reaction of solution **J** with zinc powder.

.....[1]

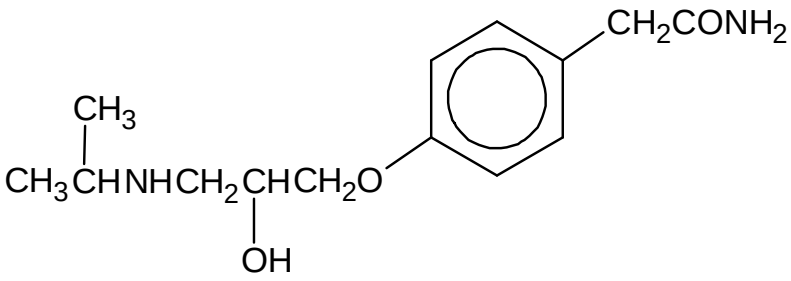
(d) Suggest the identity of gas **M** hence write a balanced equation for the action of heat on **J**.

M is .....

.....[2]

[Total: 7]

6 Atenolol is a drug mainly used to prevent hypertension and coronary heart disease. The structure of Atenolol is



(a) Draw the structural formula of the organic product formed when Atenolol is treated with the following reagents:

[Assume that the ether functional group is inert and does not undergo any reaction]

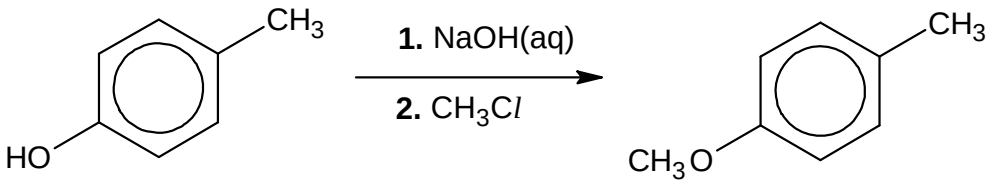
(i) Hot aqueous hydrochloric acid

(ii) Ethanoyl chloride

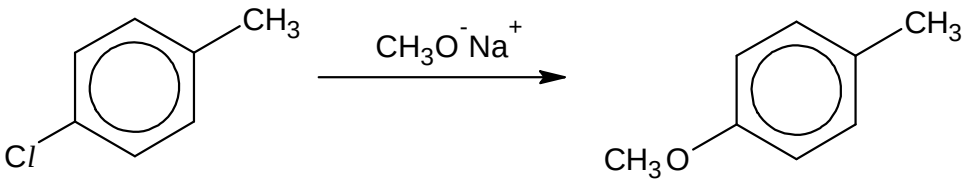
[4]

(b) Part of the reaction scheme for the formation of Atenolol involves the synthesis of the ether functional group via two possible routes:

Route 1:



Route 2:



(i) What is the role of NaOH(aq) in **Route 1**?

.....

..... [1]

(ii) Which route will give a greater yield? Explain your reasoning.

.....

.....

.....

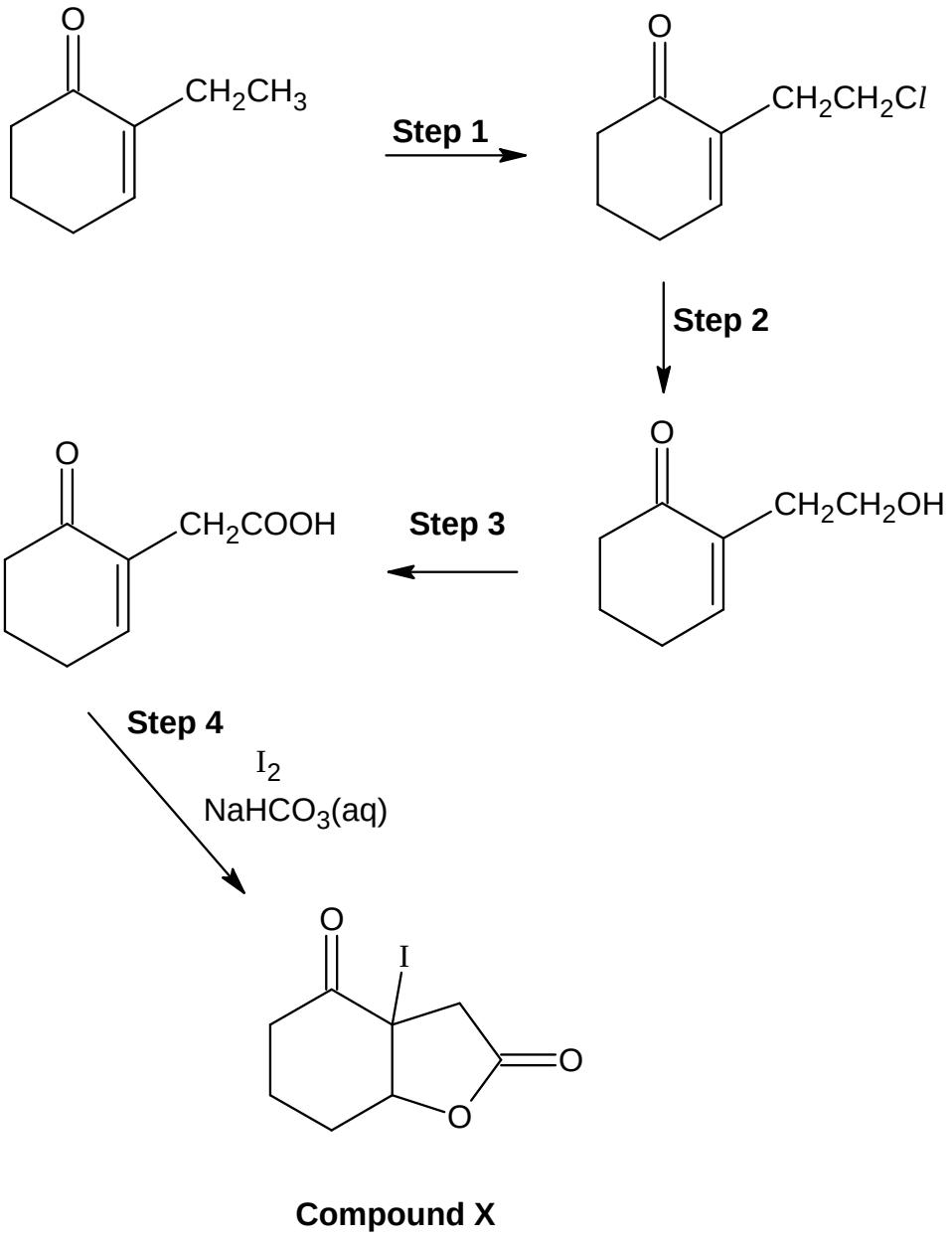
..... [2]

[Total: 7]

For Examiner's Use

7 Below is a reaction scheme for the formation of Compound **X** from Compound **Y**.

Compound Y



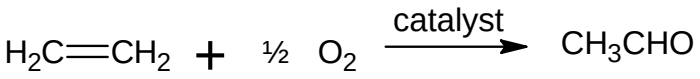
Compound X

(a) State the reagents and conditions required for **Steps 1** to **3**.

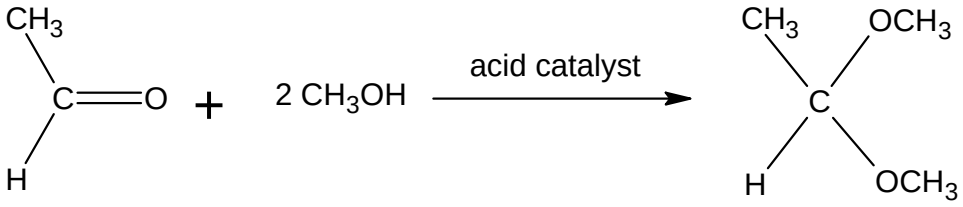
Step	Reagent	Condition
1		
2		
3		

[3]

(b) Alkenes undergo catalytic oxidation to produce aldehydes and ketones.
e.g.



Acetals (molecules that contain 2 –OR groups bonded to the same carbon) can be formed from aldehydes and ketones in an acid catalysed process.
e.g.



Predict the structure of the final product derived from Compound **Y** by catalytic oxidation, followed by $HOCH_2CH_2OH$ in an acidic medium.

[2]

(c) In **Step 4**, due to the presence of $NaHCO_3(aq)$, I_2 does not add across the double bond as expected. Instead Compound **X** was obtained.

(i) Suggest the type of reaction which occurred in **Step 4**.

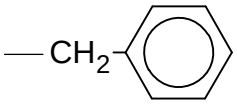
..... [1]

(ii) Hence, suggest a mechanism to explain the formation of Compound **X** in **Step 4**. In your answer, show any relevant charges, lone pairs of electrons and movement of electrons.

[3]

[Total: 9]

8(a) A polypeptide **P** was analysed and contained the following amino acids, [$RCH(NH_2)CO_2H$].

Amino acid	*Abbreviation*	*Formula of R group*
aspartic acid	asp	—CH_2CO_2H
glycine	gly	—H
serine	ser	—CH_2OH
phenylalanine	phe	
valine	val	—$CH(CH_3)_2$
cysteine	cys	—CH_2SH

Enzyme **A** digests proteins or polypeptides at the carboxylic acid end of the amino acid valine, val. The following peptides were identified after digestion of the polypeptide **P** with enzyme **A**, and subsequent separation.

asp – ser – gly – val
ser – phe – cys
phe – val

Another enzyme **B** digests at the carboxylic acid end of serine, ser. The following peptides were identified after digestion of the same polypeptide **P** with enzyme **B**, and subsequent separation.

gly – val – ser
phe – cys
phe – val – asp – ser

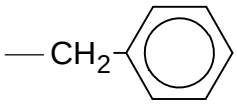
Use the information to determine the primary structure of polypeptide **P**. Justify your answer.

[3]

(b) Draw a displayed formula for the phe – cys dipeptide.

[2]

(c) State what R group interactions are possible for the five amino acids in **A** at pH 7.

Amino acid	*Formula of R group*	*R group interactions*
aspartic acid	—CH_2CO_2H	
serine	—CH_2OH	
phenylalanine		
valine	—$CH(CH_3)_2$	
cysteine	—CH_2SH	

[3]

[Total: 8]