H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

CLASS

TUTOR'S NAME

CHEMISTRY

8872/02

Paper 2

16 September 2015

2 hours

Candidates answer Section A 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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** the questions.

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

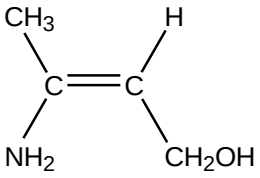
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
B5	
B6	
B7	
Total	

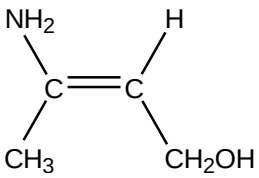
Section A

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

1 **(a)** Predict and explain which of the following isomers has a higher solubility in water.



Isomer **A**



Isomer **B**

……..

……..

……..

……..

……[3]

(b) **(i)** Draw the 'dot-and-cross' diagram of NH_2OH.

(ii) Using VSEPR (valence shell electron pair repulsion) theory, explain why the bond angle about the N atom is greater than the bond angle about the O atom.

……

……

……[3]

[Total: 6]

2 **(a)** Describe the bonding in ethene in terms of orbital overlap. You may draw a diagram to illustrate your answer.

……..

……..

……..……..[3]

(b) **(i)** Ethene can be converted into ethane-1,2-diol. State the reagents, conditions and type of reaction for this reaction.

reagents ……....

conditions ……...

type of reaction ……..

(ii) Ethene and ethane both react with chlorine. Suggest with particular reference to bonding, why ethane needs the presence of UV light but ethene does not.

……..

……..

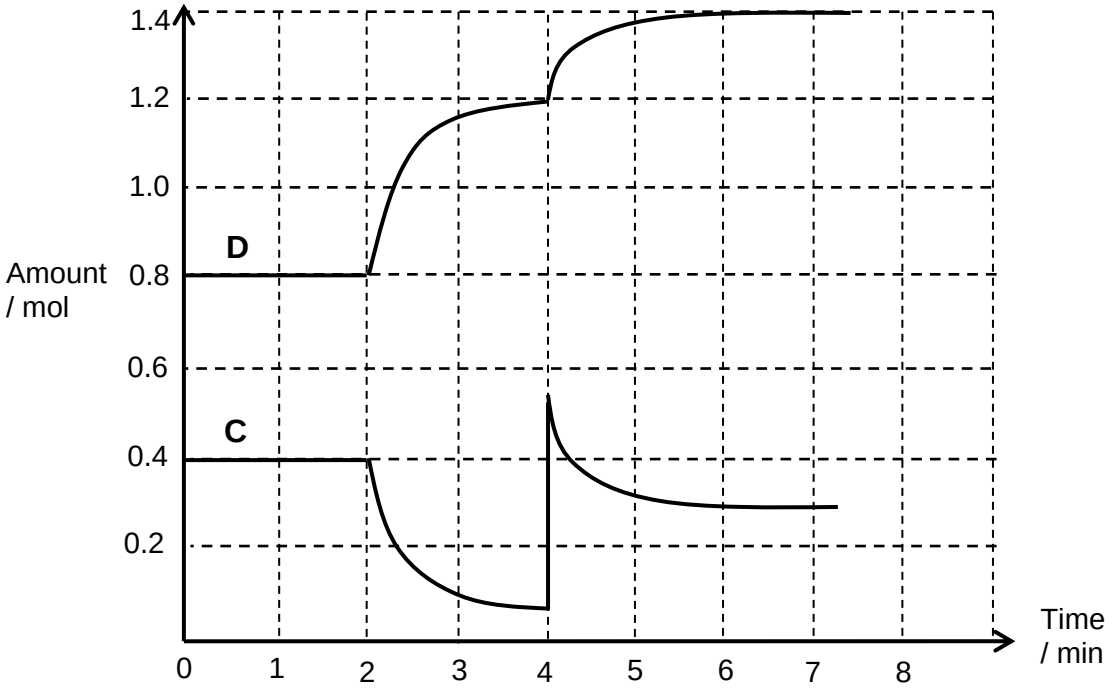
……..

……..[6]

[Total: 9]

3 When compound **C** is placed in a 2 dm^3 closed container, the following equilibrium is established. The backward reaction is exothermic.

$$2\mathbf{C} \rightleftharpoons \mathbf{D}$$



(a) (i) Write an expression for K_c for this equilibrium.

(ii) Calculate the value of the equilibrium constant for the reaction at the 1st minute, stating its units.

For Examiner's Use

(iii) A change was made to the system at the 2nd and 4th minute respectively. State the change and explain your reasoning.

Change at 2nd minute: ……..

Reason: ……..

……..

……..

……..

……..

Change at 4th minute: ……...

Reason: ……..

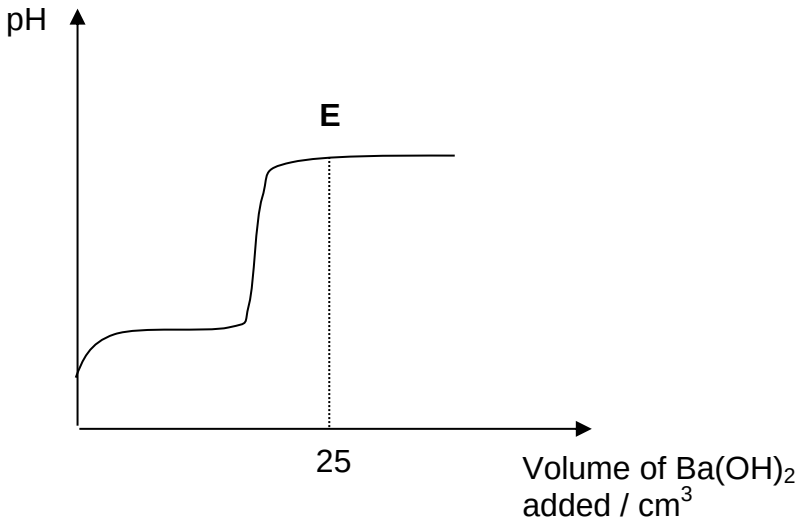
……..

……..

……..

……..[7]

(b) 10.0 cm^3 of 0.100 mol dm^{-3} of ethanoic acid is titrated against 0.0300 mol dm^{-3} of $Ba(OH)_2$. The graph of pH against volume of $Ba(OH)_2$ added is shown:



(i) Write the equation for the reaction between ethanoic acid and $Ba(OH)_2$.

……..

(ii) Calculate the volume of $Ba(OH)_2$ required at equivalence point.

(iii) Hence, calculate the pH value at point **E**.

[4]

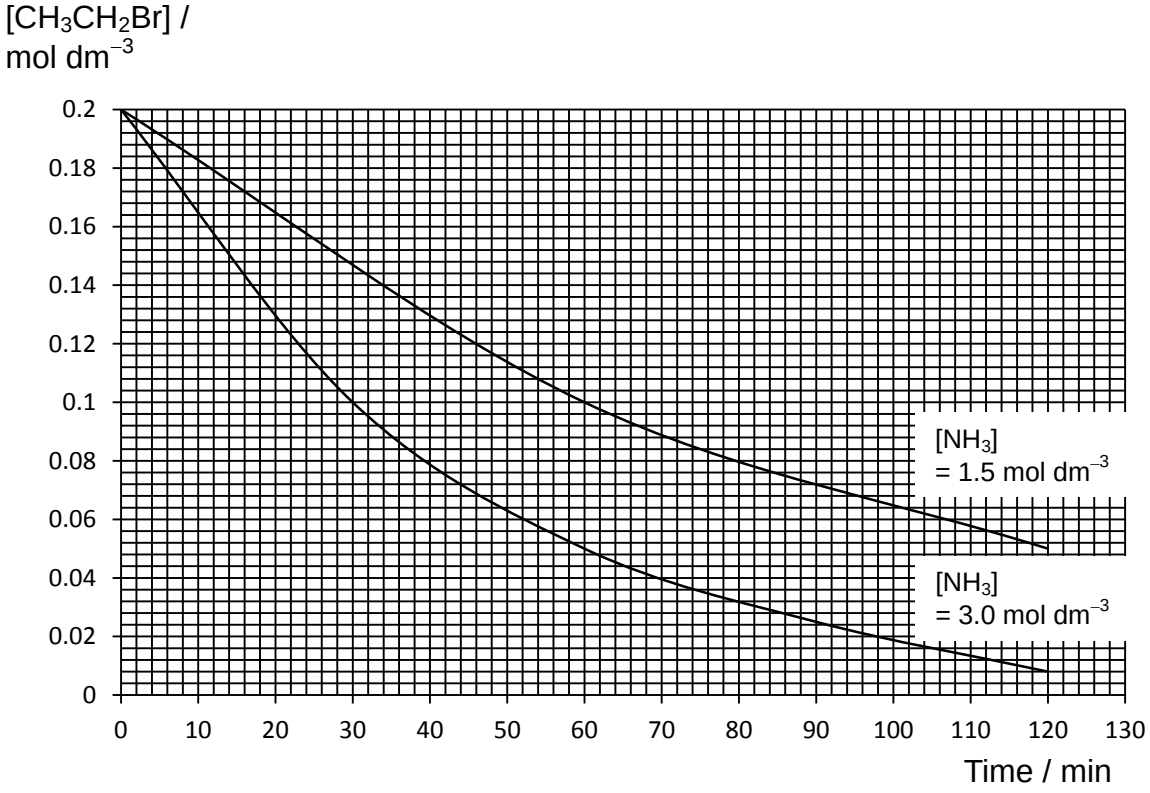
[Total: 11]

4 **(a)** Define order of reaction.

……..

……[1]

(b) The reaction kinetics of a reaction using CH_3CH_2Br and excess alcoholic NH_3 to synthesise an amine is determined by monitoring the change in the concentration of CH_3CH_2Br with time. The results are shown below.



(i) Write a balanced equation for the above reaction.

……

(ii) Use the graphs to deduce the rate equation.

rate equation ……..

(iii) Using the graph where $[NH_3]$ = 1.5 mol dm^{-3}, calculate a value for the rate constant and state its units.

rate constant ……..

[6]

(c) Halogenoalkanes are known to undergo different types of substitution reaction – unimolecular nucleophilic substitution (S_N1) and bimolecular nucleophilic substitution (S_N2), depending on the type of alkyl halide.

Compound	Type of alkyl halide	Type of substitution reaction
$CH_3CH_2CH_2Br$	Primary	S_N2
CH_3Br	Primary	S_N2
$(CH_3)_3CBr$	Tertiary	S_N1
$(CH_3CH_2)CBr(CH_3)_2$	Tertiary	S_N1

Identify the type of alkyl halide and hence suggest if CH_3CH_2Br undergoes S_N1 or S_N2 reaction.

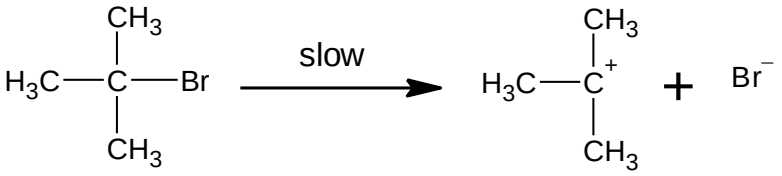
Type of alkyl halide ……..

Type of substitution reaction …...…….[2]

[Turn over

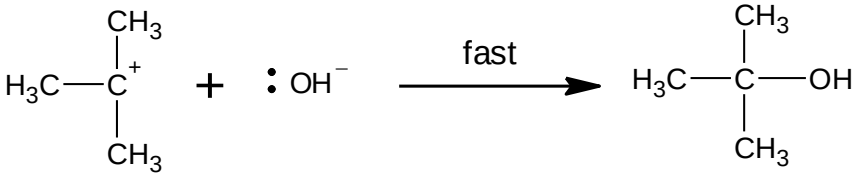
2-bromo-2-methylpropane, $(CH_3)_3CBr$ reacts with NaOH (aq) via the S_N1 mechanism. This mechanism proceeds via the formation of a carbocation intermediate as shown.

Step 1:



carbocation intermediate

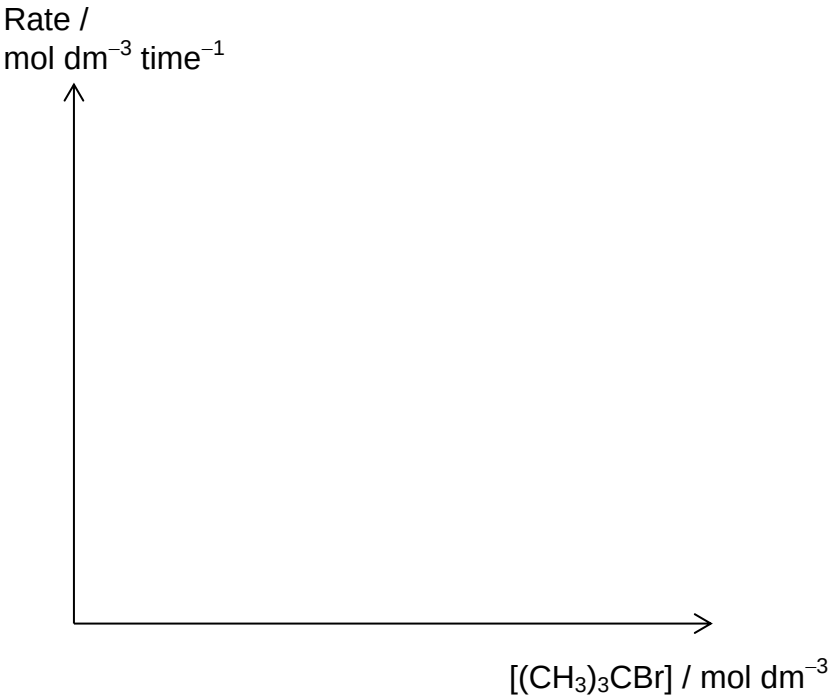
Step 2:



(d) (i) With reference to the given mechanism, write the rate equation for the above S_N1 reaction.

……

(ii) On the axis below, sketch the graph of rate against concentration of $(CH_3)_3CBr$.



[2]

(e) Depending on the solvents used for S_N1 reaction, the rate of reaction is found to change. The dielectric polarisation of some common solvents and their respective relative rates for S_N1 reaction are given in the table below.

Solvents	Dielectric polarisation	Relative rates for S_N1 reaction
Ethanol, CH_3CH_2OH	24.3	1
Methanol, CH_3OH	33.6	10
Formic acid, HCO_2H	58.0	1000
Water, H_2O	80.4	100000

Dielectric polarisation measures the ability of a solvent to act as an insulator of electric charges. Solvents of low dielectric polarisation, such as hydrocarbons, are non-polar, whereas solvents of high dielectric polarisation, such as water, are polar.

(i) State how dielectric polarization affect the rate for S_N1 reactions.

……

(ii) Suggest with a suitable diagram, how water stabilise the carbocation intermediate in the S_N1 mechanism.

(iii) Suggest a solvent that will result in a slower rate than using ethanol.

……[3]

[Total: 14]

Section B

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

5 (a) 60.0 cm^3 of 0.30 mol dm^{-3} ethanedioic acid, $H_2C_2O_4$ (aq), was mixed with 30.0 cm^3 of 1.00 mol dm^{-3} calcium chloride solution, $CaCl_2$ (aq). The precipitate, CaC_2O_4, obtained was filtered off, leaving behind the filtrate containing excess Ca^{2+} and $C_2O_4^{2-}$ ions.

The CaC_2O_4 precipitate was subsequently dissolved in dilute sulfuric acid. The resultant solution was then diluted to 1.0 dm^3 and labelled **F**. 25.0 cm^3 of this solution **F** required 11.80 cm^3 of 0.015 mol dm^{-3} potassium manganate(VII) solution for complete reaction according to the following equation:

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+}\ 10CO_2 + 8H_2O$$

(i) What is the purpose of dissolving the precipitate in dilute sulfuric acid?

(ii) Calculate the concentration of the ethanedioate in solution **F**.

(iii) What mass of CaC_2O_4 precipitated out when $CaCl_2$ (aq) was mixed with $H_2C_2O_4$ (aq)?

(iv) Hence, determine the concentration of Ca^{2+}(aq) and $C_2O_4^{2-}$(aq) remaining in the filtrate. [7]

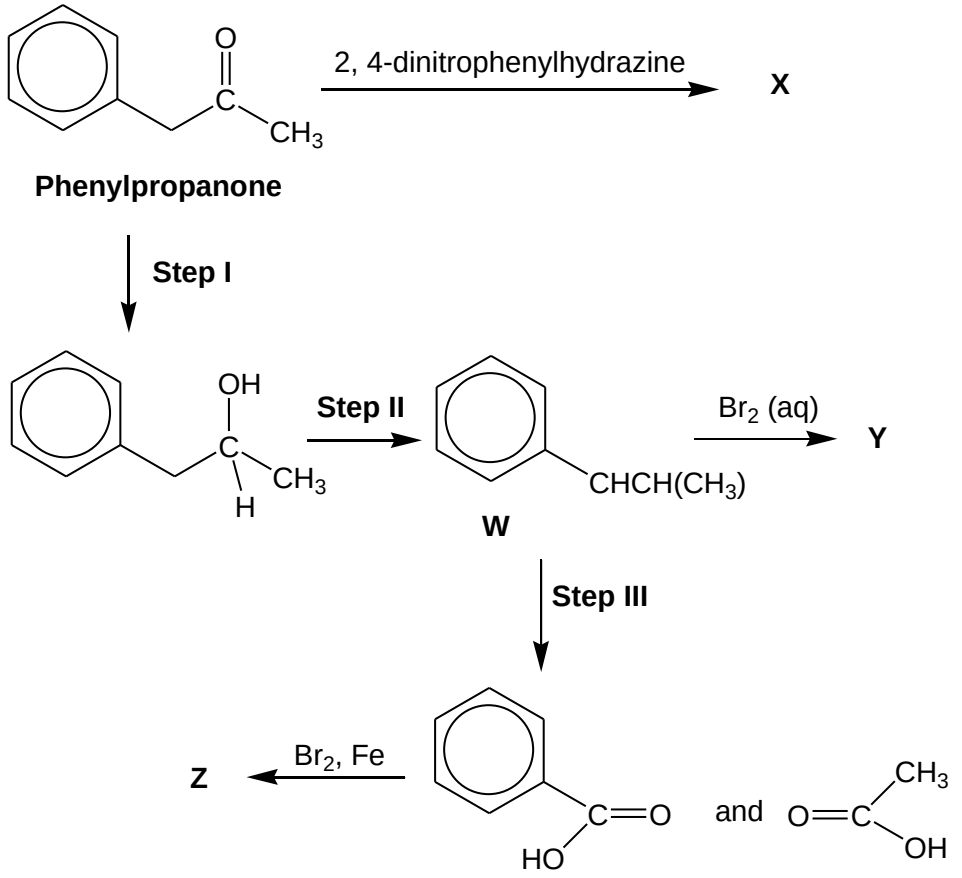
(b) (i) Define with the aid of an equation, the first ionisation energy of calcium.

(ii) Write the electronic configuration of the resulting calcium species.

(iii) Sketch the graph of the successive ionisation energies of the first 10 electrons of a calcium atom. Explain the shape of the graph. [5]

(c) Phenylpropanone, $C_6H_5CH_2COCH_3$, is used in the manufacture of amphetamine, a stimulant commonly used to treat Attention Deficit Hyperactivity Disorder (ADHD). Due to the illicit use in clandestine chemistry, it was made a controlled substance in 1979 in the United States.

A reaction scheme starting with phenylpropanone is shown below.



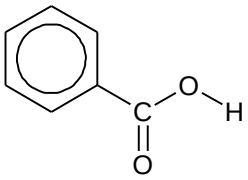
(i) Compound **W** shown in the reaction scheme, exists as a pair of stereoisomers. Draw the structures of the isomers and state the type of isomerism shown.

(ii) Draw the structures of compounds **X**, **Y** and **Z**.

(iii) Suggest reagents and conditions for steps **I** to **III**. [8]

[Total: 20]

6 (a)



benzoic acid

(i) Explain in terms of structure, why benzoic acid is acidic.

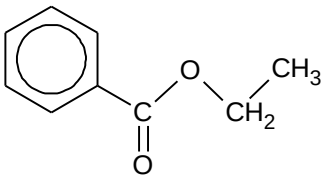
An aqueous solution of benzoic acid of concentration 0.10 mol dm^{-3} has a pH of 2.6 while an aqueous solution of ethanoic acid of concentration 0.50 mol dm^{-3} has a pH of 2.5.

(ii) Calculate the hydrogen ion concentration, $[H^+]$, of benzoic acid solution and ethanoic acid solution respectively.

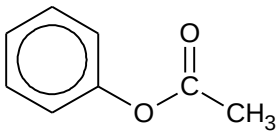
(iii) Hence by comparing the ratio of hydrogen ion concentration calculated with their respective acid concentration, explain which is the stronger acid. [4]

(b) Explain why chloroethanoic acid is more acidic than ethanoic acid. [2]

(c) Ethyl benzoate is isomeric with phenyl ethanoate and undergoes hydrolysis in the same way.



ethyl benzoate



phenyl ethanoate

(i) Write equation to show how ethyl benzoate undergoes hydrolysis using HC*l* (aq).

(ii) Hence suggest a simple chemical test to distinguish between ethyl benzoate and phenyl ethanoate. [4]

(d) In a titration experiment, 25.0 cm^3 of the benzoic acid was found to react completely with 23.00 cm^3 of 0.15 mol dm^{-3} NaOH (aq).

(i) Suggest, with a reason, a suitable indicator for the titration.

The aqueous solution of benzoic acid and sodium benzoate constitutes a buffer system. With the aid of suitable equations, explain how such a system works when

(ii) small amounts of acid, H^+ are added.

(iii) small amounts of alkali, OH^- are added. [6]

(e) Aluminium chloride is a yellowish-white solid that reacts with water in two separate ways.

- When a few drops of water are added to the solid, steamy white fumes are evolved and a white solid which is insoluble in water remains.
- When a large amount of water is added to the solid, a clear, weakly acidic solution results.

Write equations, including state symbols, for these two reactions and explain the observations clearly. [4]

[Total: 20]

7 (a) In an experiment to measure the enthalpy change of neutralisation, 20 cm^3 of 2.0 mol dm^{-3} sulfuric acid was placed in a polystyrene cup. A 30 cm^3 of 1.0 mol dm^{-3} sodium hydroxide, at the same initial temperature, is added. The temperature rose by 8.2 K. Calculate the enthalpy change of neutralization, given the heat capacity of water is 4.2 J K^{-1} cm^{-3}. [4]

(b) Across period 3 elements changes from metallic to non-metallic, causing difference in electronegativity between the elements and the oxide to decrease. This gives rise to different type of oxides formed.

Choose and describe **three** oxides which are **different in terms of structure and bonding**.

For each oxide chosen, write equation for its reaction with water where appropriate and give the approximate pH of any solution formed. [6]

(c) Compound **P** has the molecular formula $C_9H_{12}O$. **P** gives a yellow precipitate in the presence of alkaline aqueous iodine. When **P** is heated with a mixture of NaBr and concentrated H_2SO_4 under reflux, **Q** is formed.

When a solution of silver nitrate in ethanol is added to **Q** a pale cream precipitate appears after a few minutes. When **P** is heated under reflux with acidified $KMnO_4$ the colour of the solution turns from purple to colourless. The resulting organic compound **R** reacts with sodium carbonate in a 1:1 mole ratio and produced effervescence. Heating **R** with methanol in the presence of concentrated sulfuric acid gives a sweet smelling compound **S**, $C_{10}H_{10}O_4$.

Suggest structures for **P**, **Q**, **R** and **S**. Show how you deduced these structures, write equations for all of the reactions described above and state the type of reactions occurred. [10]

[Total: 20]