Index No.	Name	Form Class	Tutorial Class	Subject Tutor

ANGLO-CHINESE JUNIOR COLLEGE
PRELIMINARY EXAMINATIONS
Advanced Level

CHEMISTRY
Higher 2

9746/02

Paper 2 Structured

24 August 2009
1 hour 30 minutes

Candidates answer on the Question Paper
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, index number, form class, tutorial class and subject tutor's name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

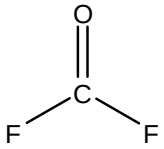
Answer **all** questions.
A Data Booklet is provided.

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 including the cover page.

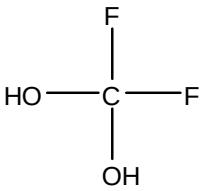
For Examiner's Use	
Question no.	**Marks**
1	
2	
3	
4	
TOTAL	

This document consists of **11** printed pages.

1 Carbonyl fluoride, COF_2 (structure as shown below) exists as a toxic gas which reacts rapidly with water to evolve two different acidic gases.



(a) **(i)** The reaction of carbonyl fluoride with water is found to proceed via the formation of an intermediate as shown:



State the reaction that has occurred to produce the above intermediate.

[1]

(ii) The above intermediate is found to dissociate rapidly to give two different acidic gases. One of the gases is carbon dioxide. State the identity of the other gas.

[1]

(iii) Using the above information, write a balanced equation of the reaction between carbonyl fluoride and water.

[1]

(b) An unknown amount of carbonyl fluoride was reacted with water (in excess). The two acidic gases released is then reacted with NaOH(aq). 25.00 cm^3 of 0.100 mol dm^{-3} of NaOH(aq) is required for **complete** neutralisation.

(i) Calculate the number of moles of NaOH that has reacted.

[1]

(ii) Calculate the number of moles of CO_2 produced.

[3]

(iii) Using your answer in **b(ii)**, calculate the volume of carbon dioxide in m^3 produced under the conditions of 30 °C and 1 atm (assuming ideal gas behaviour).

[1]

(iv) Calculate the mass of carbonyl fluoride used.

[1]

(c) Carbonyl fluoride is found to dissociate to form CO_2 and CF_4 as shown below:

$$2COF_2(g) \rightleftharpoons CO_2(g) + CF_4(g)$$

(i) Given that the K_c value of the above reaction at 1000 °C is 2.00, calculate the number of moles of COF_2 that remains undissociated at equilibrium when 0.500 mol of COF_2 is placed in a 3.50 dm^3 vessel at 1000 °C.

[4]

(ii) State and explain how the yield of CO_2 will be affected when the total pressure in the vessel is increased.

[2]

[Total: 15]

2 (a) Group II metal, **X** reacts very slowly with cold water but vigorously with steam. Group II metal, **Y** readily reacts with cold water. Suggest the identity of **X** and **Y**, and give a reason for your choice.

[2]

(b) Give one property of magnesium oxide which makes it suitable for furnace lining.

[1]

(c) (i) SiO_2, also known as silica, is a hard glassy mineral found in rock and sand. Glass contains about 70% silica, as well as 15% Na_2O and 9% CaO. Na_2O and SiO_2 react to form sodium silicates which help glass to increase elasticity.

Describe how separate samples of SiO_2, Na_2O and CaO react with water and write equations where appropriate. Estimate the pH of the resulting mixtures.

[5]

(ii) Hence, suggest a reason why CaO can be used to effectively remove SO_2 produced in power stations.

[1]

(d) The table below contains some data for the halogens.

Element	Atomic Number	Atomic Radius /nm	Ionic Radius /nm	Boiling Point /K
F	9	0.064	0.133	86
Cl	17	0.099	0.181	238
Br	35	0.111	0.196	332
I	53	0.130	0.219	456

Explain the following:

(i) The boiling point of bromine is lower than that of iodine.

[2]

(ii) The anionic radius of chlorine is larger than its atomic radius.

[2]

(e) Identify the type of reaction that occurs when chlorine reacts with hot aqueous sodium hydroxide? Write an ionic equation and describe any observations made.

[2]

[Total: 15]

3 **(a)** In the separate experiments methane was reacted with halogens when irradiated with ultraviolet light.

Experiment 1

Samples of methane gas and chlorine are mixed together.

Experiment 2

Methane gas is bubbled into liquid bromine.

(i) Write down the observations in Experiment 2.

[2]

(ii) The reaction of methane and halogens is said to occur by a 'free radical mechanism'. Explain what is meant by a *free radical*.

[1]

(b) Samples of gases methane and chlorine are mixed together and irradiated with ultraviolet light. The reaction goes through two propagation steps with the respective heat of reactions and activations energies.

Step	**ΔH / kJmol^{-1}**	**E_a / kJmol^{-1}**
Propagation Step 1	+4	17
Propagation Step 2	-109	4

(i) Briefly outline the mechanism of the two propagation steps.

[2]

(ii) Using the information above, sketch the combined energy profile diagram for the two propagation steps of the chlorination of methane showing all relevant energy changes. Please specify the reactants, products and intermediates.

[4]

(iii) Which of the propagation steps is the rate determining step? Explain.

[2]

(c) The following results were obtained when hydrolysis of chloromethane with aqueous potassium hydroxide was performed.

Experiment	Initial $[CH_3Cl]$ / $moldm^{-3}$	Initial [KOH] / $moldm^{-3}$	Initial rate / $moldm^{-3}s^{-1}$
I	0.10	0.10	0.024
II	0.10	0.15	0.036
III	0.20	0.20	0.096

(i) Determine the order of reaction with respect to both CH_3Cl and KOH and hence write the rate equation.

[3]

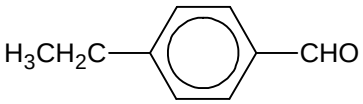
(ii) Free radical substitution of methane with chlorine often leads to polychlorinated methane such as trichloromethane. What is the product obtained when hydrolysis of trichloromethane with aqueous potassium hydroxide is performed?

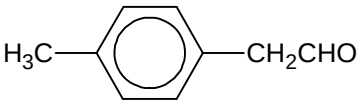
[1]

[Total: 15]

4 Describe a chemical test by which you could distinguish the following pairs of organic compounds. You should state the reagents and conditions, observations and write balanced equations.

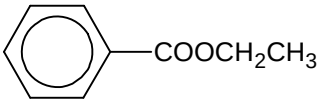
(a) **(i)**

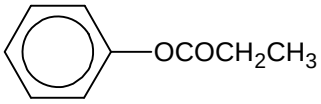




[3]

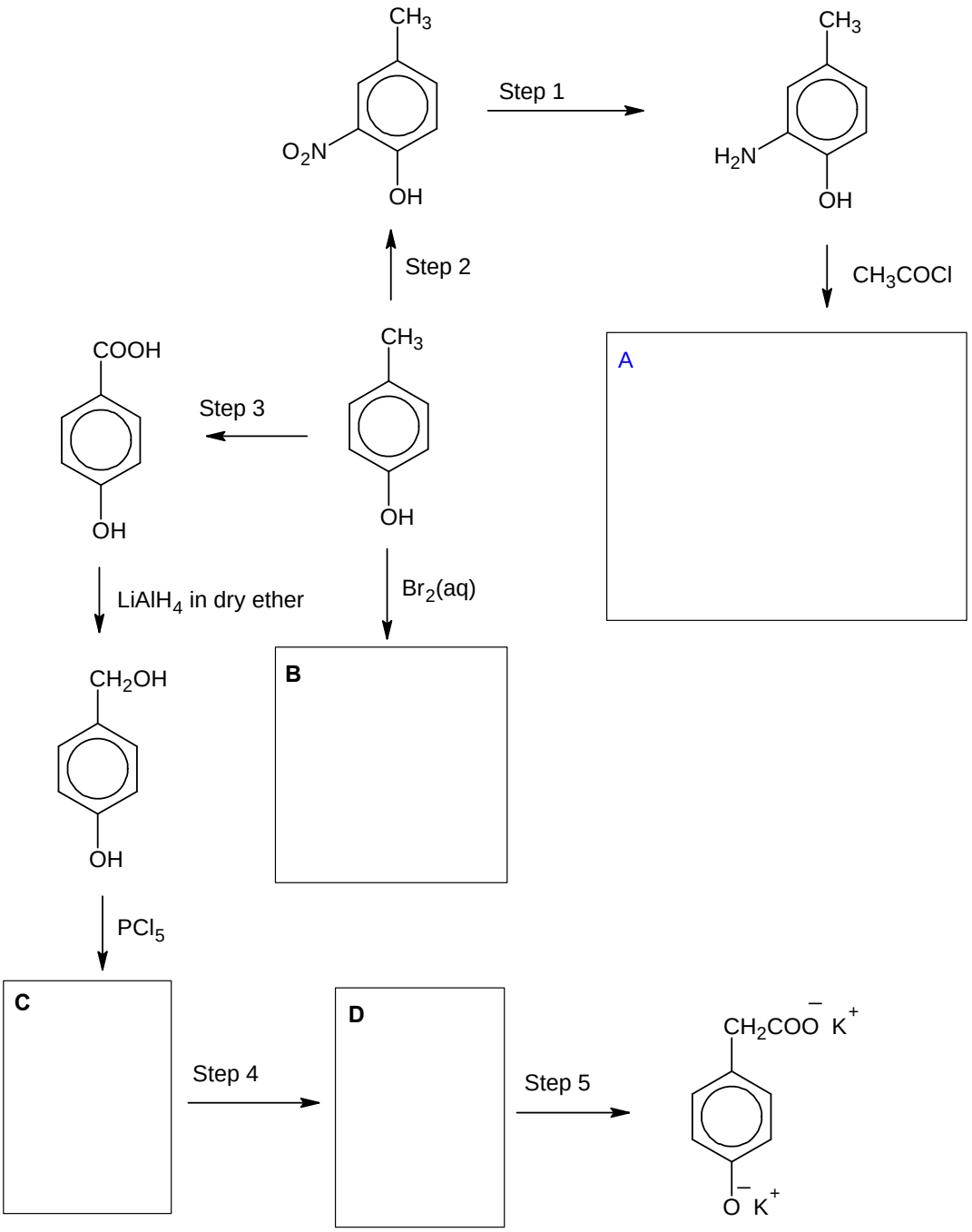
(ii)





[3]

(b) With reference to the reaction scheme shown below, draw the structures of compounds **A** to **D**. State the reagents and conditions required to bring about steps **1** to **5** as labeled in the reaction scheme.



Step 1:

Reagent(s): _____

Condition(s): _____

Step 2:

Reagent(s): _____

Condition(s): _____

Step 3:

Reagent(s): _____

Condition(s): _____

Step 4:

Reagent(s): _____

Condition(s): _____

Step 5:

Reagent(s): _____

Condition(s): _____

[9]

[Total: 15]