TUTOR'S

NAME

NANYANG JUNIOR COLLEGE JC 2 PRELIMINARY EXAMINATION Higher 1

CANDIDATE NAME

CLASS

CHEMISTRY

Paper 2

8872/02

10 September 2012 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 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.

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.

Section A				
1				
•	/ 12			
2				
	4			
3				
	5			
4				
-	/ 13			
5				
5	6			
Total				
	40			

This paper consists of 13 printed pages and 0 blank page

## Section A

Answer **all** the questions. Write your answers on the spaces provided.

- 1 Nitrides are a large class of compounds with a wide range of properties and applications. They are often used as refractory materials. Two examples are magnesium nitride, Mg<sub>3</sub>N<sub>2</sub> and boron nitride, BN.
- (a) Draw a dot-and-cross diagram to show the bonding in magnesium nitride.

[2]

For Examiner's

Use

(b) Suggest the electrical conductivity of magnesium nitride in liquid state.

(c) Boron nitride is a good lubricant like graphite. Explain, in terms of structure and bonding, this property of boron nitride.

Suggest one reason why magnesium gives the nitride, Mg<sub>3</sub>N<sub>2</sub>, in addition to its (d) oxide when burned in air. Construct a balanced equation for the combustion of Examiner's magnesium in air.

..... \_\_\_\_\_ .....[2] A 2.00 g sample of the powder obtained from burning magnesium in air was boiled (e) with water. The ammonia that was evolved neutralised 12.0 cm<sup>3</sup> of 0.500 mol dm<sup>-3</sup> hydrochloric acid. (i) Construct a balanced equation for the reaction with water. .....[1]

(ii) Calculate the percentage of magnesium nitride in the 2.00 g sample.

[3] [Total:12] [Turn Over

2 The formation of magnesium oxide from its elements may be represented by a Born-Haber cycle as shown below.



(b) Using values from the *Data Booklet* and the energy values given in the above cycle, calculate the value of  $\Delta H_1$ .

[2]

[Total:4]

3 Consider the following reversible reaction where colourless bromide ions react with For hydrogen peroxide to form a reddish-brown bromine solution. Examiner's Use  $2Br^- + H_2O_2 + 2H^+ \rightleftharpoons Br_2 + 2H_2O$  $\Delta H < 0$ Explain what is meant by the term dynamic equilibrium. (a) .....[2] (b) Predict and explain the effect on the position of equilibrium when (i) a catalyst is added, (ii) temperature is increased. ..... .....[3] [Total:5]

4 Cinnamaldehyde is used in fragrances for its jasmine-like odour.



## cinnamaldehyde

(a) Name the **two** functional groups, other than the phenyl group, that are present in cinnamaldehyde.

.....[2]

(b) Cinnamaldehyde can exhibit geometric isomerism. Draw and label the structure of the geometric isomers and explain how it arises.

..... .....[3] (c) CH=CH<sub>2</sub> CHO is a structural isomer of cinnamaldehyde.

Describe a simple chemical test you could carry out to distinguish the two isomers. Draw the structure of the organic product for the positive test.

For Examiner's Use

- (d) Cinnamaldehyde reacts with hydrogen gas in the presence of nickel catalyst to give a saturated compound **A**.
- (i) State the type of reaction taking place.

.....[1]

(ii) Draw the structural formula of compound **A**.

[2]

- (e) Draw the structural formula of each of the organic products formed when cinnamaldehyde is treated with the following reagents:
- (i) acidified potassium dichromate(VI) when heated under reflux.

(ii) 2,4-dinitrophenylhydrazine.

[2]

[Total: 13]

**5** Use of the Data Booklet is relevant to this question.

Part of the Periodic Table is shown below.

Gro	up l	II	III	IV	V	VI	VII	0
Period 2	Li	Be	В	С	Ν	0	F	Ne
Period 3	Na	Mg	Al	Si	Р	S	CI	Ar

(a) From the elements shown in the table, identify the one which exhibits each of the following property. Write your answers in the table.

- (i) It has the highest first ionisation energy.
- (ii) It has the largest ionic radius.
- (iii) It has an electronegativity similar to that of aluminium.
- (iv) It has a hydride that forms the strongest intermolecular hydrogen bonds.
- (v) It has a trifluoride with molecules of trigonal shape.
- (vi) It has a chloride that neither reacts with nor dissolves in water.
- (vii) It has an oxide with a giant structure and a chloride which is readily hydrolysed in water.
- (viii) It has an oxide that produces a strong acid when treated with water.

(i)	(ii)	(iii)	(iv)
(v)	(vi)	(vii)	(viii)

(b) Write equations for the reactions in (vii) and (viii).

[Total: 6]

[4]

For Examiner's Use

# Section B

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

- **6(a)** Propan-2-ol is a clear colourless volatile liquid. It is often used as a solvent and an antiseptic. It can be formed from the reaction between propene and steam.
- (i) Name the type of reaction and state the conditions required for the reaction to occur.
- (ii) Write a balanced equation for the complete combustion of propan-2-ol.
- (iii) When 1.00 g of propan-2-ol was burned under a container of water, it was found that 100 g of water was heated from 20 °C to 80 °C. The process was known to be only 75% efficient.

Calculate the standard enthalpy change of combustion of propan-2-ol.

[6]

- (b)(i) Use bond energy values from the *Data Booklet* to calculate another value for the standard enthalpy change of combustion of propan-2-ol.
- (ii) Suggest a reason for the discrepancy between this value and the value calculated in **b**(i).

[4]

(c) R and S are aromatic compounds with the molecular formula C<sub>9</sub>H<sub>12</sub>O. Both R and S react with sodium metal. When heated with acidified K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, the reagent does not change colour with S but turns green with compound R to produce compound T, C<sub>9</sub>H<sub>10</sub>O. Both R and T form a pale yellow precipitate with warm alkaline aqueous iodine.

In the presence of concentrated  $H_2SO_4$ , **R** and **S** form hydrocarbons **U** and **V** respectively. Both **U** and **V** react with bromine to give **W** and **X** with the following structural formula:



Identify and suggest structures for **R**, **S**, **T**, **U** and **V**.

Show how you deduce these structures and suggest the types of reaction that are occurring.

[10]

[Total: 20]

7 This question is about hydroxyacids.

One of the simplest hydroxyacids is lactic acid, 2-hydroxypropanoic acid. It can be synthesised in the laboratory by the following route.

CH<sub>3</sub>CHO I CH<sub>3</sub>CH(OH)CN II CH<sub>3</sub>CH(OH)CO<sub>2</sub>H lactic acid

(a) State the reagents and conditions needed for reaction I and reaction II.

[3]

- (b) Lactic acid is used to treat warts which are viral growths on dead skin. The value of its acid dissociation constant,  $K_a$ , is just high enough for the acid to kill the infection without damaging the live skin underneath.
- (i) Write an equation for the reaction between lactic acid and water. Indicate which species are the acid, the base and their conjugate pairs in the reaction.
- (ii) Explain what is meant by the term acid dissociation constant,  $K_a$ .
- (iii) Lactic acid is described as a *weak Bronsted acid*. What do you understand by the terms in italics?

[7]

- (c) After consuming food or drinks containing sugar, the pH in the mouth can decrease from pH 6.8 to a pH of about 4.8 as the sugar is broken down into lactic acid. In time, hydrogencarbonate ions in saliva restore the pH to its original value.
- (i) How many times greater is the hydrogen ion concentration in the mouth at pH 4.8 compared with that at pH 6.8?
- (ii) Write an equation to show how hydrogencarbonate ions decrease the acidity.

[3]

(d) When lactic acid reacts with ethanol to form an ester, the following equilibrium is established.

 $CH_{3}CH(OH)CO_{2}H(I) + CH_{3}CH_{2}OH(I) \rightleftharpoons CH_{3}CH(OH)CO_{2}CH_{2}CH_{3}(I) + H_{2}O(I)$ 

A student mixed 0.2 mol of lactic acid in a conical flask with 0.3 mol of ethanol and 1.0 mol of water. He then carefully added concentrated sulfuric acid catalyst. The flask was sealed with a bung and cooled rapidly in an ice bath. It was found that 0.05 mol of lactic acid was present at equilibrium.

- (i) Explain the purpose of cooling the conical flask rapidly.
- (ii) Write an expression for the equilibrium constant,  $K_c$ , for this reaction. Calculate the value of  $K_c$ .
- (iii) Suggest and explain what would happen to the position of equilibrium if more lactic acid were added to the conical flask. [5]
- (e) On heating in the absence of air, lactic acid loses water to give a single compound Z, C<sub>6</sub>H<sub>8</sub>O<sub>4</sub>. Compound Z is a neutral compound that does not react with both sodium and 2,4-dinitrophenylhydrazine.

Suggest the identity of compound **Z**.

[2]

[Total: 20]

- 8(a)(i) Using the chlorides of magnesium, aluminium and phosphorus as examples, describe the reactions of the chlorides of the third period of the Periodic Table with water. Write equations where appropriate.
- (ii) Suggest what influence the type of bonding present in these three chlorides has on their reaction with water.
- (iii) Aluminium chloride forms a compound with ammonia. State the type of bond that is formed during this reaction. Draw a diagram to illustrate the shape of and bonding in the product.

[7]

(b) Methylbenzene can undergo halogenation with chlorine as follows:



- (i) State the reagents and conditions needed for reaction I and reaction II.
- (ii) Use bond energy values from the *Data Booklet* to calculate the enthalpy change for reaction **I**.
- (iii) Using your answer from **b(ii)**, construct a reaction pathway diagram for reaction **I**.

[6]

(c) The hydrolysis of  $C_6H_5CH_2CI$  in alkaline solution is represented by the equation below:



In investigations of this reaction, the following results were obtained.

Experiment	Initial concentratio	Initial rate	
Experiment	[C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> CI]	[OH <sup>-</sup> ]	/ mol dm <sup>-3</sup> s <sup>-1</sup>
Ι	0.10	0.10	0.024
II	0.10	0.15	0.036
III	0.20	0.10	0.048

- (i) Deduce the order of reaction with respect to
  - C<sub>6</sub>H<sub>5</sub>CH<sub>2</sub>Cl
  - OH<sup>-</sup>

Hence construct a rate equation for the reaction.

- (ii) Predict how you would expect the rate of reaction to change if the total volume of the reaction mixture is doubled.
- (iii) With the aid of a suitable diagram, explain why a relative small increase in temperature can cause a large increase in the rate of reaction between  $C_6H_5CH_2CI$  and  $OH^-$ .

[7]

[Total:20]