



PIONEER JUNIOR COLLEGE, SINGAPORE

**JC2 PRELIMINARY EXAMINATIONS
HIGHER 1**

CANDIDATE
NAME

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INDEX
NUMBER

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CHEMISTRY

8872/02

Paper 2 Structured and Free-Response

24 September 2009

2 hours

Additional Materials: Answer Paper
 Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name on all 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 workings.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** 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			
Paper 1		Section B	
Marks	/ 30	B4	/ 20
		B5	/ 20
Section A		B6	/ 20
A1	/ 17	Total	
A2	/ 16	/ 100	
A3	/ 7	Grade	

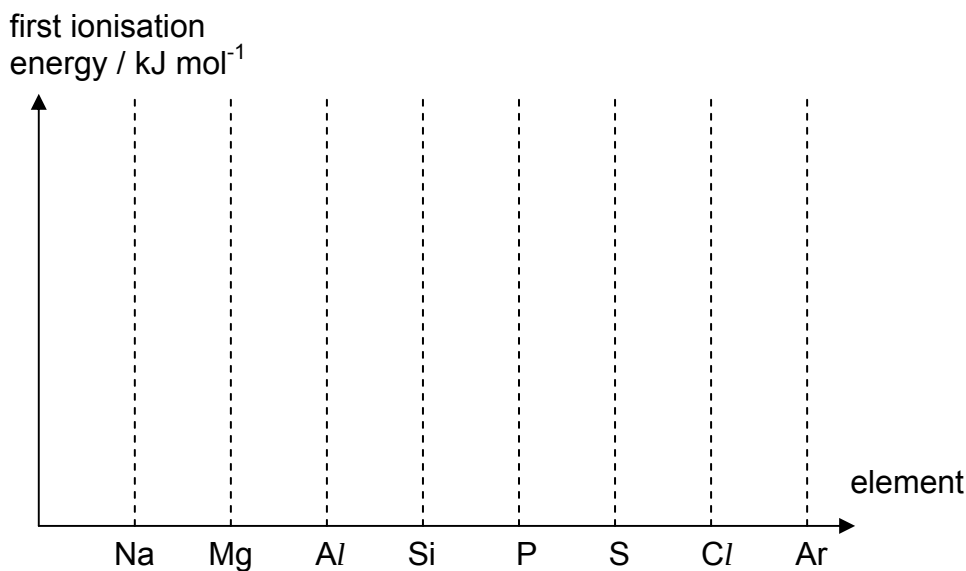
This document consists of **12** printed pages.

Section A

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

- 1** This question is about aluminium, an element in the third period of the Periodic Table.

- (a) (i)** On the grid below, sketch the trend of the first ionisation energies of elements of Period 3 from sodium to argon.



- (ii)** Write an equation for the first ionisation energy of aluminium.
- (iii)** Explain why the first ionisation energy of aluminium is lower than magnesium.

[3]

- (b)** A beam of particles of $^{27}\text{Al}^+$ and $^9\text{Be}^+$ is passed through an electric field. If the angle of deflection of the $^{27}\text{Al}^+$ particle is 3° , state the angle of deflection for the $^9\text{Be}^+$ particle.

[1]

$AlCl_3$ is a covalent compound that exists as a white solid at room temperature and pressure. When $AlCl_3$ is heated to a sufficiently high temperature, it sublimes to give the Al_2Cl_6 dimer.

- (c) Draw a dot-and-cross diagram for the Al_2Cl_6 dimer. Name the type of bond responsible for the formation of the dimer.

Type of bond: _____

[2]

- (d) 2.0 mol of gaseous $AlCl_3$ is heated at 800 K in a 750 cm^3 vessel. When dynamic equilibrium is achieved, 0.971 mol of gaseous Al_2Cl_6 is formed in the vessel.

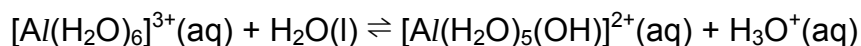
(i) Define the term *dynamic equilibrium*.

(ii) Write a balanced equation for the equilibrium.

(iii) Calculate the value and state the units of the equilibrium constant, K_c , for this reaction at 800 K.

[5]

- (e) $AlCl_3$ dissolves in water to give an acidic solution, as shown by the following equation.



- (i) Define the term *Bronsted base*. Hence, identify the two *Bronsted* bases and state one conjugate acid-base pair in the equation above.

Definition of *Bronsted base*: _____.

The two *Bronsted* bases are _____ and _____.

One conjugate acid-base pair: _____ and _____.

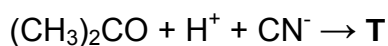
- (ii) Write an expression for the acid dissociation constant, K_a , of $[Al(H_2O)_6]^{3+}$.

- (iii) When 0.1 mol of $AlCl_3$ is dissolved in 1 dm³ of solution, the resulting solution is found to have a pH of 3. Using your equation in (ii), calculate the K_a of $[Al(H_2O)_6]^{3+}$.

[6]

[Total: 17]

- 2 Cyanohydrins can be made by reacting ketones with an acidified solution of sodium cyanide. When propanone is reacted as described, compound **T** is formed.



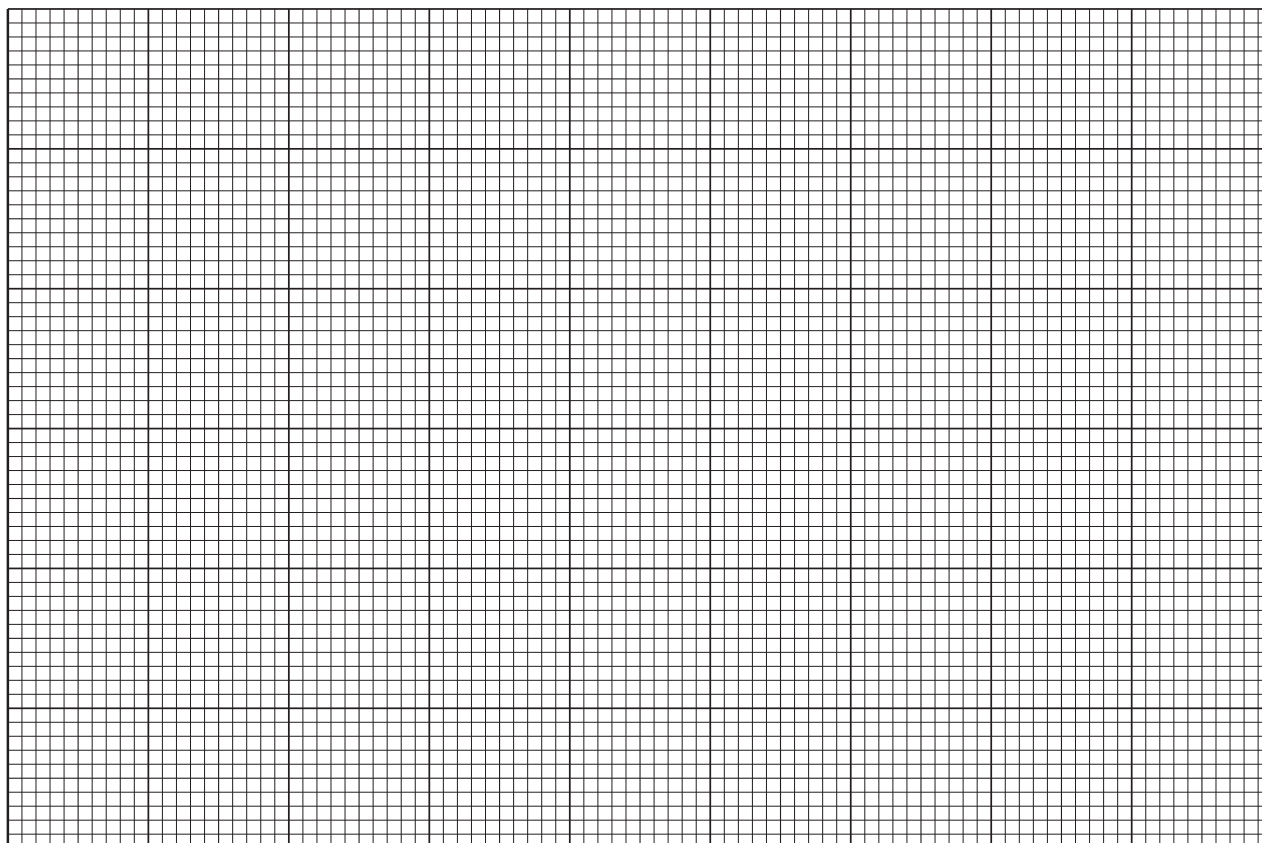
- (a) Draw the displayed formula of compound **T**. On your diagram, state the type of hybridisation of all the carbon atoms in **T**.

[2]

An experiment is performed in which 2.00 mol dm^{-3} of propanone is reacted with an excess of an acid and sodium cyanide. The following results are obtained.

time / s	$[(\text{CH}_3)_2\text{CO}] / \text{mol dm}^{-3}$
0	2.00
15	1.30
30	0.84
45	0.55
60	0.35
75	0.23

- (b) (i) On the grid provided below, plot a graph of these values on suitable axes.

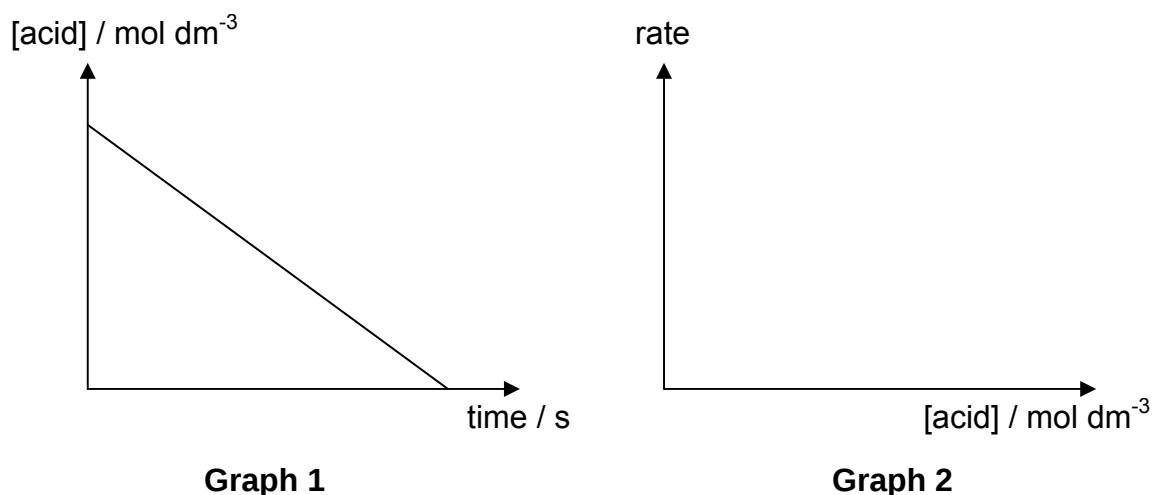


(ii) Using your graph, deduce the order of reaction with respect to propanone.

(iii) Why are the concentration of the acid and the concentration of sodium cyanide used in excess?

[5]

(c) When the experiment is repeated using 1.00 mol dm^{-3} of the acid and an excess of propanone and sodium cyanide, the following **Graph 1** of concentration of the acid against time is obtained.



On **Graph 2** above, sketch a graph for the rate of reaction of the acid against the concentration of the acid. Hence, state the order of reaction with respect to the acid.

Order of reaction with respect to the acid: _____

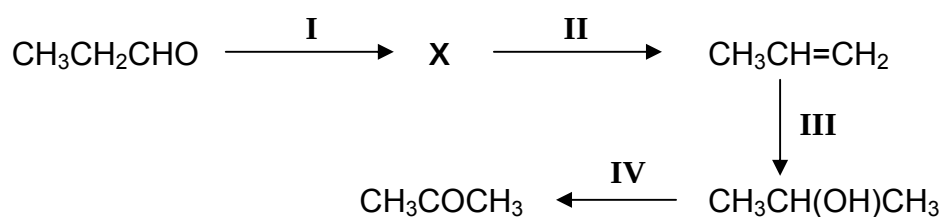
[2]

(d) The order of reaction with respect to sodium cyanide is one. Together with your answers in (b)(ii) and (c), write the rate law for this reaction.

[1]

- (e) (i) Propanal is a functional group isomer of propanone. Suggest a simple chemical test to distinguish between propanal and propanone. State any observations seen.

- (ii) Propanal can be converted to propanone in the laboratory as follows.



Identify compound X. State the reagent and conditions for Step I and III.

Compound X:

Step I:

Step III:

- (iii) Draw the structural formula of the compound formed when propanal reacts with 2,4-dinitrophenylhydrazine.

[6]

[Total: 16]

- 3 Olive oil is a popular flavouring used in Mediterranean cuisine. The main constituent of olive oil is oleic acid, $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{CO}_2\text{H}$.

(a) Name the functional groups that are present in oleic acid.

[1]

(b) State the reagent and condition to synthesise oleic acid from $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{CH}_2\text{OH}$.

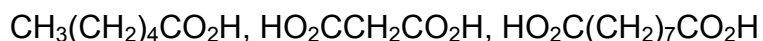
[1]

(c) State the reagents and conditions needed to convert oleic acid **into** each of the following.

compounds	reagents and conditions
$\text{CH}_3(\text{CH}_2)_7\text{CH}(\text{OH})\text{CHBr}(\text{CH}_2)_7\text{CO}_2\text{H}$	
$\text{CH}_3(\text{CH}_2)_7\text{CH}(\text{OH})\text{CH}(\text{OH})(\text{CH}_2)_7\text{CO}_2\text{H}$	
$\text{CH}_3(\text{CH}_2)_7\text{CHCl}(\text{CH}_2)_8\text{CO}_2\text{H}$	

[3]

(d) Another constituent of olive oil is linoleic acid. Linoleic acid has the same functional groups as oleic acid. When linoleic acid is oxidised, the following compounds are obtained in **equimolar** quantities.



Write the **two** possible structural formula of linoleic acid.

[2]

[Total: 7]