THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY (SALTERS)

Chemistry of Materials

2849/01

OCE/13048

Candidates answer on the Question Paper

OCR Supplied Materials:
- *Data Sheet for Chemistry (Salters)* (inserted)

Other Materials Required:
- Scientific calculator

Thursday 17 June 2010
Afternoon

Duration: 1 hour 30 minutes

2849/01

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

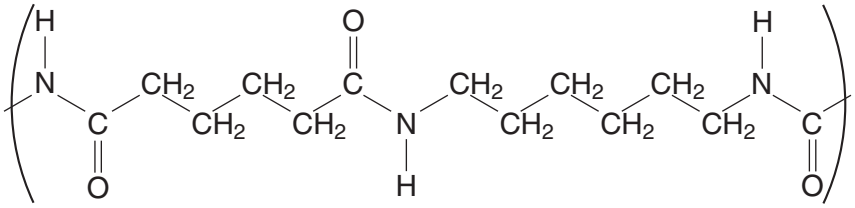
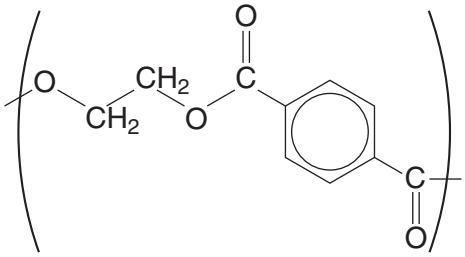
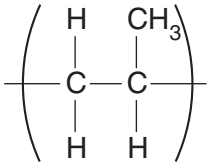
Examiner's Use Only:			
1			
2			
3			
4			
5			
Total			

DCA (SHW 00164 2/08) 13048/6

Answer **all** the questions.

1 Ropemakers, who supply products for the modernisation of working sailing ships, have recently started to make synthetic ropes.

The repeating units of three polymers used in their products are shown in the table below.

polymer listed in order of decreasing tensile strength	repeating unit	type of polymerisation
A		
B		
C		

(a) Complete the table by stating the **type** of polymerisation by which each polymer is formed. **[2]**

(b) Name the functional group joining the monomer units in polymer **B**.

..... **[1]**

(c) Polymer **C** is used as a replacement for hemp, a natural fibre.

At the end of a rope's useful life, it has to be disposed of.

Suggest one **advantage** that hemp has over polymer **C** in terms of the method of disposal.

.....

..... **[1]**

(d) A rope for a particular purpose needs to have a minimum tensile strength. The order of the polymers' strengths is shown in the table. Polymer **A** is much stronger than **B**, which is stronger than **C**.

Discuss, in terms of the different types of intermolecular interactions, the reasons for this order.

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.....

..... **[4]**

(e) In Arctic conditions many polymers become unsuitable for making ropes.

Suggest and explain why.

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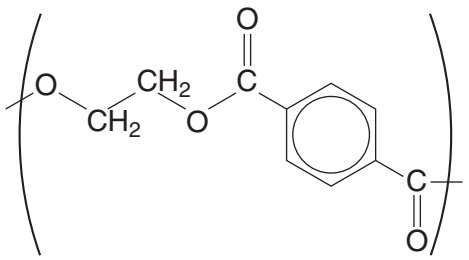
..... **[3]**

(f) (i) Give the reagent and conditions for hydrolysing polymer **B**.



polymer B

reagent .....

conditions .....

[2]

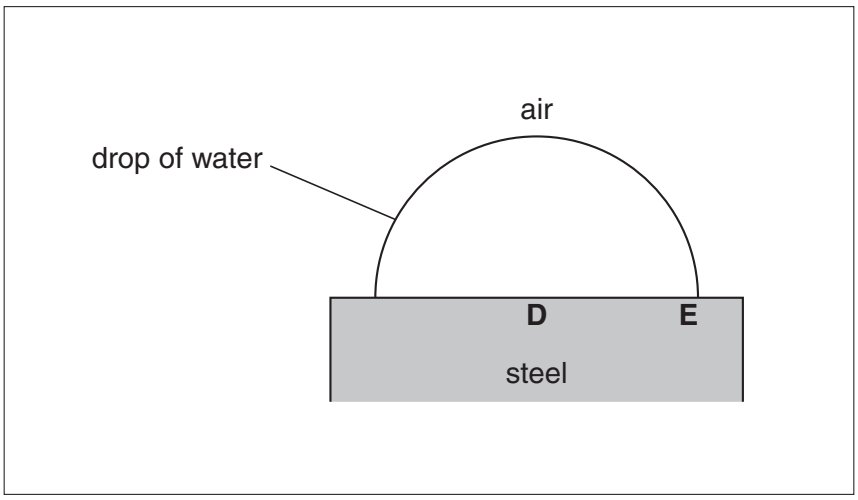
(ii) Draw the structural formulae of the **two** organic products formed from the reaction in **(i)**.

[2]

[Total: 15]

2 The 'Angel of the North' sculpture at Gateshead, near Newcastle, was constructed using Corten steel. This is a very strong material that oxidises naturally to produce a deep brown surface layer that protects the steel beneath. Corten steel contains additional copper, chromium, nickel and silicon.

(a) The diagram below is part of an explanation of how steel rusts when in contact with moist air.



(i) Give the half-equation (ion-electron equation) for the reaction involving iron occurring at **D** in the centre of the water drop.

→

[2]

(ii) Iron corrodes at **D** rather than **E**. Give the half-equation (ion-electron equation) for the reaction occurring at the position labelled **E** at the edge of the water drop.

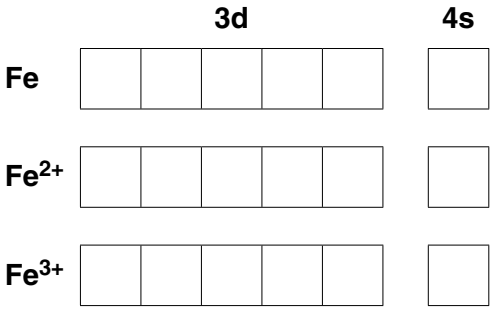
→

[2]

(iii) Draw an arrow **on the diagram at the top of the page** to show the direction of the electron flow. **[2]**

(b) The formula of rust is often written as $Fe_2O_3.xH_2O$. Iron(III) ions are responsible for the brown colouring of rust.

By drawing arrows in the appropriate boxes, complete the outer electron structures for Fe, Fe^{2+} and Fe^{3+}.

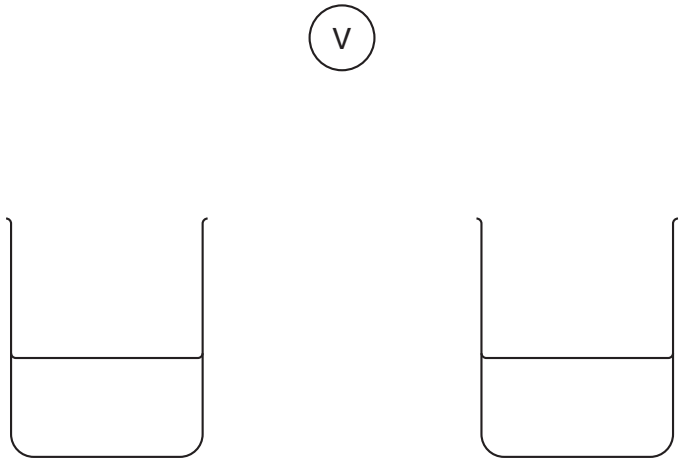


[3]

(c) When copper is in contact with iron in damp conditions, a cell is set up. The half-reactions for this cell are given below.

half-reaction	$E^{\ominus}$/V
$Fe^{2+} + 2e^- \rightarrow Fe$	–0.44
$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34

(i) Complete the diagram below to describe this cell.



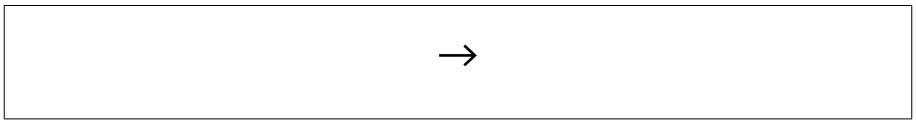
[3]

(ii) Calculate $E^{\ominus}_{cell}$ for this iron–copper cell.

$E^{\ominus}_{cell}$ = ... V **[1]**

(iii) Give the equation for the reaction that occurs when the cell delivers a current.

Include the appropriate state symbols.



[2]

(iv) The first stage in rusting involves the oxidation of iron to iron(II). Use the data given on page 6 to explain how the presence of copper causes rusting to become more severe.

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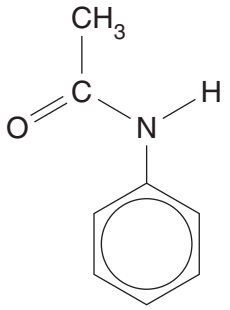
.....

.....

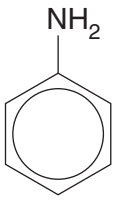
..... **[3]**

[Total: 18]

3 Acetanilide was introduced in the 1880s as a medicine for reducing the pain and high temperature effects of a fever. It can be made from phenylamine.



acetanilide



phenylamine

(a) (i) Name the functional group in acetanilide that is attached to the benzene ring.

..... **[1]**

(ii) What reagent would you use to convert phenylamine into acetanilide?

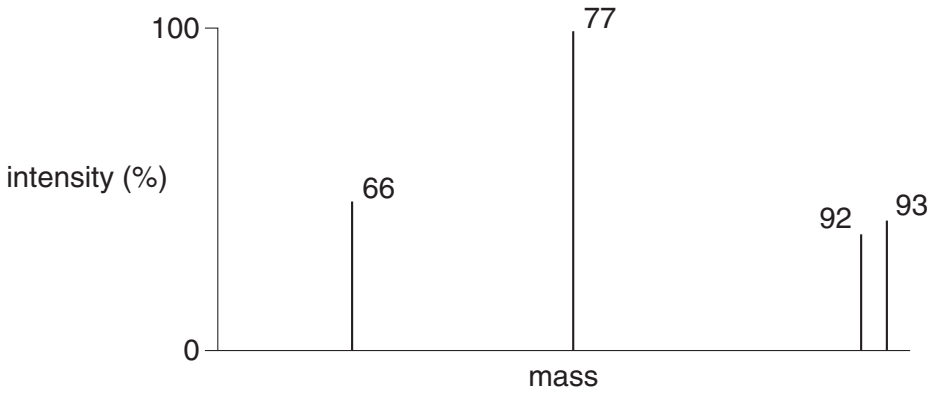
..... **[1]**

(b) Acetanilide is readily hydrolysed by heating with an aqueous solution of sodium hydroxide.

Two organic products are formed, **compound F** and a **salt G**.

$$\text{acetanilide} \xrightarrow{\text{hydrolysis}} \textbf{compound F} + \textbf{salt G}\ (\text{an amine})$$

A mass spectrum of **compound F** is shown below.



(i) What is the M_r of **compound F**?

M_r = ... **[1]**

(ii) The mass spectrometer breaks the molecule into fragments.

What is the mass of the fragment **lost** when the ion of mass 77 is formed?

mass = ... **[1]**

(iii) Suggest a formula for the fragment that has the mass you have calculated in **(ii)**.

..... **[1]**

(iv) Give the formula of the **ion** responsible for the peak at 77.

[2]

(v) Draw the structure of the hydrolysis product, **compound F**.

[2]

(c) The **salt G** is soluble in water. On adding excess hydrochloric acid, a liquid **H** is formed which is distilled off.

The table below gives the chemical shifts and the relative intensities for the peaks in the proton n.m.r. spectrum of the liquid **H**.

chemical shift	relative number of protons	type of proton
2.1	3	
11.4	1	

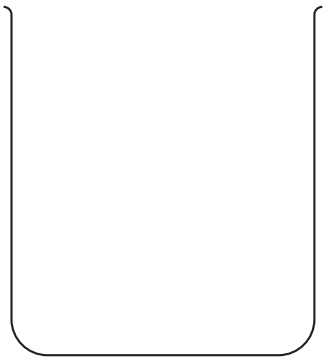
Complete the table and give the structure of the liquid **H**.

[3]

(d) A sample is thought to be impure acetanilide. Thin layer chromatography can be used to show that a solution of this sample in ethanol contains acetanilide.

Complete the diagram below of the apparatus used to set up this experiment.

Label each part of your apparatus and suggest a suitable method or agent for locating the spots.



method for locating spots ..... **[4]**

(e) At the start of the 20th century, the discovery and testing of a new medicine was a very random process. Today, medicine development is a much longer process and costs more. Often it takes 10 to 12 years to get a new product on the market.

Describe **two** ways in which **chemists** are involved in the development of a new medicine.

.....

.....

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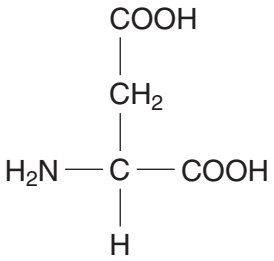
..... **[2]**

[Total: 18]

4 Dentine is the part of a tooth between the enamel crown and the soft pulp-like interior. It is hard and contains about 20% organic materials, such as proteins and amino acids. One of the amino acids present is aspartic acid.



aspartic acid

(a) Aspartic acid has two isomers, D-aspartic acid and L-aspartic acid.

(i) What type of isomerism is shown by aspartic acid?

..... **[1]**

(ii) Draw structures to show how the two isomers of aspartic acid are related.

Explain why aspartic acid can exist as two isomers.

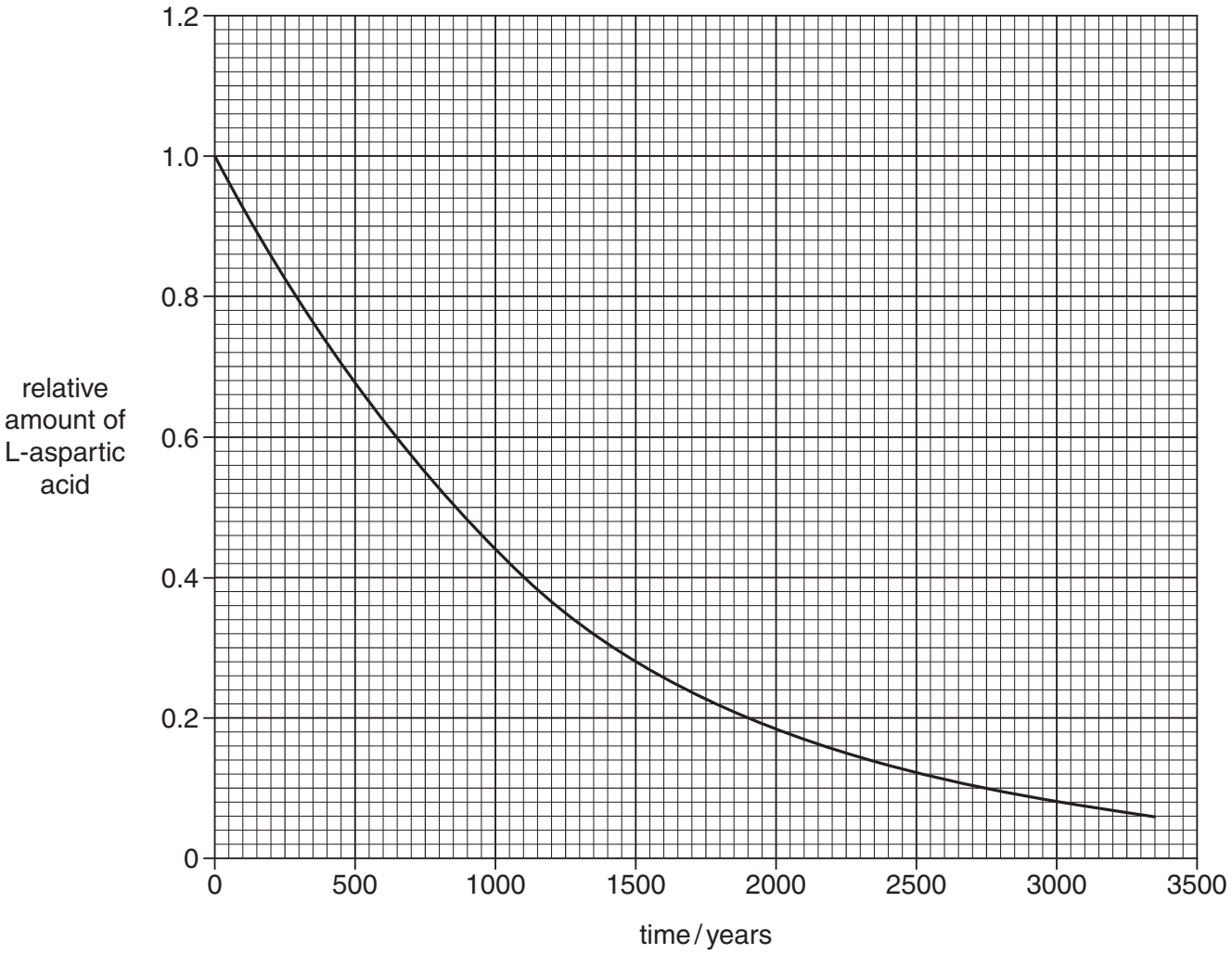
explanation .....

.....

..... **[3]**

(b) As we grow older the L-aspartic acid contained in the dentine in our teeth slowly changes to the D-form and continues to do so after we die. Chemists have used this process to date the age of human skulls that have been buried in the ground for up to 1000 years.

The graph below shows the way the concentration of L-aspartic acid changes with time.



(i) Use the graph to determine **three** half-lives for the process. Show your working on the graph.

1 .....

2 .....

3 ..... **[3]**

(ii) Explain how you can conclude that the conversion of L-aspartic acid is a first order process.

..... **[1]**

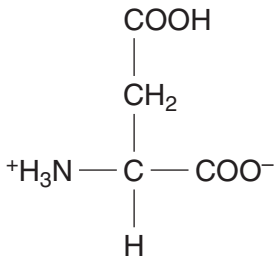
(iii) Write down the rate equation for the conversion of L-aspartic acid into its D isomer.

[2]

(iv) Give the units of the rate constant in your rate equation in **(iii)**.

units ..... **[1]**

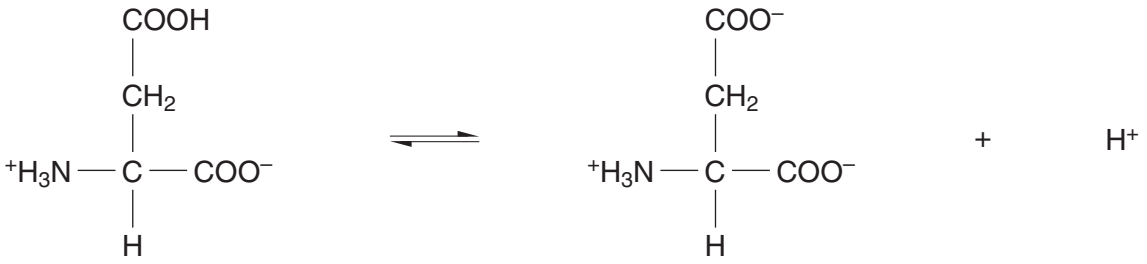
(c) The particles of aspartic acid in the solid state are ionised. Many have the structure given below.



What is the name given to this type of ion?

..... **[1]**

(d) In solution these ions are in equilibrium with other ions. The equation for one of these equilibria is given below.



ion **J** ion **K**

(i) Write the expression for the equilibrium constant, K_c, for this reaction.

You may use the letters **J** and **K** to represent the ions in your answer.

K_c =

[1]

(ii) The value of K_c at 298 K is 1.38×10^{-4} mol dm^{-3}.

At equilibrium the concentration of ion **J** is 0.50 mol dm^{-3}. Assume that ions **K** and H^+ both have the same concentration.

Calculate the concentration of H^+ ions. Give your answer to **an appropriate number** of significant figures.

$[H^+]$ = ... mol dm^{-3} **[3]**

(e) Aspartic acid is an essential component of the primary structure of a large number of proteins. Some of these proteins act as enzymes by enabling substrates to bind ionically to the active site.

(i) Explain the terms *primary* and *secondary* structure as applied to proteins.

primary .....

.....

secondary .....

..... **[2]**

(ii) Explain how enzymes can form ionic bonds with substrates.

.....

.....

..... **[2]**

[Total: 20]

5 Hydrogen peroxide is a mild oxidising agent which is used in the restoration of oil paintings. Paintings darken over time as some of the metal ions in the paints react with atmospheric pollutants. Hydrogen peroxide can be used to convert these unwanted dark coloured compounds to white products.

(a) The concentration of a hydrogen peroxide solution can be found by titration. Samples are titrated with aqueous potassium manganate(VII) of known concentration using acidic conditions.

In this question, one mark is available for the quality of spelling, punctuation and grammar.

(i) Describe how this titration would be carried out.

Give experimental details and state how the end point is determined.

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..... **[6]**

Quality of Written Communication **[1]**

(ii) A solution of hydrogen peroxide is diluted by a factor of 10.0.

$10.0\,cm^3$ of this diluted H_2O_2 reacted with exactly $18.2\,cm^3$ of $0.0200\,mol\,dm^{-3}$ MnO_4^- solution.

The equation for the reaction taking place is given below.

$$2MnO_4^-(aq) + 6H^+(aq) + 5H_2O_2(aq) \longrightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 5O_2(g)$$

Calculate the concentration of the **undiluted** H_2O_2 solution.

concentration = ... $mol\,dm^{-3}$ **[4]**

(iii) The concentration of the hydrogen peroxide solution used for treating paintings must not be greater than 3.0%. Assume this means 3.0 g of H_2O_2 in $100\,cm^3$ of solution.

A_r: H, 1.0; O, 16.0

Is the **undiluted** solution of H_2O_2 suitable to be used for treating paintings?

Show your working.

..... **[2]**

(b) Restorers of paintings are instructed to store hydrogen peroxide solutions in polythene bottles rather than glass ones. Glass acts as a catalyst for the decomposition of hydrogen peroxide.

Restorers also make up the solutions with pure water rather than tap water. Traces of transition metal ions present in tap water can also catalyse the decomposition of hydrogen peroxide.

(i) Write the equation for the decomposition of hydrogen peroxide into water and oxygen.

Give the state symbols.

$\rightarrow$

[1]

(ii) Glass acts as a heterogeneous catalyst, whereas transition metal ions are homogeneous catalysts.

Explain this difference.

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..... **[2]**

(iii) A solution of hydrogen peroxide stored in a glass bottle at room temperature was found to be completely decomposed after a few hours.

Describe an experimental procedure which could be used to measure the volume of oxygen produced at regular time intervals.

Show how you would use your results to find the initial rate of the reaction.

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..... **[3]**

[Total: 19]

END OF QUESTION PAPER

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