36046901

OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

CHEMISTRY (SALTERS)

Polymers, Proteins and Steel

2853

Thursday **24 JUNE 2004** Afternoon 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry (Salters)
Scientific calculator

Candidate Name

Centre Number

Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
  DO NOT ANSWER IN PENCIL. **DO NOT** WRITE IN THE BARCODE. **DO NOT** WRITE IN THE GREY AREAS BETWEEN THE PAGES.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry (Salters)*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu	Max.	Mark
1	12	
2	11	
3	22	
4	10	
5	18	
6	17	
TOTAL	90	

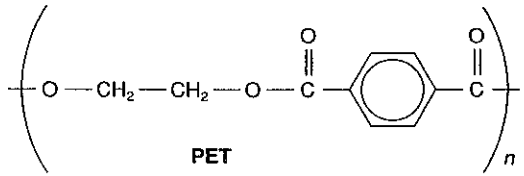
This question paper consists of 16 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

For Examiner's Use

1 The polymer PET was discovered in 1941 by two chemists working in a small research laboratory in Manchester. It was launched after World War II as the new fibre *Terylene*. The repeating unit of PET is



PET

(a) (i) One of the monomers used to make PET is ethane-1,2-diol, whose formula is $HOCH_2CH_2OH$.
Draw the **full structural** formula of the **other** monomer.

[2]

(ii) PET is an example of a condensation polymer.
Explain the meaning of the term *condensation polymer*.

.....

.....

.....

.....[2]

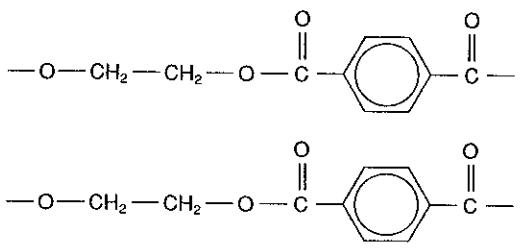
(b) PET is used for making fibres because there are strong attractive forces between the polymer chains.

(i) What is the **strongest** type of intermolecular force between the chains of PET?

.....[1]

For Examiner's Use

(ii) On the diagram below, show how these intermolecular forces arise.



[2]

(c) The average molecular mass of a polymer chain of PET is 384 000.
How many repeating units does a typical polymer chain of PET contain? Show your working.

A_r: C,12; O,16; H,1.0

number of repeating units = ... [2]

(d) At present, 11% of household waste consists of plastic and the majority is dumped in landfill sites. To solve this problem, chemists have developed methods of re-using the waste in order to save energy and oil.

Suggest **three** such methods.

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.....

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.....[3]

[Total: 12]

For Examiner's Use

2 Nitrogen monoxide, NO, is a pollutant emitted from the exhausts of vehicles. It is oxidised in the atmosphere to form nitrogen dioxide, NO_2. The overall equation for the oxidation is shown below.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

(a) A chemist investigated the rate of this reaction in the laboratory by following the formation of NO_2.
The results of his experiments are shown below.

experiment	initial [NO(g)] /mol dm^{-3}	initial [O_2(g)] /mol dm^{-3}	initial rate of formation of NO_2 /mol dm^{-3} s^{-1}
A	1.0×10^{-3}	1.0×10^{-3}	6.0×10^{-4}
B	1.0×10^{-3}	2.0×10^{-3}	1.2×10^{-3}
C	2.0×10^{-3}	1.0×10^{-3}	2.4×10^{-3}
D	2.0×10^{-3}	2.0×10^{-3}	4.8×10^{-3}

Work out the order of reaction with respect to **(i)** NO and **(ii)** O_2. Explain your reasoning.

(i) NO order .....

reason .....

.....

.....[2]

(ii) O_2 order .....

reason .....

.....

.....[2]

(iii) Use your results to write a rate equation for the reaction of nitrogen monoxide with oxygen.

rate =

[2]

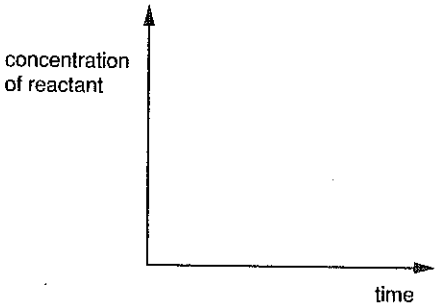
(iv) What is the overall order of this reaction?

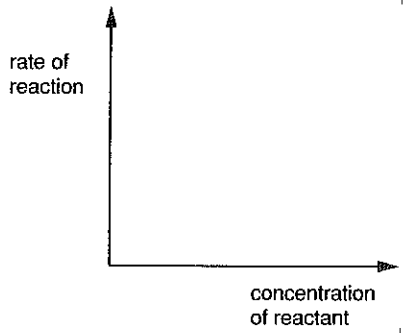
.....[1]

For Examiner's Use

(b) Below are the axes for two graphs that chemists often plot when investigating a rate of reaction.

Complete the sketch graphs below for a **first order** reaction.





[4]

[Total: 11]

For Examiner's Use

3 The mixture of nitrogen oxides, NO_x, in the atmosphere is involved in the formation of photochemical smog. The NO_x emitted from vehicle exhausts is composed mainly of nitrogen monoxide, NO and a small amount of nitrogen dioxide, NO_2.

(a) At the high temperature inside a car engine, nitrogen combines with oxygen to form NO.

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

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

$K_c =$

[2]

(ii) At room temperature, the value of K_c is 4.5×10^{-31}. What does this tell you about the position of equilibrium at this temperature?

.....[1]

(iii) How does the value of K_c at the temperature when the car engine is running compare with its value at room temperature?
Use your answer to show that the formation of NO from N_2 and O_2 is an endothermic reaction.

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.....[3]

(b) Car exhausts made of steel need to be replaced regularly because they corrode. Acidic gases such as NO_2 and SO_2, moisture from the combustion of hydrocarbons, and the high temperature, all help to create conditions that are ideal for corrosion.

(i) Use the information below to write a balanced equation for the first step of the corrosion process that occurs in acidic conditions.

	$E^\ominus$/V
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	−0.44
$H^+(aq) + e^- \rightarrow \frac{1}{2}H_2(g)$	0.00

.....[2]

(ii) In the presence of moist air, a series of reactions then occurs in which the end product is rust. Write the formula of rust.

.....[2]

For Examiner's Use

(iii) Other parts of the car are also prone to rusting. Give **two** methods that are used to help prevent the steel parts of a car from corroding.

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.....[2]

(c) About 200 million tonnes of steel are produced around the world each year from recycled steel.
Give **two** reasons why it is beneficial to recycle steel.

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.....[2]

(d) The hulls of ships are protected from corrosion by bolting blocks of another metal to them.
Use the following information to suggest a suitable metal to protect the steel.
Explain how this metal protects the steel from corroding.

					$E^{\ominus}$/V
$Mg^{2+}(aq)$	+	$2e^-$	→	Mg(s)	−2.37
$Zn^{2+}(aq)$	+	$2e^-$	→	Zn(s)	−0.76
$Fe^{2+}(aq)$	+	$2e^-$	→	Fe(s)	−0.44
$Sn^{2+}(aq)$	+	$2e^-$	→	Sn(s)	−0.14
$Cu^{2+}(aq)$	+	$2e^-$	→	Cu(s)	+0.34

name of metal .....

explanation .....

.....

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.....

.....

.....[4]

(e) Give **two** uses of steel, other than ships' hulls and car exhausts, and state a property (different in each case) on which this use depends.

use ..... property 1 .....

.....

use ..... property 2 .....

.....

[4]

[Total: 22]

For Examiner's Use

4 Cystic fibrosis is an inherited genetic condition. People who suffer from cystic fibrosis are unable to make a protein that helps to keep the lungs and other organs clear. Without this protein, the lungs become clogged with mucus which prevents them from working properly.

(a) Scientists have identified the gene that codes for this protein. They found that people with cystic fibrosis have an abnormality in the DNA forming this gene.

Describe the chemical structure of DNA.

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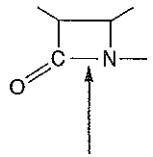
.....[4]

(b) People with cystic fibrosis carry a gene from which a group of three bases (a codon) is missing.
What effect does this have on the protein produced in the cells of people with cystic fibrosis?

.....[1]

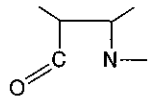
(c) People with cystic fibrosis are given penicillin to help prevent bacterial infections of the lungs.

The structure of the key portion of a penicillin molecule is shown.



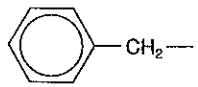
When penicillin acts as an antibiotic, hydrolysis of bond **X** occurs.

Complete the structure below to show the product when bond **X** is hydrolysed.



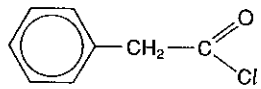
[2]

(d) One type of penicillin is penicillin **G**.
Penicillin **G** contains the following group.



Penicillin **G** can be made by the reaction of compound **Y** with an amine.
Compound **Y** is an acyl chloride.

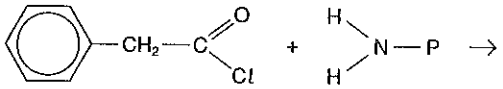
(i) Circle the acyl chloride functional group on the diagram below.



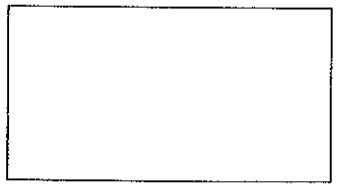
compound **Y**

[1]

(ii) The amine that reacts with compound **Y** can be represented by H_2N-P.
Complete the boxes below to show the products.



compound **Y**



+

[2]

[Total: 10]

5 **(a)** Streams and rivers where copper mining occurs can become contaminated with copper ions $Cu^{2+}(aq)$. Copper ions are toxic to plants and some micro-organisms.

(i) The atomic number of copper is 29.
Complete the sequence below to show the electron configuration of a **Cu^{2+} ion.**

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ .....

[1]

(ii) Use your understanding of ions and electron shells to explain why copper is described as a transition metal.

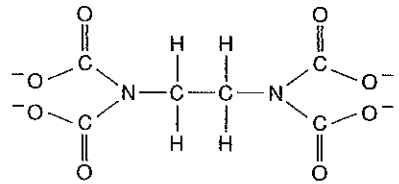
.....

.....

.....[2]

(b) Cu^{2+} ions form a blue complex with aqueous $edta^{4-}$ ions. The $edta^{4-}$ ion is an hexadentate ligand.

On the structure of $edta^{4-}$ below, circle all the atoms that would form a bond to the central Cu^{2+} ion.



[2]

For Examiner's Use

(c) A group of students working on an environmental project investigated the presence of $Cu^{2+}(aq)$ ions in a stream near a disused mine. They carried out a titration using $edta^{4-}(aq)$ ions and an indicator.

$$[Cu(H_2O)_6]^{2+} + edta^{4-} \rightarrow [Cu(edta)]^{2-} + 6H_2O$$

A 25.0 cm^3 sample of stream water was titrated with 0.00500 mol dm^{-3} $edta^{4-}$ solution. 12.0 cm^3 of the $edta^{4-}$ solution were required to reach the endpoint.

(i) Calculate the amount in moles of $edta^{4-}$ required to react completely with the water sample.

amount of $edta^{4-}$ = ... mol [1]

(ii) Calculate the concentration of Cu^{2+} in the water sample in **mg dm^{-3}**.
Give your answer to an appropriate number of significant figures.
Show your working.
A_r: Cu, 63.5 1 mg = 1×10^{-3} g

concentration of Cu^{2+} = ... mg dm^{-3} [4]

Turn over for the rest of Question 5.

For Examiner's Use

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

Colorimetry is an alternative method of analysing the copper content of the stream water.
Describe how the students could use colorimetry to determine the concentration of $Cu^{2+}(aq)$ ions in a sample of the stream water.

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.....[5]

Quality of Written Communication [1]

(e) Give **two** properties, other than colour and ability to form complexes, that are characteristic of transition metals.

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.....[2]

[Total: 18]

For Examiner's Use

6 In 1975, a scientist investigating morphine discovered the polypeptide **leucine encephalin**. Leucine encephalin is one of the body's natural painkilling molecules.

(a) When leucine encephalin was hydrolysed, the product was found to contain a mixture of four amino acids.

(i) Give the name of a reagent and the conditions that could be used to hydrolyse leucine encephalin in the laboratory.

name of reagent .....

conditions .....

.....[3]

(ii) Paper chromatography is a method which can be used to determine the amino acids present when leucine encephalin is hydrolysed.

Draw a labelled diagram and describe in outline how the scientist could use paper chromatography to show that the product of the hydrolysis of leucine encephalin contains four amino acids.

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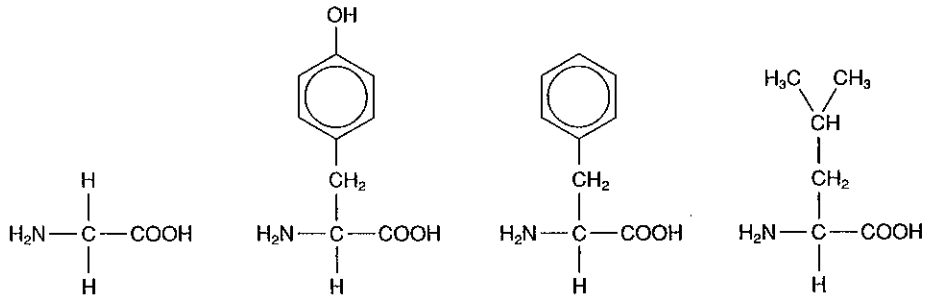
.....[4]

For Examiner's Use

(b) The four amino acids isolated from the hydrolysis of leucine encephalin are shown below.



glycine **tyrosine** **phenylalanine** **leucine**

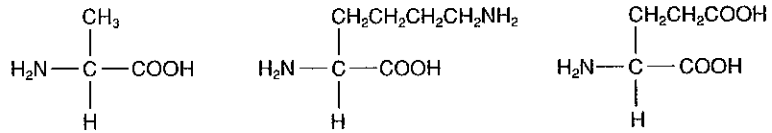
Which amino acid does **not** exist as optical isomers? Explain why.

name of amino acid .....

explanation .....

.....[2]

(c) Three other amino acids are found in β-endorphin, which is another of the body's natural painkilling molecules. The structures of these amino acids are shown below.



alanine **lysine** **glutamic acid**

For Examiner's Use

(i) The amino acids, alanine, lysine and glutamic acid are each dissolved in water and the pH of each solution measured. The three solutions have the same molar concentration. One solution is alkaline, one is neutral and the other is acidic.

Place the amino acids in order of decreasing pH of their aqueous solution. Explain why you have chosen this order.

....

decreasing pH of aqueous solution

explanation .....

.....

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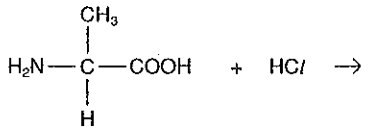
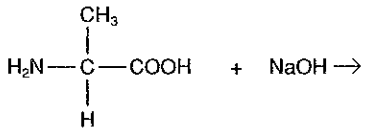
.....[4]

(ii) Complete the following equations to show the reactions of alanine with hydrochloric acid and with sodium hydroxide.





[4]

[Total: 17]

END OF QUESTION PAPER