

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**  
**Advanced GCE**

**CHEMISTRY (SALTERS)**

Polymers, Proteins and Steel

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.

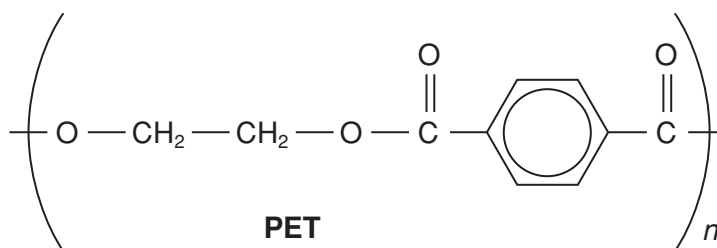
FOR EXAMINER'S USE		
Qu	Max.	Mark
1	12	
2	11	
3	22	
4	10	
5	18	
6	17	
<b>TOTAL</b>	<b>90</b>	

**This question paper consists of 16 printed pages.**

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



- (a) (i) One of the monomers used to make PET is ethane-1,2-diol, whose formula is HOCH<sub>2</sub>CH<sub>2</sub>OH.  
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*.

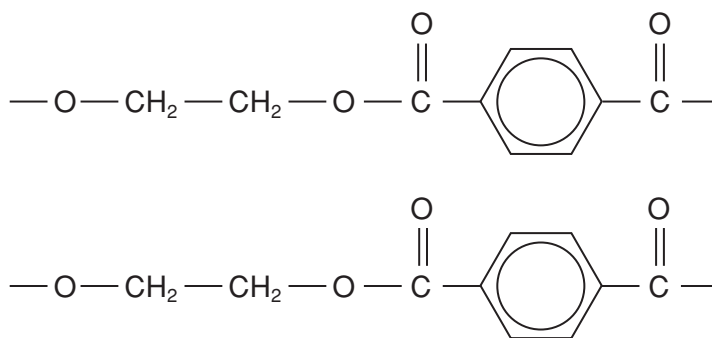
.....  
 .....  
 .....  
 .....[2]

- (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]

(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]

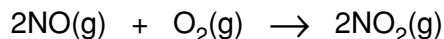
(d) At present, 11% of household waste consists of plastic and the majority is dumped in landfill sites. To solve this problem, chemists have developed methods of re-using the waste in order to save energy and oil.

Suggest **three** such methods.

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

[Total: 12]

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



- (a) A chemist investigated the rate of this reaction in the laboratory by following the formation of NO<sub>2</sub>.  
The results of his experiments are shown below.

experiment	initial [NO(g)] /mol dm <sup>-3</sup>	initial [O <sub>2</sub> (g)] /mol dm <sup>-3</sup>	initial rate of formation of NO <sub>2</sub> /mol dm <sup>-3</sup> s <sup>-1</sup>
A	1.0 × 10 <sup>-3</sup>	1.0 × 10 <sup>-3</sup>	6.0 × 10 <sup>-4</sup>
B	1.0 × 10 <sup>-3</sup>	2.0 × 10 <sup>-3</sup>	1.2 × 10 <sup>-3</sup>
C	2.0 × 10 <sup>-3</sup>	1.0 × 10 <sup>-3</sup>	2.4 × 10 <sup>-3</sup>
D	2.0 × 10 <sup>-3</sup>	2.0 × 10 <sup>-3</sup>	4.8 × 10 <sup>-3</sup>

Work out the order of reaction with respect to (i) NO and (ii) O<sub>2</sub>. Explain your reasoning.

- (i) NO      order .....
- reason .....
- .....
- .....[2]

- (ii) O<sub>2</sub>     order .....
- reason .....
- .....
- .....[2]

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

rate =

[2]

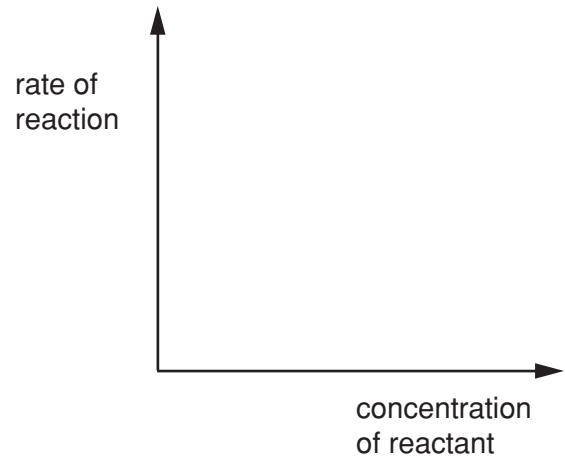
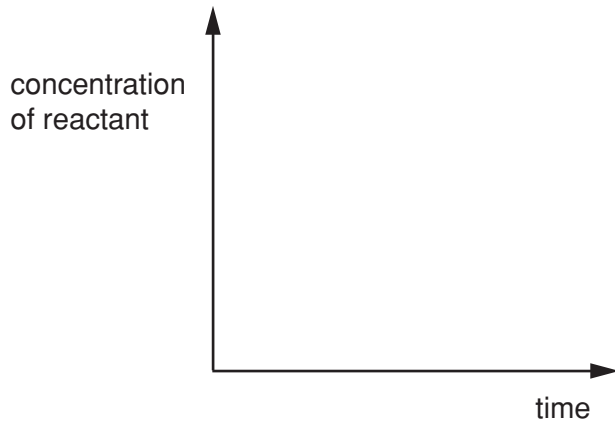
- (iv) What is the overall order of this reaction?

.....[1]

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

*For  
Examiner's  
Use*

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



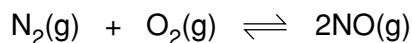
[4]

[Total: 11]

- 3 The mixture of nitrogen oxides,  $\text{NO}_x$ , in the atmosphere is involved in the formation of photochemical smog. The  $\text{NO}_x$  emitted from vehicle exhausts is composed mainly of nitrogen monoxide,  $\text{NO}$  and a small amount of nitrogen dioxide,  $\text{NO}_2$ .

For  
Examiner's  
Use

- (a) At the high temperature inside a car engine, nitrogen combines with oxygen to form  $\text{NO}$ .



- (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  $4.5 \times 10^{-31}$ . What does this tell you about the position of equilibrium at this temperature?

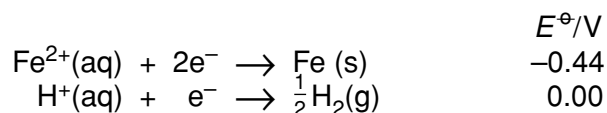
.....[1]

- (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  $\text{NO}$  from  $\text{N}_2$  and  $\text{O}_2$  is an endothermic reaction.

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

- (b) Car exhausts made of steel need to be replaced regularly because they corrode. Acidic gases such as  $\text{NO}_2$  and  $\text{SO}_2$ , 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.



.....[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]

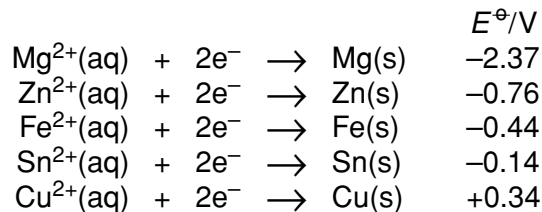
- (iii) Other parts of the car are also prone to rusting. Give **two** methods that are used to help prevent the steel parts of a car from corroding.

.....  
 .....[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.

.....  
 .....  
 .....[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.



name of metal .....

explanation .....

.....  
 .....  
 .....  
 .....  
 .....  
 .....[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]

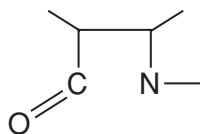
[Total: 22]





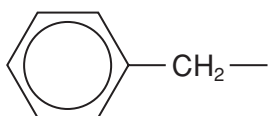
When penicillin acts as an antibiotic, hydrolysis of bond **X** occurs.

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



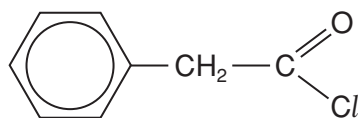
[2]

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



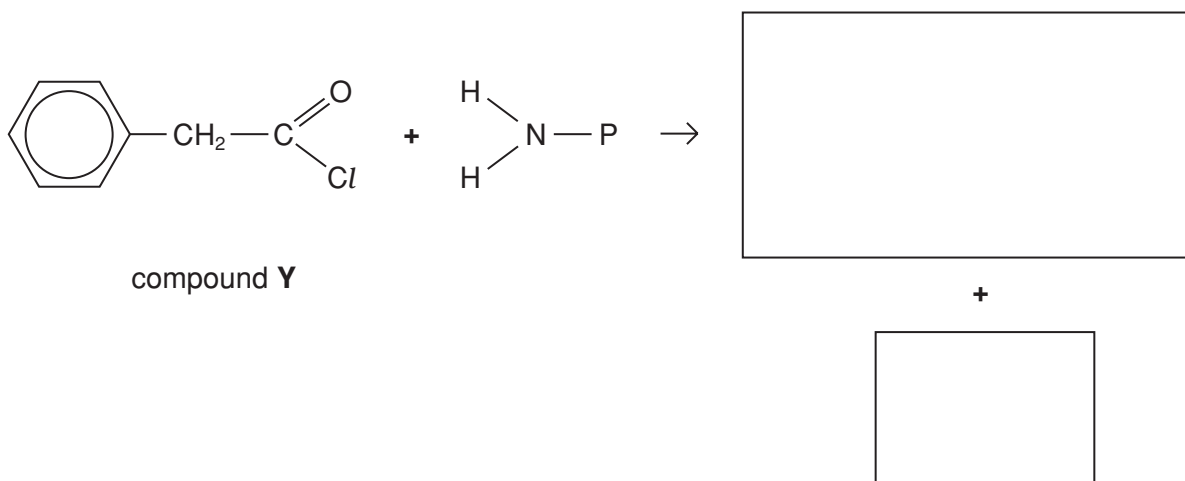
Penicillin **G** can be made by the reaction of compound **Y** with an amine.  
Compound **Y** is an acyl chloride.

- (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  $\text{H}_2\text{N-P}$ .  
Complete the boxes below to show the products.



[2]

[Total: 10]

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

For  
Examiner's  
Use

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

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

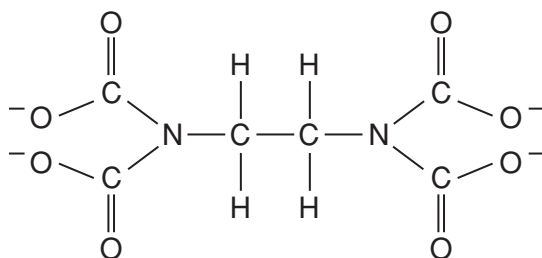
[1]

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

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

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

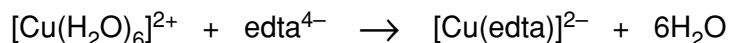
On the structure of  $\text{edta}^{4-}$  below, circle all the atoms that would form a bond to the central  $\text{Cu}^{2+}$  ion.



[2]

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

For  
Examiner's  
Use



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

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

amount of  $\text{edta}^{4-} = \dots\dots\dots \text{ mol}$  [1]

- (ii) Calculate the concentration of  $\text{Cu}^{2+}$  in the water sample in  $\text{mg dm}^{-3}$ .  
Give your answer to an appropriate number of significant figures.  
Show your working.

$A_r$ : Cu, 63.5       $1 \text{ mg} = 1 \times 10^{-3} \text{ g}$

concentration of  $\text{Cu}^{2+} = \dots\dots\dots \text{ mg dm}^{-3}$  [4]

**Turn over for the rest of Question 5.**



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

For  
Examiner's  
Use

- (a) When leucine enkephalin 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 enkephalin 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 enkephalin 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 enkephalin contains four amino acids.

.....

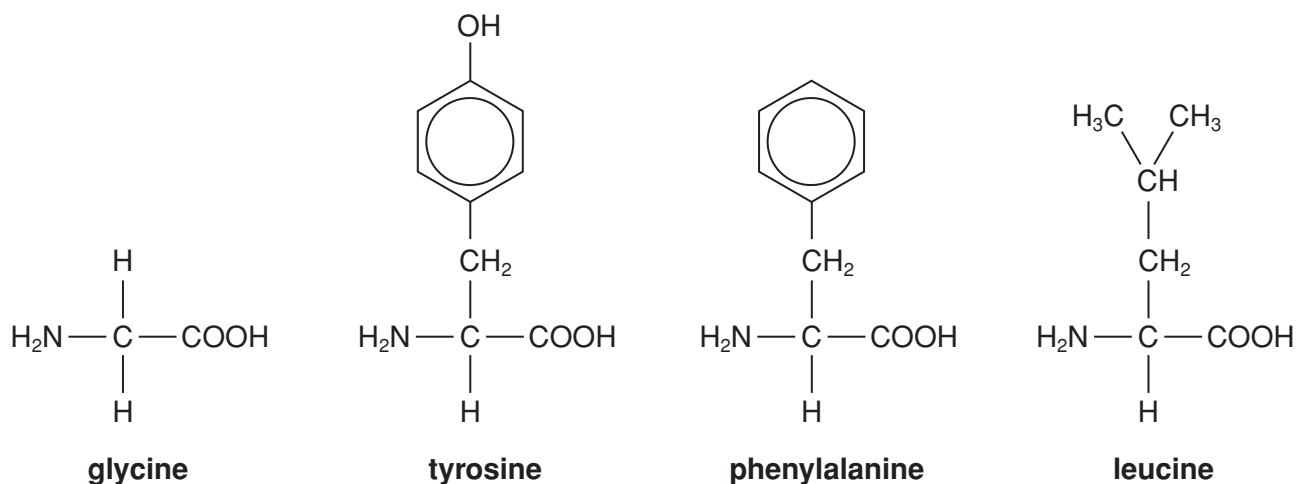
.....

.....

.....[4]

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

For  
Examiner's  
Use



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  $\beta$ -endorphin, which is another of the body's natural painkilling molecules. The structures of these amino acids are shown below.

