THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY (SALTERS)

Chemistry of Materials

2849/01

Candidates answer on the question paper

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

Other Materials Required:
- Scientific calculator

Thursday 11 June 2009
Afternoon

Duration: 1 hour 30 minutes

* 2 8 4 9 0 1 *

* C U P / T 6 9 5 2 4 *

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

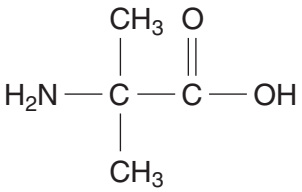
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- 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.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**29**	
2	**16**	
3	**15**	
4	**15**	
5	**15**	
TOTAL	**90**	

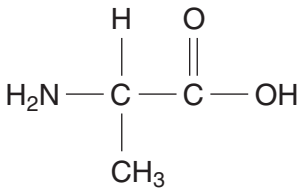
OCR is an exempt Charity

Answer **all** the questions.

1 Amino acids have been found in interstellar clouds and meteorites. In 1969, a large meteorite landed in Australia. The structures of two of the amino acids, **A** and **B**, present in this meteorite are shown below.



A



B

(a) Amino acid **B** forms two optical isomers.

(i) In the box below draw **two** three-dimensional structural formulae to show how the two isomers of amino acid **B** are related.

[2]

(ii) Explain why amino acid **A** cannot form optical isomers.

.....

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

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

One way of showing that amino acids **A** and **B** are present in a mixture is to carry out an analysis using paper chromatography.

You are given a concentrated solution **X** containing **three** amino acids. You are also given concentrated solutions of amino acids **A** and **B**.

Describe how you would carry out the chromatography experiment to show that solution **X** contains both amino acid **A** and amino acid **B**.

Draw a diagram in the box to show the chromatogram you would expect to obtain.

.....

.....

.....

.....

.....

.....

.....

.....

[6]

Quality of Written Communication **[1]**

(c) Amino acids **A** and **B** can also be distinguished by comparing their proton nuclear magnetic resonance spectra.

Give and explain **two** ways in which the spectra will differ.

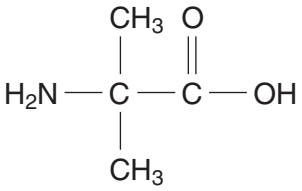
1 .....

.....

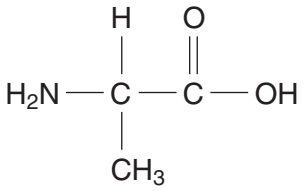
2 .....

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

(d) Amino acids **A** and **B** can be reacted together to form a dipeptide.



A



B

Draw the structure of a dipeptide formed and circle the peptide (secondary amide) link.

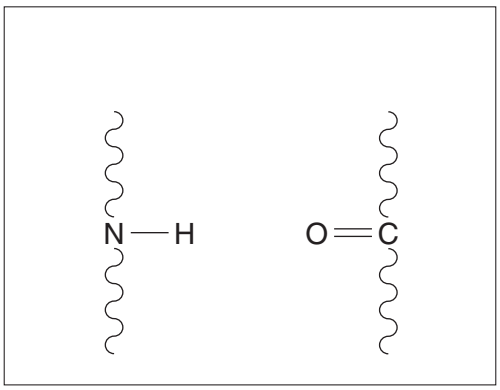
[2]

(e) Proteins have a secondary and a tertiary structure.

(i) Give **two** types of secondary structure.

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

(ii) Complete the diagram below to show how hydrogen bonds are formed between two adjacent protein chains. Include partial charges and relevant lone pairs.



[3]

(iii) Name **two** types of interaction, other than hydrogen bonds, which can hold the tertiary structure of a protein together.

.....

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

THIS QUESTION CONTINUES ON PAGE 6

(f) Amino acid **A** can be synthesised in the laboratory from propanone.

The equation for the first stage in the synthesis is given below.

$$CH_3COCH_3 + HCN \rightleftharpoons CH_3C(CN)(OH)CH_3$$

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

K_c =

[1]

(ii) Give the units of K_c.

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

(iii) The reaction is carried out using methanol as the solvent.

At equilibrium the amounts of CH_3COCH_3 and HCN present are both 1.00 mol. The total volume of the reaction mixture is 5.00 dm^3.

At the temperature of the reaction K_c has a value of 30.18.

Calculate the concentration of the product at equilibrium.

Give your answer to an **appropriate** number of significant figures.

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

(iv) In a series of experiments to find a rate equation for the reaction, a student collected the following data.

$[CH_3COCH_3]$ / mol dm^{-3}	[HCN] / mol dm^{-3}	relative rate
0.50	0.75	1
0.50	1.50	2
1.00	1.50	4

What is the order of the reaction with respect to each reactant?

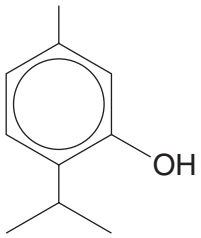
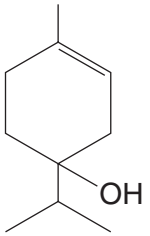
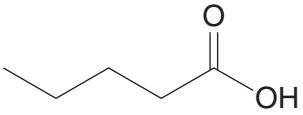
CH_3COCH_3 ..... HCN .....

[2]

[Total: 29]

2 Essential oils from a range of different plants contain compounds which can be extracted and used in foodstuffs and perfumes. **Table 1** shows the structures of three of these compounds.

Table 1

compound	structure	plant source
C		thyme
D		tea tree oil
E		valerian

(a) Give the chemical name of compound **E**.

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

(b) The mass spectrum of one of the compounds gave a peak at a mass of 57.

The ion responsible for the peak contained only carbon and hydrogen.

(i) Draw the structure of this ion.

[2]

(ii) Which compound was it formed from?

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

(c) Both **C** and **D** have an hydroxyl group.

Describe and explain how they could be distinguished by addition of neutral $FeCl_3$(aq).

.....

.....

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

(d) **(i)** List the compounds **C**, **D** and **E** in order of **increasing** acidity.

least acidic …… …… …… most acidic **[1]**

(ii) Use ideas of structure and chemical equilibrium to explain your answer to **(i)**.

.....

.....

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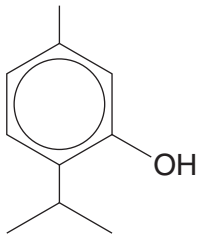
..... **[4]**

(e) Compound **C** reacts with ethanoyl chloride.

In the boxes below, draw the structure of the organic product and give the formula of the other product.



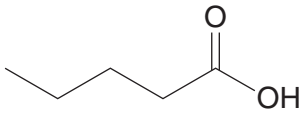
compound **C**

organic product

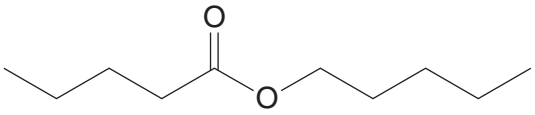
other product

[2]

(f) Compound **E** can be converted into compound **F**, which has a fruity smell and is used as a food additive.



compound **E**



compound **F**

(i) Give the structural formula of the compound that will react with compound **E** to form compound **F**.

[2]

(ii) Concentrated sulphuric acid is also used in the conversion of compound **E** to compound **F**.

Give **one** reason why this is added to the reaction mixture.

.....

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

[Total: 16]

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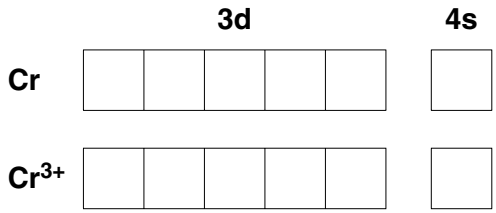
3 Chromium has been shown to be an essential element in assisting the body to break down carbohydrates and reduce sugar cravings. For these reasons manufacturers are adding a variety of chromium(III) complexes to some of their bottled water products.

(a) (i) By drawing arrows in the appropriate boxes, complete the outer electron structures for Cr and Cr^{3+}.



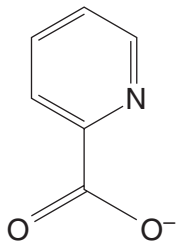
[2]

(ii) Using your answers to **(i)** explain why chromium is classified as a transition metal.

.....

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

(b) The formula of one of the chromium(III) complexes is $[Cr(C_6H_4NO_2)_3]$, where $C_6H_4NO_2^-$ is the picolinate ion. Picolinate acts as a bidentate ligand and has the structure shown below.



(i) What type of bond is formed by the ligand with the central chromium ion?

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

(ii) Describe and explain the features of the picolinate ion that enable it to act as a **bidentate** ligand.

.....

.....

.....

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

(iii) Give the coordination number of the complex and state its shape.

coordination number .....

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

(c) The chromium picolinate complex is an intense bright red colour and is soluble in water. It is used in bottled water at a concentration of about $4.00 \times 10^{-4}\,g\,dm^{-3}$.

You are given a solution of the complex of known concentration. Describe how you would use a colorimeter to measure the concentration of the complex in a sample of bottled water.

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..... **[5]**

(d) One reason for choosing the picolinate ion as the ligand is that it is a breakdown product of the essential amino acid tryptophan. Tryptophan is involved in human food metabolism.

(i) Suggest why chemists thought that picolinate would be a suitable ligand.

.....

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

(ii) Give **one** test that would have to be done before the complex was allowed to be added to bottled drinks.

.....

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

[Total: 15]

4 When food such as lasagne is stored in a steel baking pan and covered with aluminium foil a 'lasagne cell' is accidentally set up. After a few hours the foil develops small holes where it touches the lasagne, and the food surface becomes covered with small spots of a white solid.

Table 2

half-reaction	$E^{\ominus}$/V
$Al^{3+} + 3e^- \rightarrow Al$	–1.66
$Fe^{2+} + 2e^- \rightarrow Fe$	–0.44

(a) (i) The steel reacts very slightly with the lasagne to form Fe^{2+} ions.

Explain, in terms of the electrode potentials given in **Table 2**, why holes appear in the aluminium foil.

.....

.....

.....

.....

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

(ii) Write an equation for the reaction which produces the holes in the aluminium.
State symbols are **not** required.

$\rightarrow$

[2]

(b) Aluminium ions react with hydroxide ions to form aluminium hydroxide.

Write an ionic equation for this reaction, including state symbols, and explain why white spots are seen on the food.

$\rightarrow$

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

(c) **(i)** A cell is set up using iron and aluminium as the electrodes with the appropriate solutions of ions. Use data from **Table 2** to calculate the $E^{\ominus}_{cell}$ value.

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

(ii) Describe and explain **one** reason why the 'lasagne cell' is unlikely to have this value for its E_{cell}.

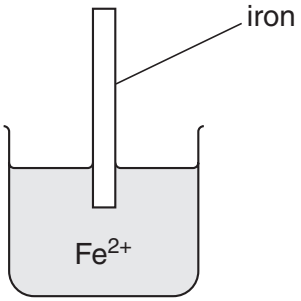
.....

.....

.....

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

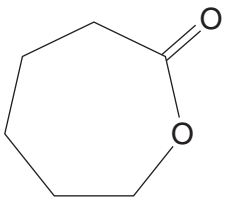
(d) Complete and label the diagram below to show how the **standard** electrode potential, $E^{\ominus}$, of iron is measured.



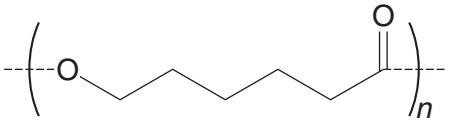
[4]

[Total: 15]

5 Poly(caprolactone), **PCL**, is made by the ring-opening polymerisation reaction of caprolactone.



caprolactone



repeating unit of PCL

(a) (i) Name the functional group in caprolactone.

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

(ii) Suggest whether the polymerisation reaction is addition or condensation.

Give a reason for your choice.

.....

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

(b) **PCL** is used in medicine for making sutures. Sutures are stitches that degrade in the body due to hydrolysis reactions.

(i) Give the reagent and conditions that are used in the **laboratory** to hydrolyse **PCL**.

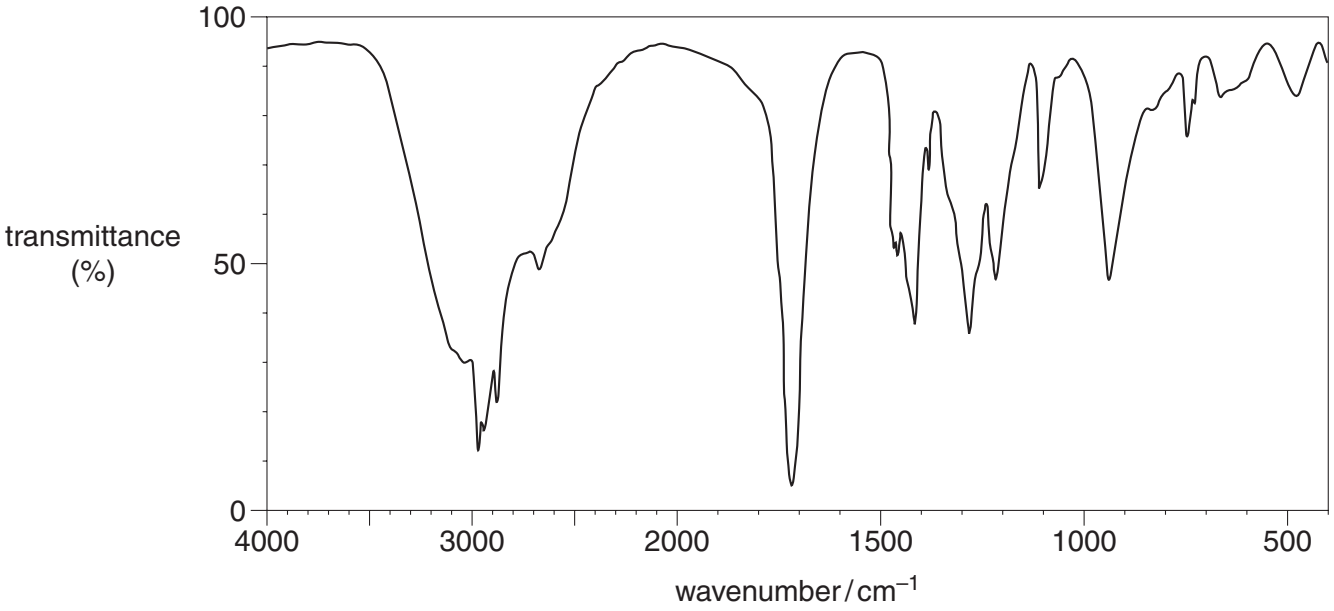
reagent .....

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

(ii) **Name** the two functional groups formed by the hydrolysis reaction.

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

(iii) Breakdown of **PCL** by microorganisms produces several compounds that have been identified by infrared spectroscopy. The infrared spectrum of one of these compounds is shown below.



Identify the functional group present. Explain your reasoning and show which peaks in the spectrum you have used.

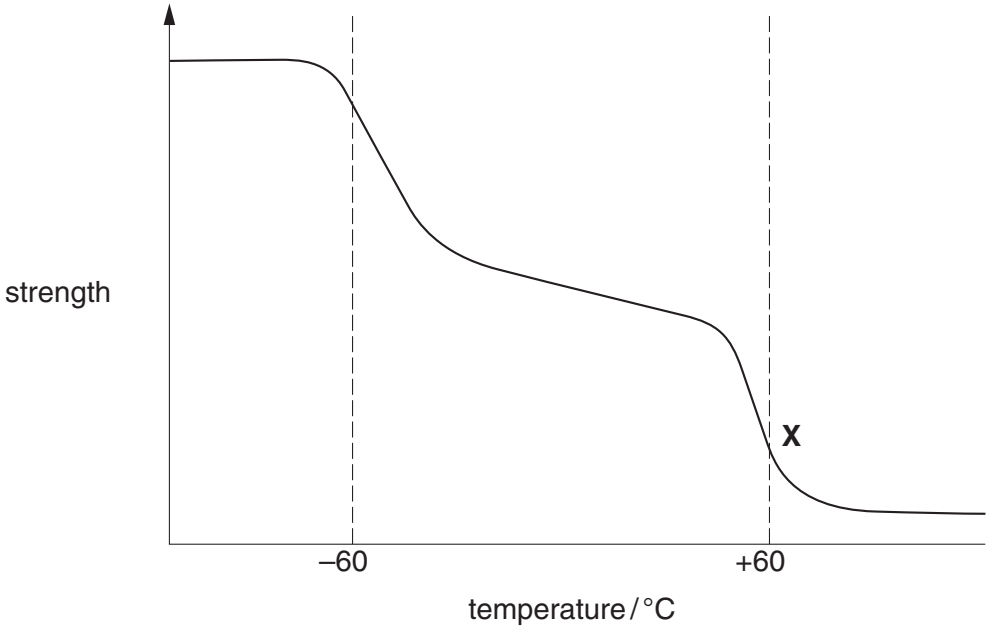
functional group .....

.....

.....

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

(c) The graph below shows how the strength of **PCL** varies with temperature.



(i) What happens to **PCL** at point **X**?

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

(ii) Describe and explain what would happen to a sample of **PCL** if you tried to bend it at –80 °C.

.....

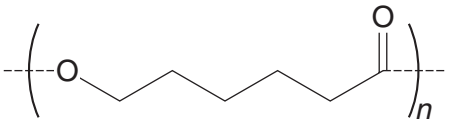
.....

.....

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

(d) Fibres made from **PCL** are stronger than those made from poly(ethene).

Name the strongest intermolecular force in **PCL** and in poly(ethene).



repeating unit of PCL

PCL .....

poly(ethene) ..... **[2]**

[Total: 15]

END OF QUESTION PAPER

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