THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY B (SALTERS)

Chemistry of Materials

F334

Candidates answer on the Question Paper
A calculator may be used for this paper

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

Other Materials Required:
- Scientific calculator

Monday 28 June 2010
Morning

Duration: 1 hour 30 minutes

OCE/13045

F334

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

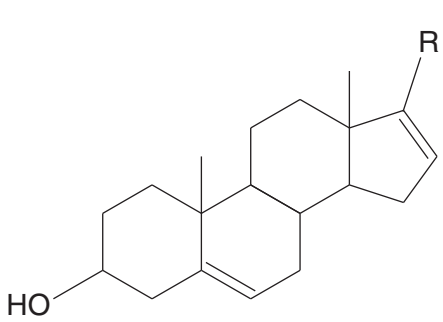
- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry B (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **90**.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Abiraterone, $C_{24}H_{31}NO$, is a new drug under trial as a treatment for cancer of the prostate gland. The structure of abiraterone is shown below.



R is a ring structure with the molecular formula C_5H_4N

abiraterone

(a) Name **two** functional groups present in the part of the abiraterone molecule shown.

.....

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

(b) A molecule of abiraterone is chiral because it has a number of asymmetric carbon atoms.

(i) On the structural formula shown above, circle **three** of these asymmetric carbon atoms. **[2]**

(ii) A molecule with an asymmetric carbon atom exists as two enantiomers. Explain why these are different compounds.

.....

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

(c) **High-resolution** mass spectrometry can be used to determine the molecular formula of a compound by measuring the mass:charge ratio of the M^+ peak.

(i) Explain how the molecular formula of abiraterone can be determined from an accurate mass:charge ratio for the M^+ peak in its mass spectrum.

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

(ii) The M_r value of abiraterone is 349 to the nearest whole number. In the low-resolution mass spectrum of abiraterone there are also peaks at mass:charge ratios of 15 and 332.

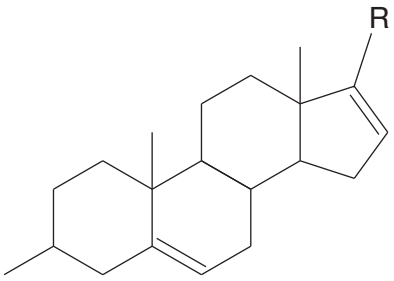
Give the formulae of the species

- responsible for the peak at 15 .....
- lost from the molecular ion to form a fragment which causes the peak at 332.

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

(d) In treating cancers, abiraterone is used as its **ethanoate** ester.

(i) On the diagram below, draw the **full** structural formula of the *ethanoate* group in the correct position.



[1]

(ii) **Name** the two substances that must be heated under reflux with abiraterone to make its ethanoate ester.

.....

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

(e) Complete the equation below for the reaction of abiraterone with **excess** bromine. Assume that the 'R group' in the structural formula of abiraterone does not react with bromine.

$C_{24}H_{31}NO$ + $\longrightarrow$

[1]

(f) Abiraterone ethanoate is a white solid which can be purified by recrystallisation. Recrystallisation removes both soluble and insoluble impurities.

Describe how a student would carry out this procedure using a suitable solvent.

In your answer you should make it clear how the removal of impurities is linked to the procedural steps.

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

(g) Clinical trials are carried out to determine the suitability of abiraterone as a drug.

Give **three** questions that **clinical trials** are designed to answer.

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

[Total: 21]

2 Iron(II) ethanoate is used for coating fabrics before they are dyed. It is made by treating scrap steel with ethanoic acid.

(a) Suggest an equation for the reaction of iron with ethanoic acid. State symbols are **not** required.

→

[2]

(b) **(i)** Complete the electronic configurations for the following iron species.

Fe atom: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$.....

Fe(II) ion: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$.....

Fe(III) ion: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$.....

[2]

(ii) Use your answers in **(i)** to explain why Fe^{3+} ions are more stable than Fe^{2+} ions.

.....

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

(c) A student added aqueous sodium hydroxide to a solution of iron(II) ethanoate. He observed the formation of a green precipitate.

(i) Give an ionic equation for the formation of the green precipitate. Include state symbols.

→

[2]

(ii) The student left the green precipitate to stand. At the surface the precipitate turned red-brown.

Name the red-brown precipitate and explain what caused the red-brown precipitate to be formed.

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

(d) The concentration of an iron(II) ethanoate solution can be determined by a redox titration with cerium(IV) sulfate. A few drops of an indicator are added. The solution turns purple at the end point.

The equation for the reaction between Ce^{4+} and Fe^{2+} is given below.

$$Ce^{4+}(aq) + Fe^{2+}(aq) \longrightarrow Ce^{3+}(aq) + Fe^{3+}(aq)$$

(i) Give the formula of cerium(IV) sulfate.

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

(ii) A student found that a 25.0 cm^3 sample of an iron(II) ethanoate solution required a titre of 18.5 cm^3 of 0.100 mol dm^{-3} cerium(IV) sulfate solution.

Calculate the concentration of Fe^{2+} in the iron(II) ethanoate solution.

concentration of Fe^{2+} = ... mol dm^{-3} **[2]**

(e) The indicator solution used in **(d)** is made by dissolving 0.10 g of a compound **A** in 0.0050 mol dm^{-3} NaOH solution to make 100 cm^3 of indicator solution.

M_r of compound **A**, 213

(i) Calculate the concentration of compound **A** in the indicator solution.
Give your answer to an **appropriate** number of significant figures.

concentration of **A** = ... mol dm^{-3} **[2]**

(ii) The table below contains data obtained from the infrared spectrum of compound **A**.

Use your *Data sheet* to complete the table. **[2]**

wavenumber / cm^{-1}	bond	location
3150		
1715		

(iii) Compound **A** is insoluble in water but soluble in alkaline solution.

Use this information and the information from **(ii)** to identify the functional group in compound **A** and so explain why **A** is soluble in an alkaline solution.

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

(f) On leaving his titration flask to stand at the end of the titration outlined in **(d)**, the student noticed that the purple colour, caused by another compound, **B**, gradually faded to yellow. The student decided to investigate the kinetics of this reaction of compound **B**.

The student used a colorimeter and was provided with a calibration curve for solutions of compound **B**. From the results he could determine the order of the reaction with respect to compound **B**.

- Explain how the student would use the colorimeter and the calibration curve to determine the concentrations of compound **B** as the purple colour faded in the titration flask.

- Explain how the student would use the results to show that the reaction taking place is first order with respect to compound **B**.

*In your answer you should use appropriate technical terms spelled correctly***.**

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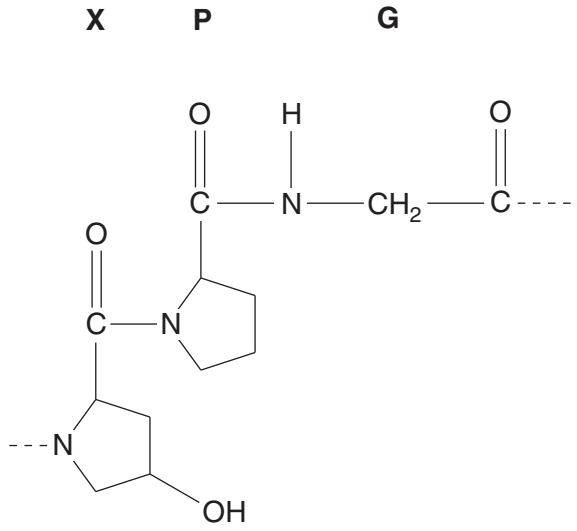
..... **[5]**

[Total: 24]

3 Skin consists mostly of the protein collagen. Collagen is made mainly from three amino acids, known as **X**, **P** and **G**. In the primary structure of collagen, the amino acid sequence -**X**-**P**-**G**- is common.



(a) The strands of collagen can be broken down into the constituent amino acids by the enzyme, collagenase, which hydrolyses the peptide links.

(i) On the diagram above circle a peptide link. **[1]**

(ii) Give the structural formula of amino acid **G**.

[1]

(iii) Suggest the formula of the zwitterion of the amino acid **P**.

[2]

Amino acid **X** is synthesised from amino acid **P** by the enzyme, proline hydroxylase.

(b) Proline hydroxylase works best at an optimum temperature and an optimum pH.

(i) Explain why the enzyme activity is less when the temperature is higher than the optimum value.

.....

.....

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

(ii) Explain why the enzyme activity is less when the pH is changed slightly from its optimum value.

.....

.....

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

(c) At low concentrations of amino acid **P**, the synthesis reaction is first order with respect to **P** and first order with respect to the enzyme.

(i) Give the rate equation for the reaction and state the units of the rate constant.

rate equation .....

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

(ii) Explain why, at low concentrations of **P**, the reaction is first order with respect to **P**.

.....

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

(iii) At high concentrations of **P** the reaction is no longer first-order with respect to **P**.

Give the new order and explain how it arises.

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

(d) Enzymes, such as the hydroxylases, are used commercially for the synthesis of compounds.

Give **two** ways that enzymes may increase the efficiency of an industrial process.

.....

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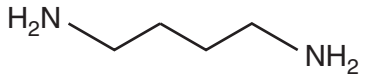
..... **[2]**

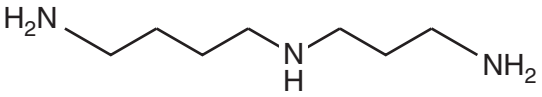
[Total: 16]

PLEASE TURN OVER FOR QUESTIONS 4 AND 5

4 Putrescine and spermidine are polyamines that are synthesised in the body. They play an important part in cell replication. The structures of putrescine and spermidine are shown below.



putrescine



spermidine

(a) Give the systematic name of putrescine.

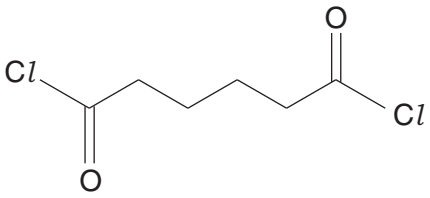
..... **[2]**

(b) Spermidine is believed to be present in cells as a cation and can form ionic bonds with certain enzymes.

Draw the structure of the spermidine cation formed when spermidine is mixed with excess acid.

[2]

(c) Putrescine reacts with monomer **C** below to form a polymer called Stanyl®.



monomer **C**

(i) Draw in the box the repeating unit of Stanyl®.

[2]

(ii) Name the **new** functional group present in Stanyl®.

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

(iii) Identify the other product formed when putrescine and **C** are polymerised and explain why this polymerisation is called a condensation reaction.

.....

.....

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

(d) Suggest and explain an environmental reason why Stanyl® is made industrially using hexanedioic acid rather than monomer **C**.

.....

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

(e) Stanyl® is a high-performance material used in cars. It has a T_m of over 300 °C whereas high density poly(ethene) has a T_m *of* about 120–130 °C. Both polymers have a high degree of crystallinity.

(i) Name the strongest type of intermolecular bond present in Stanyl® and in poly(ethene).

Stanyl® .....

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

(ii) Explain why poly(ethene) will soften at a much lower temperature than Stanyl®.

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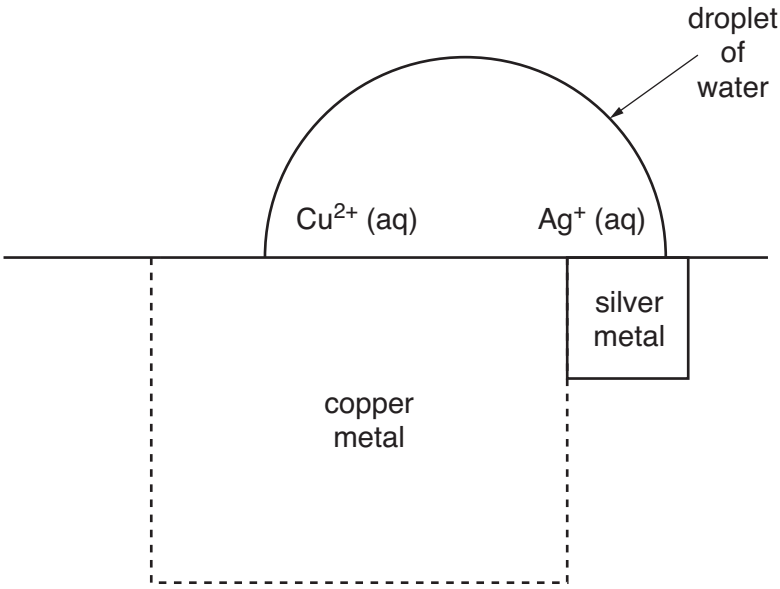
..... **[3]**

[Total: 16]

5 Brass is an alloy of copper and zinc. Brass made by modern methods oxidises more slowly than brass produced by older processes. One reason for this is that brass made before the 1940s contained higher levels of impurities such as silver.

(a) The metal impurities in pre-1940s brass allow many small electrochemical cells to be set up on the surface of the brass.

The diagram below shows a water droplet on the surface of a brass plate.



(i) Use the diagram above and data from **Table 5.1** below to explain how the silver impurity next to the copper produces an electric current, stating the direction of the electron flow.

Table 5.1

half-reaction	$E^{\ominus}$/V
$Zn^{2+} + 2e^{-} \rightarrow Zn$	–0.76
$Cu^{2+} + 2e^{-} \rightarrow Cu$	+0.34
$Ag^{+} + e^{-} \rightarrow Ag$	+0.80

.....

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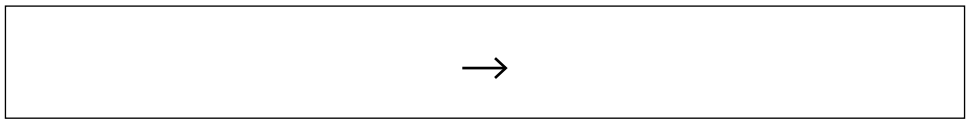
.....

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

(ii) Calculate the $E^{\ominus}_{cell}$ value for a cell using copper and silver as the electrodes with the appropriate standard solutions of ions.

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

(iii) Write an equation for the reaction taking place in the copper and silver cell in **(ii)**, when it is producing a current.



[1]

PLEASE TURN OVER FOR QUESTION 5(b)

(b) A student added excess dilute hydrochloric acid to a weighed sample of brass. The zinc reacted forming a solution and leaving the copper metal behind. She then treated the copper metal with concentrated sulfuric acid, eventually producing 250 cm^3 of copper(II) sulfate solution.

(i) Dilute hydrochloric acid will react with zinc but not copper.

Give the formula of the ion acting as the oxidising agent in the reaction.

Use **Table 5.1** to explain why the acid reacts with zinc but not copper.

oxidising agent .....

explanation .....

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.....

.....

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

(ii) The student determined the concentration of copper(II) ions in the copper(II) sulfate solution by titrating with a standard solution of $EDTA^{4-}$. The concentration of the 250 cm^3 copper(II) sulfate solution was found to be 0.150 mol dm^{-3}. The mass of the brass sample was 3.97 g.

Calculate the percentage by mass of copper in the brass sample.

answer = ... % **[3]**

(iii) Complete the table below for the complex formed between copper(II) ions and $EDTA^{4-}$.

	copper(II) complex ion formed with $EDTA^{4-}$
formula	
shape	
coordination number	

[3]

[Total: 13]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

ADDITIONAL PAGE