OCR
Oxford Cambridge and RSA

Tuesday 13 June 2017 – Afternoon

A2 GCE CHEMISTRY B (SALTERS)

F334/01 Chemistry of Materials

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry B (Salters)* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 30 minutes

* F 3 3 4 0 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

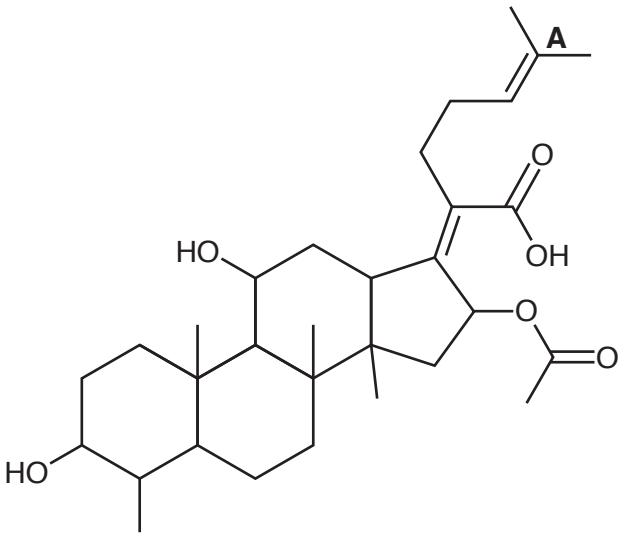
- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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 **24** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Fusidic acid is used in medicines for treating bacterial eye infections. Scientists believe it could also be used in skin treatments.



fusidic acid

(a) Which **three** questions about the medicine need to be answered before it can be used to treat skin infections?

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

(b) **(i)** One functional group in fusidic acid is the carboxyl group.

Name **three** other functional groups in fusidic acid.

1 .....

2 .....

3 .....

[2]

(ii) Fusidic acid has many asymmetric carbon atoms.

Circle **four** of them on the structure of fusidic acid above. **[1]**

(iii) A student predicts that the bond angle, labelled **A**, in the structure of fusidic acid is 120°.

State whether you agree with this prediction or not.
Give your reasoning.

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

(iv) The molecular formula of fusidic acid is $C_{31}H_{48}O_6$, (M_r 517).
Another organic compound has a different formula from fusidic acid but also has a M_r of 517.

Explain how and why high resolution mass spectra can distinguish between these compounds.

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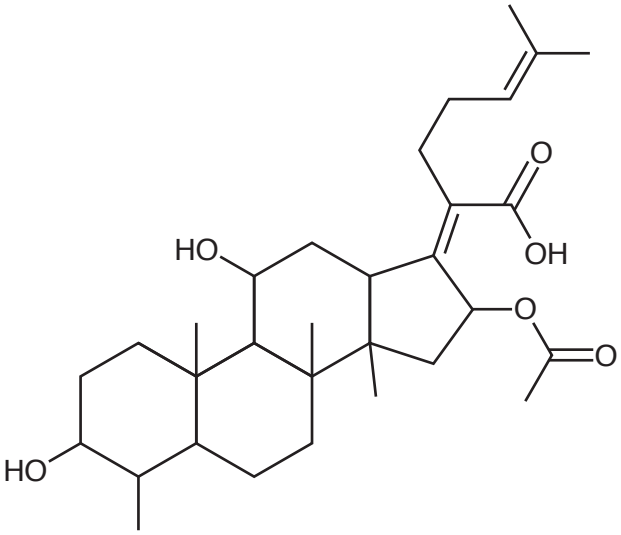

fusidic acid

(c) Fusidic acid (M_r 517) reacts with hydrogen in two different ways depending on the catalyst used.

In the presence of a **palladium** catalyst, the M_r of the product is 519.
The number of asymmetric carbon atoms present in the product is the same as in fusidic acid.

In the presence of a **platinum** catalyst, the M_r of the product is 521. The number of asymmetric carbon atoms present in the product is now **two** more than in fusidic acid.

Suggest an explanation for these observations. Give all your reasoning.

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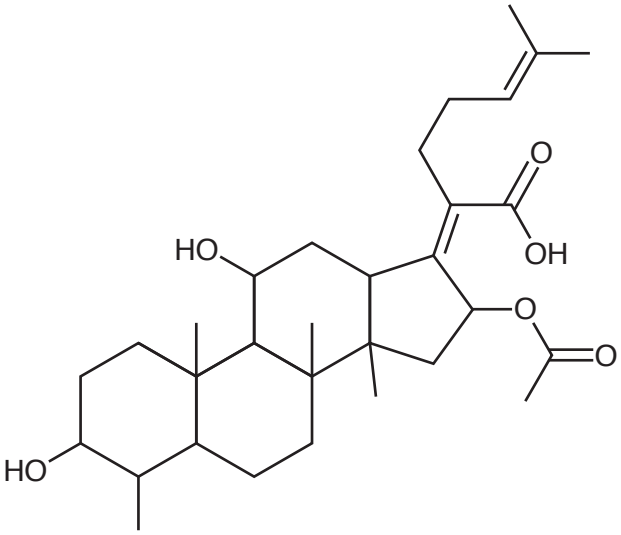
..... **[4]**



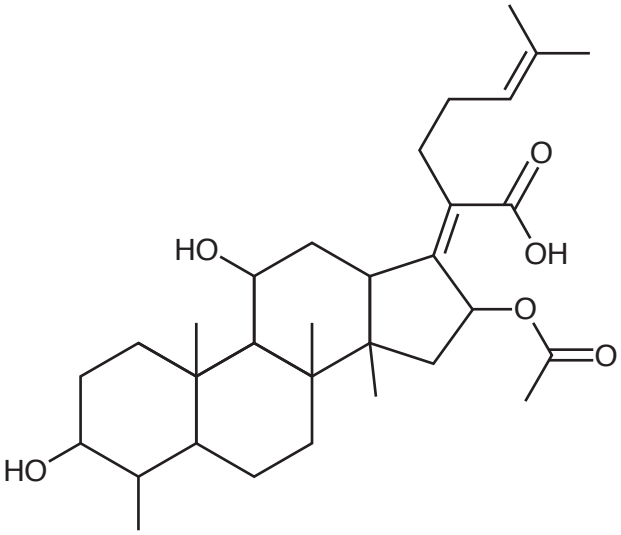
fusidic acid

(d) Fusidic acid hydrolyses in aqueous acid. Two organic products form.

(i) On the diagram above suggest the bond in fusidic acid which breaks during acid hydrolysis.

Label this bond with a **B**. **[1]**

(ii) Compound **C** is one of the products of acid hydrolysis of fusidic acid.
The infrared and mass spectra of compound **C** are shown below.



fusidic acid

Give the **name** of compound **C**.

Give your full reasoning from the structural formula of fusidic acid and the two spectra.

In your answer, you should make it clear how your points link together.

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

[Total: 20]

2 Nitrosyl chloride, ClNO, is used as an oxidising agent to improve flour in bread-making.

(a) (i) Draw an electron '*dot-and-cross*' diagram for a ClNO molecule.
Show outer electrons only.

State, with a reason, whether its shape is linear or bent.

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

(ii) In the baking of bread, ClNO forms the colourless gas NO.

Explain, in terms of oxidation states, why nitrosyl chloride is acting as an oxidising agent in this reaction.

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

(b) Nitrosyl chloride, a yellow gas, can be made by the direct combination of chlorine gas and nitrogen monoxide gas.

$$2NO + Cl_2 \longrightarrow 2ClNO$$

(i) A student studies the rate of this reaction. The student tries to measure the concentration of ClNO in a sealed gas cuvette in a colorimeter.

Suggest why the student finds the method is not very suitable.

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

(ii) Using a different method, the student obtains the data given below.

Experiment carried out at 50 °C	Initial [NO] / mol dm^{-3}	Initial [Cl_2] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.15	0.10	2.06×10^{-7}
2	0.15	0.20	4.12×10^{-7}
3	0.30	0.20	1.65×10^{-6}

From this data:

- Write down the rate equation for the reaction.
- Calculate the rate constant, *k*, for the reaction at 50 °C.
- Calculate the rate of C*l*NO formation at 50 °C when [NO] and [Cl_2] are both 0.10 mol dm^{-3}.

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

Rate equation: Rate = *k* × .....

k = ... units .....

rate of reaction = ... mol dm^{-3} s^{-1}

[5]

(iii) The student used some of the working from part **(b)(ii)** to comment on the mechanism of the reaction.

What conclusion can be made about the mechanism?
Give your reasoning.

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

(c) ClNO is also an electrophilic reagent for alkene addition reactions.

(i) Suggest a formula for the electrophile formed from ClNO.

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

(ii) Draw the structure of *Z*-but-2-ene below.
Also draw the structure of the product formed when ClNO reacts with *Z*-but-2-ene.

Z-but-2-ene	product

[2]

[Total: 17]

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3 New polymers have been produced by first condensing a hydroxycarboxylic acid with an amino acid to form an ester. These monomers are then reacted to form a polymer called PEA.

(a) (i) What is meant by the term *condensing*?

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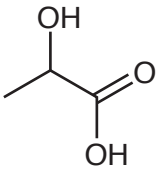
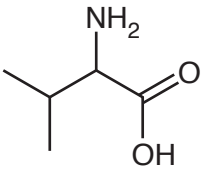
..... **[2]**

(ii) The monomer **D** is formed when 2-hydroxypropanoic acid is condensed with valine. Monomer **D** is an ester with a free NH_2 group.



2-hydroxypropanoic acid



valine

Draw the **skeletal** structure of **D** below.

[1]

(iii) A PEA polymer chain is made by condensing molecules of **D**.

Draw the structural formula of **two** repeating units of this polymer.
Show the bonds where the units join to the rest of the polymer chain.

[1]

(iv) On your diagram above circle **two** different linkages in the polymer chain and label them **E** and **F**.

[1]

(v) Give the name of each linkage.

E .....

F .....

[2]

(b) A student hydrolyses a different PEA polymer in acid.
A pure solid sample of an amino acid is obtained from the hydrolysis.

The student thinks this amino acid is either valine or alanine.

Describe how the student would use paper chromatography to identify which amino acid has been obtained.

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

(c) Suggest why chemists researching PEA polymers thought that the polymers might be biodegradable.

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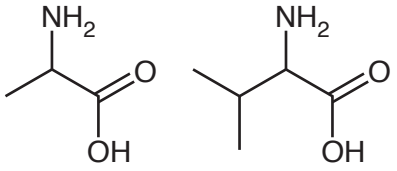
..... **[1]**

(d) Polymers made using alanine instead of valine have a higher degree of crystallinity.



alanine **valine**

(i) What is meant by the term *crystallinity*?

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

(ii) Suggest a reason why polymers made with valine have a lower degree of crystallinity than those using alanine.

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

(iii) Predict, with a reason, which of the two polymers would have the higher T_m value.

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

(iv) Give **two** ways of modifying polymers to make them more crystalline.

1 .....

2 .....

[2]

[Total: 19]

4 Domestic water systems often use copper tubing. When using water from the mains in these pipes, there is no damaging corrosion.

There is no damaging corrosion because a thin red-brown copper(I) oxide layer forms on the inside of the pipe as the copper reacts with dissolved oxygen. This is followed by a second oxide layer, black in colour, formed from the copper(I) oxide. Both layers are insoluble and protect the pipe from any further corrosion.

(a) (i) Write equations for the formation of the two oxide layers.
Include state symbols.

1st layer → _____

2nd layer → _____

[2]

(ii) A drum made from new copper is filled with mains water and left to stand.

Oxide layers do not form on the inside of the drum but oxide layers form inside new copper tubes used for domestic water systems.

Suggest a reason for this difference.

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

(iii) Complete the electron configurations for the copper species listed below.

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

Cu^+ $1s^2 2s^2 2p^6$ .....

Cu^{2+} $1s^2 2s^2 2p^6$ .....

[2]

(b) Problems with corrosion of copper pipes can arise if the water becomes too acidic. The problem is referred to as 'Blue Water'.

(i) On adding hydrochloric acid to blue water, the colour of the water changes to green because of the formation of a complex anion containing chlorine.

Give the formula of the ion responsible for the green colour.
State, with reasons, the **type** of reaction taking place.

formula .....

type of reaction .....

reasoning .....

.....

[3]

(ii) Describe how a student would use a colorimeter to measure the concentration of the ion causing the blue colour in the water.

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

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

(c) Corrosion inhibitors are often added to water systems that have copper pipes.
One inhibitor is compound **G**, $HOCH_2CH_2NH_2$.

Give the systematic name of compound **G**.

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

(d) Compound **G** forms a complex ion with copper(II) ions. The formula of the complex ion is $[Cu(HOC_2H_4NH_2)_3]^{2+}$ and it has an octahedral shape.

(i) What is the coordination number of the complex ion?

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

(ii) Draw a diagram to show how **one** molecule of compound **G** bonds to a Cu^{2+} ion. Show any relevant lone pairs.

[2]

(iii) Name the type of bond which joins compound **G** to the Cu^{2+} ion.

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

[Total: 17]

5 The TV and Film industries use potassium manganate(VII) to paint objects.
The manganate(VII) is easily converted to brown manganese(IV) oxide which makes the objects look older.

(a) Table **5.1** lists some electrode potential data.

Half-reaction	E^{e} / V
$2CO_2 + 2H^+ + 2e^- \rightarrow H_2C_2O_4$	−0.49
$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.51
$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$	+1.70
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	+2.01

Table 5.1

(i) Use data from table **5.1** to choose a suitable reagent and conditions for reacting with $KMnO_4$ to produce MnO_2.

formula of reagent .....

systematic name of reagent .....

conditions .....

.....

reasoning .....

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.....

[4]

(ii) Give a balanced equation for the formation of MnO_2 using your reagent from part **(a)(i)**.

$\rightarrow$

[1]

(b) The concentration of a MnO_4^- solution can be found by titration with a standard solution of Mohr's salt, $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$. ($M_r$ 392)

A solution of Mohr's salt was made by dissolving 9.80 g of the hydrated salt in water and making the solution up to 250 cm^3.

10.00 cm^3 of this solution of Mohr's salt reacts with 17.50 cm^3 MnO_4^- solution.

The equation for the reaction is:

$$10(NH_4)_2Fe(SO_4)_2(aq) + 2KMnO_4(aq) + 8H_2SO_4(aq) \rightarrow 2MnSO_4(aq) + 10(NH_4)_2SO_4(aq) + 5Fe_2(SO_4)_3(aq) + K_2SO_4(aq) + 8H_2O(l)$$

Calculate the concentration of the MnO_4^- solution.

$[MnO_4^-]$ = ... mol dm^{-3} **[5]**

(c) Describe how a student would carry out a single titration in part **(b)**.

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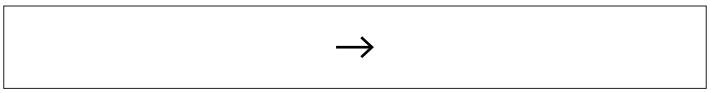
..... **[3]**

(d) (i) Excess sodium hydroxide solution is added to a solution of Mohr's salt, $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$.

What would be observed?

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

(ii) Give an ionic equation for the reaction in part **(d)(i)**.



[1]

(e) A solution of iron(II) sulfate is readily oxidised by air. Addition of acid to the solution prevents any oxidation.

Suggest why the ammonium ions present in a solution of Mohr's salt prevent iron(II) ions from readily oxidising in air.

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

[Total: 17]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).