Candidate Name	Centre Number	Candidate Number
		2

General Certificate of Education
Advanced

334/01

CHEMISTRY – CH4

A.M. TUESDAY, 22 January 2008
(1 hour 40 minutes)

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:
- a calculator;
- an 8 page answer book;
- a **Data Sheet** which contains a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1	
	2	
	3	
B	4	
	5	
TOTAL MARK		

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **both** questions in **Section B** in a separate answer book which should then be placed inside this question-and-answer book.

ADVICE TO CANDIDATES

Candidates are advised to allocate their time appropriately between **Section A (35 marks)** and **Section B (40 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 75.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

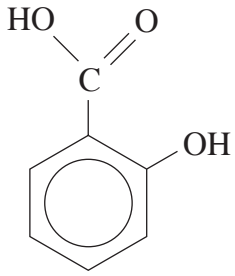
You are reminded that marking will take into account the Quality of Written Communication used in your answers.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

Answer **all** *the questions in the spaces provided.*

1. *(a)* Salicylic acid, which was originally derived from the bark of the Willow (Salix), has been used for centuries to treat a variety of complaints including fever and pain. It is now used extensively in the treatment of a range of skin conditions. It has the structure shown below.



(i) **Name** the **two** functional groups in the molecule. [2]

I. .....

II. .....

(ii) Calculate the relative molecular mass of salicylic acid. [1]

.....

.....

(iii) Draw the structure of the organic product formed when salicylic acid is treated with

I. ethanol and concentrated sulphuric acid, [1]

II. aqueous sodium hydroxide. [2]

(b) 0·01 mole of a compound **A** reacts with bromine water to form 3·31g of a white compound **B**. Quantitative analysis of compound **B** shows that it contains 21·8% C, 0·90% H, 4·80% O and 72·5% Br by mass. Compound **A** also gives a purple colour with aqueous iron(III) chloride.

(It may be assumed that one mole of **A** reacts to give one mole of **B**.)

(i) Calculate both the empirical and molecular formulae of compound **B**. [3]

.....

.....

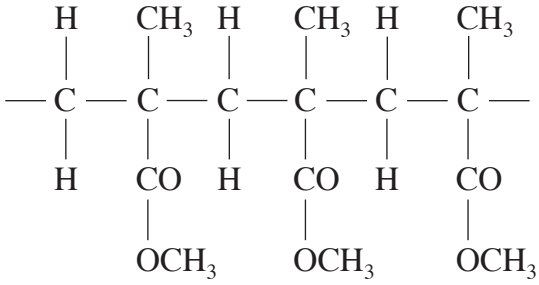
.....

.....

(ii) Give the structural formulae of compounds **A** and **B**. [2]

Total [11]

2. *(a)* Over the last 50 years, one of the great advances in chemistry has been in the field of polymers. A typical example of an addition polymer is perspex, a transparent plastic that can be used as a substitute for glass. Part of the structure is shown below.



Draw the structure of the monomer from which the plastic is formed. [1]

(b) A typical example of a condensation polymer is nylon. Most of the nylon made in the UK is nylon-6,6 formed from hexanedioic acid and hexane-1,6-diamine.

(i) Draw the graphic (full structural) formula of hexanedioic acid. [1]

(ii) Give a test, other than the use of indicators, to show that hexanedioic acid acts as a carboxylic acid.

State all the reagents and observations. [2]

.....

.....

.....

(iii) Write a balanced equation for the ethanoylation of **one** amine group in hexane-1,6-diamine.
Use RNH_2 as the formula for hexane-1,6-diamine. [1]

.....

(iv) Hexane-1, 6-diamine is not very soluble in water. Explain why it dissolves readily in aqueous hydrochloric acid. [2]

.....

.....

.....

(v) The repeating unit in nylon-6, 6 is shown below.

$$\left[\text{HN} - (\text{CH}_2)_6 - \text{NH} - \text{CO} - (\text{CH}_2)_4 - \text{CO} \right]$$

I. State the type of condensation polymer to which nylon-6, 6 belongs. [1]

.....

II. Give a reason for nylon made in this way being called nylon-6, 6. [1]

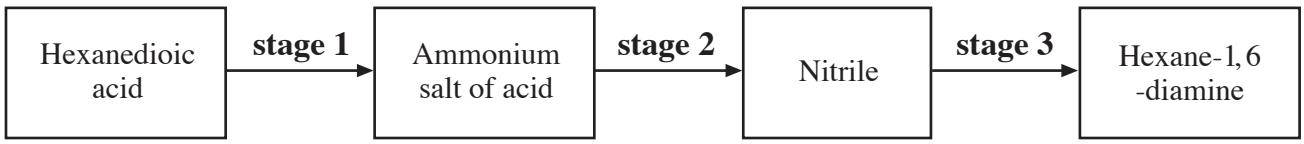
.....

.....

(vi) Give **two** large scale uses of nylon. [1]

.....

(c) Hexane-1, 6-diamine can be made from hexanedioic acid in a three stage process.



Classify the type of reaction which takes place in **stage 3** and name the reagent used for the conversion.

Type of reaction .....

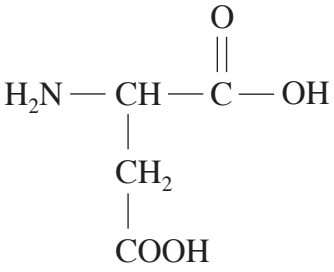
[1]

Reagent .....

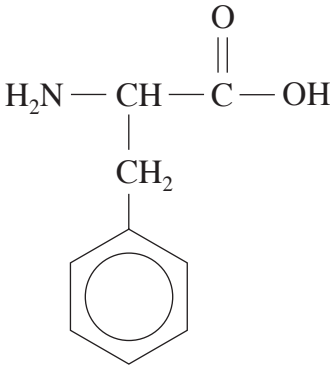
[1]

Total [12]

3. *(a)* Aspartame is an artificial sweetener which is about 200-times sweeter than sucrose. It is a methyl ester of a dipeptide formed from the following two α–amino acids.



aspartic acid



phenylalanine

(i) Draw the structure of a dipeptide formed between these two α–amino acids. [1]

(ii) On the diagram of the structure of **aspartic acid**, identify, using an asterisk (*), a chiral centre in the molecule. [1]

(iii) Draw diagrams to show the two optical isomers of aspartic acid. [1]

mirror

(iv) State how the optical isomers of aspartic acid could be distinguished from each other. [1]

.....

.....

(v) In solution, phenylalanine exists largely in zwitterion form. Give the graphic formula of the zwitterion form of phenylalanine. [1]

(vi) A disadvantage of using aspartame as a sweetener is that it breaks down quickly. In soft drinks stored in bottles, about 10% of the aspartame is destroyed each month. Suggest a reason, in terms of structure, for aspartame breaking down in this way. [1]

.....

.....

(b) When an electrical discharge is passed through hydrogen gas under suitable conditions, electromagnetic radiation is emitted.

(i) Explain what processes cause this radiation to be emitted. [3]

.....

.....

.....

.....

(ii) The emission spectrum of atomic hydrogen is obtained as a series of discrete lines which converge.

Explain why

I. the lines are discrete, [1]

.....

.....

II. the lines converge. [1]

.....

.....

(iii) State what information can be derived from the convergence limit of the Lyman Series. [1]

.....

.....

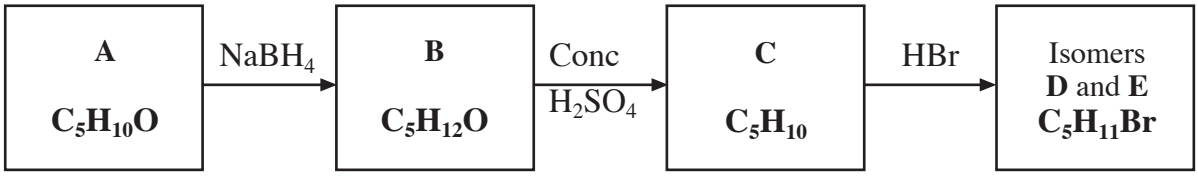
Total [12]

Section A Total [35]

SECTION B

Answer **both** *questions in this section in the separate answer book provided.*

4. *(a)* Study the reaction scheme shown below.



(i) The infrared spectrum of **A** shows a strong absorption band at 1715 cm^{-1}.

The mass spectrum of **A** shows a strong peak at *mass/charge* 57.

The NMR spectrum of **A** has only two peaks, a triplet centered around 1.1 δ, peak area 3 and a quartet centred around 2.4 δ, peak area 2.

The infrared spectrum of **B** shows a broad absorption at 3350 cm^{-1}.

Use **all** the information to give the graphic (full structural) formulae for compounds **A**, **B** and **C**, explaining your reasoning. [8]

(ii) State the type of reaction taking place for the conversion of

I. **A** ⟶ **B**,

II. **B** ⟶ **C**. [2]

(iii) I. Name the type of isomerism shown by **C**. [1]

II. Explain why reacting HBr with **C** produces two isomers, **D** and **E**. [1]

III. Name the type of isomerism shown by isomers **D** and **E**. [1]

(b) A sample of 1-bromobutane is divided into two portions. The first is warmed with dilute aqueous sodium hydroxide, whilst the second is warmed with concentrated sodium hydroxide in ethanol. In each case, a different organic product is formed.

(i) For the first portion, name the organic product formed and give the mechanism for the reaction. [4]

(ii) For the second portion, name the organic product formed and write an equation for the reaction. [2]

(c) Give a large scale use of a **named** organic halogen-containing compound of your own choice. [1]

Total [20]

5. *(a)* Consider the following six compounds:

A CH_3CH_2COOH **D** CH_3CH_2CHO

B $CH_3CH_2CH_2OH$ **E** CH_3COCH_3

C $CH_3CH(OH)CH_3$ **F** $CH_3CH_2COOCH_3$

(i) State, giving an explanation, which compound would have the highest boiling temperature. [2]

(ii) Describe a reaction where compounds **D** and **E** show a similar chemical reaction. [1]

(iii) For **each** of the following pairs of compounds, describe a **chemical** test that can be used to distinguish between them. The reagent(s) as well as the observation(s) for **each** compound, are required.

I. Compounds **D** and **E** [2]

II. Compounds **B** and **C** [2]

(iv) State the reagent(s) and condition(s) needed for each stage in the following synthesis.

B $\longrightarrow$ **A** $\longrightarrow$ **F** [4]

(b) Although ethylamine can be prepared directly from chloroethane, phenylamine cannot be prepared directly from chlorobenzene. However, phenylamine can be synthesised from benzene.

(i) State the type of reaction taking place when chloroethane is converted into ethylamine. [1]

(ii) Give a reason why phenylamine cannot be prepared directly from chlorobenzene. [1]

(iii) Outline a **two** step synthesis of phenylamine from benzene. Your answer should include reagents and conditions for **each** step. [4]

(c) During a synthesis of phenylamine from benzene, 10·0 cm^3 of benzene produced 4·20 cm^3 of phenylamine. Given that the density of benzene is 0·878 g cm^{-3}, and that of phenylamine is 1·00 g cm^{-3}, calculate the percentage yield of the synthesis correct to 3 significant figures. [3]

Total [20]

Section B Total [40]