THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY

Chains, Rings and Spectroscopy

2814/01

OCE/18083

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

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

Other Materials Required:
- Scientific calculator

Thursday 17 June 2010
Afternoon

Duration: 1 hour 30 minutes

2814014

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* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- This document consists of **16** pages. Any blank pages are indicated.

Examiner's Use Only:			
1			
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Total			

SHW 00150 1/08 18083/3

OCR is an exempt Charity

Answer **all** the questions.

1 Benzene and phenol are used in the chemical and pharmaceutical industry as starting materials for making more complex aromatic compounds.

(a) Benzene can be nitrated to form nitrobenzene, $C_6H_5NO_2$.

(i) State the reagents and conditions needed for the nitration of benzene.

.....

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

(ii) An electrophile is formed during the nitration of benzene.

What is the formula of the electrophile?

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

(iii) Write an equation for the production of the electrophile.

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

(iv) Describe, with the aid of curly arrows, the mechanism for the nitration of benzene.

[4]

(v) 3.9 g of benzene were nitrated to give 4.9 g of nitrobenzene.

Calculate the percentage yield. Give your answer to **two** significant figures.

[3]

(b) Benzene and phenol both react with bromine.

The reaction between benzene and bromine requires a catalyst.
The reaction between phenol and bromine does **not** require a catalyst.

(i) Identify a suitable catalyst for the reaction between benzene and bromine.

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

(ii) In this question, one mark is available for the quality of use and organisation of scientific terms.

- Describe what you would see when phenol reacts with bromine and identify the organic product.
- Explain the relative ease of bromination of phenol compared with benzene.

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..... **[6]**

Quality of Written Communication **[1]**

[Total: 20]

2 Azo dyes can be made from amines and phenols.

(a) Describe how you could prepare a sample of an azo dye in the laboratory from phenylamine, phenol and any other reagents.

Include in your answer:

- essential reagents and conditions for each stage;
- the displayed formula of the organic products in each stage.

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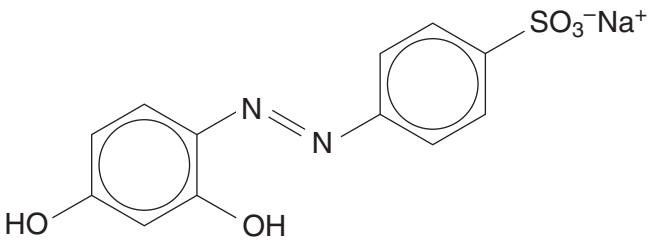
..... **[5]**

(b) Resorcinol Yellow, **E103**, is an azo dye which was used as a colouring agent in food.

The structure of **E103** is shown below.



E103

(i) On the structure above, draw a circle around the functional group that identifies **E103** as an azo dye. **[1]**

(ii) How many carbon and hydrogen atoms are there in the structure of **E103** shown above?

carbon atoms, ...

hydrogen atoms. .....
[2]

(iii) In the boxes below, draw the structures of a phenol and an amine that could have been used to make **E103** by the method described in **(a)**.

phenol	**amine**

[2]

(c) **E103** can also be used as an acid-base indicator. At high pH, **E103** turns red.

Suggest the structure of **E103** at high pH.

[1]

[Total: 11]

3 Poly(lactic acid), PLA, is a biodegradable plastic derived from renewable sources such as sugar cane and corn starch.

(a) Lactic acid, $CH_3CH(OH)COOH$, can be produced in the laboratory from ethanal, CH_3CHO, in a two stage process.

$$CH_3CHO \xrightarrow{\textbf{stage 1}} CH_3CH(OH)CN \xrightarrow{\textbf{stage 2}} CH_3CH(OH)COOH$$

(i) Describe, with the aid of curly arrows, the reaction mechanism in **stage 1**.

Show any relevant dipoles and identify the reagents used.

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

(ii) For **stage 2**, state the type of reaction and write a balanced equation.

type of reaction .....

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

(b) Lactic acid can also be produced by bacterial fermentation.

Explain the difference between a sample of lactic acid prepared by bacterial fermentation and a sample of lactic acid prepared in the laboratory.

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.....

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

(c) Lactic acid, $CH_3CH(OH)COOH$, polymerises to form poly(lactic acid), PLA.

(i) Draw a section of PLA to show **two** repeat units.

[2]

(ii) PLA is a biodegradable plastic derived from renewable sources.

Suggest why PLA is better for the environment than oil-based hydrocarbon polymers.

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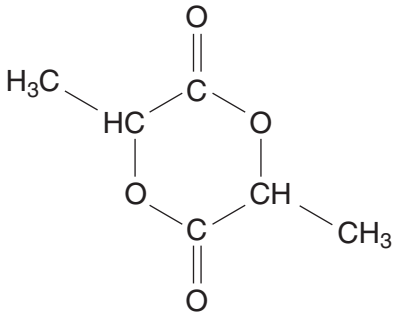
..... **[2]**

(d) Lactic acid can be dimerised to produce the compound below.



Write a balanced equation for the dimerisation of lactic acid.

[2]

[Total: 16]

4 All α-amino acids have the general formula $H_2NCH(R)COOH$.

(a) The α-amino acid, ornithine, has the formula $H_2NCH(CH_2CH_2CH_2NH_2)COOH$.

(i) Identify the R group in ornithine.

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

(ii) Draw the skeletal formula of ornithine.

[2]

(b) Ornithine reacts with both acids and bases.

(i) Identify the organic product when ornithine reacts with **excess** HCl(aq).

[2]

(ii) Identify the organic product when ornithine reacts with NaOH(aq).

[1]

(c) In the laboratory ornithine can be converted into an acyl chloride.

An incomplete equation for this conversion is shown below.

$H_2NCH(CH_2CH_2CH_2NH_2)COOH$ + …… → $H_2NCH(CH_2CH_2CH_2NH_2)COCl$ + …… + ……

Complete the equation above. **[3]**

(d) Ornithine, orn, and alanine, ala, can be reacted to form a mixture of dipeptides.

Analysis of the mixture revealed that four different dipeptides had been formed.

The four dipeptides are:

orn–orn
orn–ala
ala–orn
ala–ala.

- The formula of ornithine is $H_2NCH(CH_2CH_2CH_2NH_2)COOH$.
- The formula of alanine is $H_2NCH(CH_3)COOH$.

Draw the two dipeptides: orn–ala and ala–orn.

orn–ala

ala–orn

[3]

[Total: 12]

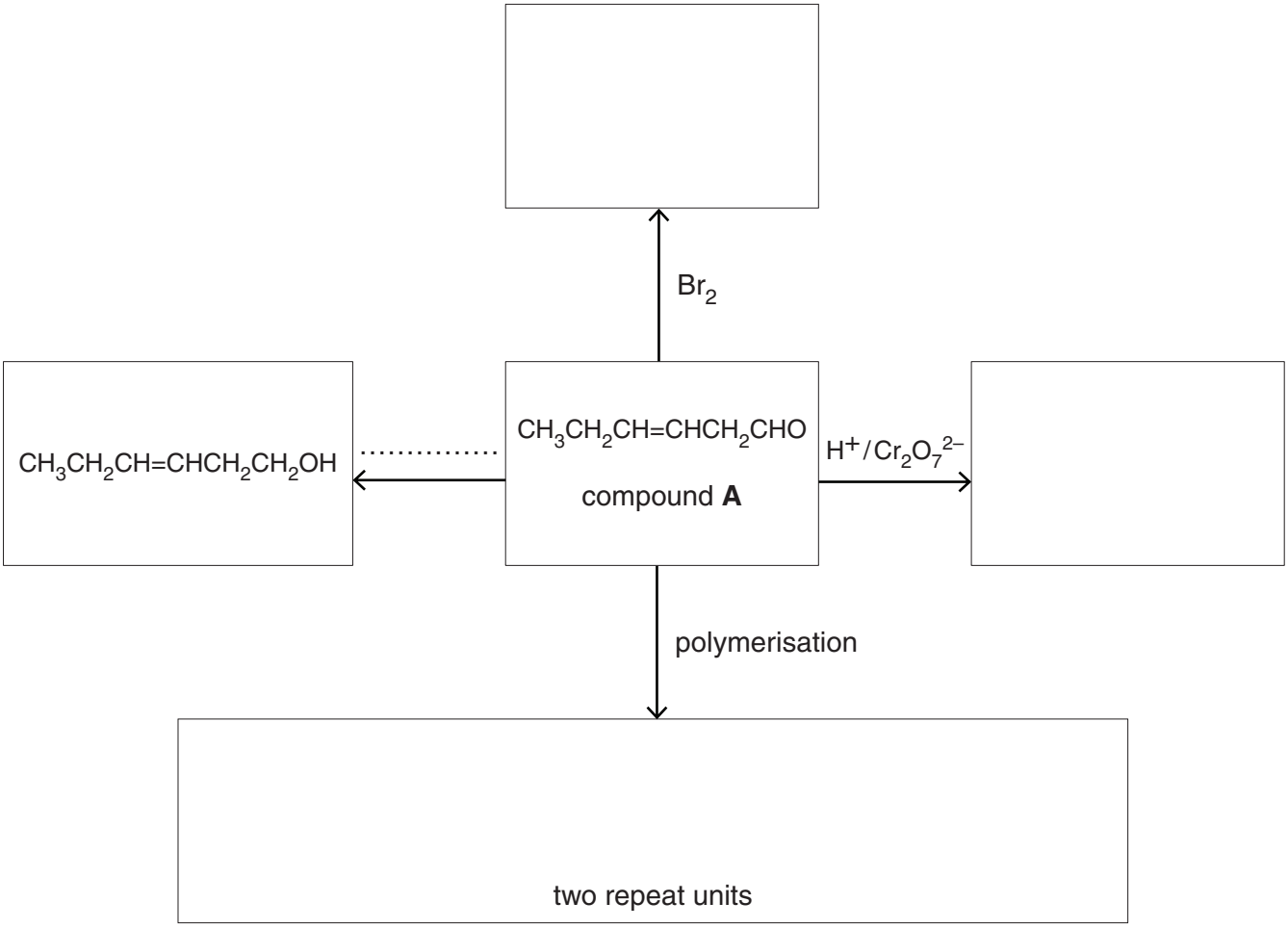
5 Compound **A**, $CH_3CH_2CH=CHCH_2CHO$, is produced in small amounts by most plants and insects.

(a) Name compound **A**.

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

(b) The flowchart shows some reactions of compound **A**.

Complete the flowchart below.



[5]

(c) There are two stereoisomers of $CH_3CH_2CH=CHCH_2CHO$.

Draw and label these stereoisomers.

[2]

[Total: 9]

6 This question is about identifying aldehydes and ketones.

(a) Describe two **chemical** tests:

- one to confirm that the compound was either an aldehyde or a ketone;
- one to distinguish between an aldehyde and a ketone.

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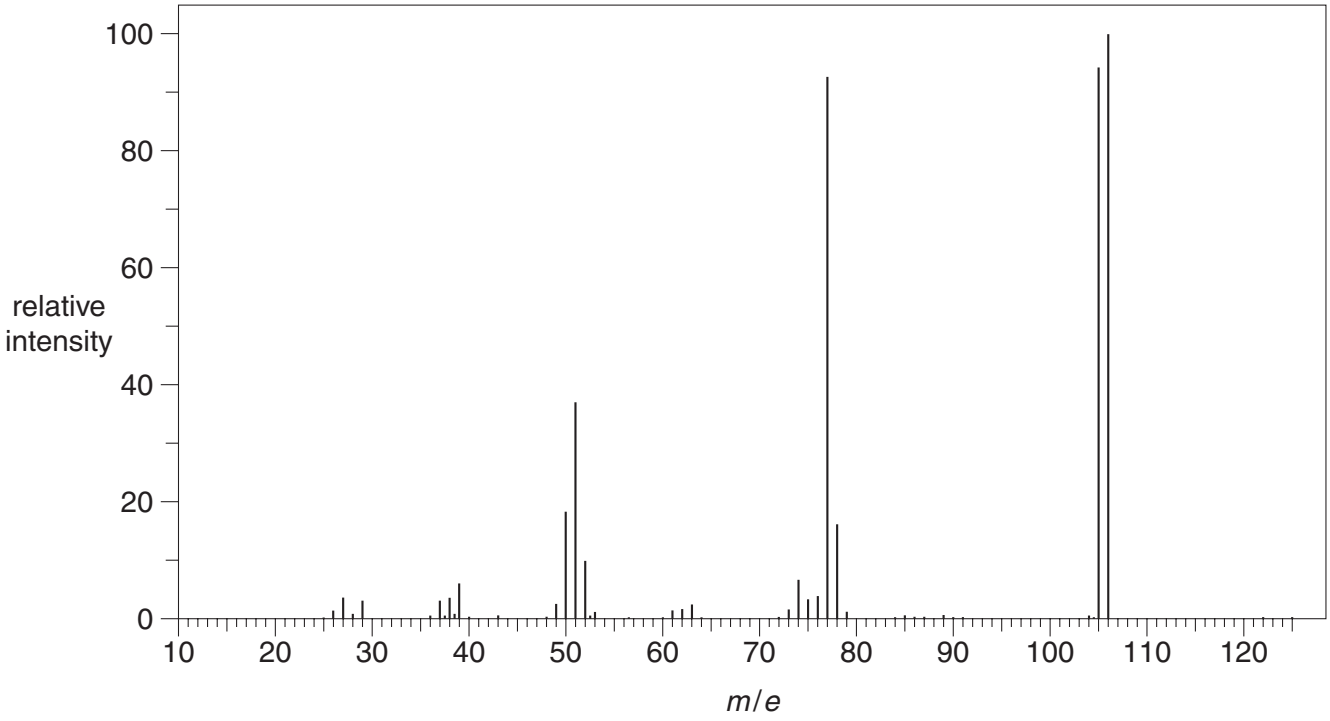
..... **[5]**

(b) An unknown compound **B** is thought to be either an aldehyde or a ketone with the molecular formula C_xH_yO.

The molecular formula of the unknown compound **B** was deduced with the help of the mass spectrum shown below.



(i) On the mass spectrum, write the letter **M** next to the peak that can be used to identify the molecular ion. **[1]**

(ii) Deduce the molecular formula of compound **B**.

molecular formula = ... **[2]**

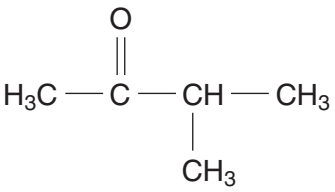
(c) Another unknown compound **C** is an aldehyde with the molecular formula $C_5H_{10}O$.

Show the four structural isomers of $C_5H_{10}O$ that are aldehydes.

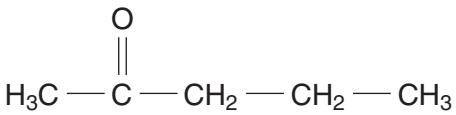
[4]

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

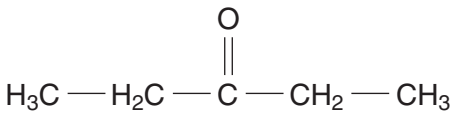
The three ketones **D**, **E** and **F** are structural isomers.



D



E



F

Explain how the three isomers **D**, **E** and **F** can be distinguished by their n.m.r. spectra.

For each isomer, describe:

- the number of peaks and their relative peak areas;
- the chemical shift of each peak;
- the splitting pattern of each peak.

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.... [9]

Quality of Written Communication **[1]**

[Total: 22]

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