## OXFORD CAMBRIDGE AND RSA EXAMINATIONS

## Advanced GCE

## CHEMISTRY

## 2814

Chains, Rings and Spectroscopy
Wednesday 18 JUNE 2003 Afternoon 1 hour 30 minutes
Candidates answer on the question paper.
Additional materials: Data Sheet for Chemistry Scientific calculator

|  | Candidate Name <br> Candre Number |  |  |  | Candidate <br> Number |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  |  |  |  |  |  |  |  |  |

TIME 1 hour 30 minutes

## INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer all the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.


## INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the Data Sheet for Chemistry.
- You are advised to show all the steps in any calculations.

| FOR EXAMINER'S USE |  |  |
| :---: | :---: | :---: |
| Qu. | Max. | Mark |
| 1 | 12 |  |
| 2 | 12 |  |
| 3 | 12 |  |
| 4 | 8 |  |
| 5 | 12 |  |
| 6 | 10 |  |
| 7 | 9 |  |
| 8 | 10 |  |
| 9 | 5 |  |
| TOTAL | 90 |  |

## Answer all the questions.

1 (a) (i) Name the compound $\mathrm{CH}_{3} \mathrm{CHO}$.
$\qquad$
(ii) Name the functional group of $\mathrm{CH}_{3} \mathrm{CHO}$.
$\qquad$
(iii) Draw structural formulae for the organic products of the reactions below.

(b) (i) Describe what is meant by nucleophilic addition. Use the mechanism of the reaction of $\mathrm{CH}_{3} \mathrm{CHO}$ with HCN in the presence of KCN in your answer.
$\qquad$
$\qquad$
$\qquad$
(ii) Explain why this reaction is not normally carried out in a school or college laboratory.
$\qquad$
$\qquad$
(iii) Will the product consist of optical isomers or not? Explain your answer.
$\qquad$
$\qquad$
$\qquad$
$\qquad$

2 Compound $A, \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{CH}\left(\mathrm{CH}_{3}\right)_{2}$, can be made by heating benzene with 2-chloropropane in the presence of a catalyst.
(a) (i) Draw the structural formula of 2-chloropropane.
(ii) Write the equation for the synthesis of $\mathbf{A}$.
$\qquad$
(iii) Suggest the type of catalyst required.
$\qquad$
(b) The n.m.r. spectrum of $A, \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{CH}\left(\mathrm{CH}_{3}\right)_{2}$, is shown below.

(i) Suggest the identity of the protons responsible for the groups of peaks $\mathbf{X}, \mathbf{Y}$, and $\mathbf{Z}$. For each group of peaks, explain your reasoning in terms of the chemical shift value.

X
$\qquad$
Y
$\qquad$
Z
$\qquad$
(ii) Explain why peak $\mathbf{X}$ is split into a doublet.
$\qquad$
$\qquad$
$\qquad$
(iii) Suggest a reason why peak $\mathbf{Y}$ is split into many lines.
$\qquad$
$\qquad$
$\qquad$

3 Analysis of some samples of soy sauce recently showed the presence of the potentially harmful chemical 3-chloropropane-1,2-diol. This could be formed from soya oil during the hydrolysis of soya.
(a) (i) Draw a displayed formula for 3-chloropropane-1,2-diol.
(ii) Does your displayed formula contain a chiral centre? Explain your answer.
$\qquad$
$\qquad$
(b) In this question, one mark is available for the quality of written communication.

Explain how two spectroscopic techniques could be used to confirm the presence of an OH group in an organic compound such as 3-chloropropane-1,2-diol or ethanol.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(c) Soya is a useful source of protein for vegetarians. Soya protein can be hydrolysed in the laboratory.
(i) State the reagent used.
$\qquad$
(ii) Draw a displayed formula for the functional group which is hydrolysed in the protein.
(iii) State the class of organic compounds produced by hydrolysis of proteins.
$\qquad$
[Total: 12]

4 In aqueous solution, some organic compounds are bases and some are acids; others are neither.
(a) Identify an organic compound that acts as an acid in water, and give an equation to show this behaviour.
name or formula
equation
(b) Phenylamine, $\mathrm{C}_{6} \mathrm{H}_{5} \mathrm{NH}_{2}$, acts as a base in water.
(i) Give an equation to show this behaviour.
$\qquad$
(ii) Explain why phenylamine is a weaker base than ethylamine, $\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{NH}_{2}$.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(c) Identify an organic compound which can act both as an acid and as a base. Explain your answer.
name or formula $\qquad$ explanation $\qquad$
$\qquad$
$\qquad$
$\qquad$

5 Benzene and phenylethene are aromatic hydrocarbons. Phenylethene also has an alkene group in its side chain, and shows reactions typical of both arenes and alkenes.
(a) In this question, one mark is available for the quality of written communication.

Describe the bonding in benzene. Include in your answer the model used for the arrangement of electrons.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(b) Phenylethene, $\mathrm{C}_{6} \mathrm{H}_{5} \mathrm{CH}=\mathrm{CH}_{2}$, reacts readily with bromine in an inert solvent. Benzene reacts with bromine only in the presence of a catalyst.
(i) Draw the structural formula of the organic product obtained when phenylethene reacts with bromine in an inert solvent.
(ii) Explain why benzene reacts less readily than phenylethene with bromine.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(c) State one major use for phenylethene.
$\qquad$

## 6 Compound $B$ is a secondary iodoalkane, $\mathrm{C}_{4} \mathrm{H}_{9} \mathrm{I}$.

(a) Deduce the mass:charge ratio $(\mathrm{m} / \mathrm{e})$ of the molecular ion in the mass spectrum of $\mathbf{B}$.
$\qquad$
(b) When $\mathrm{B}, \mathrm{C}_{4} \mathrm{H}_{9} \mathrm{I}$, is reacted with hot ethanolic sodium hydroxide, HI is eliminated and three isomeric alkenes $\mathbf{C}, \mathbf{D}$ and $\mathbf{E}$ are formed. C, D and $\mathbf{E}$ form the same compound, $\mathbf{F}$, when reacted with hydrogen in the presence of a palladium catalyst.
(i) Suggest structural formulae for B, C, D, E and F. Give your reasoning.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(ii) Classify the type of reaction in which $\mathbf{C}, \mathbf{D}$ or $\mathbf{E}$ is converted into $\mathbf{F}$ using hydrogen and a palladium catalyst.
$\qquad$

7 Diazonium salts are important reactive intermediates. They are made from aromatic amines, which themselves are usually made from aromatic nitro-compounds.
(a) (i) State the reagents required for the preparation of phenylamine from nitrobenzene.
$\qquad$
(ii) A student obtained 6.80 g phenylamine starting from 10.0 g nitrobenzene. Calculate the percentage yield of phenylamine. Give your answer to three significant figures.
answer
(b) State the reagents and conditions needed to make a diazonium salt from phenylamine. reagents
$\qquad$
$\qquad$ conditions
$\qquad$
[Total: 9]

8 There are two major types of polymerisation: addition polymerisation and condensation polymerisation.
(a) (i) Propene undergoes addition polymerisation.

Give a balanced equation for this polymerisation, using structural formulae.
(ii) Explain the differences between addition polymerisation and condensation polymerisation.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(b) Polymer $\mathbf{G}$ is also formed by addition polymerisation.

## a section of polymer G



Deduce the structure of a monomer from which $\mathbf{G}$ could be made.
(c) The monomer shown below can form a condensation polymer, $\mathbf{H}$.

(i) Suggest a structure for the polymer, showing two repeat units.
(ii) Concentrated aqueous NaOH solution can be transported in containers made of poly(propene) but not in containers made of polymer $\mathbf{H}$. Suggest reasons for this difference.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
$\qquad$
[Total: 10]

9 From the information given, draw the structural formula for each organic compound.
(a) This compound is made by reaction of benzene with concentrated nitric acid in the presence of concentrated sulphuric acid.

(b) These two compounds react together in the presence of concentrated sulphuric acid to make methyl ethanoate, $\mathrm{CH}_{3} \mathrm{COOCH}_{3}$.

(c) These two different compounds can be made by reaction of $\mathrm{C}_{6} \mathrm{H}_{5} \mathrm{CH}\left(\mathrm{NH}_{2}\right) \mathrm{COOH}$ with $\mathrm{CH}_{3} \mathrm{CH}\left(\mathrm{NH}_{2}\right) \mathrm{COOH}$.
$\square$


## Acknowledgement.

SDBS Web: http//www.aist.go.jp/RIODB/SDBS/21.06.02
OCR has made every effort to trace the copyright holders of items used in this Question paper, but if we have inadvertently overlooked any, we apologise.

