Write-on

Chemistry A
Unit H432

Practice Paper 2C

Name	

Time allowed
2 hours 15 minutes

Information
- The total marks available for this paper is 100. The number of marks available for each question is shown in brackets.
- Answer all questions and show all working

You will need:
An OCR A Chemistry data sheet

You may use:
- A scientific or graphical calculator
- A pencil for graphs and drawings
- A ruler

Question	Mark
MCQs	
16	
17	
18	
19	
20	
21	
Total	

Paper 2C

SECTION A

You should aim to finish this section within 20 minutes.

1 A compound has the structural formula $CH_3CH_2CH_2CCCH_3$. Which of these is a molecular formula of a compound in the same homologous series?

A C_3H_5

B CH

C C_2H_2

D $C_{17}H_{30}$

Your answer ☐

2 A student wanted to carry out NMR of organic compounds based on ^{31}P. Which of these is the most appropriate requirement for a suitable standard to use for ^{31}P NMR?

A Must not produce many peaks in ^{31}P NMR

B Must be gaseous

C Must produce a peak that is roughly in the middle of other common phosphorous containing compounds

D Must react with compounds containing phosphorous

Your answer ☐

3 Which of the following statements describes a σ bond?

A Attraction between electrons in s orbitals

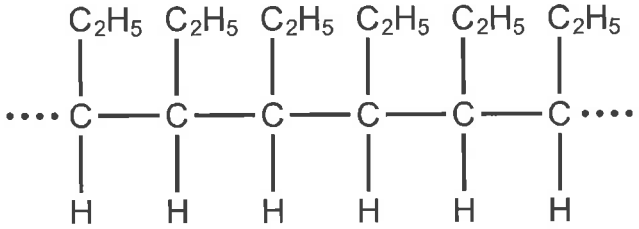
B Attraction between electrons in p orbitals

C Direct overlap of orbitals

D Sideways overlap of orbitals

Your answer ☐

4 A section of a polymer is shown. Name the monomer used to create it.



A But-2-ene

B But-1-ene

C Propene

D Hex-3-ene

Your answer ☐

5 A sample of methanol reacted with methanoic acid that had been labelled with ^{13}C in the presence of a concentrated sulfuric acid catalyst. Calculate the relative formula mass of the organic product.

A 62

B 61

C 60

D 59

Your answer ☐

6 3-methylpentan-3-ol was mixed with acidified potassium dichromate and warmed. The product was isolated and tested with 2,4-DNP. Identify the expected observation.

A Yellow precipitate dissolves

B Yellow precipitate forms

C Yellow precipitate remains unchanged

D No yellow precipitate

Your answer ☐

7 Sodium hydroxide was poured into an empty measuring cylinder with 0.05 cm^3 divisions. A student read a value of 2.00 cm^3 for the volume of sodium hydroxide in the measuring cylinder. Which of these gives the correct recording of the absolute uncertainty?

A 2.00 ± 0.025

B 2.00 ± 0.03

C 2.00 ± 0.05

D 2.00 ± 0.1

Your answer ☐

8 Which of the following is not a reason for why the problems caused by CFCs have taken a long time to resolve?

A It can take a long time for CFCs to reach the atmosphere.

B Old devices using CFCs are still in use.

C International cooperation is hard to enforce.

D CFCs remain very reactive for a long time.

Your answer ☐

9 Which of the following explains why NO emissions can be monitored from car exhausts using IR?

A NO has distinctive reactions.

B NO is very stable.

C The bond in NO vibrates at a characteristic frequency.

D NO is a radical.

Your answer ☐

10 When propanone is reacted with $NaBH_4$ part of the mechanism can be represented by:

$$C_3H_6O + H^- \rightarrow C_3H_7O^-$$

To form propan-2-ol, the product of this first step needs to be protonated. Where does the proton come from?

A $NaBH_4$

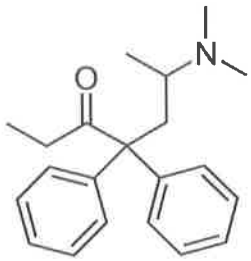
B Another C_3H_6O

C H_2O solvent

D HCl

Your answer ☐

11 The structure of the controversial narcotic and pain relief drug methadone is shown. How many chiral centres does it contain?



A 0

B 1

C 2

D 3

Your answer ☐

12 The molecule shown can be reacted with sodium hydroxide to form an alcohol. Calculate the atom economy of this reaction to the nearest whole number.

A 50 %

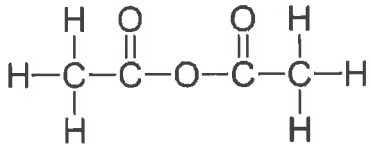
B 60 %

C 49 %

D 61 %

Your answer ☐

13 Which of these is true for the following molecule?



1. The dipoles in the molecule cancel out to make it non-polar overall.
2. It can react with propan-1-ol to make propyl ethanoate.
3. Its molecular and empirical formulae are the same.

A 1 and 3 only

B 2 and 3 only

C 1 and 3 only

D 1, 2 and 3

Your answer ☐

14 Which of these is true of molecules with the formula $C_5H_7Br_5$?

1. Some are unsaturated
2. Some are alicyclic
3. None of them will have peaks above $\delta = 120$ in their carbon NMR

A 3 only

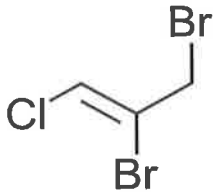
B 2 only

C 1 and 2 only

D 1 and 3 only

Your answer ☐

15 Which of the following is true of this molecule?



1. It can be made in one step from at least three different alcohols
2. It is a Z isomer
3. It is likely to be easy to separate from water using a separating funnel and a dichloromethane solvent

A 1 only

B 2 only

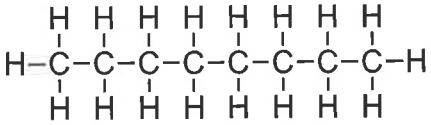
C 2 and 3 only

D 1, 2 and 3

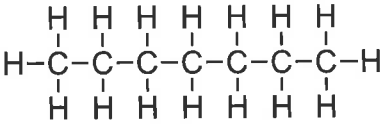
Your answer ☐

SECTION B

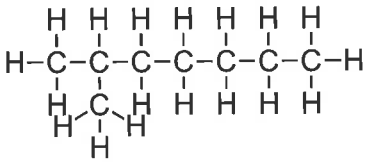
16 Octane, C_8H_{18}, is an alkane that is commonly used in fuels, along with heptane and 2-methylheptane.



Octane



Heptane



2-methylheptane

a) Octane and 2-methylheptane are structural isomers. Draw the structures of three more structural isomers of these compounds.

(2)

b) Explain why octane, heptane and 2-methylheptane above have a very low reactivity.

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(2)

c) Explain the difference in boiling point between octane and the other two compounds.

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(4)

d) i) What volume of oxygen, in dm^3, is required to combust 3.00 kg of octane completely at RTP?

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(3)

ii) Write an equation for the incomplete combustion of octane, forming CO and another product.

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(1)

iii) Explain why carbon monoxide presents a risk to health.

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(2)

e)* Octane can also be made to react with chlorine in the presence of UV light to form 1-chlorooctane.

Name and outline the stages involved in the production of 1-chlorooctane, giving equations for stages, and explain why this is not a useful way to prepare 1-chlorooctane synthetically.

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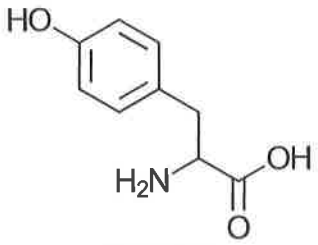
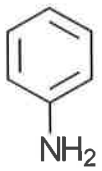
(6)

QUESTION TOTAL: 20 MARKS

17 Nitrogen compounds are found in various forms throughout nature, and include vital compounds such as ATP and DNA. Tyrosine is an example of an important amino acid, and aniline (aminobenzene) is an example of an important molecule used to make nitrogen-containing compounds.



Tyrosine



Aniline

a) i) Explain why tyrosine is described as an α-amino acid.

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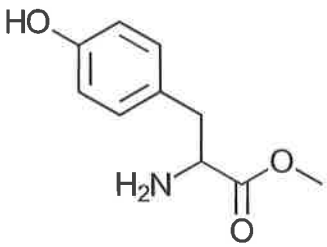
(1)

ii) Draw the structure of tyrosine at pH 1.

(1)

iii) Explain how tyrosine can be converted to the following molecule:



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(2)

iv) Tyrosine can be polymerised under certain reaction conditions to form a polyamide. Draw the repeat unit of this polymer and identify the side product of polymerisation.

(2)

b)* In order to be useful for synthesis, aniline must first be purified by removal of water and then redistilled.

Describe what these processes involve. You should include equipment and descriptions of practical procedures in your answer.

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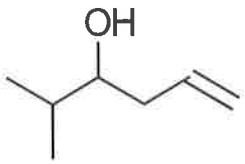
QUESTION TOTAL: 12 MARKS

18 Molecule A is an example of a bifunctional compound – a compound that contains two functional groups.



Molecule A

a) Draw the displayed formula of Molecule A.

(1)

b) Give the IUPAC name for Molecule A.

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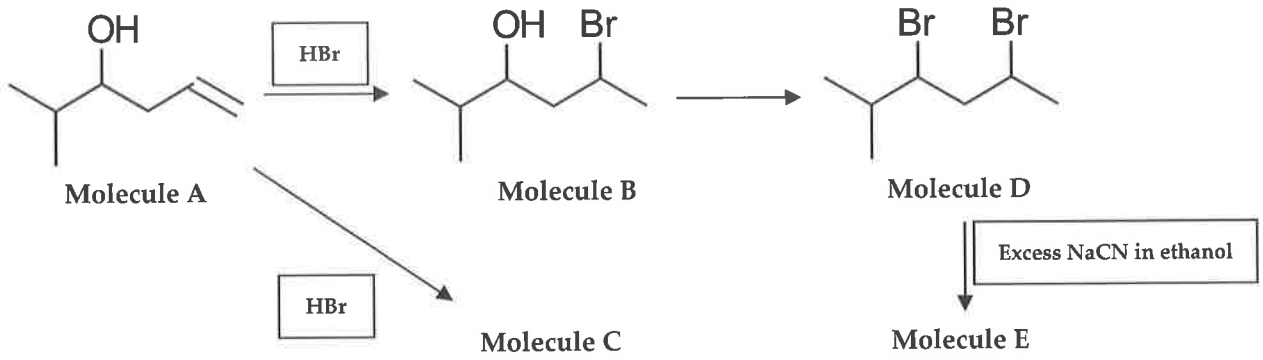
(1)

The following sequence represents some reactions of Molecule A.



c) i) Draw the mechanism for the formation of Molecule B from Molecule A, and name the type of mechanism involved.

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(4)

ii) This mechanism involves heterolytic fission. Define the term 'heterolytic fission'.

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(1)

iii) Molecule C forms at the same time as Molecule B via a competing reaction.

Draw Molecule C, and explain whether you would expect more of Molecule B or Molecule C to form.

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d) Identify the reagents required to convert Molecule B to Molecule D.

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(1)

e) Draw the structure of Molecule E, and name the mechanism involved in the reaction.

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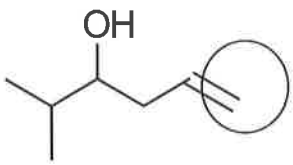
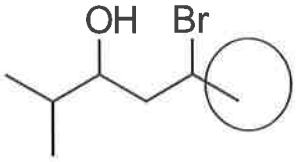
(2)

f) Different analytical techniques can be used to follow the progress of these reactions. For instance, the peak for the circled hydrogen environment in the ^1H NMR can be used to determine when Molecule A has formed Molecule B.

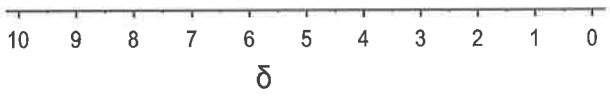




On the scales below, sketch the appearance of the peaks, and label the integration of the circled hydrogens in Molecule A and Molecule B.

Circled environment on Molecule A

Circled environment on Molecule B



(3)

g) The conversion of Molecule B to Molecule D can be followed by infrared spectroscopy. Explain how infrared spectroscopy will show when the reaction has finished.

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(1)

h) A student suggested $AgNO_{3(aq)}$ could be used to show when Molecule D had been converted to Molecule E.

State the observation that would be expected if the student did this, and explain why this method cannot be used to show when a sample of Molecule D has been converted to Molecule E.

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(3)

QUESTION TOTAL: 20 MARKS

19 Gas chromatography is an important technique for the analysis of small organic compounds, particularly those which are not suitable for thin layer chromatography.

a)* Explain why gas chromatography can be used to separate a mixture of two substances.

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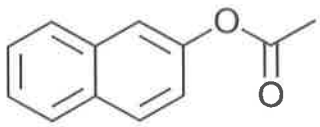
(2)

b) A chemist wanted to reuse some solvent that had previously been used in a reaction with 2-naphthyl ethanoate, but wanted to determine the concentration of any naphthyl ethanoate contaminant first. Describe how the concentration of 2-naphthyl ethanoate could be confirmed using gas chromatography.



2-naphthyl ethanoate

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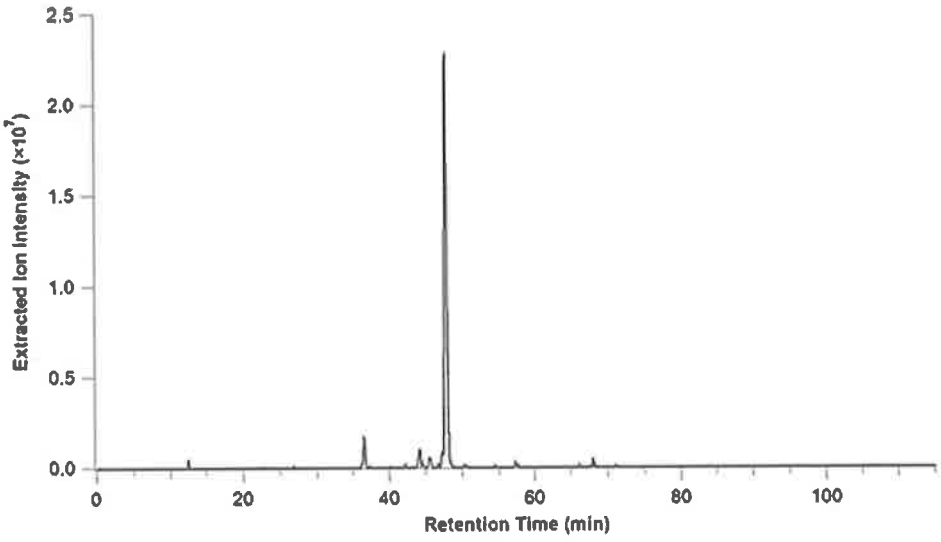
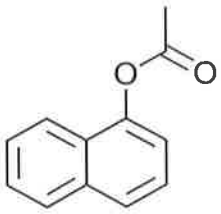
(3)

c) A chemist carried out a gas chromatogram of the solvent and obtained the following result. (The small peaks either side of the main peak may be considered as 'noise' and discounted.)



The chemist states that this result showed that 2-naphthyl ethanoate was the only contaminant, and that another contaminant, 1-naphthyl ethanoate, was absent. Explain whether the chemist is correct.



1-naphthyl ethanoate

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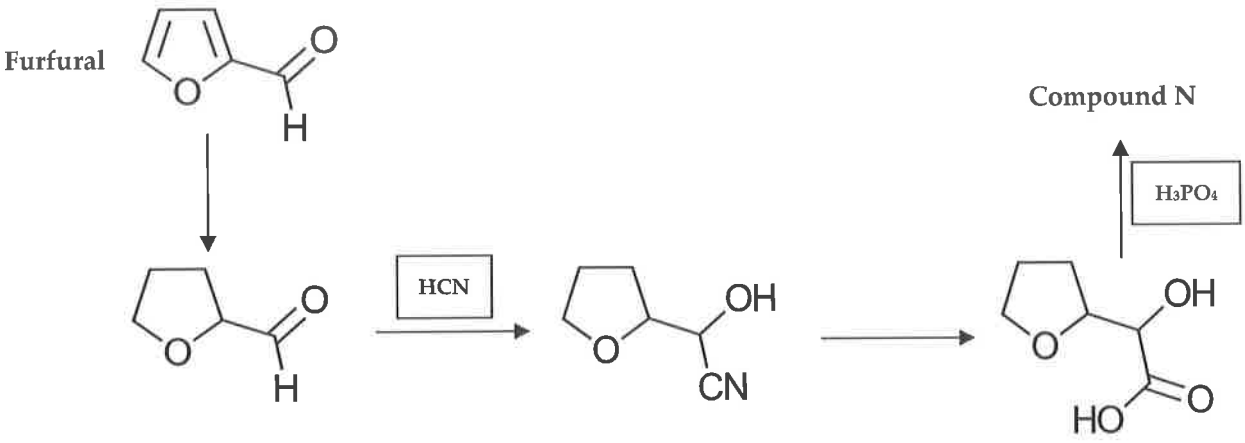
(1)

QUESTION TOTAL: 6 MARKS

20 Furfural is a compound found in oats, wheat and almonds. It is shown at the start of a series of reactions below.



a) i) Identify the reagents necessary to convert furfural to **K**.

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(1)

ii) Explain how mass spectrometry could be used to confirm that furfural had been converted to **K**.

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(1)

iii) Draw the species responsible for a peak at 29 in the mass spectrum of **K**.

(1)

iv) Tollens' reagent can be used to confirm that the aldehyde group is still present in **K**.

State how Tollens' reagent confirms the presence of an aldehyde, and give equations for the redox processes occurring. (You may represent **K** as RCHO.)

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(3)

b) The mechanism for the conversion of **K** to **L** involves the CN^- ion.

i) Draw a dot and cross diagram for CN^- showing outer electrons only.

(1)

ii) Draw the mechanism for the conversion of **K** to **L**.

(2)

iii) Assuming that Tollens' reagent gives a negative reaction with the product, how could the presence of the alcohol group in the product be confirmed?

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(2)

c) A student chose to confirm the presence of the acid group in **M** by a series of tests.

Test 1: The student added sodium carbonate solution and recorded any observations.

Test 2: The student added M to 100.0 cm^3 of 0.0500 mol dm^{-3} $NH_{3(aq)}$ in the presence of universal indicator.

i) Give an equation for the reaction occurring in Test 1, using RCOOH to represent **M**, and state the expected observation.

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(2)

ii) State the mass of **M** that should be required to turn the universal indicator green in Test 2.

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(2)

d) Two possible isomers of **N** can form. Draw these isomers, and name a reagent that can be used to confirm that **N** has been formed.

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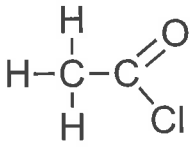
(3)

QUESTION TOTAL: 18 MARKS

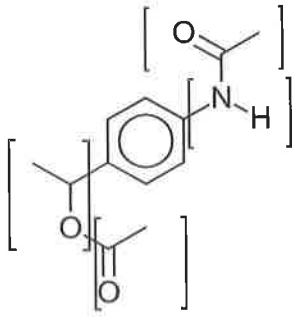
21 Ethanoyl chloride is a useful reagent for creating many different functional groups. For the purposes of this question, you may assume that ethanoyl chloride undergoes the same sort of reactions as ethanoic acid, but more easily.



Ethanoyl chloride

A student wanted to make compound Q. She noted that aside from the benzene ring, there were four key parts of the molecule, which she put in brackets. She determined that compound Q could be prepared from benzene by using the following steps, but in a different order.

- Two different reduction steps
- A Friedel–Crafts reaction
- A condensation reaction with ethanoyl chloride (indicated), followed by the addition of a mild base to neutralise any leftover acid
- An electrophilic substitution step



Compound Q, with key parts in brackets

Complete the boxes for the reaction conditions and intermediate structures below to suggest how the multifunctional compound shown can be prepared from benzene in five steps. You may use only the reagents in the box, which the chemist had access to. Each reagent may be used once, more than once, or not at all. Excess space is given below in case you make a mistake.

Available reagents: Conc HCl; Conc H_2SO_4; Conc HNO_3; NH_3; Ag; Fe; Sn; $NaBH_4$; $K_2Cr_2O_7$; ethanoyl chloride

Reagents: Fe; ethanoyl chloride

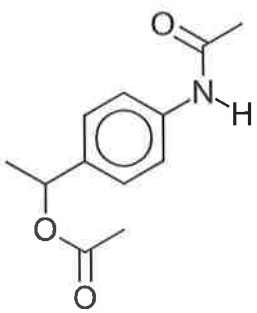
Intermediate 1

Reagents:

Intermediate 2

Reagents:

Compound Q



Reagents:
i) Excess CH_3COCl
ii) dil alkali

Condensation using ethanoyl chloride, followed by neutralisation of product

Intermediate 4

Reagents:

Intermediate 3

[9]

QUESTION TOTAL: 9 MARKS