OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

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Candidate signature _____

INTERNATIONAL A-LEVEL

CHEMISTRY (9620)

Unit 4: Organic 2 and Physical 2

Tuesday 12 June 2018 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

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

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0 1 This question is about three isomers of C_4H_8O

A	B	C
$CH_3CH_2COCH_3$	$CH_3CH_2CH_2CHO$	$CH_3CH{=}CHCH_2OH$

0 1 . 1 Give the IUPAC name for isomer **B** and for isomer **C**.

[2 marks]

B _____

C _____

0 1 . 2 Isomers **A** and **B** both react with KCN followed by dilute acid.

Name the mechanism for this reaction.

Draw the two enantiomers formed by isomer **A** in this reaction and show how the two enantiomers are related to each other.

[3 marks]

Mechanism _____

Enantiomer 1 Enantiomer 2

Do not write outside the box

0 1 . 3 Describe a test-tube reaction to distinguish isomer **C** from isomer **A**.

State the observations.

[2 marks]

Test _____

_____

Observation(s) with isomer **A** _____

_____

Observation(s) with isomer **C** _____

_____

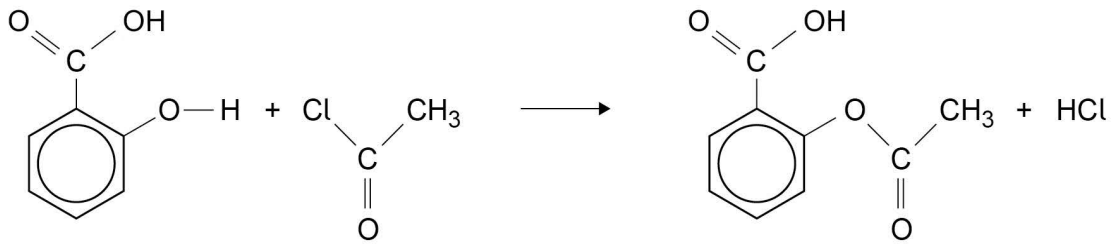
7

Turn over for the next question

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0 2 Aspirin can be produced by the acylation of 2-hydroxybenzoic acid (salicylic acid), as shown in **Figure 1**. In this reaction, ethanoyl chloride is a powerful acylating agent.

Figure 1



0 2 . 1 In the industrial manufacture of aspirin, ethanoic anhydride is used instead of ethanoyl chloride as the acylating agent.

Give **two** reasons why ethanoic anhydride is used instead of ethanoyl chloride.

[2 marks]

Reason 1 _____

_____

Reason 2 _____

_____

0 2 . 2 In the laboratory, the aspirin produced is impure. It is purified by recrystallisation using water as the solvent.

Complete the steps carried out in a recrystallisation practical.

[3 marks]

Step 1 _____

Step 2 Filter whilst hot

Step 3 _____

Step 4 Vacuum filter

Step 5 _____

Step 6 Dry in a desiccator

Do not write outside the box

0 2 . 3 Outline how you could confirm that a sample of aspirin is pure.

[2 marks]

0 2 . 4 Ethanoyl chloride reacts with amines to produce amides.

Name and outline the mechanism for the reaction between ethanoyl chloride and methylamine.

[5 marks]

Name of mechanism _____

Question 2 continues on the next page

Do not write outside the box

Amines can be prepared from different compounds.

0 2 . 5 Propylamine ($CH_3CH_2CH_2NH_2$) can be prepared in two different **one-step** reactions.

For each reaction, identify:

- the organic starting material, and
- the reagent and condition(s).

[4 marks]

Reaction 1

Organic starting material _____

Reagent and condition(s) _____

_____

Reaction 2

Organic starting material _____

Reagent and condition(s) _____

_____

16

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0 3 Gas chromatography (GC) was used to separate a mixture of five compounds, **D**, **E**, **F**, **G** and **H**.

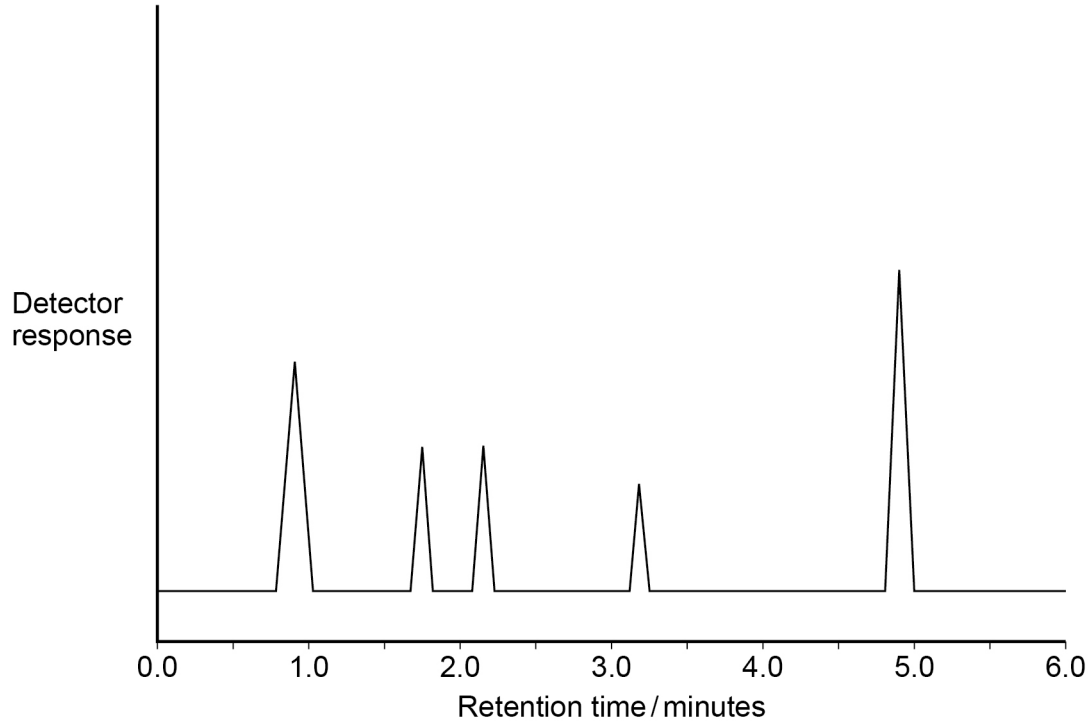
Table 1 shows the names and formulae of these compounds.

Table 1

Compound	Name	Formula
D	1-bromopentane	$CH_3CH_2CH_2CH_2CH_2Br$
E	trichloroethanoic acid	Cl_3CCOOH
F	hexane	$CH_3CH_2CH_2CH_2CH_2CH_3$
G	methoxybutane	$CH_3OCH_2CH_2CH_2CH_3$
H	methylbenzene	$C_6H_5CH_3$

Figure 2 shows the output from the detector in this separation.

Figure 2



0 3 . 1 State the meaning of the term retention time.

[1 mark]

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0 3 . 2 Two of the compounds are present in the mixture in equal amounts.

Explain how **Figure 2** shows this.

[1 mark]

0 3 . 3 Give a reason why nitrogen is used rather than oxygen as the carrier gas.

[1 mark]

0 3 . 4 Polyethane-1,2-diol (PEG) is a liquid and is part of the stationary phase.

Identify what else is needed to complete the stationary phase.

Tick (✓) **one** box.

[1 mark]

Aluminium oxide ☐

Argon ☐

Carbon dioxide ☐

Epoxyethane ☐

0 3 . 5 Polyethane-1,2-diol (PEG) can be represented as

$$H - [O - CH_2 - CH_2]_n - O - H$$

Explain why PEG is polar.

[2 marks]

Do not write outside the box

0 3 . 6 Deduce the compound in the mixture with retention time 4.9 minutes.

Give a reason for your choice.

[2 marks]

Compound _____

Reason _____

_____

_____

_____

_____

0 3 . 7 Some modifications to the GC apparatus were considered to improve the separation of the same mixture of components.

Predict the effect, if any, of each modification on the retention times of the components.

[3 marks]

Increasing the column temperature _____

_____

Decreasing the column length _____

_____

Decreasing the carrier gas flow rate _____

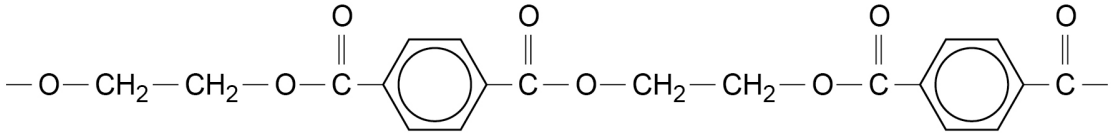
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11

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0 4 Clothes are often made from polyesters such as Terylene.

Two repeating units of the polymer Terylene are shown.



0 4 . 1 Draw the skeletal formulas of the two monomers that react to form Terylene.

[2 marks]

Monomer 1 Monomer 2

0 4 . 2 Explain why Terylene is biodegradable but polychloroethene is not.

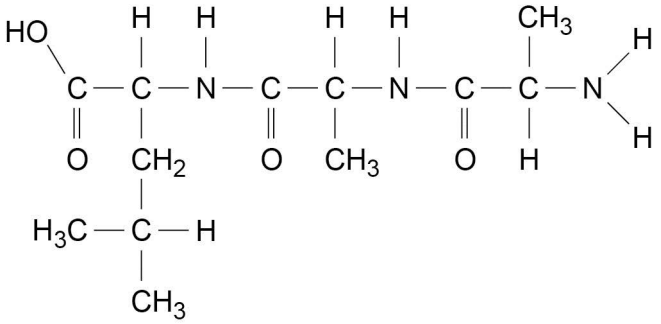
[3 marks]

Question 4 continues on the next page

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Proteins are chains of amino acids linked together.

The structure of a tripeptide is



0 4 . 3 Draw a circle around one peptide link on the diagram.

[1 mark]

0 4 . 4 Draw the displayed formula of the zwitterion formed by the amino acid which makes up the central section of the tripeptide in Question **04.3**.

[1 mark]

0 4 . 5 Name the type of structure where protein chains form α-helixes and β-pleated sheets.

[1 mark]

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0 4 . 6 Name the interactions that hold protein chains in a β-pleated sheet.

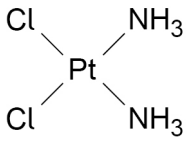
Explain how these interactions are formed.

[3 marks]

Question 4 continues on the next page

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Cisplatin is used as an anticancer drug.



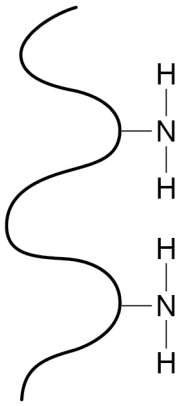
0 4 . 7 Cisplatin bonds with DNA by ligand replacement.

Figure 3 shows part of a DNA strand.

Complete **Figure 3** to show the complex formed when one molecule of cisplatin binds with the part of DNA shown.

[1 mark]

Figure 3



0 4 . 8 State how cisplatin affects cancer cells.

[2 marks]

14

Turn over for the next question

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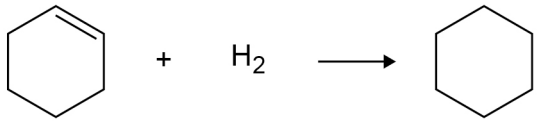
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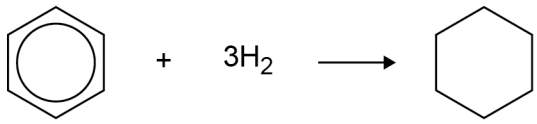
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0 5 . 1 The molecule cyclohexa-1,3,5-triene does not exist and is described as theoretical.

State and explain the stability of benzene compared with the theoretical cyclohexa-1,3,5-triene.

Use the following data.

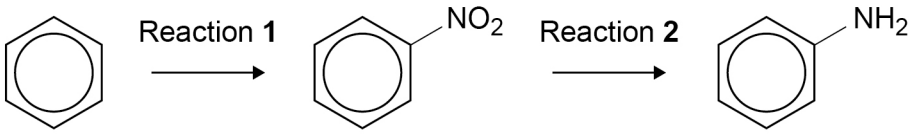




[4 marks]

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Benzene can be converted into phenylamine by a two-step synthesis as shown.



0 5 . 2 The mechanism of Reaction **1** involves attack by an electrophile.

Give the reagents used to produce the electrophile needed in Reaction **1**.

[2 marks]

The percentage yield of the two-step synthesis where benzene is converted into phenylamine was found to be 68%.

0 5 . 3 State the **two** measurements that need to be recorded to calculate the percentage yield.

[2 marks]

Measurement 1

Measurement 2

0 5 . 4 Explain why phenylamine is a weaker base than hexylamine.

[2 marks]

Turn over for the next question

10

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0 6 This question is about carboxylic acids and alkalis.

0 6 . 1 Carboxylic acids are **weak** acids.

State what is meant by weak in this statement.

[1 mark]

0 6 . 2 Barium hydroxide, $Ba(OH)_2$, is a strong alkali.

Calculate the pH of a 0.0120 mol dm^{-3} solution of barium hydroxide at 298K

Give your answer to two decimal places.

The ionic product of water, $K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6} at 298K

[3 marks]

pH _____

0 6 . 3 The value of the acid dissociation constant (K_a) for benzenecarboxylic (benzoic) acid (C_6H_5COOH) is 6.31×10^{-5} mol dm^{-3}

Calculate the pH of a 0.0120 mol dm^{-3} solution of this acid.
Give your answer to two decimal places.

[3 marks]

pH _____

0 6 . 4 1.09 g of sodium benzenecarboxylate (C_6H_5COONa) is added to 200 cm^3 of a 2.4×10^{-3} mol dm^{-3} solution of benzenecarboxylic acid.

Calculate the pH of the buffer solution produced.

M_r (C_6H_5COONa) = 144.0

[5 marks]

Do not write outside the box

pH _____

12

Turn over for the next question

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0 7 The isomers of $C_6H_{12}O_2$ can be distinguished using NMR spectroscopy.

0 7 . 1 Tetramethylsilane (TMS) is used as a standard in recording both ^1H and ^{13}C NMR spectra. TMS is non-toxic and inert.

Give **two other** reasons why TMS is used as a standard in recording NMR spectra.
[2 marks]

Reason 1 _____

_____

_____

Reason 2 _____

_____

_____

Compound **X** is an isomer of $C_6H_{12}O_2$

Figure 4 shows the ^1H NMR spectrum for compound **X**.

Figure 4

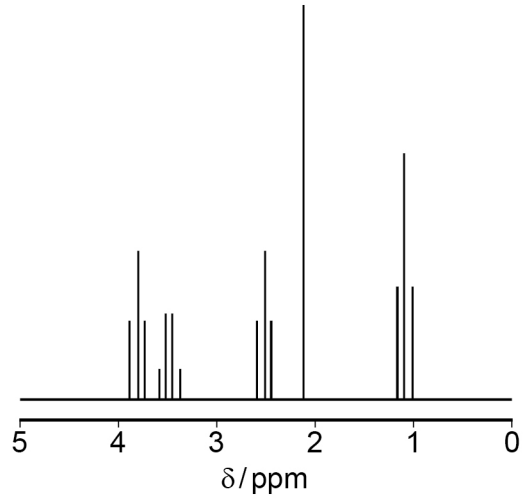


Table 2 shows information about the five peaks shown in **Figure 4**.

Table 2

δ / ppm	3.8	3.5	2.6	2.2	1.2
Integration ratio	2	2	2	3	3

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Use **Table B** in the Data Sheet, **Figure 4** and **Table 2** to answer Questions **07.2**, **07.3** and **07.4**.

0 7 . 2 Deduce the part of the structure responsible for the peak at δ = 2.2 ppm

[1 mark]

0 7 . 3 Deduce the part of the structure responsible for the peaks at δ = 3.5 ppm and δ = 1.2 ppm

[1 mark]

0 7 . 4 Deduce the part of the structure responsible for the peaks at δ = 3.8 ppm and δ = 2.6 ppm

[1 mark]

0 7 . 5 Draw the structure of the isomer of $C_6H_{12}O_2$ that would produce the ^1H NMR spectrum shown in **Figure 4**.

[1 mark]

Turn over ►

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Questions **07.6**, **07.7** and **07.8** are about different isomers of $C_6H_{12}O_2$

0 7 . 6 Two isomers of $C_6H_{12}O_2$ are both esters.

Each isomer has only two peaks in their ^1H NMR spectrum. The integration ratio for both esters is 3:1

Draw the two esters.

[2 marks]

Ester 1 Ester 2

0 7 . 7 Another isomer of $C_6H_{12}O_2$ is a carboxylic acid with a chiral centre. This isomer has five peaks in its ^{13}C NMR spectrum.

Draw the structure of this isomer.

[1 mark]

0 7 . 8 Another isomer of $C_6H_{12}O_2$ is a cyclic compound.

This isomer has only two peaks in its ^{13}C NMR spectrum. The infrared spectrum of this isomer does not show an absorption in the region 1680–1750 cm^{-1}

Draw the structure of this isomer. Use **Table A** in the data sheet.

[1 mark]

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10

END OF QUESTIONS

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