AQA A-LEVEL CHEMISTRY · 7405

CHEMISTRY



EXAM QUESTION PACK

3.3.6 ORGANIC ANALYSIS

SCORE	PERCENTAGE
/267	%

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Q1.

Four compounds, all colourless liquids, are

- butan-2-ol
- butanal
- butanone
- 2-methylpropan-2-ol

Two of these compounds can be identified using different test-tube reactions.

Describe these **two** test-tube reactions by giving reagents and observations in each case. Suggest how the results of a spectroscopic technique could be used to distinguish between the **other** two compounds.

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(Total 6 marks)

Q2.

The oxidation of propan-1-ol can form propanal and propanoic acid.
The boiling points of these compounds are shown in the table.

Compound	Boiling point / °C
propan-1-ol	97
propanal	49
propanoic acid	141

In a preparation of propanal, propan-1-ol is added dropwise to the oxidising agent and the aldehyde is separated from the reaction mixture by distillation.

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(a) Explain, with reference to intermolecular forces, why distillation allows propanal to be separated from the other organic compounds in this reaction mixture.

(3)

(b) Give **two** ways of maximising the yield of propanal obtained by distillation of the reaction mixture.

1.

2.

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(2)

(c) Describe how you would carry out a simple test-tube reaction to confirm that the sample of propanal obtained by distillation does **not** contain any propanoic acid.

_____

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(2)

(d) A student carried out an experiment to determine the enthalpy of combustion of ethanol.
Combustion of 457 mg of ethanol increased the temperature of 150 g of water from 25.1 °C to 40.2 °C

Calculate a value, in kJ mol^{-1}, for the enthalpy of combustion of ethanol in this experiment.
Give your answer to the appropriate number of significant figures.

(The specific heat capacity of water is 4.18 J K^{-1} g^{-1})

Enthalpy of combustion _____ kJ mol^{-1}

(3)

(e) A mixture of isomeric alkenes is produced when pentan-2-ol is dehydrated in the presence of hot concentrated sulfuric acid. Pent-1-ene is one of the isomers produced.

Name and outline a mechanism for the reaction producing pent-1-ene.

Name of mechanism _____

Mechanism

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(4)

(f) A pair of stereoisomers is also formed in the reaction in **part (e)**.

Name the less polar stereoisomer formed.
Explain how this type of stereoisomerism arises.

Name _____

Explanation _____

_____

_____

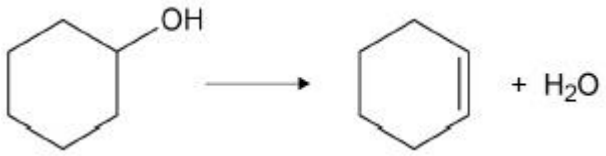
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(2)

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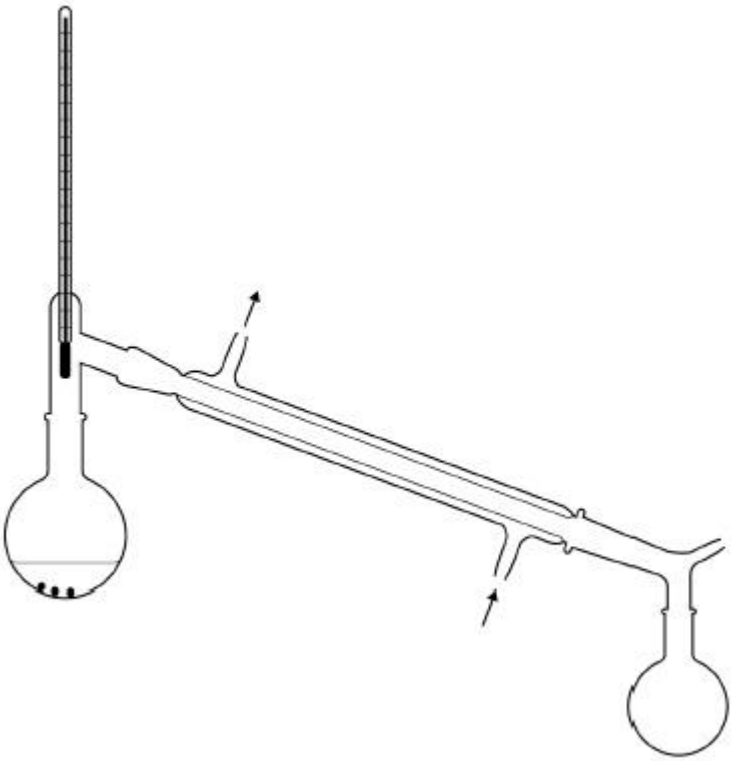
Q3.

Cyclohexene (boiling point = 83 °C) can be prepared by the dehydration of cyclohexanol (boiling point = 161 °C) using concentrated phosphoric acid.



A student prepared cyclohexene by placing 10 cm^3 of cyclohexanol (density = 0.96 g cm^{-3}) into a round-bottomed flask.
3 cm^3 of concentrated phosphoric acid were then carefully added to the flask.
The student added a few anti-bumping granules and set up the apparatus shown in the diagram.

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- The student heated the mixture and collected the liquid that distilled at temperatures below 100 °C
- The distillate was poured into a separating funnel and washed by shaking with sodium carbonate solution.
- Periodically, the separating funnel was inverted and the tap opened.
- The aqueous layer was discarded and the final organic product was dried using anhydrous calcium chloride.
- After the product was dried, the drying agent was removed by filtration under reduced pressure.

(a) The student collected 5.97 g of cyclohexene in the experiment.

Calculate the percentage yield of cyclohexene.

Percentage yield _____ %

(3)

(b) Describe a test-tube reaction, on the product, to show that the cyclohexanol had been dehydrated.

State what you would observe. _____

_____

_____

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_____

(2)

(c) Suggest why sodium carbonate solution was used to wash the distillate.

_____

_____

_____

(1)

(d) Explain why it is important to open the tap of the separating funnel periodically.

_____

_____

_____

(1)

(e) Give a property of anhydrous calcium chloride, other than its ability to absorb water, that makes it suitable as a drying agent in this preparation.

_____

_____

_____

(1)

(f) Describe the apparatus used to remove the drying agent by filtration under reduced pressure. Your description of the apparatus can be either a labelled diagram or a description in words.

(2)

(g) A sample of cyclohexene has been contaminated with cyclohexanol. The cyclohexene can be separated from the cyclohexanol by column chromatography. Silica gel is used as the stationary phase and hexane as the mobile phase.

Explain why cyclohexene has a shorter retention time than cyclohexanol.

_____

_____

_____

_____

_____

_____

(2)

(h) Explain how an infrared spectrum would confirm that the cyclohexene obtained from the chromatography column did not contain any cyclohexanol.

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_____

_____

_____

(1)

(Total 13 marks)

Q4.

Compounds **A**, **B** and **C** all have the molecular formula C_5H_{10}

A and **B** decolourise bromine water but **C** does not.

B exists as two stereoisomers but **A** does **not** show stereoisomerism.

Use this information to deduce a possible structure for each of compounds **A**, **B** and **C** and explain your deductions.

State the meaning of the term stereoisomers and explain how they arise in compound **B**.

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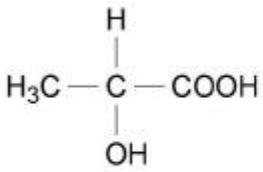
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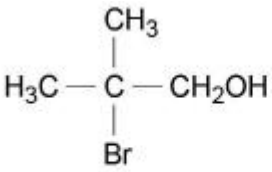
Q5.

Test-tube reactions can be used to identify the functional groups in organic molecules.

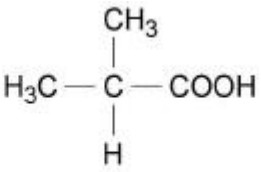
You are provided with samples of each of the four compounds.



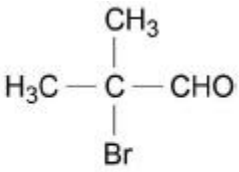
K



L



M



N

Describe how you could distinguish between all four compounds using the minimum number of tests on each compound.

You should describe what would be observed in each test.

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_____

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_____

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_____

(Total 6 marks)

Q6.

A student was given unlabelled samples of pentan-1-ol, pent-1-ene, pentanoic acid and pentanal.

(a) Name the reagent(s) that the student could use to identify the sample that was pent-1-ene.
Describe the observation(s) that the student would make to confirm this.

Reagent(s) _____

_____

Observation(s) _____

(2)

(b) Name the reagent(s) that the student could use to identify the sample that was pentanoic acid.

Describe the observation(s) that the student would make to confirm this.

Reagent(s) _____

_____

Observation(s) _____

(2)

(c) Name the reagent(s) that the student could use to identify the sample that was pentanal.

Describe the observation(s) that the student would make to confirm this.

Reagent(s) _____

_____

Observation(s) _____

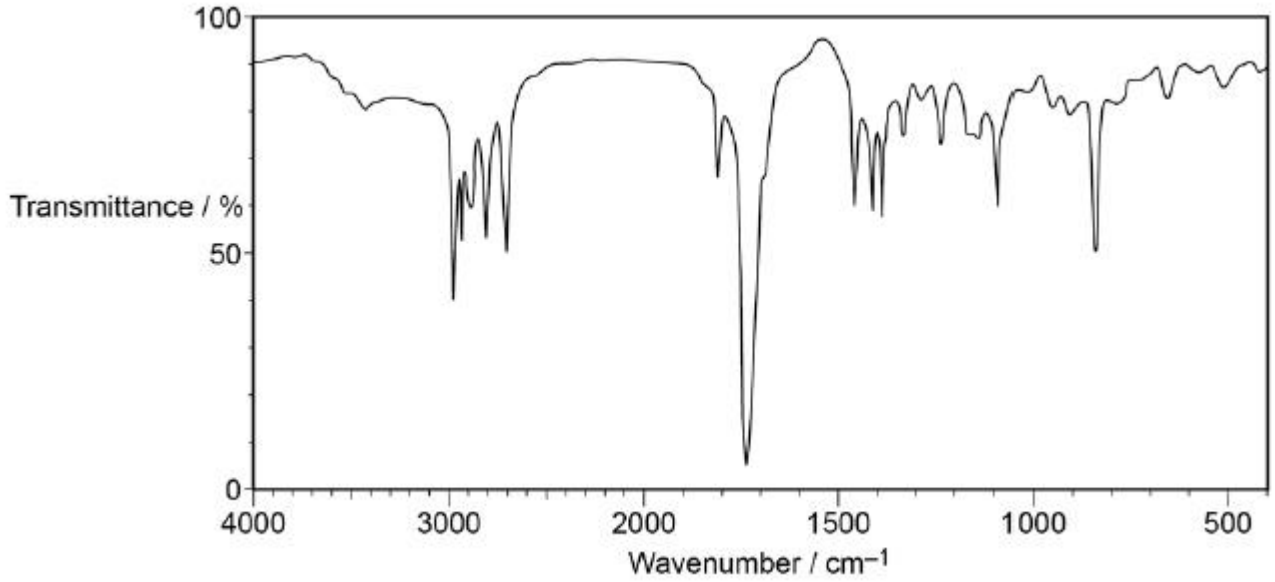
_____

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_____

(2)

(d) The student deduced that the spectrum in the image below was that of pentanal.



Justify this deduction and suggest why this spectrum **cannot** be that of pentan-1-ol, pentanoic acid or pent-1-ene.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

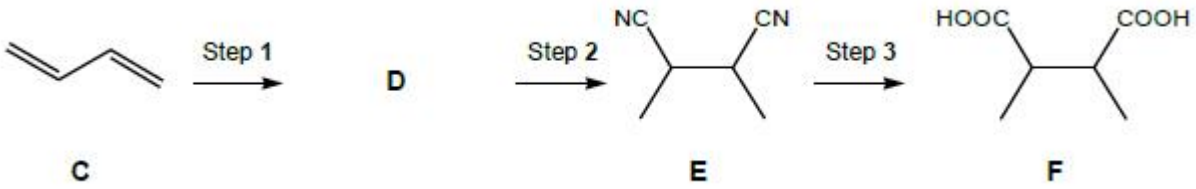
(Total 10 marks)

Q7.

Chemists design synthetic routes to convert one organic compound into another.

Buta-1,3-diene, **C**, is converted into compound **F** as shown in the diagram below.

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C E F

(a) State the IUPAC name of compound **F**.

_____

(1)

(b) Deduce the structure of compound **D**.

For each of the conversions in steps **1** and **2**, suggest a reagent for the conversion and name the mechanism.

Suggest the type of reaction occurring in step **3**.

Structure of **D**

Step **1** _____

_____

_____

_____

_____

Step **2** _____

_____

_____

_____

_____

Type of reaction in Step **3** _____

_____

(6)

(c) Compound **F** can also be made from compound **G**.



F G

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State a reagent (or combination of reagents) that can be used in a test-tube reaction to distinguish between F and G.

Describe what you would observe when the reagent is added to each compound and the test tube is shaken.

Reagent(s) _____

_____

Observation with **F** _____

_____

_____

Observation with **G** _____

_____

_____

(3)

(d) Compounds **F** and **G** react to form a polymer.

Draw the repeating unit of the polymer.

(2)

(e) In an experiment, 0.930 kg of purified **F** were obtained from 1.11 dm^3 of **G** (density 1.04 g cm^{-3}).

Calculate the percentage yield.

Give your answer to the appropriate number of significant figures.

Percentage yield _____ %

(4)

(f) One reason for a yield of less than 100% in part **(e)** is that **G** reacts to form a number of other compounds.

The other compounds are all liquids at room temperature.

Name the technique that should be used to separate and collect each of these other compounds from the reaction mixture.

Include in your answer a description of the apparatus.

Your description of the apparatus can be either a description in words or a labelled

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sketch.

Name of technique _____

Apparatus

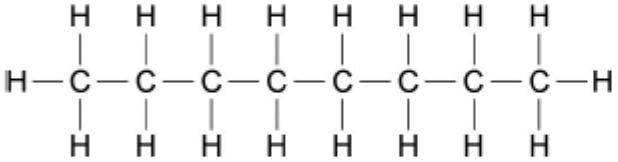
(4)
(Total 20 marks)

Q8.

Octane and isooctane are structural isomers with the molecular formula C_8H_{18}.
The displayed formulas and boiling points of octane and isooctane are shown in **Figure 1**.

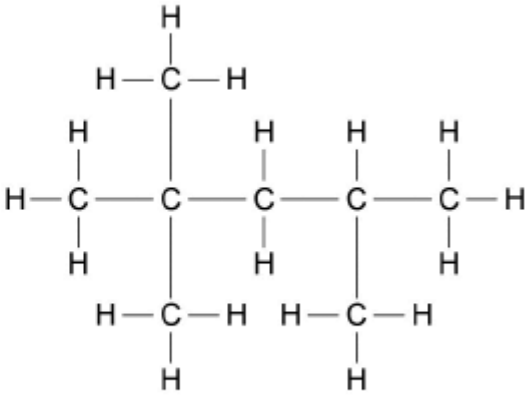
Figure 1

Octane



Boiling point: 125 °C

Isooctane



Boiling point: 99 °C

(a) Give the IUPAC name for isooctane.

_____

(1)

(b) Octane and isooctane can be separated in the laboratory.

Name a laboratory technique that could be used to separate isooctane from a mixture of octane and isooctane.

Outline how this technique separates isooctane from octane.

Name _____

Outline _____

_____

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_____

_____

_____

(3)

(c) Isooctane is added to petrol to increase its octane rating. Some high-performance engines require fuel with a higher octane rating.

Write an equation for the complete combustion of isooctane. Use the molecular formula (C_8H_{18}) of isooctane in your equation.

_____

(1)

(d) Explain, in general terms, how a catalyst works.

_____

_____

_____

(2)

(e) Carbon monoxide is produced when incomplete combustion takes place in engines. Nitrogen monoxide is another pollutant produced in car engines.

Write an equation to show how these pollutants react together in a catalytic converter.

_____

(1)

(f) Platinum, palladium and rhodium are metals used inside catalytic converters. A very thin layer of the metals is used on a honeycomb ceramic support.

Explain why a thin layer is used in this way.

_____

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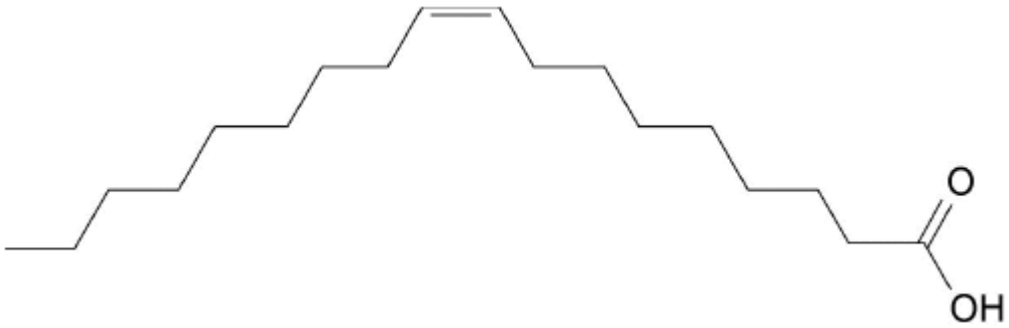
_____

(2)

(g) Oleic acid ($C_{18}H_{34}O_2$) is a straight-chain fatty acid obtained from plant oils. Isooctane can be made from oleic acid. The skeletal formula of oleic acid is shown in **Figure 2**.

Figure 2

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Identify a reagent that could be used in a chemical test to show that oleic acid is unsaturated.

State what would be observed in this test.

Reagent _____

Observation _____

_____

(2)

(Total 12 marks)

Q9.

Which of the following compounds would form an orange-red precipitate when heated with Fehling's solution?

A CH_3CH_2CN ⬭

B CH_3CH_2COOH ⬭

C CH_3CHO ⬭

D CH_3COCH_3 ⬭

(Total 1 mark)

Q10.

Compounds **A**, **B**, **C** and **D** are isomers with the molecular formula $C_4H_{10}O$
They all have a broad absorption in their infrared spectra in the range 3230–3550 cm^{-1}.

(a) Use **Table A on the data sheet** to identify the bond and the functional group present responsible for this absorption.

_____

(1)

(b) Compounds **A** and **B** are both straight-chain compounds.
A can be oxidised to form **P**.
B can be oxidised to form **Q**.
P and **Q** are isomers with molecular formula C_4H_8O

Tollens' reagent and Fehling's solution can be used to distinguish between isomers

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P and **Q**. The results shown in the table are obtained.

Compound	Observation with Tollens' reagent	Observation with Fehling's solution
P	No visible change	No visible change
Q	Silver mirror formed	Brick-red precipitate formed

Use the information about compounds **P** and **Q** to identify compounds **A** and **B**. Explain your answer with reference to the functional groups in **P** and **Q**.

Identity of **A** _____

Identity of **B** _____

Explanation _____

_____

_____

_____

(3)

(c) Isomer **C** is resistant to oxidation.
Isomer **C** reacts to form compound **R** that has an absorption in its infrared spectrum in the range 1620–1680 cm^{-1}.

State the bond that causes the absorption in the range 1620–1680 $^{-1}$.

Give the displayed formula of isomer **C**.

Identify the reagent and give **one** reaction condition needed to convert **C** into **R**.

Bond _____

Displayed formula of **C**

Reagent_____

Condition _____

(4)

(d) Compound **D** is a branched-chain isomer that can be oxidised to form compounds **S** and **T**.

(i) Compound **S** is obtained by distilling it off as it forms during the oxidation.
Compound **T** is formed when the oxidation takes place under reflux.

Identify the functional groups in **S** and **T**.

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Explain, with reference to intermolecular forces, why it is possible to obtain compound **S** but not **T** from the reaction mixture by distilling off **S** as soon as it forms.

_____

_____

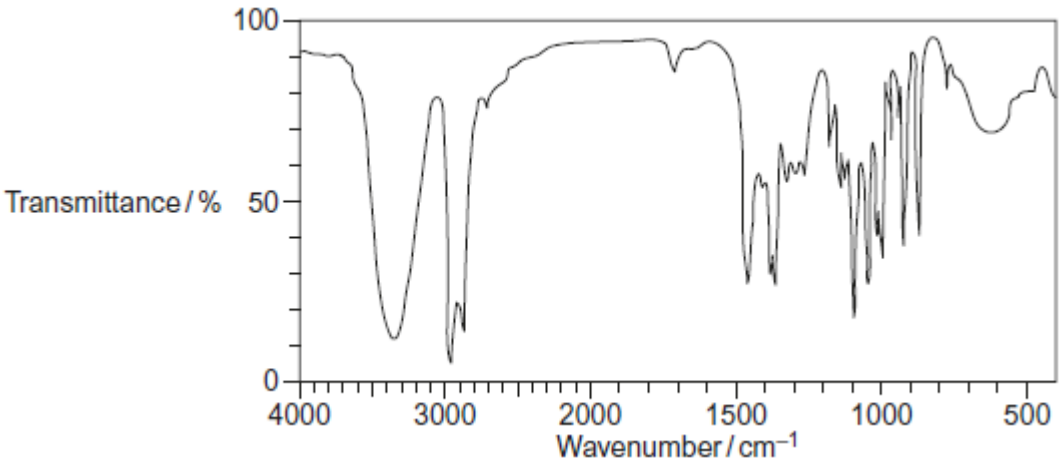
_____

_____

_____

(3)

(ii) A student claims to have oxidised compound **D**.
The infrared spectrum of the product obtained by the student is shown.



Suggest two ways in which the spectrum shows that compound **D** has **not** been oxidised.

_____

_____

_____

_____

_____

(2)

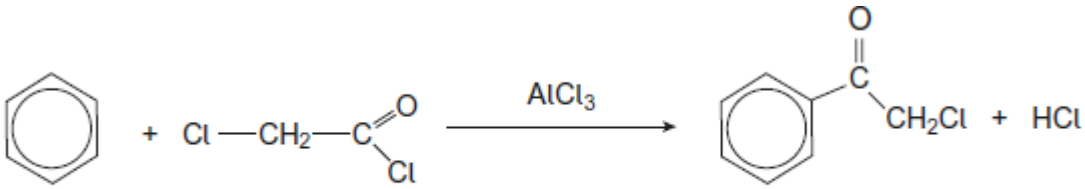
(Total 13 marks)

Q11.

Compound **X** ($ClCH_2COCl$) is used as a reagent in organic synthesis.

(a) One important reaction of **X** is in the preparation of compound **P** as shown.

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X **P**

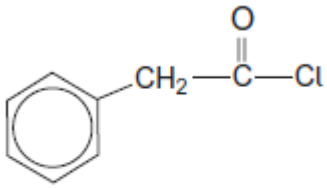
(i) Draw the structure of the electrophile formed by the reaction of **X** with $AlCl_3$.

(1)

(ii) Outline the mechanism for the reaction of the electrophile from part **(a)(i)** with benzene in the preparation of **P**.

(3)

(b) Compound **Q** is an alternative product that could be formed when **X** reacts with benzene.



Q

Describe how you could distinguish between **P** and **Q** by a test-tube reaction. Give the reagent used and the observation with each compound.

Reagent _____

Observation with **P** _____

Observation with **Q** _____

(3)

(c) **X** is also used to make the compound $HOCH_2COOH$. This compound is polymerised to form the polymer known as PGA. PGA is used in surgical sutures (stitches).

(i) Draw the repeating unit of PGA.

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(1)

(ii) Production of PGA occurs via a cyclic compound. Two $HOCH_2COOH$ molecules react together to form the cyclic compound and two molecules of water.

Draw the structure of this cyclic compound.

(1)

(d) Poly(propene) is also used in surgical sutures.

(i) Draw the repeating unit of poly(propene).

(1)

(ii) Suggest an advantage of surgical sutures made from PGA rather than from poly(propene).
Explain your answer.

_____

_____

_____

_____

(2)

(Total 12 marks)

Q12.

The following pairs of compounds can be distinguished by simple test−tube reactions.

For each pair of compounds, give a reagent (or combination of reagents) that, when added separately to each compound, could be used to distinguish between them. State what is observed in each case.

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(a) Butan−2−ol and 2−methylpropan−2−ol

Reagent _____

Observation with butan−2−ol

_____

_____

Observation with 2−methylpropan−2−ol

_____

_____

(3)

(b) Propane and propene

Reagent _____

Observation with propane

_____

_____

Observation with propene

_____

_____

(3)

(c) Aqueous silver nitrate and aqueous sodium nitrate

Reagent _____

Observation with aqueous silver nitrate

_____

_____

Observation with aqueous sodium nitrate

_____

_____

(3)

(d) Aqueous magnesium chloride and aqueous barium chloride

Reagent _____

Observation with aqueous magnesium chloride

_____

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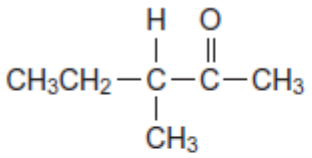
Observation with aqueous barium chloride

(3)

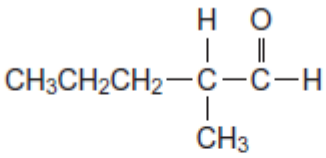
(Total 12 marks)

Q13.

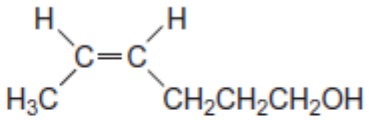
The following five isomers, **P**, **Q**, **R**, **S** and **T**, were investigated using test-tube reactions and also using n.m.r. spectroscopy.



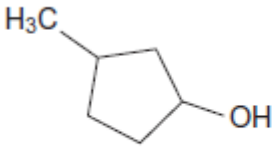
P



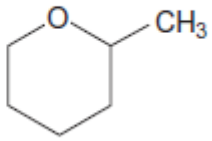
Q



R



S



T

(a) A simple test-tube reaction can be used to distinguish between isomers **P** and **S**.

Identify a reagent (or combination of reagents) you could use.
State what you would observe when both isomers are tested separately with this reagent or combination of reagents.

(3)

(b) A simple test-tube reaction can be used to distinguish between isomer **Q** and all the other isomers.

Identify a reagent (or combination of reagents) you could use.
State what you would observe when **Q** is tested with this reagent or combination of reagents.

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_____

_____

_____

_____

(2)

(c) State which **one** of the isomers, **P**, **Q**, **R**, **S** and **T**, has the least number of peaks in its ^{1}H n.m.r. spectrum.
Give the number of peaks for this isomer.

_____

_____

_____

(2)

(d) Write the **molecular** formula of the standard used in ^{13}C n.m.r. spectroscopy.
Give **two** reasons why this compound is used.

_____

_____

_____

_____

_____

(3)

(e) **Figure 1** and **Figure 2** show the ^{13}C n.m.r. spectra of two of the five isomers.

Figure 1

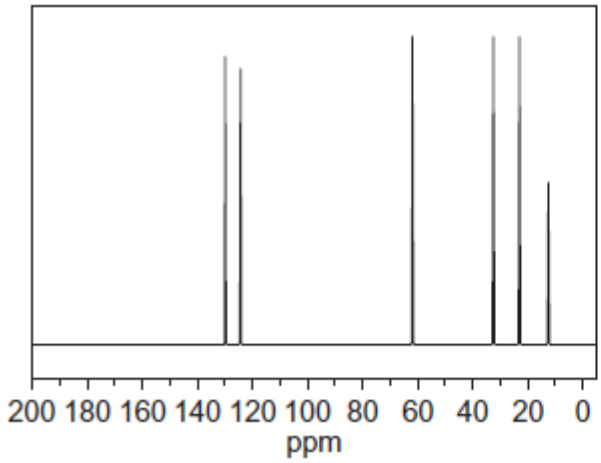
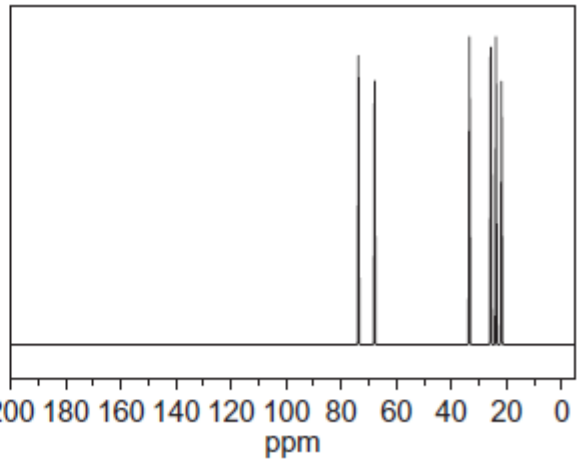
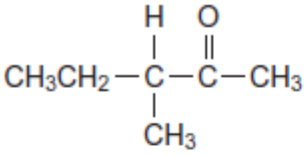


Figure 2

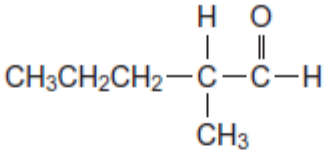


The structures of the five isomers are repeated to help you answer this question.

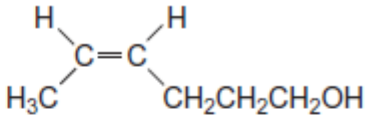
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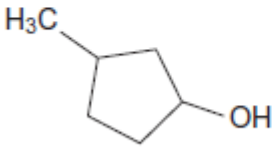
P



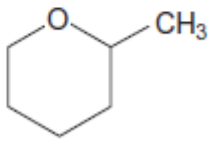
Q



R



S



T

State which isomer produces the spectrum in **Figure 1** and which isomer produces the spectrum in **Figure 2**.

Explain your answer.

You do not need to identify every peak in each spectrum.
Use **Table C** on the Data Sheet to answer the question.

(5)

(f) **U** and **V** are other isomers of **P**, **Q**, **R**, **S** and **T**.
The ^{1}H n.m.r. spectrum of **U** consists of two singlets.
V is a cyclic alcohol that exists as optical isomers.

Draw the structure of **U** and the structure of **V**.

U **V**

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(2)

(Total 17 marks)

Q14.

The following table gives the names and structures of some structural isomers with the molecular formula C_5H_{10}.

	Name of isomer	Structure
Isomer **1**	pent-2-ene	$CH_3CH = CHCH_2CH_3$
Isomer **2**	cyclopentane	
Isomer **3**	3-methylbut-1-ene	$(CH_3)_2CHCH = CH_2$
Isomer **4**	2-methylbut-2-ene	$(CH_3)_2C = CHCH_3$
Isomer **5**	2-methylbut-1-ene	$H_2C = C(CH_3)CH_2CH_3$

(a) Isomer **1** exists as E and Z stereoisomers.

(i) State the meaning of the term **stereoisomers**.

_____

_____

_____

_____

_____

(2)

(ii) Draw the structure of the E stereoisomer of Isomer **1**.

(1)

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(b) A chemical test can be used to distinguish between separate samples of Isomer **1** and Isomer **2**.

Identify a suitable reagent for the test.
State what you would observe with Isomer **1** and with Isomer **2**.

Reagent _____

Observation with Isomer **1** _____

_____

Observation with Isomer **2** _____

_____

(3)

(c) Use **Table A** on the Data Sheet when answering this question.
Isomer **3** and Isomer **4** have similar structures.

(i) State the infrared absorption range that shows that Isomer **3** and Isomer **4** contain the same functional group.

_____

_____

(1)

(ii) State **one** way that the infrared spectrum of Isomer 3 is different from the infrared spectrum of Isomer **4**.

_____

_____

_____

(1)

(d) Two alcohols are formed by the hydration of Isomer **4**.

Draw the **displayed formula** for the alcohol formed that is oxidised readily by acidified potassium dichromate(VI).

(1)

(e) Isomer **4** reacts with hydrogen bromide to give two structurally isomeric bromoalkanes.

(i) Name and outline a mechanism for the reaction of Isomer **4** with hydrogen bromide to give 2-bromo-2-methylbutane as the major product.

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$(CH_3)_2C = CHCH_3 + HBr \longrightarrow (CH_3)_2CBrCH_2CH_3$

Name of mechanism _____

Mechanism

(5)

(ii) The minor product in this reaction mixture is 2-bromo-3-methylbutane.

Explain why this bromoalkane is formed as a minor product.

_____

_____

_____

_____

_____

(2)

(f) Name and outline a mechanism for the following reaction to form Isomer **5**.
State the role of the hydroxide ion in this reaction.

$(CH_3)_2CBrCH_2CH_3 + KOH \longrightarrow H_2C = C(CH_3)CH_2CH_3 + KBr + H_2O$

Name of mechanism _____

Mechanism

Role of hydroxide ion _____

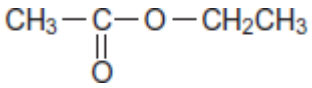
(5)

(Total 21 marks)

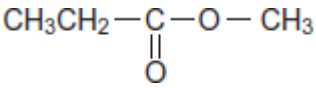
Q15.

(a) **Ester 1** and **Ester 2** were studied by ^1H n.m.r. spectroscopy.

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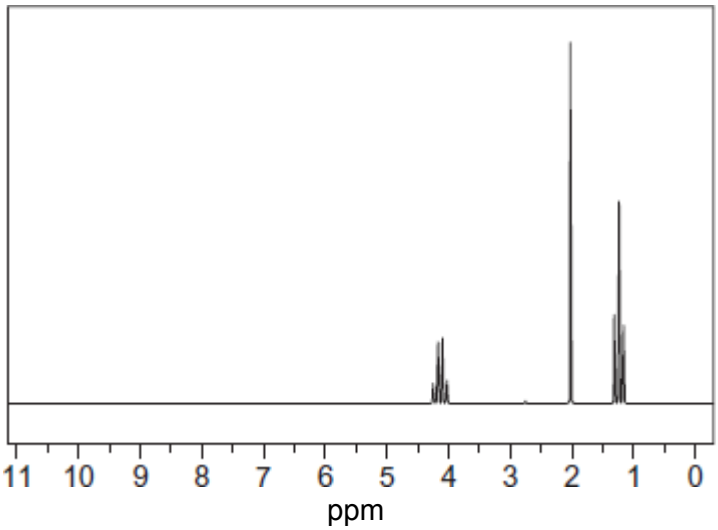


Ester 1



Ester 2

One of the two esters produced this spectrum.



Deduce which of the two esters produced the spectrum shown. In your answer, explain the position and splitting of the quartet peak at δ = 4.1 ppm in the spectrum.

Predict the δ value of the quartet peak in the spectrum of the other ester.

Use **Table B** on the Data Sheet.

(4)

(b) Cetrimide is used as an antiseptic.

$[CH_3(CH_2)_{15}N(CH_3)_3]^+ Br^-$

cetrimide

Name this type of compound.

Give the reagent that must be added to $CH_3(CH_2)15NH_2$ to make cetrimide and state

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the reaction conditions.

Name the type of mechanism involved in this reaction.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Give a reagent that could be used in a test-tube reaction to distinguish between benzene and cyclohexene.
Describe what you would see when the reagent is added to each compound and the test tube is shaken.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

Q16.

Ethanoic acid, propyl ethanoate and propan-1-ol are all colourless liquids. Esters do **not** give a positive result with any of the usual tests for functional groups.

State how you could use chemical tests to show the presence of ethanoic acid and propan-1-ol in a mixture of the acid, the alcohol and the ester.

_____

_____

_____

_____

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_____

_____

_____

_____

(Total 4 marks)

Q17.

The following pairs of compounds can be distinguished by simple test-tube reactions.

For each pair, give a suitable reagent that could be added separately to each compound to distinguish between them.
Describe what you would observe in each case.

(a) AgBr(s) and AgI(s)

Reagent _____

Observation with AgBr(s) _____

_____

Observation with AgI(s) _____

_____

(3)

(b) HCl(aq) and HNO_3(aq)

Reagent _____

Observation with HCl(aq) _____

_____

Observation with HNO_3(aq) _____

_____

(3)

(c) Cyclohexane and cyclohexene

Reagent _____

Observation with cyclohexane _____

_____

Observation with cyclohexene _____

_____

(3)

(d) Butanal and butanone

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Reagent _____

Observation with butanal _____

_____

Observation with butanone _____

_____

(3)

(Total 12 marks)

Q18.

(a) A chemist discovered four unlabelled bottles of liquid, each of which contained a different pure organic compound. The compounds were known to be propan-1-ol, propanal, propanoic acid and 1-chloropropane.

Describe four **different** test-tube reactions, one for each compound, that could be used to identify the four organic compounds.
Your answer should include the name of the organic compound, the reagent(s) used and the expected observation for each test.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(8)

(b) A fifth bottle was discovered labelled propan-2-ol. The chemist showed, using infrared spectroscopy, that the propan-2-ol was contaminated with propanone.

The chemist separated the two compounds using column chromatography. The column contained silica gel, a polar stationary phase.

The contaminated propan-2-ol was dissolved in hexane and poured into the column. Pure hexane was added slowly to the top of the column. Samples of the eluent (the solution leaving the bottom of the column) were collected.

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- Suggest the chemical process that would cause a sample of propan-2-ol to become contaminated with propanone.
- State how the infrared spectrum showed the presence of propanone.
- Suggest why propanone was present in samples of the eluent collected first (those with shorter retention times), whereas samples containing propan-2-ol were collected later.

(4)

(Total 12 marks)

Q19.

The table shows the structures and names of three compounds with M_r = 72.0

Compound	Formula	Name
1	$CH_3CH_2CH_2CHO$	butanal
2	$CH_3CH_2CH_2CH_2CH_3$	pentane
3	$CH_3CH_2COCH_3$	butanone

(a) Explain why M_r values, measured to five decimal places, cannot distinguish between compounds **1** and **3** but can distinguish between compounds **1** and **2**.

(2)

(b) A simple chemical test, using either Fehling's solution or Tollens' reagent, can be

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used to distinguish between compound **1** and compound **3**.
Choose one of these two reagents and state what you would observe with each of compound **1** and compound **3**.

Chosen reagent _____

Observation with compound **1** _____

_____

Observation with compound **3** _____

_____

(2)

(Total 4 marks)

Q20.

A sample of an alcohol was thought to be contaminated with an alkene. Give a reagent that could be used to confirm the presence of an alkene. State what you would observe.

Reagent _____

Observation _____

(Total 2 marks)

Q21.

(a) Propanoic acid can be made from propan-1-ol by oxidation using acidified potassium dichromate(VI). Propanal is formed as an intermediate during this oxidation.

(i) State the colour of the chromium species after the potassium dichromate(VI) has reacted.

_____

(1)

(ii) Describe the experimental conditions and the practical method used to ensure that the acid is obtained in a high yield. Draw a diagram of the assembled apparatus you would use.

Conditions _____

_____

Apparatus

(4)

(iii) Describe the different experimental conditions necessary to produce propanal in high yield rather than propanoic acid.

_____

_____

(2)

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(b) Propan-1-ol is a volatile, flammable liquid.
Give **one** safety precaution that should be used during the reaction to minimise this hazard.

_____

(1)

(c) A student followed the progress of the oxidation of propan-1-ol to propanoic acid by extracting the organic compounds from one sample of reaction mixture.

(i) Give a chemical reagent which would enable the student to confirm the presence of propanal in the extracted compounds.
State what you would observe when propanal reacts with this reagent.

Reagent _____

Observation _____

_____

(2)

(ii) Give a chemical reagent that would enable the student to confirm the presence of propanoic acid in the extracted compounds.
State what you would observe when propanoic acid reacts with this reagent.

Reagent _____

Observation _____

_____

(2)

(d) Predict which **one** of the compounds, propan-1-ol, propanal and propanoic acid will have the highest boiling point. Explain your answer.

Prediction _____

Explanation _____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q22.

Samples of 1-chloropropane and ethanoyl chloride can be distinguished by the addition of an aqueous solution of silver nitrate.
State what you would observe with each sample.

Observation with 1-chloropropane

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_____

_____

Observation with ethanoyl chloride.

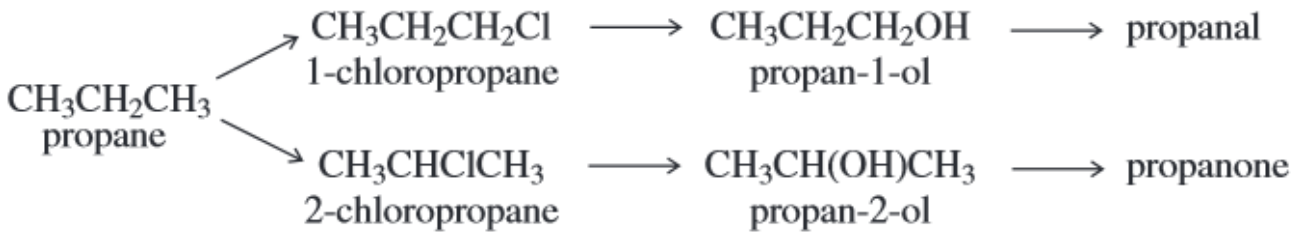
_____

_____

(Total 2 marks)

Q23.

Consider the following scheme of reactions.



(a) State the type of structural isomerism shown by propanal and propanone.

_____

(1)

(b) A chemical test can be used to distinguish between separate samples of propanal and propanone.

Identify a suitable reagent for the test.
State what you would observe with propanal and with propanone.

Test reagent _____

Observation with propanal _____

Observation with propanone _____

(3)

(c) State the structural feature of propanal and propanone which can be identified from their infrared spectra by absorptions at approximately 1720 cm^{-1}.

_____

(1)

(d) The reaction of chlorine with propane is similar to the reaction of chlorine with methane.

(i) Name the type of mechanism in the reaction of chlorine with methane.

_____

(1)

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(ii) Write an equation for each of the following steps in the mechanism for the reaction of chlorine with propane to form l-chloropropane ($CH_3CH_2CH_2Cl$).

Initiation step

_____

First propagation step

_____

Second propagation step

_____

A termination step to form a molecule with the empirical formula C_3H_7

_____

(4)

(e) High resolution mass spectrometry of a sample of propane indicated that it was contaminated with traces of carbon dioxide.

Use the data in the table to show how precise M_r values can be used to prove that thesample contains both of these gases.

Atom	Precise relative atomic mass
^{12}C	12.00000
^{1}H	1.00794
^{16}O	15.99491

_____

_____

_____

(2)

(Total 12 marks)

Q24.

Many naturally-occurring organic compounds can be converted into other useful products.

(a) Glucose, $C_6H_{12}O_6$, can be fermented to make ethanol, which can then be dehydrated to make the unsaturated compound, ethane.

(i) Write an equation for the fermentation of glucose to form ethanol.

_____

(ii) Identify a catalyst for the dehydration of ethanol to form ethene. Write an

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equation for this reaction.

Catalyst _____

Equation _____

(3)

(b) Vegetable oils, which contain unsaturated compounds, are used to make margarine. Identify a catalyst and a reagent for converting a vegetable oil into margarine.

Catalyst _____

Reagent _____

(2)

(c) Oleic acid can be obtained from vegetable oils. Oleic acid is an example of an unsaturated compound.

$CH_3(CH_2)_7CH=CH(CH_2)_7COOH$

oleic acid

(i) Deduce the molecular formula and the empirical formula of oleic acid.

Molecular formula _____

Empirical formula _____

(ii) State what is meant by the term *unsaturated*.

_____

(iii) Identify a reagent for a simple chemical test to show that oleic acid is unsaturated. State what you would observe when oleic acid reacts with this reagent.

Reagent _____

Observation with oleic acid _____

_____

(5)

(Total 10 marks)

Q25.

(a) (i) The addition of aqueous silver nitrate, followed by concentrated aqueous ammonia, can be used to distinguish between separate aqueous solutions of sodium bromide and sodium iodide.
Record what is observed in the table below.

	The addition of $AgNO_3(aq)$	followed by	the addition of concentrated $NH_3(aq)$
Observation with			

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NaBr(aq)		
Observation with NaI(aq)		

(ii) Explain why it is not possible to distinguish between separate solutions of sodium nitrate and sodium fluoride by the addition of silver nitrate solution.

_____

(5)

(b) When aqueous sodium thiosulphate is added to solid silver bromide a reaction occurs and a colourless solution is formed.

(i) Identify the silver-containing species present in the colourless solution.

_____

(ii) Write an equation for this reaction.

_____

(iii) Give **one** use of this reaction.

_____

(3)

(c) Aqueous silver nitrate can be used to distinguish between chloroethanoic acid and ethanoyl chloride.

(i) Draw the structure of ethanoyl chloride. Predict what, if anything, you would observe when ethanoyl chloride is added to aqueous silver nitrate.

Structure of ethanoyl chloride

Observation _____

_____

(ii) Draw the structure of chloroethanoic acid. Predict what, if anything, you would observe when chloroethanoic acid is added to aqueous silver nitrate.

Structure of chloroethanoic acid

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Observation _____

_____

(4)

(d) (i) Tollens' reagent is formed by the addition of aqueous ammonia to aqueous silver nitrate. Identify the silver-containing complex present in Tollens' reagent and state its shape.

Silver-containing complex _____

Shape _____

_____

(ii) Draw the structure of methanoic acid. By reference to this structure, suggest why a silver mirror is formed when this acid reacts with Tollens' reagent.

Structure _____

Explanation _____

_____

(iii) Deduce the identity of a carbon-containing species formed when methanoic acid reacts with Tollens' reagent.

_____

(5)

(Total 17 marks)

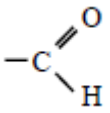
Q26.

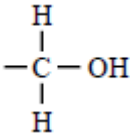
Certain chemical tests were performed on the pain-relief drug ibuprofen. The results of these tests are given in the table below.

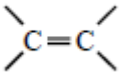
Test	**Result**
Aqueous sodium carbonate	Effervescence
Bromine water	Remained orange
Acidified potassium dichromate(VI) and heat	Remained orange
Fehling's solution and heat	Remained blue

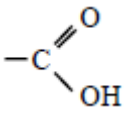
Which one of the following functional groups do these results suggest that ibuprofen contains?

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A 

B 

C 

D 

(Total 1 mark)

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