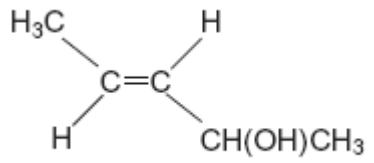
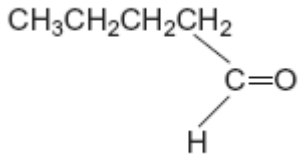
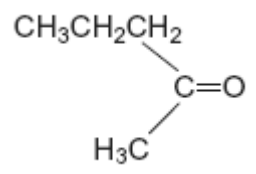


Q1. The table below shows the structures of three isomers with the molecular formula $C_5H_{10}O$

<p>Isomer 1</p> 	<p>(<i>E</i>)-pent-3-en-2-ol</p>
<p>Isomer 2</p> 	<p>pentanal</p>
<p>Isomer 3</p> 	

(a) Complete the table by naming Isomer 3.

(1)

(b) State the type of structural isomerism shown by these three isomers.

.....

(1)

(c) The compound (*Z*)-pent-3-en-2-ol is a stereoisomer of (*E*)-pent-3-en-2-ol.

(i) Draw the structure of (*Z*)-pent-3-en-2-ol.

(1)

- (ii) Identify the feature of the double bond in (*E*)-pent-3-en-2-ol and that in (*Z*)-pent-3-en-2-ol that causes these two compounds to be stereoisomers.

.....

(1)

- (d) A chemical test can be used to distinguish between separate samples of Isomer **2** and Isomer **3**.

Identify a suitable reagent for the test.

State what you would observe with Isomer **2** and with Isomer **3**.

Test reagent

Observation with Isomer **2**.....

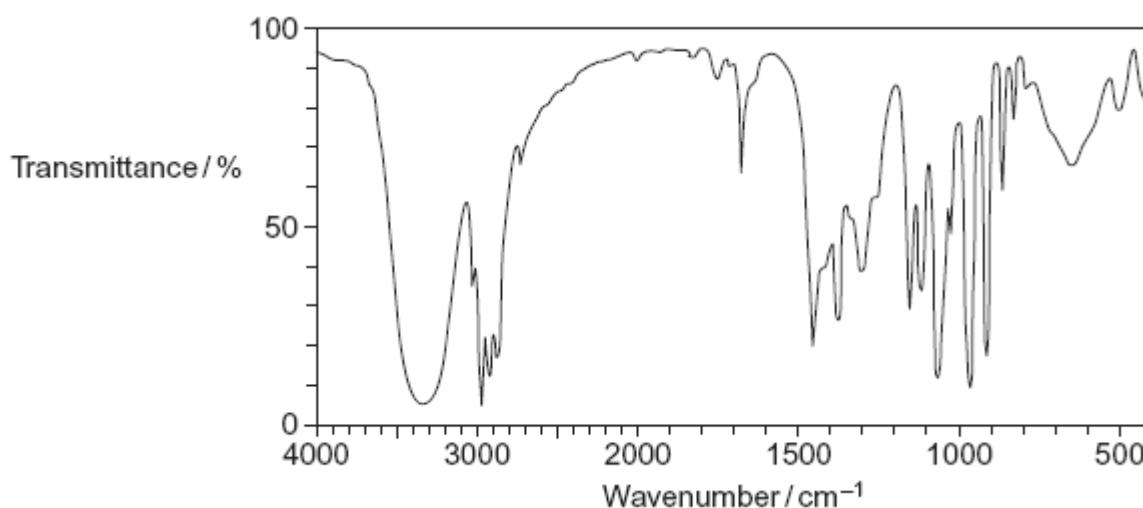
.....

Observation with Isomer **3**.....

.....

(3)

- (e) The following is the infrared spectrum of one of the isomers **1**, **2** or **3**.



- (i) Deduce which of the isomers (**1**, **2** or **3**) would give this infrared spectrum. You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

(1)

- (ii) Identify two features of the infrared spectrum that support your deduction. In each case, identify the functional group responsible.

Feature 1 and functional group

.....

.....

.....

Feature 2 and functional group

.....

.....

.....

(2)
(Total 10 marks)

- Q2.** The table below gives some of the names and structures of isomers having the molecular formula C_4H_9Br

Structure	Name
$CH_3CH_2CH_2CH_2Br$	
$ \begin{array}{c} CH_3 \\ \\ H_3C - C - CH_3 \\ \\ Br \end{array} $	2-bromo - 2-methylpropane
	1-bromo - 2-methylpropane
$ \begin{array}{c} CH_3CH_2 - CH - CH_3 \\ \\ Br \end{array} $	2-methylpropane

Complete the table.

(Total 2 marks)

Q3. How many different alkenes are formed when 2-bromo-3-methylbutane reacts with ethanolic potassium hydroxide?

- A** 2
- B** 3
- C** 4
- D** 5

(Total 1 mark)

Q4. Which one of the following can exhibit both geometrical and optical isomerism?

- A** $(\text{CH}_3)_2\text{C}=\text{CHCH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- B** $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- C** $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_2\text{CH}_3)_2$
- D** $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{C}=\text{CH}_2$

(Total 1 mark)

Q5. Octane is the eighth member of the alkane homologous series.

- (a) State **two** characteristics of a homologous series.

.....

.....

.....

.....

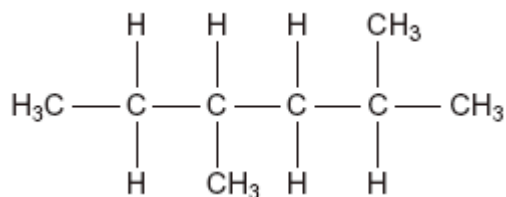
(2)

- (b) Name a process used to separate octane from a mixture containing several different alkanes.

.....

(1)

- (c) The structure shown below is one of several structural isomers of octane.



Give the meaning of the term structural isomerism.
 Name this isomer and state its empirical formula.

.....

.....

.....

.....

(4)

- (d) Suggest why the branched chain isomer shown above has a lower boiling point than octane.

.....

.....

(2)

(Total 9 marks)

- Q6.** There are **seven** isomeric carbonyl compounds with the molecular formula $C_5H_{10}O$. The structures and names of some of these isomers are given below.

Structure	Name
$ \begin{array}{c} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{C}=\text{O} \\ \\ \text{H} \end{array} $	pentanal
$ \begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{CH}_2-\text{CH}-\text{C}=\text{O} \\ \\ \text{H} \end{array} $	2-methylbutanal
$ \begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}-\text{C}=\text{O} \\ \quad \\ \text{CH}_3 \quad \text{H} \end{array} $	2, 2-dimethylpropanal
$ \begin{array}{c} \text{CH}_3\text{CH}_2-\text{C}-\text{CH}_2\text{CH}_3 \\ \\ \text{O} \end{array} $	
	pentan-2-one

(a) (i) Complete the table.

- (ii) **Two** other isomeric carbonyl compounds with the molecular formula $C_5H_{10}O$ are not shown in the table. One is an aldehyde and one is a ketone. Draw the structure of each.

isomeric aldehyde

isomeric ketone

(4)

- (b) Pentanal, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$, can be oxidised to a carboxylic acid.

(i) Write an equation for this reaction. Use [O] to represent the oxidising agent.

.....

(ii) Name the carboxylic acid formed in this reaction.

.....

(2)

(c) Pentanal can be formed by the oxidation of an alcohol.

(i) Identify this alcohol.

.....

(ii) State the class to which this alcohol belongs.

.....

(2)

(Total 8 marks)

Q7. (a) Hexane (C₆H₁₄) is a hydrocarbon which is a component of LPG (liquid petroleum gas), used as a fuel for heating. When burning fuels in boilers it is important to ensure complete combustion.

(i) Give two reasons why boilers are designed to ensure complete combustion.

Reason 1

.....

Reason 2

.....

(ii) Write an equation for the incomplete combustion of hexane.

.....

(iii) Suggest how an engineer or a chemist could demonstrate that the combustion of hexane in a faulty boiler was incomplete.

.....

(5)

(b) Branched chain alkanes are often preferred as fuels. Draw the structure of two branched chain isomers of hexane and name the first isomer.

Isomer 1

Isomer 2

Name of isomer 1

(3)

(c) Hexane can be cracked in the presence of a catalyst to produce another hydrocarbon, Z, and methane.

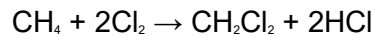
(i) Draw a possible structure for Z.

(ii) Give a suitable catalyst for this reaction.

.....
(iii) Suggest why the product Z has more commercial value than hexane.
.....
.....

(3)

(d) The overall equation for the production of dichloromethane from methane and chlorine is shown below.



(i) Calculate the % atom economy for the formation of CH_2Cl_2 in this reaction.
.....
.....
.....

(ii) Give one reason why this atom economy of less than 100% is an important consideration for the commercial success of this process and predict how a chemical company would maximise profits from this process.
.....
.....
.....

(3)
(Total 14 marks)

Q8. Hexane is a member of the homologous series of alkanes.

(a) State **two** characteristics of a *homologous series*.

Characteristic 1

Characteristic 2

.....

(2)

- (b) (i) Hexane can be converted into 2,2-dichlorohexane.

Draw the displayed formula of 2,2-dichlorohexane and deduce its empirical formula.

Displayed formula

Empirical formula

.....

(2)

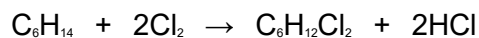
- (ii) Explain why 2,2-dichloro-3-methylpentane is a structural isomer of 2,2-dichlorohexane.

.....

.....

(2)

- (c) A reaction of hexane with chlorine is shown by the equation below.



Calculate the percentage atom economy for the formation of $\text{C}_6\text{H}_{12}\text{Cl}_2$ in this reaction.

.....

.....

.....

(2)

- (d) The boiling points of some straight-chain alkanes are shown below.

Alkane	C_4H_{10}	C_5H_{12}	C_6H_{14}
Boiling point / °C	- 0.5	36.3	68.7

(i) Explain the trend in these boiling points.

.....
.....
.....

(2)

(ii) Name a process which can be used to separate C_5H_{12} from C_6H_{14}

.....

(1)

(Total 11 marks)