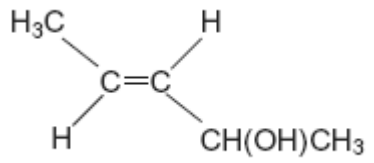
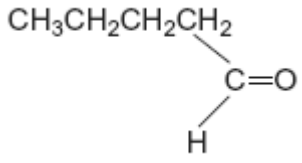
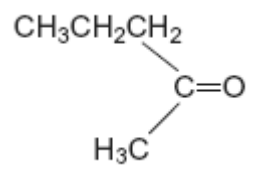


**Q1.** The table below shows the structures of three isomers with the molecular formula  $C_5H_{10}O$

<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**.....

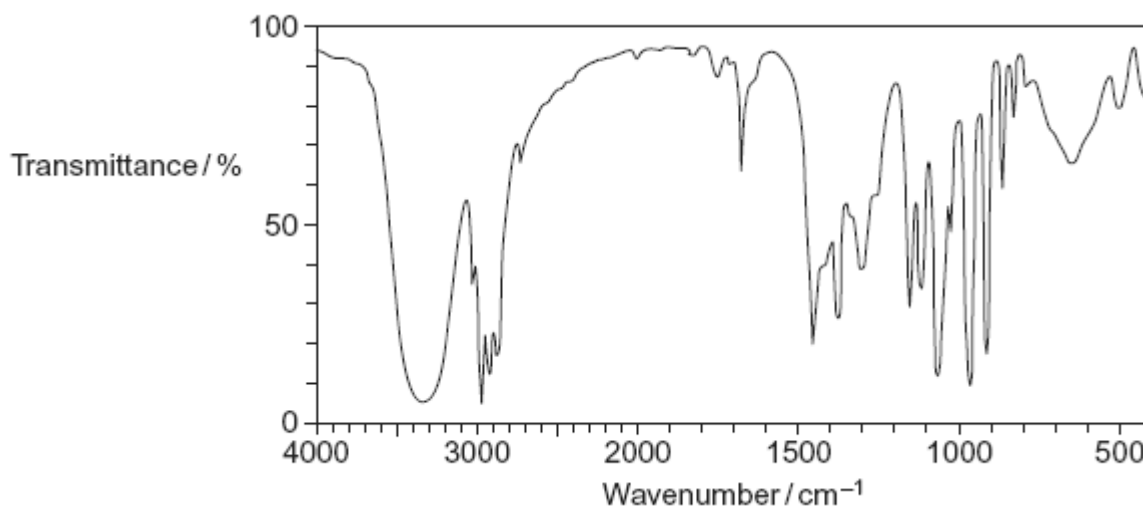
.....

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 fractions obtained from petroleum contain saturated hydrocarbons that belong to the homologous series of alkanes.

(a) Any homologous series can be represented by a general formula.

(i) State **two** other characteristics of homologous series.

*Characteristic 1* .....

.....

*Characteristic 2* .....

.....

(ii) Name the process which is used to obtain the fractions from petroleum.

.....

(iii) State what is meant by the term *saturated*, as applied to hydrocarbons.

.....  
.....

(4)

(b) Decane has the molecular formula  $C_{10}H_{22}$

(i) State what is meant by the term *molecular formula*.

.....  
.....

(ii) Give the molecular formula of the alkane which contains 14 carbon atoms.

.....

(iii) Write an equation for the incomplete combustion of decane,  $C_{10}H_{22}$ , to produce carbon and water only.

.....

(3)

(c) When petrol is burned in an internal combustion engine, some nitrogen monoxide,  $NO$ , is formed. This pollutant is removed from the exhaust gases by means of a reaction in a catalytic converter.

(i) Write an equation for the reaction between nitrogen and oxygen to form nitrogen monoxide.

.....

(ii) Identify a catalyst used in a catalytic converter.

.....

- (iii) Write an equation to show how nitrogen monoxide is removed from the exhaust gases as they pass through a catalytic converter.

.....

(3)

(Total 10 marks)

**Q3.** Octane is the eighth member of the alkane homologous series.

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

.....

.....

.....

.....

(2)

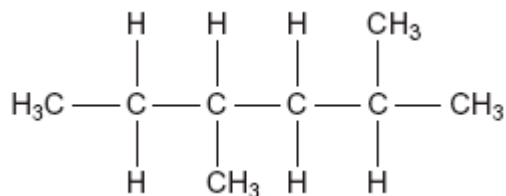
- (b) Name a process used to separate octane from a mixture containing several different alkanes.

.....

.....

(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)

**Q4.** Pent-1-ene is a member of the alkene homologous series.

- (a) Pent-1-ene can be separated from other alkenes.

State the physical property of alkenes that allows them to be separated from a mixture by fractional distillation.

.....

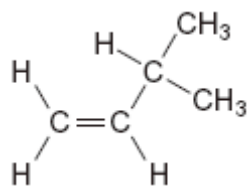
(1)

- (b) (i) State the meaning of the term *structural isomerism*.

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

(2)

(ii) Name the branched chain isomer of pent-1-ene shown below.



.....

(1)

(iii) Draw the structure of a functional group isomer of pent-1-ene.

(1)

(c) The cracking of one molecule of compound **X** produces pent-1-ene, ethene and butane in a 1:2:1 mol ratio.  
Deduce the molecular formula of **X** and state a use for the ethene formed.

Molecular formula of **X** .....

.....

Use of ethene .....

(2)

(Total 7 marks)

**Q5.** 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 .....

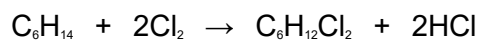
(2)

- (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)

**Q6.** Alkanes are saturated hydrocarbons which can be obtained from crude oil. Pentane is an example of an alkane. A molecule of pentane contains five carbon atoms.

(a) (i) State the meaning of the term *saturated* and of the term *hydrocarbon* as applied to alkanes.

Saturated .....

.....

Hydrocarbon .....

.....

(2)

(ii) Give the general formula for the alkanes.

.....

(1)

(b) Pentane burns completely in oxygen.

(i) Write an equation for this reaction.

.....

(1)

(ii) State how the products of this reaction may affect the environment.

.....

.....

(1)

(c) Give the name of a solid pollutant which may form when pentane burns incompletely in air.

.....

(1)

(d) One molecule of  $C_9H_{20}$  can be cracked to form one molecule of pentane and one other product.

(i) Write an equation for this cracking reaction.

.....

(1)

(ii) Suggest a type of compound that can be manufactured from the other product of this cracking reaction.

.....

.....

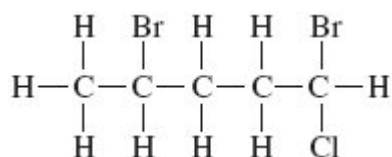
(1)

(iii) State why a high temperature is needed for cracking reactions to occur.

.....  
.....

(1)

(e) Pentane can react to form the following haloalkane **Q**.

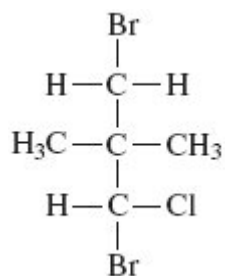


(i) Name **Q**.

.....

(1)

(ii) State the type of structural isomerism shown by **Q** and the haloalkane shown below.



.....

(1)

(Total 11 marks)