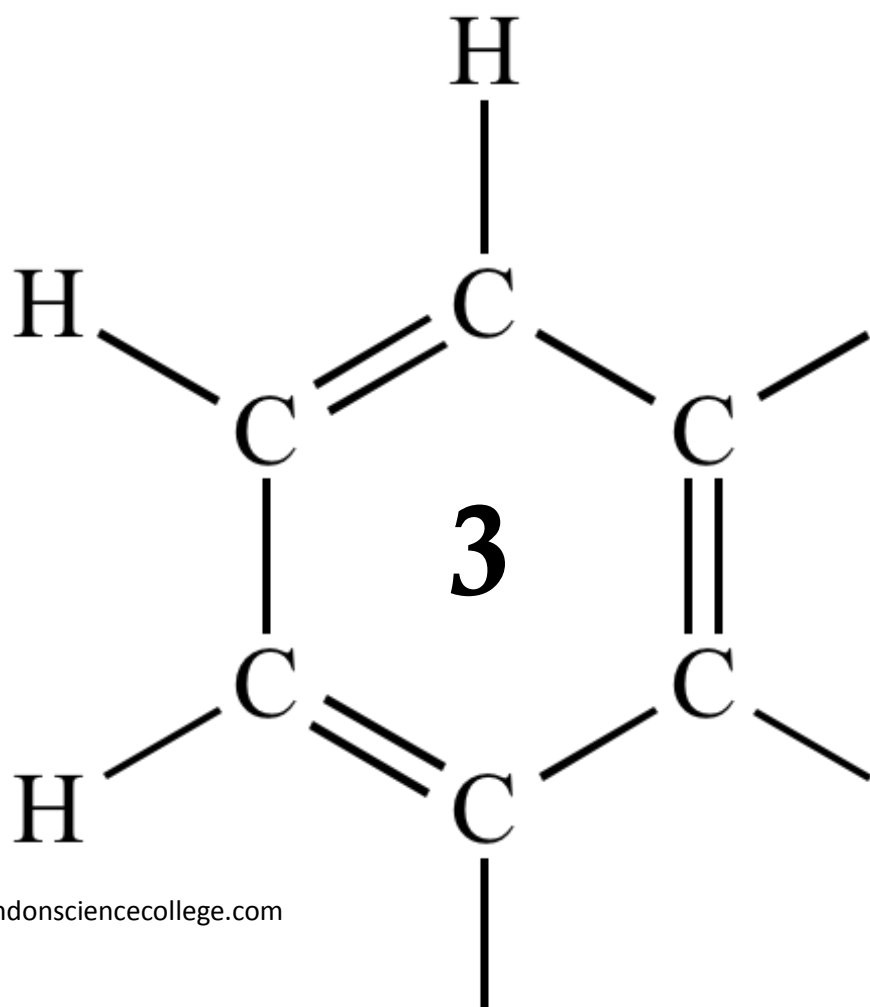


AQA AS CHEMISTRY  
**INTRO TO ORGANIC**



1

(a) The hydrocarbon but-1-ene ( $C_4H_8$ ) is a member of the homologous series of alkenes. But-1-ene has structural isomers.

(i) State the meaning of the term *structural isomers*.

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

(2)

(ii) Give the IUPAC name of the **position** isomer of but-1-ene.

.....

(1)

(iii) Give the IUPAC name of the **chain** isomer of but-1-ene.

.....

(1)

(iv) Draw the displayed formula of a **functional group** isomer of but-1-ene.

(1)

(b) But-1-ene burns in a limited supply of air to produce a solid and water only.

(i) Write an equation for this reaction.

.....

(1)

(ii) State **one** hazard associated with the solid product in part (b)(i).

.....

(1)

(c) One mole of compound **Y** is cracked to produce two moles of ethene, one mole of but-1-ene and one mole of octane ( $C_8H_{18}$ ) only.

(i) Deduce the molecular formula of **Y**.

.....

(1)

(ii) Other than cracking, give **one** common use of **Y**.

.....

(1)

(d) In cars fitted with catalytic converters, unburned octane reacts with nitrogen monoxide to form carbon dioxide, water and nitrogen only.

(i) Write an equation for this reaction.

.....

(1)

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

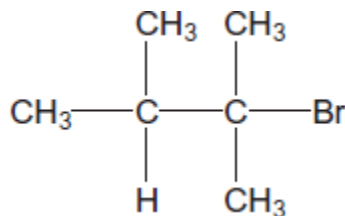
.....

(1)

(Total 11 marks)

2

(a) The structure of the bromoalkane **Z** is



Give the IUPAC name for **Z**.

Give the general formula of the homologous series of straight-chain bromoalkanes that contains one bromine atom per molecule.

Suggest **one** reason why 1-bromohexane has a higher boiling point than **Z**.

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.....  
.....  
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(Extra space) .....

.....  
.....

(3)

(b) Draw the displayed formula of 1,2-dichloro-2-methylpropane.

State its empirical formula.

.....  
.....

(2)  
(Total 5 marks)

3

Chlorine can be used to make chlorinated alkanes such as dichloromethane.

(a) Write an equation for each of the following steps in the mechanism for the reaction of chloromethane (CH<sub>3</sub>Cl) with chlorine to form dichloromethane (CH<sub>2</sub>Cl<sub>2</sub>).

Initiation step

.....

First propagation step

.....

Second propagation step

.....

The termination step that forms a compound with empirical formula CH<sub>2</sub>Cl.

.....

(4)

(b) When chlorinated alkanes enter the upper atmosphere, carbon-chlorine bonds are broken. This process produces a reactive intermediate that catalyses the decomposition of ozone. The overall equation for this decomposition is



(i) Name the type of reactive intermediate that acts as a catalyst in this reaction.

.....

(1)

- (ii) Write **two** equations to show how this intermediate is involved as a catalyst in the decomposition of ozone.

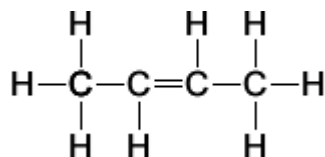
Equation 1.....

Equation 2.....

(2)  
(Total 7 marks)

4

Compound **X** is shown below. It is a member of a homologous series of hydrocarbons.



- (a) (i) Deduce the general formula of the homologous series that contains **X**.

.....

(1)

- (ii) Name a process used to obtain a sample of **X** from a mixture containing other members of the same homologous series.

.....

(1)

- (b) There are several isomers of **X**.

- (i) Give the IUPAC name of the position isomer of **X**.

.....

(1)

- (ii) Draw the structure of a functional group isomer of **X**.

(1)

- (c) At high temperatures, one molecule of  $\text{C}_{15}\text{H}_{32}$  can be converted into two molecules of **X** and one molecule of another compound.

- (i) Write an equation for this reaction.

.....

(1)

- (ii) State the name of the process used to obtain a high yield of **X** from  $C_{15}H_{32}$ .  
Give **one** reason why this process is used in industry.

Name .....

Reason .....

.....

(2)

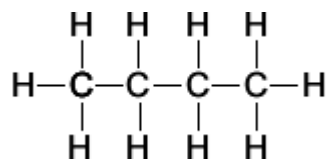
- (iii) State why high temperatures are needed for this process.

.....

.....

(1)

- (d) Compound **X** can be converted into compound **Y**.  
Compound **Y** is shown below.



- (i) Suggest the formula of a reagent that could be added to **X** in order to convert it into **Y**.

.....

(1)

- (ii) Give **one** use of **Y**.

.....

(1)

- (iii) Write an equation to show the reaction of **Y** in a limited supply of air to produce a solid and water only.

.....

(1)

- (iv) When a sample of **Y**, contaminated with  $CH_3SH$ , is burned completely in air, a toxic gas is formed.  
Identify this toxic gas and suggest a compound that could be used to remove the toxic gas from the products of combustion.

Toxic gas .....

Compound used to remove toxic gas .....

.....

(2)

- (v) Suggest the name of the process that occurs when the toxic gas in part (d)(iv) is removed.

.....

(1)

- (e) Explain why the boiling points of X and Y are similar.

.....

.....

.....

.....

(2)

(Total 16 marks)

5

Hexane (C<sub>6</sub>H<sub>14</sub>) is a member of the homologous series of alkanes.

- (a) (i) Name the raw material from which hexane is obtained.

.....

(1)

- (ii) Name the process used to obtain hexane from this raw material.

.....

(1)

- (b) C<sub>6</sub>H<sub>14</sub> has structural isomers.

- (i) Deduce the number of structural isomers with molecular formula C<sub>6</sub>H<sub>14</sub>.

Write the number in this box.

(Space for working)

(1)

- (ii) State **one** type of structural isomerism shown by the isomers of C<sub>6</sub>H<sub>14</sub>

.....

(1)

(c) One molecule of an alkane **X** can be cracked to form one molecule of hexane and two molecules of propene.

(i) Deduce the molecular formula of **X**.

.....  
.....

(1)

(ii) State the type of cracking that produces a high percentage of alkenes. State the conditions needed for this type of cracking.

Type of cracking .....

Conditions .....

.....

(2)

(iii) Explain the main economic reason why alkanes are cracked.

.....  
.....

(1)

(d) Hexane can react with chlorine under certain conditions as shown in the following equation.



(i) Both the products are hazardous. The organic product would be labelled 'flammable'. Suggest the most suitable hazard warning for the other product.

.....

(1)

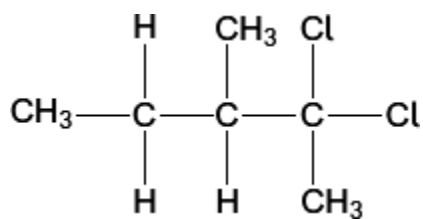
(ii) Calculate the percentage atom economy for the formation of  $\text{C}_6\text{H}_{13}\text{Cl}$  ( $M_r = 120.5$ ) in this reaction.

.....  
.....

(1)



- (e) A different chlorinated compound is shown below. Name this compound and state its empirical formula.



Name .....

Empirical formula .....

(2)  
(Total 12 marks)

6

Pentane is a member of the alkane homologous series.

- (a) Give the general formula for the homologous series of alkanes.

.....

(1)

- (b) One of the structural isomers of pentane is 2,2-dimethylpropane.

Draw the displayed formula of 2,2-dimethylpropane.

State the type of structural isomerism shown.

.....

(2)

- (c) A molecule of hydrocarbon **Y** can be thermally cracked to form one molecule of pentane and two molecules of ethene only.

Deduce the molecular formula of **Y**.

State why high temperatures are necessary for cracking reactions to occur.

Give **one** reason why thermal cracking reactions are carried out in industry.

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*(Extra space)* .....  
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**(3)**

- (d) Write an equation for the incomplete combustion of pentane to form a solid pollutant.

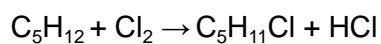
Suggest why this solid pollutant is an environmental problem.

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

*(Extra space)* .....  
.....

**(2)**

(e) Pentane can react with chlorine as shown in the following equation.



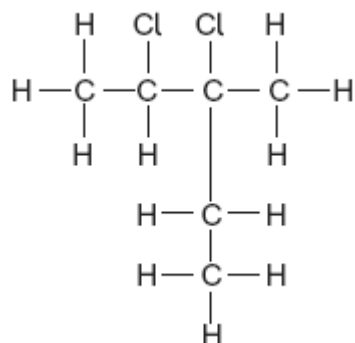
Calculate the percentage atom economy for the formation of  $\text{C}_5\text{H}_{11}\text{Cl}$

Deduce how many straight-chain isomers of  $\text{C}_5\text{H}_{11}\text{Cl}$  could be formed.

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.....  
.....  
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.....  
*(Extra space)*.....  
.....

**(3)**

(f) Consider the following compound.



Name this compound.

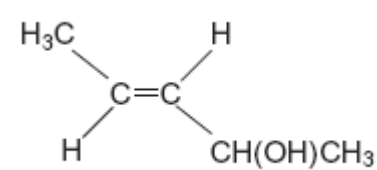
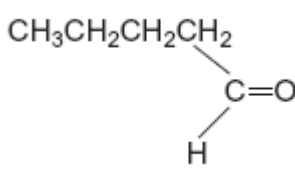
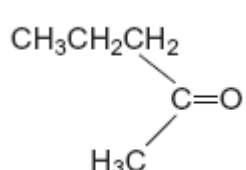
Deduce the empirical formula of this compound.

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.....  
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**(2)**  
**(Total 13 marks)**

7

The table below shows the structures of three isomers with the molecular formula C<sub>5</sub>H<sub>10</sub>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**.....

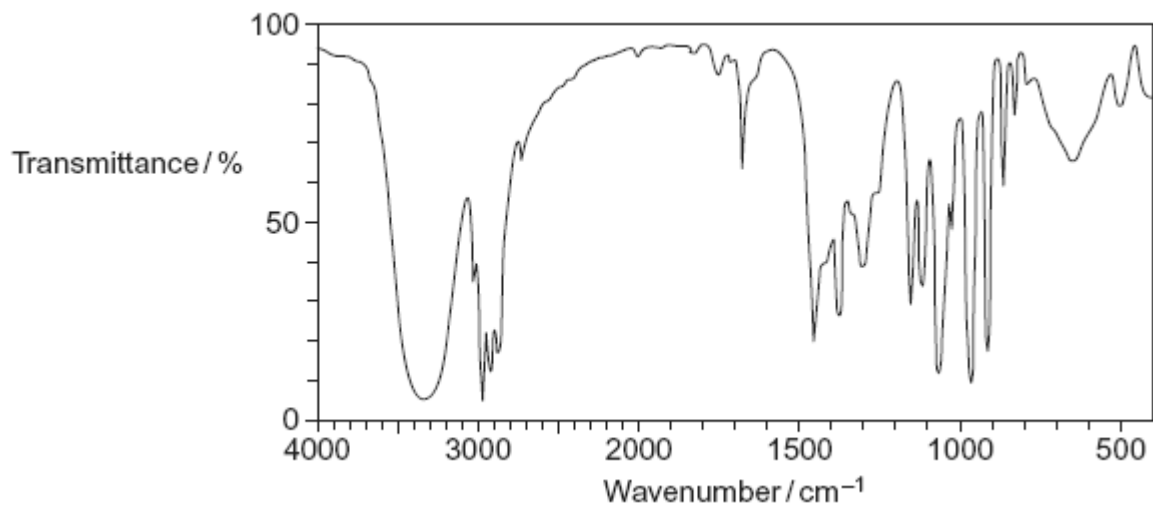
.....

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)

8

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.

.....

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(1)

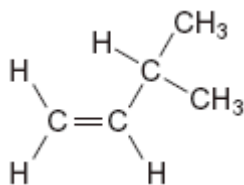


(b) (i) State the meaning of the term *structural isomerism*.

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

(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)



10

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.

.....  
.....

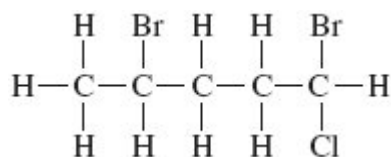
(1)

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

.....  
.....

(1)

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

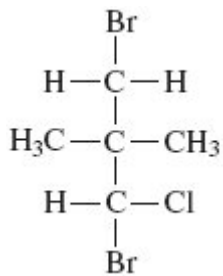


- (i) Name **Q**.

.....

(1)

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



.....

(1)  
(Total 11 marks)