Q1.(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)

Q2. The following table shows the boiling points of some straight-chain alkanes.

	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}
Boiling point / °C	−162	−88	−42	−1	36

(a) State a process used to separate an alkane from a mixture of these alkanes.

.....

(1)

(b) Both C_3H_8 and C_4H_{10} can be liquefied and used as fuels for camping stoves.

Suggest, with a reason, which of these two fuels is liquefied more easily.

.....

.....

.....

(1)

(c) Write an equation for the complete combustion of C_4H_{10}

.....

(1)

(d) Explain why the complete combustion of C_4H_{10} may contribute to environmental problems.

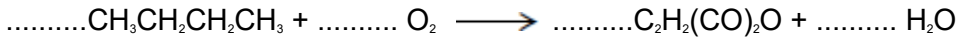
.....

.....

.....

(1)

(e) Balance the following equation that shows how butane is used to make the compound called maleic anhydride.



(1)

(f) Ethanethiol (C_2H_5SH), a compound with an unpleasant smell, is added to gas to enable leaks from gas pipes to be more easily detected.

(i) Write an equation for the combustion of ethanethiol to form carbon dioxide, water and sulfur dioxide.

.....

(1)

(ii) Identify a compound that is used to react with the sulfur dioxide in the products of combustion before they enter the atmosphere.

Give **one** reason why this compound reacts with sulfur dioxide.

Substance .....

Reason .....

.....

(2)

(iii) Ethanethiol and ethanol molecules have similar shapes.

Explain why ethanol has the higher boiling point.

.....

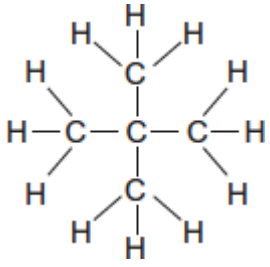
.....

.....

.....

(2)

(g) The following compound **X** is an isomer of one of the alkanes in the table on above.



(i) Give the IUPAC name of **X**.

.....

(1)

(ii) **X** has a boiling point of 9.5 °C.

Explain why the boiling point of **X** is lower than that of its straight-chain isomer.

.....

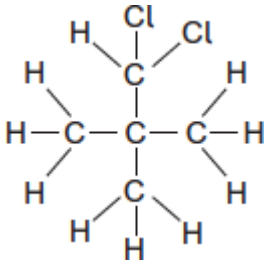
.....

.....

.....

(2)

(iii) The following compound **Y** is produced when **X** reacts with chlorine.



Deduce how many **other** position isomers of **Y** can be formed.
Write the number of **other** position isomers in this box.

(1)

(h) Cracking of one molecule of an alkane **Z** produces one molecule of ethane, one molecule of propene and two molecules of ethene.

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

.....

(1)

(ii) State the type of cracking that produces a high proportion of ethene and propene.
Give the **two** conditions for this cracking process.

Type of cracking .....

Conditions .....

.....

(2)
(Total 17 marks)

Q3. Hexane (C_6H_{14}) 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_6H_{14} has structural isomers.

(i) Deduce the number of structural isomers with molecular formula C_6H_{14}

Write the number in this box. ☐

(Space for working)

(1)

(ii) State **one** type of structural isomerism shown by the isomers of C_6H_{14}

.....

(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.

$$C_6H_{14} + Cl_2 \longrightarrow C_6H_{13}Cl + HCl$$

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

.....

(1)

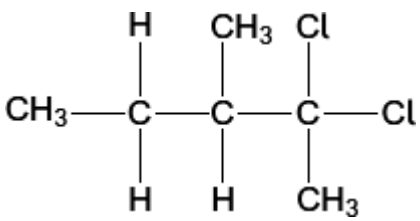
(ii) Calculate the percentage atom economy for the formation of $C_6H_{13}Cl$ (M_r = 120.5) in this reaction.

.....

.....

(1)

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



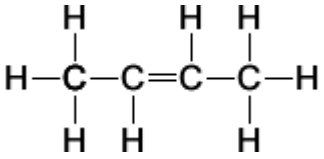
Name .....

Empirical formula .....

(2)

(Total 12 marks)

Q4. 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 $C_{15}H_{32}$ 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)

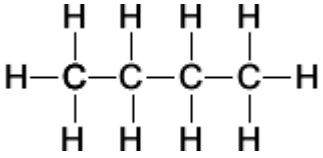
(iii) State why high temperatures are needed for this process.

.....

.....

(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)