

Q1. Central heating fuel, obtained by the fractional distillation of crude oil, contains saturated hydrocarbons with the molecular formula $C_{16}H_{34}$

- (a) Give the meaning of the terms **saturated** and **hydrocarbon** as applied to saturated hydrocarbons.

Saturated

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Hydrocarbon

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(2)

- (b) If the boiler for a central heating system is faulty, a poisonous gas may be produced during the combustion of $C_{16}H_{34}$

Write an equation for the reaction that forms this poisonous gas and one other product only.

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(1)

- (c) Explain why the sulfur compounds found in crude oil should be removed from the fractions before they are used for central heating fuel.

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(2)

- (d) A hydrocarbon $C_{16}H_{34}$ can be cracked to form C_8H_{18} , ethene and propene.

- (i) Write an equation to show this cracking reaction.

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(1)

- (ii) Suggest **one** important substance manufactured on a large scale from

propene.

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(1)

(iii) Draw the **displayed formula** of the functional group isomer of propene.

(1)

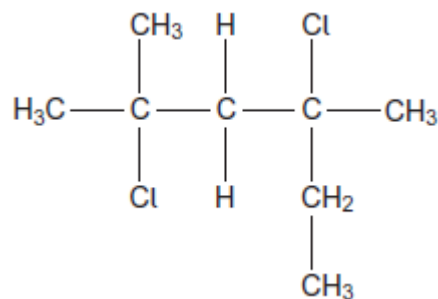
(e) There are many structural isomers with the molecular formula C_8H_{18}

Draw the structure of 2,3,3-trimethylpentane.

(1)

(f) A compound C_8H_{18} reacts with chlorine to give several haloalkanes.

Give the IUPAC name of the following haloalkane.



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Q2. Some oil-fired heaters use paraffin as a fuel.

One of the compounds in paraffin is the straight-chain alkane, dodecane ($C_{12}H_{26}$).

- (a) Give the name of the substance from which paraffin is obtained.
State the name of the process used to obtain paraffin from this substance.

Substance

Process

(2)

- (b) The combustion of dodecane produces several products.

Write an equation for the **incomplete** combustion of dodecane to produce gaseous products only.

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(1)

- (c) Oxides of nitrogen are also produced during the combustion of paraffin in air.

- (i) Explain how these oxides of nitrogen are formed.

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(2)

- (ii) Write an equation to show how nitrogen monoxide in the air is converted into nitrogen dioxide.

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(1)

- (iii) Nitric acid (HNO_3) contributes to acidity in rainwater.

Deduce an equation to show how nitrogen dioxide reacts with oxygen and water to form nitric acid.

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(1)

- (d) Dodecane ($\text{C}_{12}\text{H}_{26}$) can be cracked to form other compounds.

- (i) Give the general formula for the homologous series that contains dodecane.

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(1)

- (ii) Write an equation for the cracking of one molecule of dodecane into equal amounts of two different molecules each containing the same number of carbon atoms.

State the empirical formula of the straight-chain alkane that is formed.
Name the catalyst used in this reaction.

Equation

Empirical formula of alkane

Catalyst

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(3)

- (iii) Explain why the melting point of dodecane is higher than the melting point of the straight-chain alkane produced by cracking dodecane.

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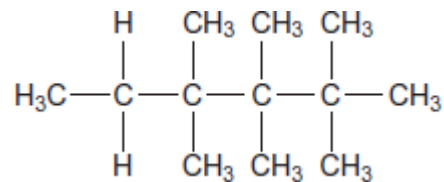
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(2)

- (e) Give the IUPAC name for the following compound and state the type of structural isomerism shown by this compound and dodecane.



IUPAC name

Type of structural isomerism

(2)

- (f) Dodecane can be converted into halododecanes.

Deduce the formula of a substance that could be reacted with dodecane to produce 1-chlorododecane and hydrogen chloride only.

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(1)

(Total 16 marks)

- Q3.** (a) (i) Name the process used to separate petroleum into fractions.

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- (ii) Give the molecular formula for an alkane with nine carbon atoms.

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- (iii) Write an equation for the complete combustion of the alkane $\text{C}_{11}\text{H}_{24}$.

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- (iv) Write an equation for the incomplete combustion of $\text{C}_{11}\text{H}_{24}$ to produce carbon and water only.

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(4)

- (b) Alkenes can be produced by cracking the naphtha fraction obtained from petroleum.

- (i) Write an equation for the thermal cracking of one molecule of $\text{C}_{10}\text{H}_{22}$ to give

one molecule of propene and one molecule of an alkane only.

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(ii) Draw the structure of the chain isomer of but-1-ene.

(2)

(c) The alkanes and the alkenes are examples of homologous series of compounds. One feature of an homologous series is the gradual change in physical properties as the relative molecular mass increases. State **two** other general features of an homologous series of compounds.

Feature 1

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Feature 2

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(2)
(Total 8 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.

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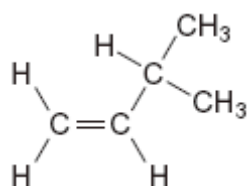
(1)

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

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(2)

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



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(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**

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Use of ethene

(2)
(Total 7 marks)

Q5.The following table shows the boiling points of some straight-chain alkanes.

	CH ₄	C ₂ H ₆	C ₃ H ₈	C ₄ H ₁₀	C ₅ H ₁₂
Boiling point / °C	-162	-88	-42	-1	36

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

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(1)

- (b) Both C₃H₈ and C₄H₁₀ can be liquefied and used as fuels for camping stoves. Suggest, with a reason, which of these two fuels is liquefied more easily.

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(1)

- (c) Write an equation for the complete combustion of C₄H₁₀

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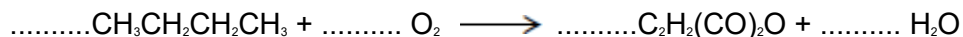
(1)

- (d) Explain why the complete combustion of C₄H₁₀ may contribute to environmental problems.

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(1)

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



(1)

- (f) Ethanethiol ($\text{C}_2\text{H}_5\text{SH}$), 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.

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(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

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(2)

- (iii) Ethanethiol and ethanol molecules have similar shapes.

Explain why ethanol has the higher boiling point.

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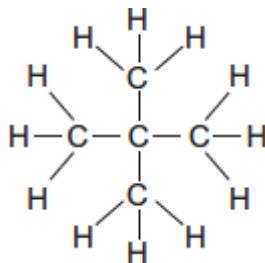
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(2)

- (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**.

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(1)

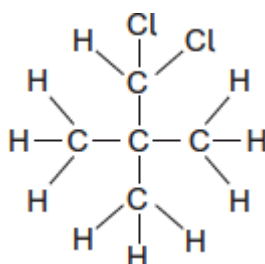
- (ii) **X** has a boiling point of 9.5 °C.

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

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(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**.

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(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

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(2)

(Total 17 marks)