

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)

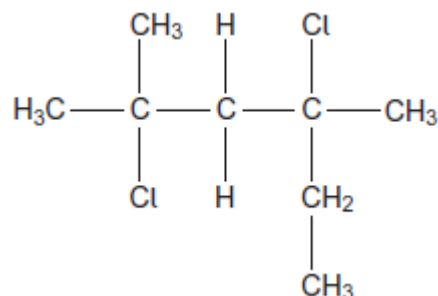
(e) There are many structural isomers with the molecular formula C_8H_{18}

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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(1)
(Total 10 marks)

Q2. How many structural isomers have the molecular formula C_4H_9Br ?

A 2

B 3

C 4

D 5

(Total 1 mark)

Q3. How many secondary amines have the molecular formula $C_4H_{11}N$?

A 2

B 3

C 4

D 5

(Total 1 mark)

Q4. Compound **J**, known as leaf alcohol, has the structural formula $CH_3CH_2CH=CHCH_2CH_2OH$ and is produced in small quantities by many green plants. The *E* isomer of **J** is responsible for the smell of freshly cut grass.

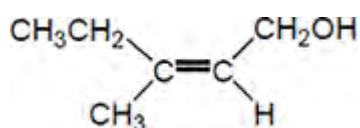
(a) Give the structure of the *E* isomer of **J**.

(1)

- (b) Give the **skeletal formula** of the organic product formed when **J** is dehydrated using concentrated sulfuric acid.

(1)

- (c) Another structural isomer of **J** is shown below.



Explain how the Cahn-Ingold-Prelog (CIP) priority rules can be used to deduce the full IUPAC name of this compound.

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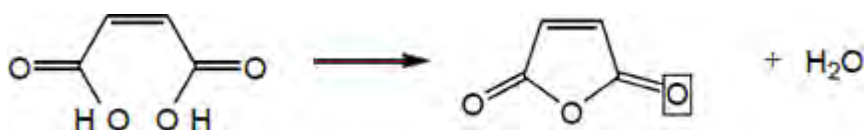
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(6)

- (d) The effect of gentle heat on maleic acid is shown below.



A student predicted that the yield of this reaction would be greater than 80%.

In an experiment, 10.0 g of maleic acid were heated and 6.53 g of organic product were obtained.

Is the student correct? Justify your answer with a calculation using these data.

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(2)
(Total 10 marks)

Q5. How many isomers have the molecular formula C_5H_{12} ?

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

(Total 1 mark)

Q6. 2-bromo-2-methylpentane is heated with potassium hydroxide dissolved in ethanol. Two structural isomers are formed.

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

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(1)

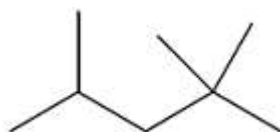
- (b) Name and draw the mechanism for the formation of **one** of the isomers.

Name of mechanism

Mechanism

(5)
(Total 6 marks)

Q7. Isooctane (C_8H_{18}) is the common name for the branched-chain hydrocarbon that burns smoothly in car engines. The skeletal formula of isooctane is shown below.



- (a) Give the IUPAC name for isooctane.

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(1)

- (b) Deduce the number of peaks in the ^{13}C NMR spectrum of isooctane.

5





(1)

- (c) Isooctane can be formed, together with propene and ethene, in a reaction in which one molecule of an alkane that contains 20 carbon atoms is cracked.

Using molecular formulas, write an equation for this reaction.

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(1)

- (d) How do the products of the reaction in part (c) show that the reaction is an example of thermal cracking?

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(1)

- (e) Deduce the number of monochloro isomers formed by isooctane.
Draw the structure of the monochloro isomer that exists as a pair of optical isomers.

Number of monochloro isomers

Structure

(2)

- (f) An isomer of isooctane reacts with chlorine to form only one monochloro compound.

Draw the **skeletal formula** of this monochloro compound.

(1)

- (g) A sample of a monochlorooctane is obtained from a comet. The chlorine in the monochlorooctane contains the isotopes ^{35}Cl and ^{37}Cl in the ratio 1.5 : 1.0. Calculate the M_r of this monochlorooctane.

$M_r = \dots\dots\dots$

(2)

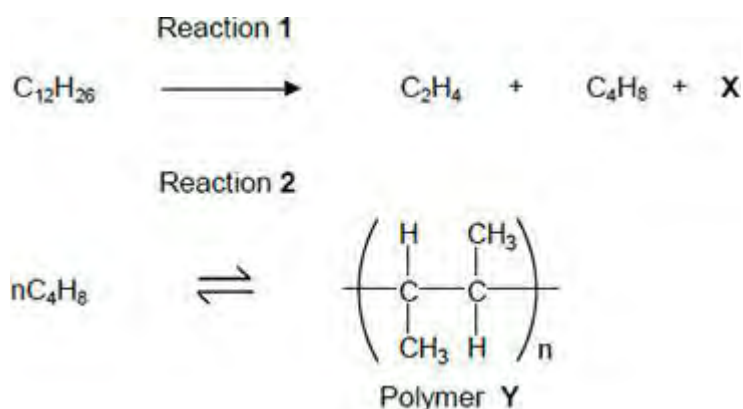
- (h) Isooctane reacts with an excess of chlorine to form a mixture of chlorinated compounds. One of these compounds contains 24.6% carbon and 2.56% hydrogen by mass. Calculate the molecular formula of this compound.

Molecular formula =

(3)

(Total 12 marks)

Q8. Dodecane ($C_{12}H_{26}$) is a hydrocarbon found in the naphtha fraction of crude oil. Dodecane can be used as a starting material to produce a wide variety of useful products. The scheme below shows how one such product, polymer **Y**, can be produced from dodecane.



- (a) Name the homologous series that both C_2H_4 and C_4H_8 belong to.
 Draw a functional group isomer of C_4H_8 that does **not** belong to this homologous series.

Name

Functional group isomer

(2)

- (b) Identify compound **X**.

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(1)

- (c) Name polymer **Y**.

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(1)

- (d) Reaction 1 is an example of thermal cracking and is carried out at a temperature of $750\text{ }^\circ\text{C}$.

State **one other** reaction condition needed.

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(1)

- (e) Reaction **2** is exothermic. A typical compromise temperature of 200 °C is used industrially for this reaction.

Explain the effect of a change of temperature on both the position of equilibrium and the rate of reaction, and justify why a compromise temperature is used industrially.

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(6)

(Total 11 marks)