

Organic chemistry

30 questions: 15 multiple choice, 15 structured.

1 Core Formulae, functional groups and terminology [1]

The general formula of a homologous series is C_nH_{2n+2} .

Which compound is a member of this homologous series?

- A C_5H_{10}
- B $C_5H_{11}OH$
- C C_4H_9COOH
- D C_5H_{12}

2 Core Formulae, functional groups and terminology [1]

Which compound is unsaturated?

- A $CH_3CH_2CH_3$
- B CH_3CH_2OH
- C $CH_2=CHCH_3$
- D CH_3COOH

3 Supplement Formulae, functional groups and terminology [1]

Which pair of structural formulae shows two compounds that are structural isomers of each other?

- A $CH_3CH(CH_3)CH_2CH_3$ and $CH_3CH_2CH_2CH_2CH_3$
- B $CH_3CH_2CH=CH_2$ and $CH_2=CHCH_2CH_3$
- C $CH_3CH_2CH_2CH_3$ and $CH_3CH=CHCH_3$
- D CH_3CH_2OH and $CH_3CH_2CH_2OH$

The table shows the molecular formulae of four compounds. Each compound belongs to a different homologous series.

Compound	Molecular formula
W	C_3H_8
X	C_3H_6
Y	$\text{C}_3\text{H}_7\text{OH}$
Z	$\text{C}_2\text{H}_5\text{COOH}$

- (a) State what is meant by the term *homologous series*. [2]

- (b) Identify the functional group present in compound Y. [1]

- (c) Compound X is an alkene. Use the general formula of the alkenes to give the molecular formula of the alkene with five carbon atoms per molecule. [1]

- (d) Compound Y is an alcohol. Use the general formula of the alcohols to give the molecular formula of the alcohol with four carbon atoms per molecule. [1]

The table shows the boiling points of five unbranched alcohols. In each alcohol the –OH group is on the carbon atom at the end of the chain. The boiling point of pentan-1-ol is not given.

Alcohol	Molecular formula	Boiling point / °C
methanol	CH ₃ OH	65
ethanol	C ₂ H ₅ OH	78
propan-1-ol	C ₃ H ₇ OH	97
butan-1-ol	C ₄ H ₉ OH	117
pentan-1-ol	C ₅ H ₁₁ OH	?

- (a) Describe the trend in boiling point shown in the table.

[1]

- (b) Predict the boiling point of pentan-1-ol.

[1]

- (c) A trend in physical properties is one characteristic of a homologous series. State **two other** characteristics of a homologous series.

[2]

- (d)

- (i) Write the structural formula of butan-1-ol.

[1]

- (ii) Explain why the molecular formula C_4H_9OH does not tell you that the compound is butan-1-ol, but a structural formula does.

[2]

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A hydrocarbon has the molecular formula C_4H_8 .

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(a) Define the term *structural isomers*. [2]

(b) Show that C_4H_8 fits the general formula of the alkenes. [1]

(c) Write the structural formulae of the **two** unbranched alkenes that have the molecular formula C_4H_8 . [2]

(d) The displayed formula of a molecule shows all of its atoms and all of its bonds. For a molecule of but-1-ene, $CH_2=CHCH_2CH_3$, state:

(i) the number of carbon–hydrogen bonds [1]

(ii) the number of carbon–carbon single bonds. [1]

7

Core

Naming organic compounds

[1]

A compound is called propene.

Which row shows the type of compound and its molecular formula?

	type of compound	molecular formula
A	alkane	C_3H_8
B	alkene	C_3H_8
C	alkene	C_3H_6
D	alcohol	C_3H_7OH

8

Supplement

Naming organic compounds

[1]

An ester used in a fruit flavouring has the structural formula $CH_3CH_2COOCH_2CH_2CH_2CH_3$.

What is the name of this ester?

- A propyl butanoate
- B butyl butanoate
- C pentyl propanoate
- D butyl propanoate

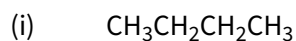
9

Supplement

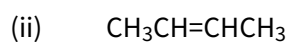
Naming organic compounds

[5]

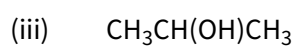
(a) Name each of the following compounds.



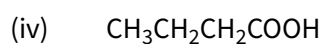
[1]



[1]



[1]



[1]

(b) Write the structural formula of butan-2-ol.

[1]

10

Core

Fuels

[1]

Which statement about petroleum is correct?

- A It is a single compound that contains only carbon and hydrogen.
- B It consists mainly of methane.
- C It is a mixture of hydrocarbons.
- D It is a mixture of compounds that contain only carbon and oxygen.

11

Core

Fuels

[1]

Petroleum is separated in a fractionating column.

How does a fraction collected near the **top** of the column compare with a fraction collected near the bottom?

	chain length	boiling point	viscosity
A	shorter	lower	lower
B	shorter	higher	lower
C	longer	lower	higher
D	shorter	lower	higher

An oil refinery separates petroleum into useful fractions.

- (a) Describe how petroleum is separated into fractions by fractional distillation. [3]

- (b) Name the fraction that is used:

- (i) as jet fuel [1]

- (ii) for making roads [1]

- (iii) as a chemical feedstock. [1]

The table gives information about four fractions, P, Q, R and S, obtained from petroleum.

Fraction	Boiling range / °C	Number of carbon atoms per molecule
P	below 40	1–4
Q	160–250	10–16
R	above 350	more than 35
S	250–350	14–20

(a)

- (i) State which fraction is collected at the top of the fractionating column. [1]

- (ii) List the four fractions in order of increasing viscosity, starting with the least viscous. [1]

- (b) State which fraction is the most volatile. Give a reason for your answer using the information in the table. [2]

- (c) One compound in fraction Q is an alkane with 12 carbon atoms per molecule. Give its molecular formula. [1]

(d) Petroleum and natural gas are two fossil fuels.

(i) Name **one** other fossil fuel. [1]

(ii) Name the main constituent of natural gas. [1]

14 **Supplement** Alkanes

[1]

A mixture of ethane and chlorine is exposed to ultraviolet light. One hydrogen atom in each ethane molecule is replaced.

Which statement about this reaction is correct?

- A** It is an addition reaction and $\text{C}_2\text{H}_5\text{Cl}$ is the only product.
- B** It is a substitution reaction, the ultraviolet light acts as a catalyst, and the products are $\text{C}_2\text{H}_5\text{Cl}$ and H_2 .
- C** It is a substitution reaction, and the products are $\text{C}_2\text{H}_4\text{Cl}_2$ and H_2 .
- D** It is a substitution reaction, the ultraviolet light provides the activation energy, and the products are $\text{C}_2\text{H}_5\text{Cl}$ and HCl .

Propane, C_3H_8 , is an alkane. It is used as a fuel for camping stoves.

- (a) Explain why propane is described as a *saturated hydrocarbon*.

[2]

- (b) Alkanes are generally unreactive. Name the **two** types of reaction that alkanes do undergo.

[2]

- (c) Propane reacts with chlorine in the presence of ultraviolet light. Only one hydrogen atom in each propane molecule is replaced.

- (i) Write the balanced equation for this reaction, using molecular formulae.

[1]

- (ii) Two different organic products with the molecular formula $\text{C}_3\text{H}_7\text{Cl}$ can form. Write the structural formulae of **both** products.

[2]

- (iii) State the role of the ultraviolet light in this reaction.

[1]

16**Core**

Alkenes

[1]

Aqueous bromine is added to a sample of hexane and to a sample of hexene. Each mixture is shaken.

Which row shows the observations?

	hexane	hexene
A	orange to colourless	stays orange
B	stays orange	orange to colourless
C	orange to colourless	orange to colourless
D	stays orange	colourless to orange

17**Supplement**

Alkenes

[1]

Which reaction of but-2-ene, $\text{CH}_3\text{CH}=\text{CHCH}_3$, forms butane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$?

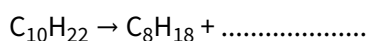
- A addition of bromine
- B addition of steam in the presence of an acid catalyst
- C addition of hydrogen in the presence of a nickel catalyst
- D heating strongly with a catalyst

Decane, $C_{10}H_{22}$, is a long-chain alkane. It can be cracked to make smaller molecules.

- (a) State the **two** conditions used for cracking.

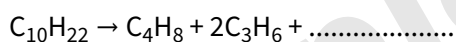
[2]

- (b) Complete the equation for one way in which decane can crack.



[1]

- (c) A different molecule of decane cracks to form two different alkenes and one other product. Complete the equation.



[1]

- (d) Describe **two** reasons why oil refineries crack larger alkane molecules.

[2]

But-2-ene, $\text{CH}_3\text{CH}=\text{CHCH}_3$, undergoes addition reactions.

- (a) State what is meant by an *addition reaction*, in terms of the number of products formed. [1]

- (b) Write the structural formula of the product formed when but-2-ene reacts with:

- (i) bromine [1]

- (ii) hydrogen in the presence of a nickel catalyst [1]

- (iii) steam in the presence of an acid catalyst. [1]

- (iv) Name the product formed in (iii). [1]

- (c) Explain why but-2-ene reacts with bromine at room temperature but butane does not. [2]

Which conditions are used to make ethanol by fermentation of aqueous glucose?

	temperature / °C	other conditions
A	30	yeast, oxygen absent
B	30	yeast, oxygen present
C	300	acid catalyst, 6000 kPa
D	80	yeast, oxygen absent

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21

Core

Alcohols

[6]

Ethanol, $\text{C}_2\text{H}_5\text{OH}$, is made on a large scale and has several uses.

(a) State **two** uses of ethanol.

[2]

(b) Write the balanced equation for the complete combustion of ethanol.

[2]

(c) When ethanol burns in a limited supply of air, a toxic gas can be produced. Name this toxic gas.

[1]

(d) Ethanol can be made by the fermentation of aqueous glucose. Name the other product of fermentation.

[1]

Ethanol can be manufactured by two methods:

- method 1: fermentation of aqueous glucose obtained from sugar cane
- method 2: catalytic addition of steam to ethene obtained from petroleum

(a) State the conditions used in method 2.

[2]

(b) Write the equation for the reaction in method 2.

[1]

(c) Describe **two** advantages and **two** disadvantages of method 1 compared with method 2.

[4]

Ethanoic acid reacts with calcium carbonate.

Which row shows the formula of the salt formed and the gas given off?

	formula of salt	gas given off
A	CH_3COOCa	carbon dioxide
B	$(\text{CH}_3\text{COO})_2\text{Ca}$	carbon dioxide
C	$(\text{CH}_3\text{COO})_2\text{Ca}$	hydrogen
D	CH_3COOCa	hydrogen

Ethanoic acid can be made from ethanol.

- (a) In the laboratory, ethanol is oxidised to ethanoic acid by warming it with acidified aqueous potassium manganate(VII). State the colour change seen. [2]

- (b) State how ethanol is converted to ethanoic acid during the production of vinegar. [1]

- (c) Ethanoic acid reacts with zinc. Name the **two** products. [2]

- (d) Ethanoic acid reacts with methanol when they are warmed with an acid catalyst.

- (i) Name the ester formed. [1]

- (ii) Write the structural formula of this ester. [1]

(iii) Name the other product of the reaction.

[1]

25

Core

Polymers

[1]

Which statement is correct?

- A Polymers are small molecules made by joining together many large molecules.
- B Polymers are large molecules built up from many smaller molecules called monomers.
- C Monomers are large molecules built up from many smaller molecules called polymers.
- D Plastics are made from monomers that have not been joined together.

26

Supplement

Polymers

[1]

The repeat unit of an addition polymer used to make water pipes is $-\text{[CH}_2\text{-CHCl]}-$.

What is the monomer?

- A $\text{CH}_3\text{CH}_2\text{Cl}$
- B CHCl=CHCl
- C $\text{CH}_2=\text{CCl}_2$
- D $\text{CH}_2=\text{CHCl}$

27

Supplement

Polymers

[1]

Which statement describes a difference between addition polymerisation and condensation polymerisation?

- A In condensation polymerisation a small molecule such as water is formed as well as the polymer, but in addition polymerisation the polymer is the only product.
- B In addition polymerisation a small molecule such as water is formed as well as the polymer, but in condensation polymerisation the polymer is the only product.
- C Condensation polymerisation needs monomers that contain $\text{C}=\text{C}$ double bonds, but addition polymerisation does not.
- D Addition polymers contain amide or ester linkages, but condensation polymers do not.

Poly(ethene) is used to make carrier bags and food packaging.

- (a) Describe how poly(ethene) is formed from ethene. [2]

- (b) Poly(ethene) is unreactive and is not broken down by bacteria. Explain how these properties cause a problem when used poly(ethene) is put into landfill sites. [2]

- (c) Describe **one** problem caused when plastics accumulate in the oceans. [1]

- (d) State why burning plastic waste can harm people and the environment. [1]

A polymer used in biodegradable packaging is made from two monomers:

- butanedioic acid, $\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{COOH}$
- ethane-1,2-diol, $\text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$

(a)

- (i) State the type of polymerisation that occurs. [1]

- (ii) Name the small molecule that is formed at the same time as each linkage. [1]

- (b) Write the repeat unit of this polymer as a structural formula. [2]

- (c) Name the type of linkage in this polymer. [1]

- (d) Butanedioic acid can also react with the diamine $\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}_2$ to form a polyamide. Write the structural formula of the linkage in this polyamide. [1]

30

Supplement

Polymers

[5]

- (a) Propene, $\text{CH}_2=\text{CHCH}_3$, forms the addition polymer poly(propene). Write the repeat unit of poly(propene) as a structural formula. [2]

- (b) The addition polymer used as a non-stick coating has the repeat unit $-\text{[CF}_2\text{-CF}_2\text{]}-$. Deduce the structural formula of its monomer. [1]

- (c) PET is a polyester used to make drinks bottles. Describe how PET can be chemically recycled so that it can be used to make new PET. [2]
