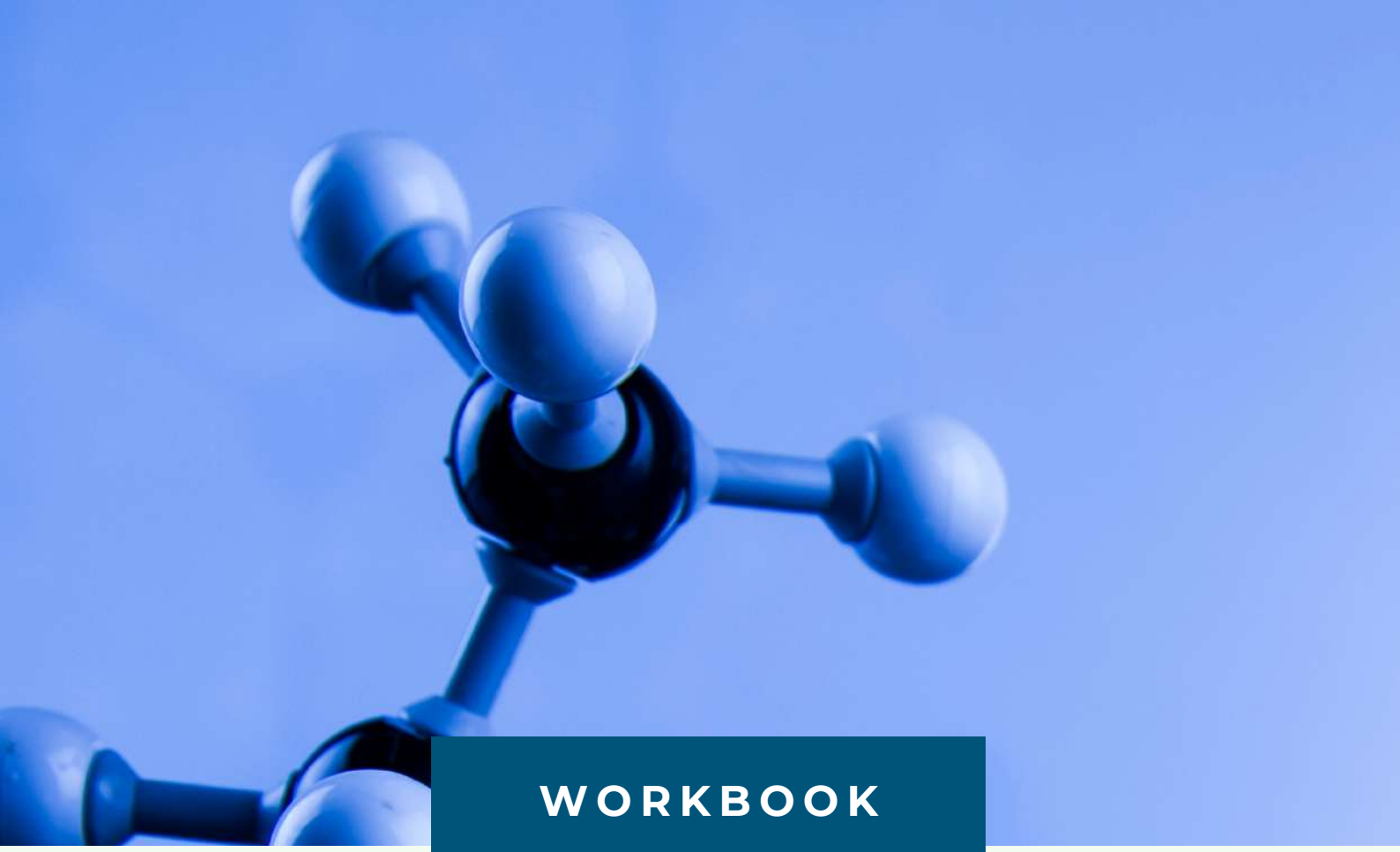


WORKBOOK

Online Chem Tuition

Organic Chemistry

TOPIC SEVEN

9TH APRIL

HELLO!

Welcome to your AQA GCSE Chemistry revision session. This workbook is designed to be straightforward and directly aligned with what I'll cover in the live lesson, it offers a practical way to apply your knowledge as you learn.

What's in the Workbook:

- **Questions**: These are selected to match the lesson topic, providing you with a chance to practice and solidify your understanding.
- **Symbols Guide**:
  HT - Indicates advanced content aimed at **Higher Tier** students.

  - Signifies material for **GCSE Chemistry** students only.

Using the Workbook During Lesson:

- **Stay Engaged**: Be ready to participate and use the workbook alongside the lesson. You can use the chat to ask questions or get help.
- **Peer Learning**: Take advantage of the group setting. Your classmates' questions can provide additional insights.

Zoom Lesson:

Make sure you have your workbook and a pen ready and join us here.

See you on Zoom!

ALISON GREEN

Online Chem Tuition

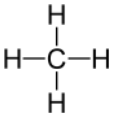
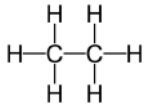
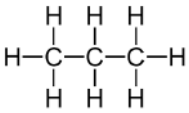
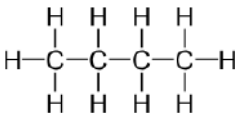
CARBON COMPOUNDS AS FUELS/FEEDSTOCKS

CRUDE OIL AND HYDROCARBONS

Crude oil is a **finite resource** found in rocks. Crude oil is the remains of an ancient biomass consisting mainly of plankton that was buried in mud. Crude oil is a mixture of a very large number of compounds. Most of the compounds in crude oil are **hydrocarbons**, which are molecules **made up of hydrogen and carbon atoms only.**

ALKANES

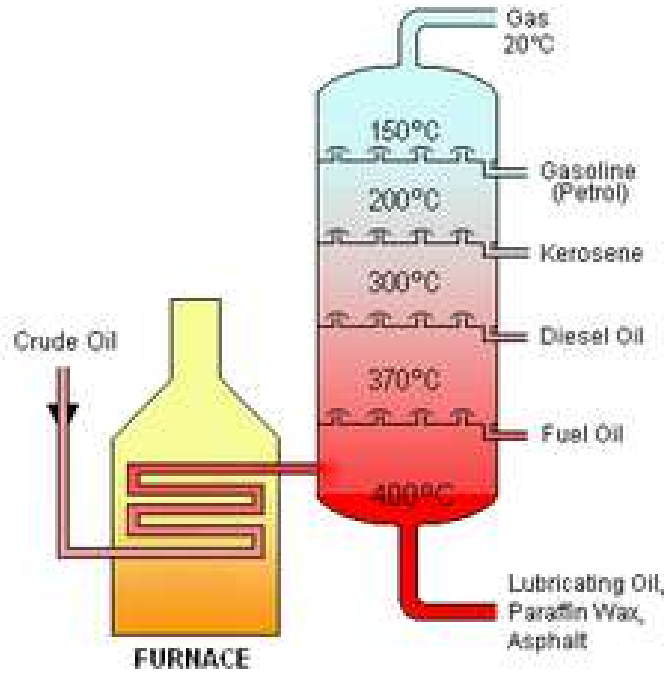
Most of the hydrocarbons in crude oil are alkanes.
The **general formula** for the homologous series of alkanes is $\mathbf{C_nH_{2n+2}}$
The first four members of the alkanes are methane, ethane, propane and butane.

methane	CH_4	
ethane	C_2H_6	
propane	C_3H_8	
butane	C_4H_{10}	

PHYSICAL PROPERTIES

· **Boiling points and viscosity** of hydrocarbons increase as the **molecules get bigger** (because the **intermolecular forces become larger** as the molecules become bigger).
· **Flammability** of the hydrocarbons **decreases** as the **molecules get bigger**.

FRACTIONAL DISTILLATION



The many hydrocarbons in crude oil may be separated into **fractions**, each of which contains molecules with a similar number of carbon atoms, by **fractional distillation.**
The fractions can be processed to produce **fuels and feedstock** for the petrochemical industry.

1. Oil is heated until it **evaporates** and then passed into a column.
2. The vapours rise through a column, which is hot at the bottom, and cooler at the top.
3. The vapours **condense** when they reach a part of the column that is below the temperature of their boiling point and flow out of the column in a pipe
4. Some vapours stay as gases and rise out the top of the column

Each fraction has a different boiling point and condenses at different levels in the fractionating column

COMBUSTION OF HYDROCARBONS

The combustion of hydrocarbon fuels releases energy. During combustion, the carbon and hydrogen in the fuels are oxidised. The complete combustion of a hydrocarbon produces carbon dioxide and water.

hydrocarbon + oxygen → carbon dioxide + water

e.g. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

CRACKING AND ALKENES

Hydrocarbons can be broken down (cracked) to produce smaller, more **useful molecules**.
The **cracking** process involves heating the hydrocarbons to vaporise them. The vapours are either · passed over a hot catalyst · or mixed with steam and heated to a very high temperature.

The **products** of cracking include **alkanes** and another type of hydrocarbon called **alkenes**.

Heptane → Propane + Butene

$C_7H_{16} \rightarrow C_3H_8 + C_4H_8$

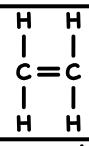
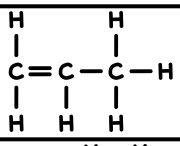
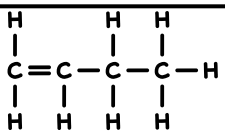
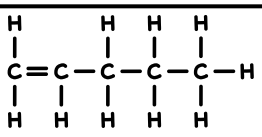
There is a high demand for fuels with small molecules and so some of the products of cracking are useful as fuels. Alkenes are used to produce polymers and as starting materials for the production of many other chemicals.

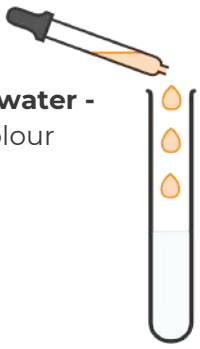
ALKENES

Hydrocarbons with a **double carbon-carbon bond**. The general formula for the homologous series of alkenes is $\mathbf{C_nH_{2n}}$
Alkene molecules are **unsaturated** because they contain two fewer hydrogen atoms than the alkane with the same number of carbon atoms.

The first four members of the homologous series of alkenes are ethene, propene, butene and pentene.

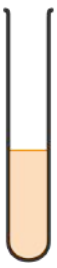
Alkenes are **more reactive than alkanes** and react with bromine water, which is used as a test for alkenes.

ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	
pentene	C_5H_{10}	



Bromine water - orange colour

Alkane



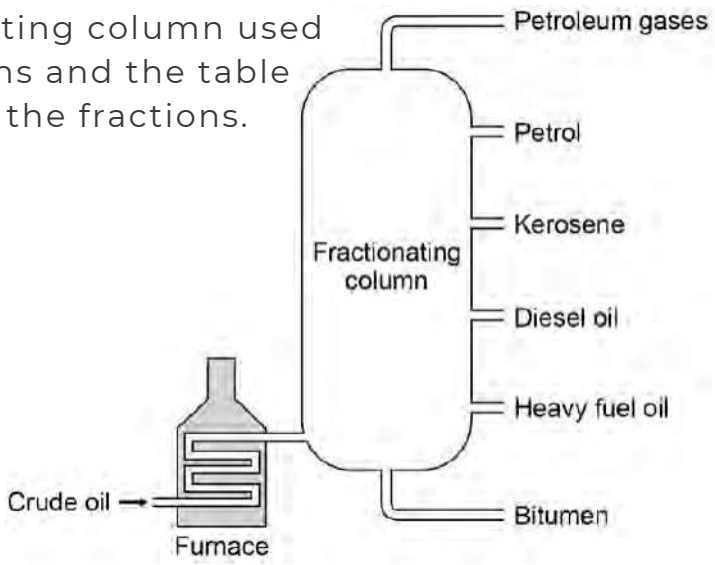
no change - bromine water stays orange

Alkene

decolourises bromine water

The diagram shows the fractionating column used to separate crude oil into fractions and the table gives information about some of the fractions.

Fraction	Boiling point range in °C
Petroleum gases	Below 30
Petrol	40–110
Kerosene	180–260
Diesel oil	260–320
Heavy fuel oil	320–400
Bitumen	400–450



Q1.a) Use the table to explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

[2 marks]

AQA June 19 H Q1.2

Q1.b) Suggest two reasons why bitumen is not used as a fuel.

[2 marks]

AQA June 19 H Q1.3

Q1.c) Petrol contains mainly alkanes. Which of the following compounds is an alkane?

C_2H_4 C_4H_8 C_6H_{14} C_8H_{16}

[1 mark]

AQA June 19 H Q1.4

Q1.d) Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules. Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

[2 marks]

AQA June 19 H Q1.5

Q1.d) Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

[2 marks]

AQA June 19 H Q1.6

Q1.d) Balance the equation for the combustion of methane to produce carbon monoxide.

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + \_\_\_\_\_$$

[1 mark]

AQA June 19 H Q1.7

Crude oil is separated into fractions by fractional distillation. The fractions obtained from crude oil include: • lubricating oil • naphtha • petroleum gases. The table shows the boiling point range of these fractions.

Fraction	Boiling point range in °C
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Q2.a) Explain how these fractions are obtained from crude oil by fractional distillation.

[4 marks]

AQA June 20 H Q4.1

Q3.a) When methane burns it can produce both carbon monoxide and carbon dioxide. Explain the process by which carbon monoxide can be produced when methane is burned.

[2 marks]

AQA June 19 H Q5.2

Q3.b) Balance the equation for the combustion of methane to produce carbon monoxide

$$\_\_\_ CH_4(g) + \_\_\_ O_2(g) \rightarrow \_\_\_ CO(g) + \_\_\_ H_2O(l)$$

[1 mark]

AQA June 19 H Q5.3

Q4.) Complete the equation for the complete combustion of C_9H_{20}.

$$C_9H_{20} + \_\_\_\_\_ \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

[2 marks]

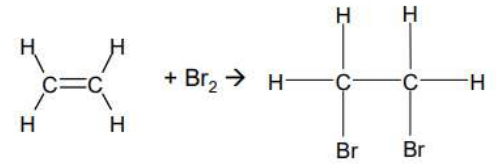
AQA June 21 H Q4.3

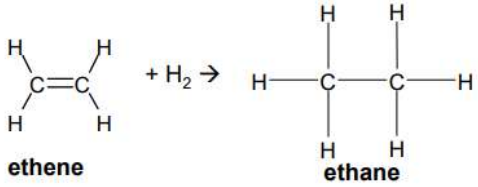
REACTIONS OF ALKENES AND ALCOHOLS

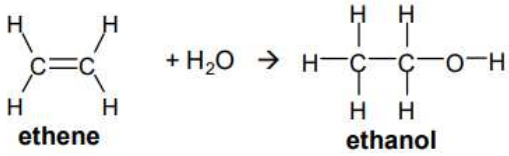
REACTION OF ALKENES

Alkenes are hydrocarbons with the functional group C=C. It is the generality of reactions of functional groups that determine the reactions of organic compounds.
Alkenes react with oxygen in combustion reactions in the same way as other hydrocarbons, but they tend to burn in air with smoky flames because of incomplete combustion.

Alkenes react with hydrogen, water and the halogens, by the addition of atoms across the carbon-carbon double bond so that the double bond becomes a single carbon-carbon bond.

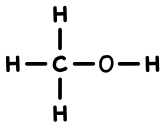
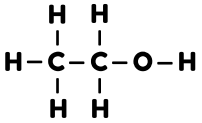
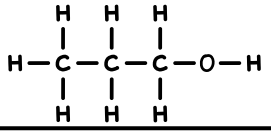
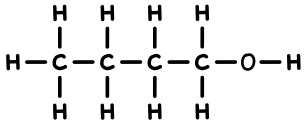






ALCOHOLS

Alcohols contain the functional group –OH. Methanol, ethanol, propanol and butanol are the first four members of a homologous series of alcohols.

methanol	CH_3OH	
ethanol	CH_3CH_2OH	
propanol	$CH_3CH_2CH_2OH$	
butanol	$CH_3CH_2CH_2CH_2OH$	

REACTIONS

- dissolve in water to form a **neutra**l solution
- react with **sodium** to produce **hydrogen**
- burn in air e.g. $CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

Alcohols can be oxidised to **carboxylic acids** by oxidising agents (such as potassium dichromate)
Ethanol can be oxidised to ethanoic acid, either by chemical oxidising agents, or by oxygen in the air

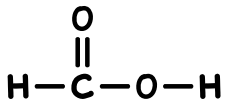
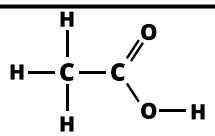
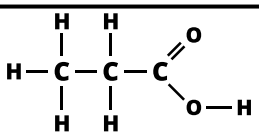
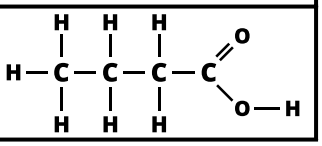
Aqueous **solutions of ethanol** are produced when **sugar solutions are fermented using yeas**t.

glucose → ethanol + carbon dioxide
$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$

The conditions needed are:
- yeast
- no air
- temperatures 30 – 40°C

CARBOXYLIC ACIDS

Carboxylic acids have the functional group –COOH.
The first four members of a homologous series of carboxylic acids are methanoic acid, ethanoic acid, propanoic acid and butanoic acid..

methanoic acid	HCOOH	
ethanoic acid	CH_3COOH	
propanoic acid	CH_3CH_2COOH	
butanoic acid	$CH_3CH_2CH_2COOH$	

REACTIONS

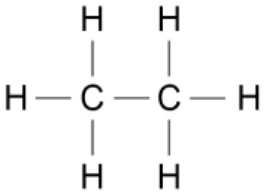
• dissolve in water to produce acidic solutions
• react with carbonates to produce carbon dioxide
• react with alcohols in the presence of an acid catalyst to produce esters.
Ethyl ethanoate is the ester produced from ethanol and ethanoic acid
.
Carboxylic acids do not ionise completely when dissolved in water and so are weak acids.
Aqueous solutions of weak acids have a higher pH value than aqueous solutions of strong acids with the same concentration.

Q5.a) Bromine water is added to hexane and to hexene. What would be observed when bromine water is added to hexane and to hexene?

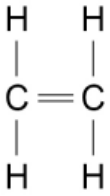
[2 marks]

AQA June 20 H Q3.2

Q5.b) Ethane is an alkane and ethene is an alkene. Below is the displayed structural formulae of ethane and of ethene



Ethane



Ethene

Compare ethane with ethene. You should refer to:
• their structure and bonding • their reactions.

[6 marks]

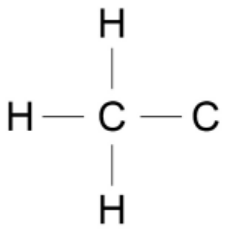
AQA June 20 H Q3.3

Q6.a) Describe how ethanol is produced from sugar solution. Give the name of this process.

[3 marks]

AQA June 18 H Q2.5

Q6.b) Below is part of the displayed formula for ethanol.
Complete the diagram.



[1 mark]

AQA June 18 H Q2.6

Q6.c) Name the gas produced when sodium is added to ethanol.

[1 mark]

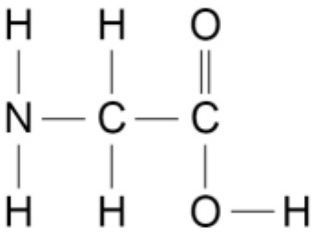
AQA June 18 H Q2.7

Q6.d) Methanol is used to produce methanoic acid. What type of substance reacts with methanol to produce methanoic acid?

[1 mark]

AQA June 18 H Q2.7

The structural formula for glycine is



Q7. How many functional groups are there in the molecule.

1 ☐ 2 ☐ 3 ☐ 4 ☐

[1 mark]

AQA June 20 H Q6.1

Q8.a) Carboxylic acids belong to a homologous series. The table shows information about the first three carboxylic acids in this homologous series. Complete the table.

Name	Formula	pH of a 0.01 mol/dm^3 solution
Methanoic acid		2.91
Ethanoic acid	CH_3COOH	3.39
	CH_3CH_2COOH	3.44

[2 marks]

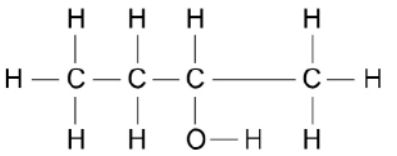
AQA June 20 H Q7.1

Q8.b) Give the name of the ester produced when ethanoic acid reacts with ethanol.

[1 mark]

AQA June 20 H Q7.5

Q8.c) Ethanoic acid and ethanol join together to produce an ester. Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?



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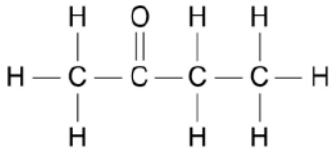

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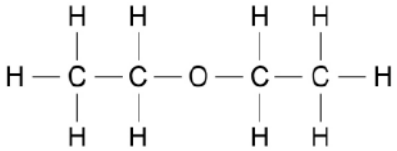

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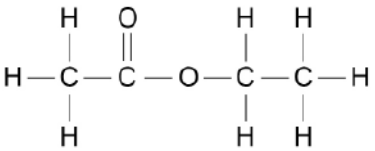


☐

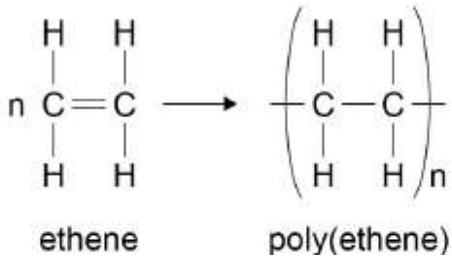
[1 mark]

AQA June 20 H Q7.6

POLYMERS

ADDITION POLYMERISATION.

Alkenes can be used to make polymers such as poly(ethene) and poly(propene) by addition polymerisation. In addition polymerisation reactions, many small molecules (monomers) join together to form very large molecules (polymers).



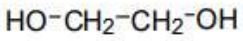
In addition polymers the repeating unit has the same atoms as the monomer because no other molecule is formed in the reaction.

HT CONDENSATION POLYMERS

Condensation polymerisation involves monomers with two functional groups. When these types of monomers react they join together, usually losing small molecules such as **water**, and so the reactions are called condensation reactions.
The simplest polymers are produced from two different monomers with two of the same functional groups on each monomer.

For example:

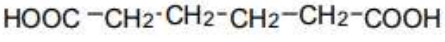
Monomer 1



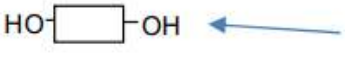
ethanediol

reacts with

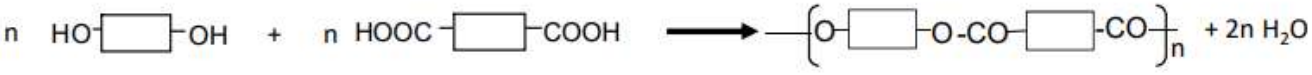
Monomer 2



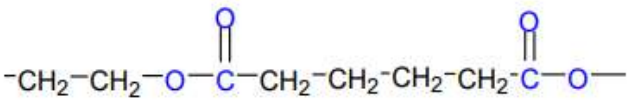
Hexanedioic acid



Polymerise to form a polyester

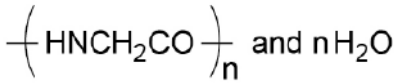


This shows the main bonds present in the repeating unit.
Learn the ester linkage.
This is a poly(ester)



HT AMINO ACIDS

Amino acids have two different functional groups in a molecule. Amino acids react by condensation polymerisation to produce polypeptides.
For example: glycine is H_2NCH_2COOH and polymerises to produce the polypeptide



Different amino acids can be combined in the same chain to produce proteins.

NATURAL POLYMERS

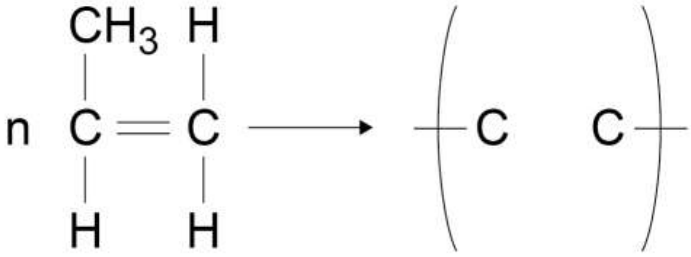
Monomer	Polymer
Nucleotide	DNA
Amino acid	Protein
Glucose	Starch
Glucose	Cellulose

Q9.a) Polyesters are produced when monomers join together and lose a small molecule. Name the small molecule lost.

[1 mark]

AQA June 18 H Q6.1

Q9.b) Below is part of the displayed formula for ethanol.
Complete the diagram.

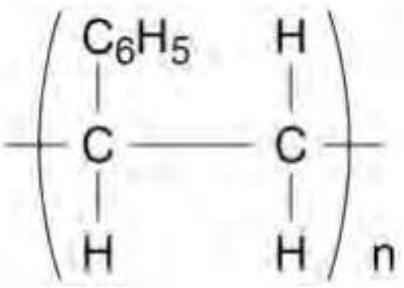


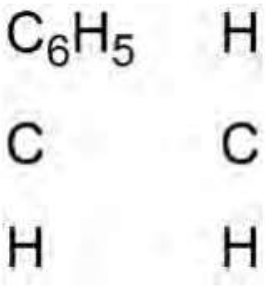
[3 marks]

AQA June 18 H Q6.2

Q10.a) To the right is the displayed structural formula of poly(styrene).

Complete the displayed structural formula of the monomer styrene.





[2 marks]

AQA June 19 H Q6.1

Two monomers, A and B, are needed to make the polyester. The diagram shows how these two monomers are represented.

Monomer **A** Monomer **B**

Q10.b) Name the functional group in monomer B.

[1 mark]

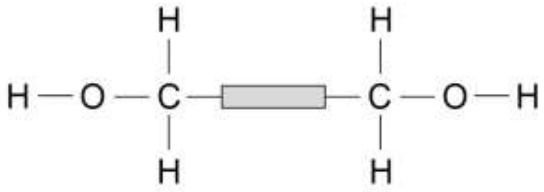
AQA June 19 H Q6.2

Q10.b) Monomers A and B join together to produce a polyester and a small molecule. Name the small molecule.

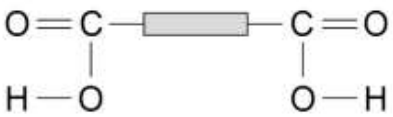
[1 mark]

AQA June 19 H Q6.3

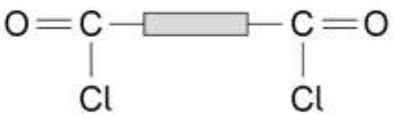
Below are three monomers, A, B and C. Monomer A can react with monomer B and with monomer C to produce polyesters.



Monomer **A**



Monomer **B**



Monomer **C**

Q11.a) Draw a circle above around an alcohol functional group. **[1 mark]**

AQA June 21 H Q4.5

Q11.b) Complete table to show the formula of the small molecule produced when:

- monomer A reacts with monomer B
- monomer A reacts with monomer C.

Reacting monomers	Formula of small molecule produced
A and **B**	
A and **C**	

[1 mark]

AQA June 21 H Q4.6

ADDITIONAL RESOURCES

Congratulations on completing the workbook!

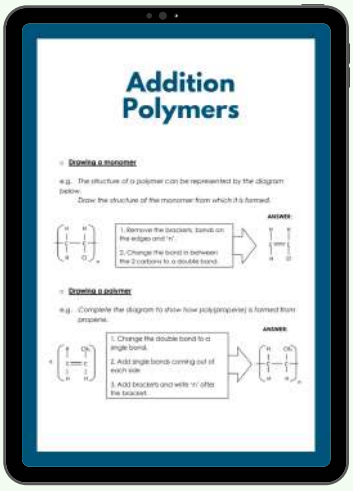
To further enhance your understanding and support your revision, I've curated a list of additional FREE resources.

VIDEO

POLYMERS

This Facebook Live recording goes through polymerisation

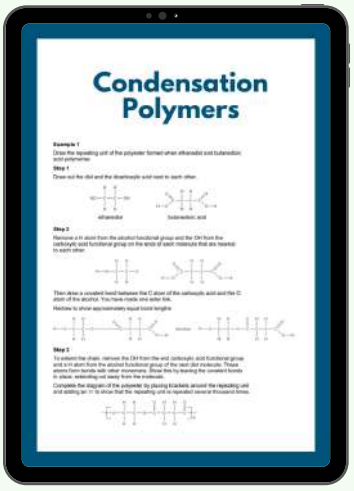
ACCESS NOW



ADDITION POLYMERS

ACCESS NOW

WORKSHEET



CONDENSATION POLYMERS

ACCESS NOW