AQA Chemistry Unit 10 & 11

Organic Reactions and Polymers – Chemistry Only

Crompton House Chemistry

ORGANIC REACTIONS		Learned it	Revised it
1	I can name the first five alkenes		
2	I can describe the combustion reactions of alkenes and reactions of alkenes with hydrogen, water, and halogens		
3	I can state the functional group of alcohols, carboxylic acids and the first four members of the homologous series of alcohols and I can represent alcohols using formulae		
4	I can describe some properties and reactions of the first four members of alcohols, including dissolving in water, reacting with sodium, burning in air, oxidation and their use as fuels, solvents and alcoholic drinks		
5	I can describe some properties and reactions if carboxylic acids, including dissolving in water, reacting with carbonates, and reacting with alcohols to make esters		

Polymers		Learned it	Revised it
1	I can describe, draw, and identify addition polymers		
2	I can describe the process of condensation polymerisation		
3	I can explain how amino acids react by condensation polymerisation to produce polypeptides		
4	I can describe DNA as a large molecule of two polymer chains		
5	I can state and describe some other naturally occurring polymers such as proteins, starch and cellulose		

DODDLE QUIZZES

AQA Alcohols: _____%

AQA Carboxylic Acids and Esters: _____%

AQA Making Polymers: _____%

AQA Polymers Extension: _____%

Kerboodle Extension Quizzes

Positive Points/postcards for completion

C10 Homework: Organic reactions 1 _____%

C10 Homework: Organic reactions 2 _____%

C10 Progress Quiz: Organic reactions 1 _____%

C10 Progress Quiz: Organic reactions 2 _____%

C10 Checkpoint quiz: Organic reactions _____%

C11 Homework: Polymers _____%

C11 Progress Quiz: Organic reactions 1 _____%

C11 Progress Quiz: Organic reactions 2 _____%

C11 Checkpoint quiz: Polymers _____%

Self-Reflection

WWW:

EBI:

Checked by Teacher:

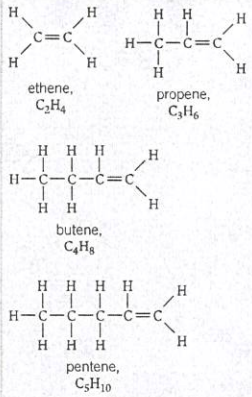
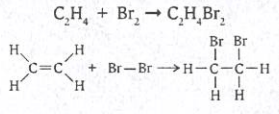
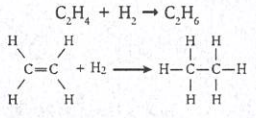
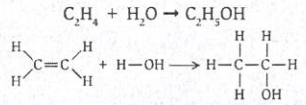
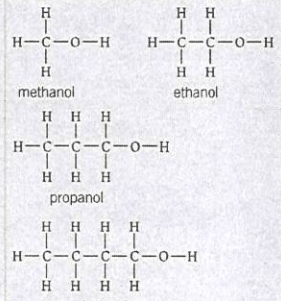
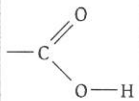
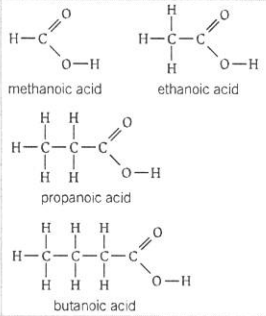
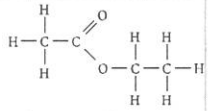
Date:

Chapter 10: Organic reactions

Knowledge organiser

Organic chemistry

There are lots of different 'families' of carbon-containing compounds, for example, alkanes and **alkenes**. These families are called a **homologous series**. Each compound within a homologous series has similar properties and reactions. They all contain specific atoms in specific orders, called the **functional group**.

Homologous series	Functional group	First four of homologous series	Formation	Uses	Combustion reaction	Other reactions	Other information
alkenes		 ethene, C_2H_4; propene, C_3H_6; butene, C_4H_8; pentene, C_5H_{10}	cracking	• formation of polymers • a chemical feedstock	• complete combustion produces carbon dioxide and water • incomplete combustion more likely, resulting in a smoky yellow flame • both types of alkene combustion release less energy per mole than alkanes	**Addition with halogens** The two atoms from the halogen molecule are *added* across the carbon – carbon double bond.  **Addition with hydrogen** The two atoms from the hydrogen molecule are *added* across the carbon – carbon double bond to form an alkane.  **Addition with steam** React with steam at high temperature and pressure in the presence of a catalyst to form alcohols. 	Alkenes are called **unsaturated** because they have double bonds. As such, atoms can be added to the molecule by breaking the double bond. This contrasts with alkanes which are called **saturated** as there is no space to add more atoms. Alkenes have a general formula C_nH_{2n}.
alcohols	–OH	 methanol; ethanol; propanol; butanol	Ethanol can be formed from the **fermentation** of sugar – warm a sealed mixture of yeast and a sugar solution. glucose → ethanol + carbon dioxide $C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$	• *ethanol* is used in alcoholic drinks • first four alcohols mix easily with water, so are used as solvents for substances that don't dissolve in water • common in perfumes, aftershaves and mouthwashes	• short alcohols are very effective fuels and combust easily, burning with a blue flame and producing carbon dioxide and water $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$	**Reaction with sodium** Alcohols react with sodium to release hydrogen. The product from this reaction is called an **alkoxide**, which if added to water forms a strongly alkaline solution. **Oxidation** Alcohols can react with **oxidising agents**, like potassium dichromate, to form carboxylic acids.	Alcohols are highly flammable and must not be handled near naked flames.
carboxylic acids		 methanoic acid; ethanoic acid; propanoic acid; butanoic acid	oxidation of alcohols	• ethanoic acid is used in vinegar	• carboxylic acids can undergo combustion, but we do not generally do this or use them as a fuel	Carboxylic acids react in the same way as other acids. **Reaction with sodium carbonate** Carboxylic acids react with bases to form salts. For example, carboxylic acids react with a metal carbonate to produce a salt, carbon dioxide, and water. **Reaction with alcohols** Carboxylic acids react with alcohols to make water and **esters**. The reaction requires sulfuric acid as a catalyst.  Esters have distinctive smells and are used in perfumes and flavourings. The product of ethanol and ethanoic acid is ethyl ethanoate.	(HT only) When added to water, carboxylic acids are partially ionised to form weakly acidic solutions. They are weak acids.

Key terms Make sure you can write a definition for these key terms.

addition reaction · alcohols · alkene · alkoxide · carboxylic acid · ester · fermentation · cracking · functional group · homologous series · oxidation · oxidising agent · saturated · unsaturated

Chapter 11: Polymers

Knowledge organiser

Polymers

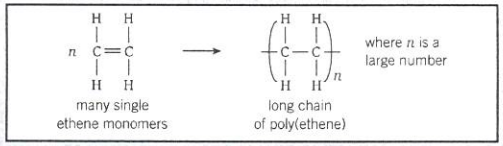
Polymers are very long molecules made up of lots of smaller molecules joined together in a repeating pattern. The smaller molecules are called **monomers**. The process of turning many monomers into a polymer is called polymerisation.

There are two main types of polymerisation.

Type of polymerisation	Monomers	Products of polymerisation
addition polymerisation	molecules with C=C bonds, such as alkenes	just the polymer
condensation polymerisation	diols, dicarboxylic acids, or diamines	polymer and water

Addition polymerisation

Addition polymerisation starts with molecules with a C=C bond (e.g., alkenes) as the monomer. The carbon-carbon double bond breaks in each molecule, and the carbon atoms then link together.



The n refers to a large number of molecules. The rounded brackets and the bonds sticking out of them represent where the next molecule in the chain goes.

The inside of the brackets is known as the **repeating unit** – the section that repeats over and over again many thousands of times in the polymer.

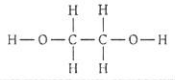
Addition polymers are named after the monomer used to create them.

- An addition polymer made of ethene is called poly(ethene).
- An addition polymer made of propene is called poly(propene).

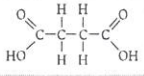
Condensation polymerisation (HT only)

Condensation polymerisation can involve two different monomers, each has *two* functional groups.

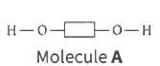
Molecule **A** is a diol. It has two –OH groups: one at either end.

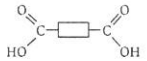


Molecule **B** is a **dicarboxylic acid**. It has a carboxylic acid group at either end.

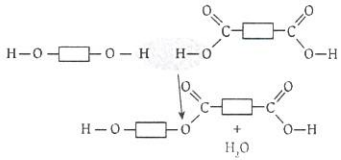


To simplify the diagrams, a rectangle is used to represent  .

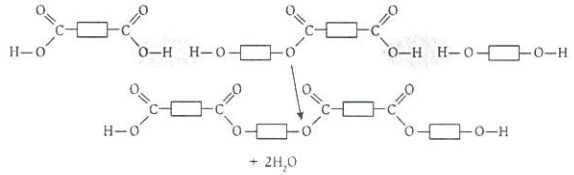

Molecule **A**


Molecule **B**

When molecule **A** and molecule **B** react together, the –OH group from the carboxylic acid and a hydrogen atom from the –OH group on the alcohol join together to form water.

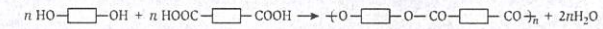


Another molecule **B** and another molecule **A** can now react with either side of the molecule that has been formed.



You could keep adding more molecules in the pattern ABABABABA. Every time a molecule is added, a water molecule is produced. This type of reaction is called a **condensation reaction**.

If you keep adding molecules, a condensation polymer is produced. This is represented by:



When diols (compounds with two –OH groups) and dicarboxylic acids react together, they form polyesters.

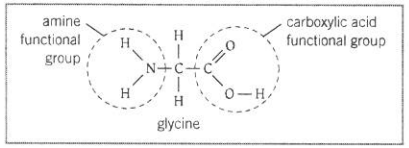
Natural polymers

Amino acids and proteins (HT only)

Condensation reactions can also happen with just one monomer molecule, so long as the molecule has two different functional groups.

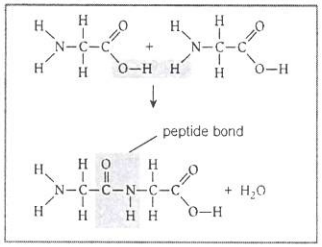
Amino acids have an **amine** functional group and a carboxylic acid functional group. The amine functional group has a nitrogen bonded to a carbon and two hydrogens.

Glycine is the simplest amino acid.



When many molecules of glycine react together they form a **polypeptide**.

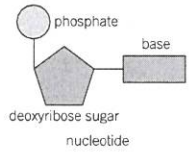
There are many different types of amino acids. They can react together to form many different polypeptides. When lots of polypeptides come together they form something called a **protein**.



DNA

All genetic information is stored in **DNA**. Genetic information contains the instructions for the functioning and development of living organisms.

DNA is made of two long polymers that wind around each other in a double helix. The polymers are made of four different monomers called **nucleotides**.



Starch and cellulose

Starch and cellulose are another two **natural polymers**. Both of these are made from glucose molecules joined together. Whether the resulting polymer is starch or cellulose depends on how the glucose molecules form chains with each other.

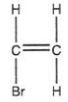
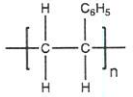
Key terms

Make sure you can write a definition for these key terms.

addition polymerisation · amine · amino acid · condensation polymerisation · DNA · monomer · natural polymer · nucleotide · polymer · polypeptide · protein · repeating unit

ORGANIC 5

1) Addition polymers can be made from alkenes. Complete the table about some addition polymers. (10)

Monomer		Polymer		
Name	Structure	Name	Structure	Repeating unit
bromoethene				
		poly(styrene)		
propene				

2) Many polymers are thermosoftening while others are thermosetting.

a) How do these two types of polymers act on heating? .....

.....

.....

..... (2)

b) Explain the difference in their behaviour in terms of structure and bonding. .....

.....

.....

.....

.....

..... (2)

3) What is the difference in how addition and condensation polymers are formed?

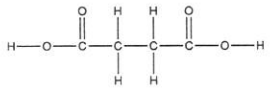
.....

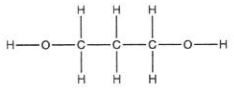
.....

.....

..... (2)

4) The following two monomers react together to form a polyester.

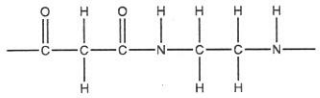




Draw the repeating unit of the polyester.

(2)

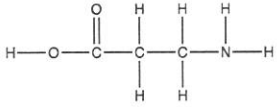
5) The following polyamide can be made from two monomers.



Draw the displayed structure of the two monomers.

(2)

6) The following amino acid can be polymerised.



Draw the repeating unit of the polymer.

(2)

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can draw polymer repeating units			How addition / condensation formed		
Good SPG			Can name monomers & polymers			Repeating unit of condensation polymers		
Can draw monomers			Heat on thermosoft / set polymers					
Can draw polymers			Why polymers act with heat differently					

EXAM QUESTIONS

Q1. This question is about hydrocarbons.

Hexane and hexene are hydrocarbons containing six carbon atoms in each molecule.

Hexane is an alkane and hexene is an alkene.

(a) Draw **one** line from each hydrocarbon to the formula of that hydrocarbon.

Hydrocarbon	**Formula**
	C_6H_8
Hexane	C_6H_{10}
	C_6H_{12}
Hexene	C_6H_{14}
	C_6H_{16}

(2)

(b) Bromine water is added to hexane and to hexene.

What would be observed when bromine water is added to hexane and to hexene?

Hexane

_____

_____

Hexene

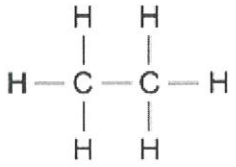
_____

_____

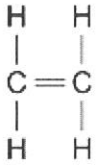
(2)

(c) Ethane is an alkane and ethene is an alkene.

The diagram below shows 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)

(Total 10 marks)

Q2. This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon, $C_{18}H_{38}$

$$C_{18}H_{38} \rightarrow C_6H_{14} + C_4H_8 + 2\,C_3H_6 + C_2H_4$$

(a) Which product of the reaction shown is an alkane?

Tick **one** box.

C_2H_4 ☐

C_3H_6 ☐

C_4H_8 ☐

C_6H_{14} ☐

(1)

(b) The table below shows the boiling point, flammability and viscosity of $C_{18}H_{38}$ compared with the other hydrocarbons shown in the equation.

	Boiling point	**Flammability**	**Viscosity**
A	highest	lowest	highest
B	highest	lowest	lowest
C	lowest	highest	highest
D	lowest	highest	lowest

Which letter, **A**, **B**, **C** or **D**, shows how the properties of $C_{18}H_{38}$ compare with the properties of C_2H_4, C_3H_6, C_4H_8 and C_6H_{14}?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) The hydrocarbon C_4H_8 was burnt in air.

Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?

A $C_4H_8 + 4O \rightarrow 4CO + 4H_2$

B $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$

C $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

D $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

Tick **one** box.

A ☐

B ☐

C ☐

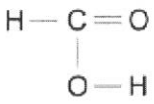
D ☐

(1)

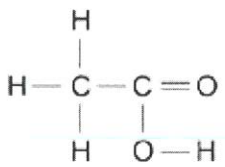
(d) Propanoic acid is a carboxylic acid.

Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?

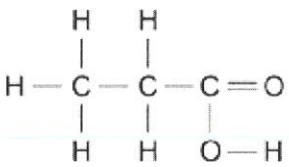
A



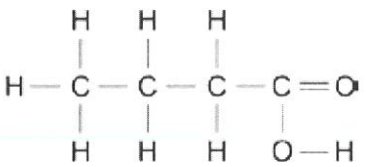
B



C



D



Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(e) Propanoic acid is formed by the oxidation of which organic compound?

Tick **one** box.

Propane ☐

Propene ☐

Propanol ☐

Polyester ☐

(1)

(Total 5 marks)

Q3. A molecule of ethene (C_2H_4) is represented as:

(a) A sample of ethene is shaken with bromine water.

Complete the sentence.

The bromine water turns from orange to _____ .

(1)

(b) Most ethene is produced by the process of cracking.

(i) Complete the sentence.

Cracking is a type of thermal _____ .

(1)

(ii) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

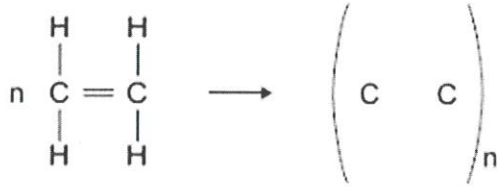
Complete the equation to show the formula of the other product.

$C_{10}H_{22} \longrightarrow C_2H_4 +$ _____

(1)

(c) Many molecules of ethene join together to produce poly(ethene).

(i) Complete the structure of the polymer in the equation.



(2)

(ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q4.

(a) Alkenes can be made by cracking large alkane molecules.

(i) Explain how the cracking process is carried out.

_____

_____

_____

_____

(2)

(ii) Give a chemical test which would show the difference between an alkene and an alkane.

Test

_____

Result of test

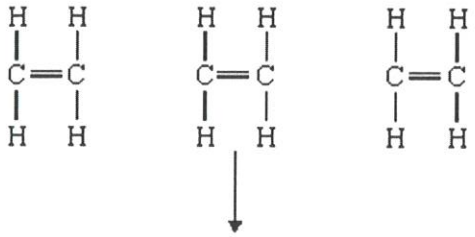
_____

_____

(2)

(b) Alkenes, such as ethene, can be made into polymers.

(i) Complete the following to show how the ethene molecules bond to form part of a polymer.



(1)

(ii) Name the polymer formed from ethene.

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(1)

(iii) Explain **one** important problem caused by the everyday use of this polymer.

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(2)

(Total 8 marks)