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GRADE	12	SUBJECT	PHYSICAL SCIENCES	Week 7	
Topic	Organic molecules: homologous series				
ATP	(± 1week): Learners are able to: • Define Organic Chemistry • Define Molecular formula • Differentiate between Molecular formula, Structural formula and Condensed structural formula • Define Homologous series • Differentiate between positional isomers, structural isomers and functional isomers • Name organic compounds				


 ORGANIC
 CHEMISTRY 2021.pp

TERMINOLOGY

Organic Chemistry – is the study of carbon and its compounds of carbon (except the oxides of carbon and the carbonates)

Hydrocarbons – organic compounds that contain only carbon and hydrogen.

Catenation - the ability of carbon atoms to form long chains.

Saturated compounds – compounds which only have single bonds and contain the maximum number of hydrogens atoms.

Unsaturated compounds – Compounds in which carbon forms double and triple bonds

Homologous series – is a group of organic compounds all of which have the same the same functional group and whose consecutive members differ by $-\text{CH}_2$

Functional group – is a structural feature in an organic molecule that allows us to classify organic compounds according to reactivity.

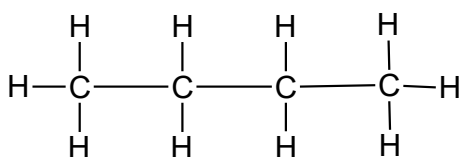
Structural Isomers – molecules with the same molecular formula, but different structural formula

Additional reaction – always occur at a double bond; the double bond becomes a single bond and the two electron orbitals that were taken up in the double bond are now free to bond covalently with 2 other atoms or groups.

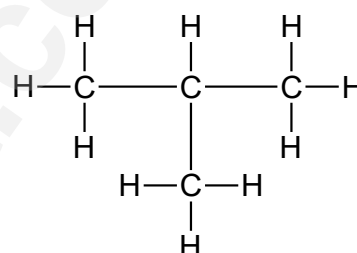


Structural isomer: Organic molecules with the same molecular formula, but different structural formulae

- Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.
- Restrict structural isomers to chain isomers, positional isomers and functional isomers.
 - Chain isomers:** Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane.

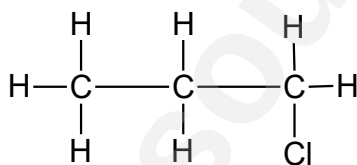


butane

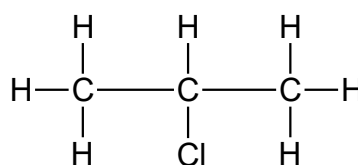


2-methylpropane

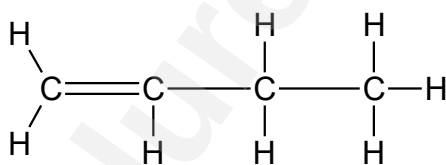
- Positional isomers:** Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene



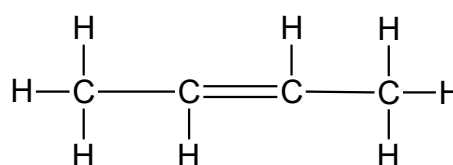
1-chloropropane



2-chloropropane

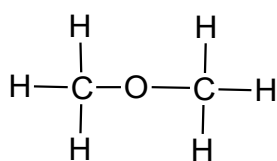


but-1-ene

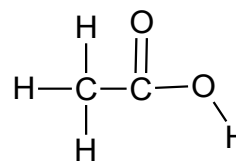


but-2-ene

- Functional isomers:** Same molecular formula, but different functional groups, e.g. methyl methanoate and ethanoic acid



methyl methanoate



ethanoic acid

HOMOLOGOUS SERIES

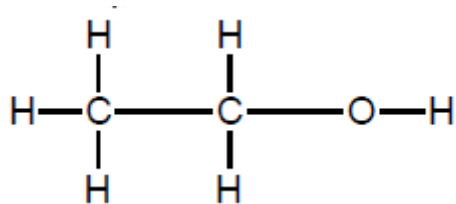
Homologous Series	Structure of functional group	
	Structure	Name / Description
Alkanes	$\begin{array}{c} & \\ -C & -C- \\ & \end{array}$	Only C–H and C–C single bonds
Alkenes	$\begin{array}{c} \diagup & \diagdown \\ C & =C \\ \diagdown & \diagup \end{array}$	Carbon-carbon double bond
Alkynes	$-C \equiv C-$	Carbon-carbon triple bond
Haloalkanes	$\begin{array}{c} \\ -C-X \\ \end{array}$ (X = F, Cl, Br, I)	Halogen atom bonded to a saturated C atom.
Alcohols	$\begin{array}{c} \\ -C-O-H \\ \end{array}$	Hydroxyl group bonded to a saturated C atom
Aldehydes	$\begin{array}{c} O \\ \\ -C-H \end{array}$	Formyl group
Ketones	$\begin{array}{c} O \\ \\ -C-C-C- \\ & \end{array}$	Carbonyl group bonded to two C atoms
Carboxylic acids	$\begin{array}{c} O \\ \\ -C-O-H \end{array}$	Carboxyl group
Esters	$\begin{array}{c} O \\ \\ -C-O-C- \\ \end{array}$	-

Alcohols

- Alcohols with one hydroxyl group have the general formula $C_nH_{2n+1}OH$
- Most alcohols have polar molecules.
- The simplest member of the group,
- The simplest member of the group, methanol, contains one carbon atom and is commonly known as methyl alcohol.
- Ethanol has two carbon atoms. It is the product of the fermentation process of fruits and other plant material. Ethanol is used in alcoholic beverages.
- The strong hydrogen bonds in alcohols result in alcohols having higher melting and boiling points than similar sized hydrocarbons.
- Alcohols are classified according to the position of the hydroxyl group on the carbon chain.

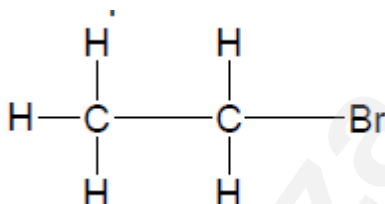
Primary alcohol: One C atom is bonded to the C atom bonded to hydroxyl group.

Example:



Primary haloalkane: One C atom is bonded to the C atom bonded to the halogen.

Example:



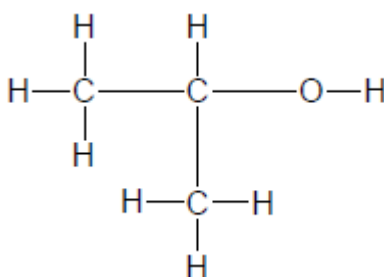
Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains.

OR

Compounds with only single bonds between C atoms in their hydrocarbon chains.

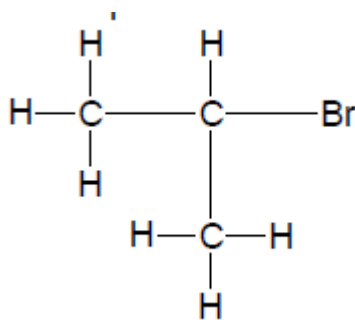
Secondary alcohol: Two C atoms bonded to the C atom that is bonded to hydroxyl group.

Example:



Secondary haloalkane: Two C atoms bonded to the C atom bonded to the halogen.

Example:

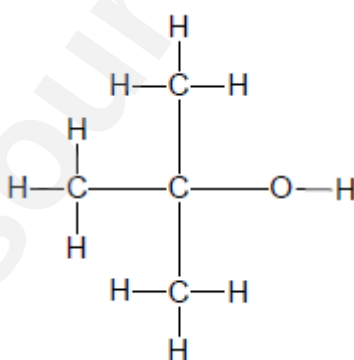


Structural formula: A structural formula of a compound shows which atoms are attached to which within the molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold the atoms together.

Substitution reaction: A reaction in which an atom or a group of atoms in a molecule is replaced by another atom or group of atoms.

Tertiary alcohol: Three C atoms bonded to carbon that is bonded to hydroxyl group.

Example:



Aldehydes and ketones

Both these homologous series contain the carbonyl functional group $\text{C}=\text{O}$.

Aldehydes

- A hydrogen atom is bonded to the carbonyl group.
- Aldehydes names end in the suffix $-\text{al}$.
- The simplest aldehyde is methanol, also known as formaldehyde ($\text{H}_2\text{C}=\text{O}$)

Ketones

- The carbon atom in the carbonyl group is bonded to a carbon on both sides.
- Ketones names ends in $-\text{one}$.
- The simplest ketone is propanone (acetone). This is a pleasant-smelling liquid used mainly as a solvent for organic compounds and an active ingredient in nail polish remove.
- Aldehydes are more reactive than ketones.



- Aldehydes and ketones contribute to the distinctive smells of foods and plants.

Carboxylic acids

- They have a general formula $C_nH_{2n+1}COOH$.
- All organic acids are carboxylic acids.
- They all contain the functional group $-COOH$.
- Methanoic acid is a liquid found in stinging nettles and ants.
- Ethanoic acid is the sour component of vinegar.
- Butanoic acid gives the unpleasant smell to rancid butter.
- Carboxylic acids names end in $-oic$ acid.

Esters

- Esters have pleasant smells, and they are largely responsible for the flavours and scents of fruits and flowers.
- They form from alcohols and carboxylic acids in an esterification reaction
- The name of the ester consists of two parts: the first part is derived from the parent alcohol and the second part is derived from the carboxylic acid. The name has the suffix $-oate$. An example is methanol that reacts with propanoic acid to form the ester methyl propanoate.



Question 2

The letters **A** to **G** in the table below represent seven organic compounds.

A		B	
C		D	
E	Butane	F	
G	Ethyl propanoate		

2.1. Write down the:

2.1.1. Name of the homologous series to which compound **F** belongs.

(1)

2.1.2. Name of the functional group of compound **D**.

(1)

2.1.3. Letter that represents a primary alcohol.

(1)

2.1.4. IUPAC name of compound **A**.

(2)

2.1.5. Structural formula of the monomer of compound **B**.

(2)

2.1.6. Balanced equation, using molecular formulae, for the combustion of compound **E** in excess oxygen.

(3)

2.2. Briefly explain why compounds **C** and **D** are classified as POSITIONAL ISOMERS.

(2)

2.3. Compound **G** is prepared using an alcohol as one of the reactants. Write down the balanced equation for the reaction using structural formulae for all the organic reagents.

(7)

[19]

Question 3



Consider the organic compounds represented by the letters A to F in the table below.

A	2,2,4-trimethylhexane	B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
C		D	
E			Pentan-2-one

3.1. Write down the LETTER that represents the following:

- 3.1.1. An aldehyde. (1)
- 3.1.2. A condensation polymer (1)
- 3.1.3. A compound which has a carbonyl group bonded to two carbon atoms as its functional group. (1)

3.2. Write down the IUPAC name of:

- 3.2.1. Compound **C** (3)
- 3.2.2. The monomer of compound **D** (1)

3.3. Write down the structural formula of:

- 3.3.1. Compound **A** (2)
- 3.3.2. Compound **F** (2)

3.4. The table contains compounds which are functional isomers.

- 3.4.1. Define the term *functional isomer*. (2)
- 3.4.2. Write down the LETTERS that represent two compounds that are functional isomers. (1)

[14]

SOLUTIONS



Question 2

2.1.

2.1.1. Alkynes ✓

(1)

2.1.2. Hydroxyl group ✓

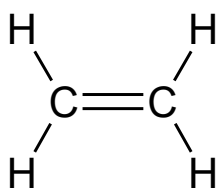
(1)

2.1.3. C ✓

(1)

2.1.4. 2-methylpentan-3-one ✓✓

(2)



2.1.5. ✓✓

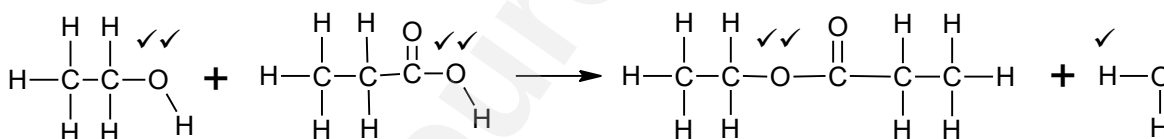
(2)

2.1.6. $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$ ✓ Bal. ✓

(3)

2.2. Same molecular formula, ✓ but different positions of the functional group. ✓

(2)



2.3.

(7)

[19]

Question 3

3.1.

3.1.1. B ✓

(1)

3.1.2. E ✓

(1)

3.1.3. F ✓

(1)

3.2.

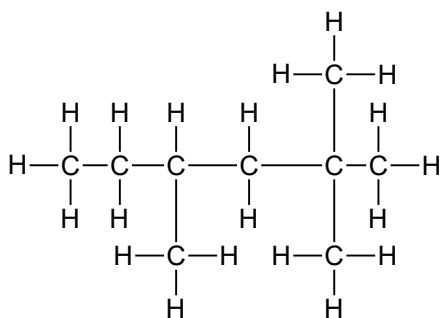
3.2.1. 2-bromo-3-chloro-4-methylpentane ✓✓✓

(3)

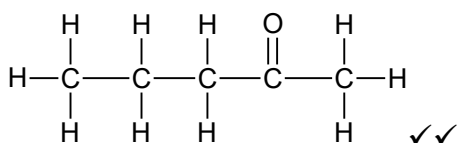
3.2.2. Ethene ✓

(1)

3.3.



3.3.1. ✓✓ (2)



3.3.2. ✓✓ (2)

3.4.

3.4.1. Compounds with the same molecular formula ✓ but different functional groups / different homologous series. ✓

Verbindings met dieselfde molekulêre formule, maar verskillende funksionele groepe / verskillende homoloë reeks. (2)

3.4.2. B & F ✓ (1)
[14]



GRADE	12	SUBJECT	PHYSICAL SCIENCES	Week	8
Topic	Organic Molecules: Physical Properties				
ATP	(± 1week) - At the end of the lesson learners should be able to: • Name Physical properties of organic compounds • Define Boiling point • Define Melting point • Define Vapour pressure • Explain the relationship between Physical Properties with Strength of Intermolecular formula, Types of Function Group, Chain Length and Branched Chains				

Structure and physical properties (boiling point, melting point, vapour pressure) relationships

- For a given example (from the above functional groups), explain the relationship between physical properties and:
 - Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
 - Type of functional groups
 - Chain length
 - Branched chains

Oxidation of alkanes

- State the use of alkanes as fuels.
- Write down an equation for the combustion of an alkane in excess oxygen.

Esterification

- Write down an equation, using structural formulae, for the formation of an ester.
- Name the alcohol and carboxylic acid used and the ester formed.
- Write down reaction conditions for esterification.



Substitution, addition and elimination reactions

- Identify reactions as elimination, substitution or addition.
- Write down, using structural formulae, equations and reaction conditions for the following addition reactions of alkenes:
 - **Hydrohalogenation:**
The addition of a hydrogen halide to an alkene
 - **Halogenation:**
The reaction of a halogen (Br_2 , Cl_2) with a compound
 - **Hydration:**
The addition of water to a compound
 - **Hydrogenation:**
The addition of hydrogen to an alkene
- Write down, using structural formulae, equations and reaction conditions for the following elimination reactions:
 - **Dehydrohalogenation of haloalkanes:**
The elimination of hydrogen and a halogen from a haloalkane
 - **Dehydration of alcohols:**
Elimination of water from an alcohol
 - **Cracking of alkanes:**
The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules.
- Write down, using structural formulae, equations and reaction conditions for the following substitution reactions:
 - **Hydrolysis of haloalkanes**
Hydrolysis: The reaction of a compound with water
 - Reactions of HX ($\text{X} = \text{Cl}, \text{Br}$) with alcohols to produce haloalkanes
 - **Halogenation of alkanes**
The reaction of a halogen (Br_2 , Cl_2) with a compound
- Distinguish between saturated and unsaturated hydrocarbons using bromine water.



- Educator and learners discuss the following answers to the baseline questions:
 - The three main types of intermolecular forces are:
 - ✓ Hydrogen bonds
 - ✓ Van der Waals forces
 - ✓ London forces
 - Dipole-dipole forces

Hydrogen bond is the intermolecular force that exists between two molecules made of hydrogen and a small electronegative element. Hydrogen bonds are found between water, hydrogen fluoride and ammonia molecules.

- Educators explain and discuss with learners the following:

PROPERTIES OF ORGANIC MOLECULES

Physical properties

- The spatial structure of organic molecules determines their physical properties, e.g. melting and boiling points, viscosity and vapour pressure
- These factors determine spatial structure:
 - ✓ Intermolecular forces
 - ✓ Chain length
 - ✓ Branched chains
- Number and type of functional groups

Intermolecular forces

- Weak **Van der Waals** forces act between non-polar molecules, such as hydrocarbons.
- Stronger **hydrogen bonds** exist between a hydrogen atom of one molecule and oxygen, nitrogen or fluorine atom on another molecule, for example in alcohols and carboxylic acids.
- **Chain length**
 - As the length of the molecules increases, the surface area in contact between adjacent molecules increases and there are more opportunities for Van der Waals forces to form weak bonds.
 - Large molecules usually have stronger forces than small molecules- melting and boiling contain –OH groups and hydrogen bonds exist between their molecules.
 - Hydrogen bonds are stronger than Van der Waals forces. Melting and boiling points of alcohols and carboxylic acids are generally higher than similar-sized hydrocarbons.



- **Vapour pressure** is an indication of the ease of evaporation of a liquid. A substance with a high vapour pressure is referred to as volatile. Weaker forces between molecules result in lower boiling points. Molecules can evaporate more easily and vapour pressures are higher at given temperature. (weak forces low → boiling points → high vapour pressure)
-

Question 8

- 4.1. Give a reason why alkanes are *saturated* hydrocarbons. (1)
- 4.2. Write down the structural formula of:
- 4.2.1. The functional group of alcohols. (1)
- 4.2.2. A tertiary alcohol that is a structural isomer of butan-1-ol. (2)
- 4.3. Learners investigate factors that influence the boiling points of alkanes and alcohols. In one of the investigations they determine boiling points of the first three alkanes.
- 4.3.1. Write down an investigative question for this investigation. (2)
- 4.3.2. Fully explain why the boiling point increases from methane to propane. (3)
- 4.4. The learners find that the boiling point of propan-1-ol is higher than that of propane. Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)



Question 9

Learners use compounds **A** to **C**, shown in the table below, to investigate a factor which influences the boiling point of organic compounds.

A	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
C	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

- 5.1. Which ONE of the compounds (**A**, **B** or **C**) has the highest boiling point? (1)
- 5.2. For this investigation, write down the:
- 5.2.1. Independent variable (1)
- 5.2.2. Dependent variable (1)
- 5.3. Write down the name of the type of Van der Waals force that occurs between the molecules of compound **B**. (1)
- 5.4. How will the vapour pressure of 2-methylpentane compare to that of compound **C**? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

The learners now compare the boiling points of compounds **D** and **E**, shown in the table below.

D	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
E	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$

- 5.5. How does the boiling point of compound **D** compare to that of compound **E**? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. Fully explain the answer. (4)

[9]

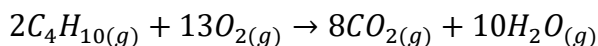


Question 10

Four compounds of comparable molecular mass are used to investigate the effect of functional groups on vapour pressure. The results obtained are shown in the table below.

COMPOUND		VAPOUR PRESSURE (kPa at 20°C)
A	Butane	204
B	Propan-2-one	24,6
C	Propan-1-ol	2
D	Ethanoic acid	1,6

- 6.1. Define the term *functional group* of an organic compound. (2)
- 6.2. Which ONE of the compounds (**A**, **B**, **C** or **D**) in the table has the:
- 6.2.1. Highest boiling point
(Refer to the vapour pressure in the table to give a reason for the answer.) (2)
- 6.2.2. Weakest intermolecular forces. (1)
- 6.3. Refer to the type of intermolecular forces to explain the difference between the vapour pressure of compound **A** and compound **B**. (3)
- 6.4. The vapour pressure of compounds **C** and **D** are much lower than those of compounds **A** and **B**. Name the type of intermolecular force in **A** and **B** that is responsible for this difference. (1)
- 6.5. Briefly explain the difference in vapour pressure between compound **C** and **D**. (2)
- 6.6. During a combustion reaction in a closed container of adjustable volume, 8 cm^3 of compound **A** (butane) reacts in excess oxygen according to the following balanced equation:



If the initial volume of the oxygen in the container 60 cm^3 was, calculate the TOTAL volume of the gases that are present in the container at the end of the reaction. All gases in the container are at the same temperature and pressure.

(5)

[16]



GRADE	12	SUBJECT	Physical SCIENCES	Week	9
Topic	ORGANIC MOLECULES: REACTIONS				
ATP	At the end of the lesson learners should know the following: • The different types of organic compounds reactions • Elimination • Substitution • Polymerisation • Additions • Esterification • Cracking				

Oxidation of alkanes

- State the use of alkanes as fuels.
- Write down an equation for the combustion of an alkane in excess oxygen.

Esterification

- Write down an equation, using structural formulae, for the formation of an ester.
- Name the alcohol and carboxylic acid used and the ester formed.
- Write down reaction conditions for esterification.

Substitution, addition and elimination reactions

- Identify reactions as elimination, substitution or addition.
- Write down, using structural formulae, equations and reaction conditions for the following addition reactions of alkenes:
 - **Hydrohalogenation:**
The addition of a hydrogen halide to an alkene
 - **Halogenation:**
The reaction of a halogen (Br_2 , Cl_2) with a compound
 - **Hydration:**
The addition of water to a compound
 - **Hydrogenation:**
The addition of hydrogen to an alkene
- Write down, using structural formulae, equations and reaction conditions for the following elimination reactions:
 - **Dehydrohalogenation of haloalkanes:**
The elimination of hydrogen and a halogen from a haloalkane
 - **Dehydration of alcohols:**
Elimination of water from an alcohol
 - **Cracking of alkanes:**



The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules.

- Write down, using structural formulae, equations and reaction conditions for the following substitution reactions:
 - **Hydrolysis of haloalkanes**
Hydrolysis: The reaction of a compound with water
 - Reactions of HX (X = Cl, Br) with alcohols to produce haloalkanes
 - **Halogenation of alkanes**
The reaction of a halogen (Br₂, Cl₂) with a compound
- Distinguish between saturated and unsaturated hydrocarbons using bromine water.

Substitution reaction

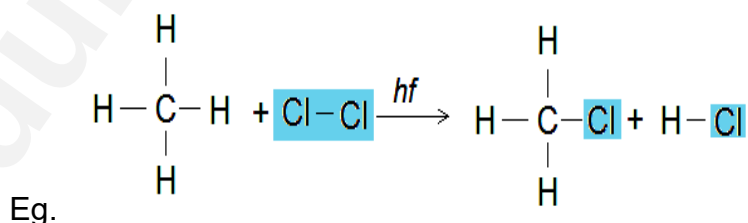
A substitution reaction is a reaction in which an atom or a group of atoms in a molecule is replaced by another atom or group of atoms.

Substitution reactions require a group “leaving” and a/an atom or group of atoms that can replace it. This replacing group takes the place of the “leaving” group in the molecule. The rest of the molecule does not change; there is just a substitution of the “leaving” group by the replacing group.

Alkanes are organic molecules that have single bonds ONLY. These types of molecules include also alkyl halides and alcohols for our purposes.

An important example of the reaction of alkanes with the halogens include substitution with any of the following halogens: F₂, Cl₂, I₂ and Br₂. The reaction of alkanes with halogens requires light or heat to take place.

1. Substitution reaction of alkanes with a halogen, eg., methane with chlorine

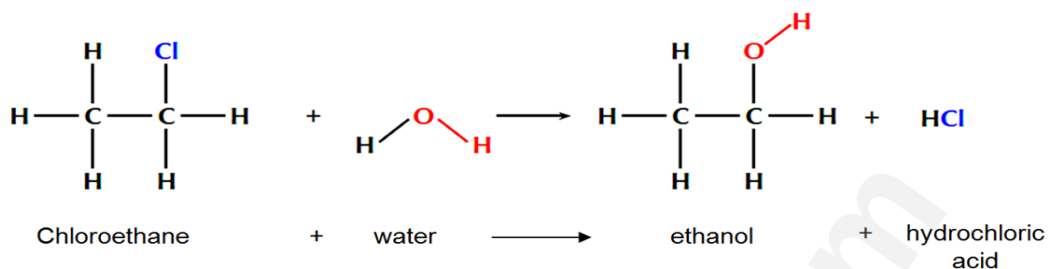


2. Haloalkanes can undergo substitution with water to form alcohols. Haloalkanes do not mix with water. This process is called hydrolysis.

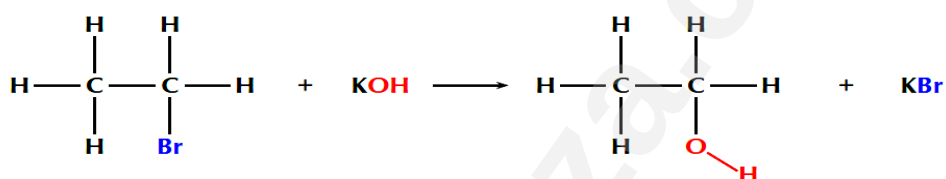
Hydrolysis is the reaction of compounds with water to form other compounds.

Haloalkanes undergo substitution with water to form alcohols.

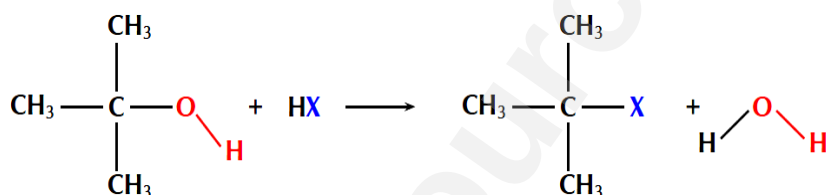
Haloalkanes do not mix with water. In this substitution reaction (hydrolysis) the halogen atom is replaced by an OH group to form an alcohol.



Moderate heating of a haloalkane with an aqueous solution of a base gives the corresponding alcohol.



Haloalkanes can be formed when the hydroxyl (-OH) group of an alcohol is replaced by a halogen atom (X = Cl, Br).



Addition reaction

An addition reaction occurs when two or more reactants combine to form a single product. This product will contain all the atoms that were present in the reactants. Addition reactions occur with unsaturated compounds.

Parts of the reactants are added to each carbon atom of a carbon-carbon double or triple bond which converts to a carbon-carbon single bond or double bond respectively.

In addition, reactions two compounds join together to form a single compound.

During the reaction, the weaker bonds of the double or triple bond is broken and new atoms are added onto the two carbons where the double or triple bond occurred.

Types of addition reaction:

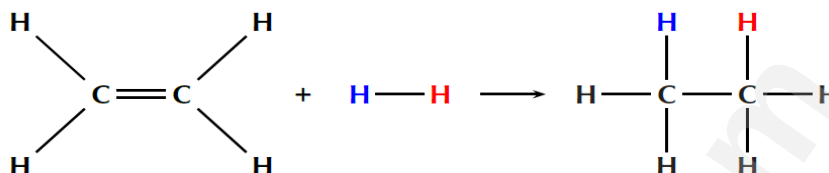
Depending on the compounds added addition reactions are given different names:

- **Hydrogenation**-The addition of H₂. This reaction is used to manufacture margarine from oils.
- **Hydration**- The addition of water (H₂O). This reaction forms an alcohol from an alkene.
- **Halogenation** - The reaction of a halogen (Br₂, Cl₂) with a compound.
- **Hydrohalogenation** – The addition of a hydrogen halide to an alkene.



Hydrogenation

Example 1



Reaction conditions:

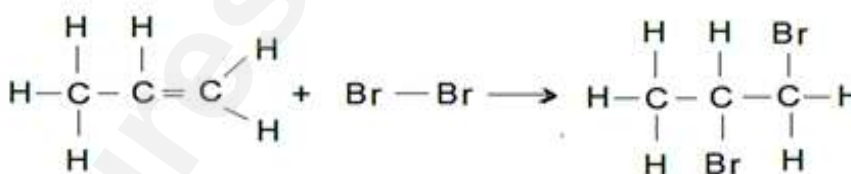
- a catalyst such as platinum (Pt), palladium (Pd) or nickel (Ni) is needed for these reactions.
- heating is required.
- the reaction must be done under an inert atmosphere, not air (e.g. $\text{N}_2(\text{g})$ atmosphere).

The hydrogenation of vegetable oils to form margarine is an example of this addition reaction.

Halogenation

The addition of a halogen to an alkene or alkyne is called halogenation (addition of X_2 ($\text{X} = \text{Cl}, \text{Br}, \text{I}, \text{F}$) to alkenes or alkynes).

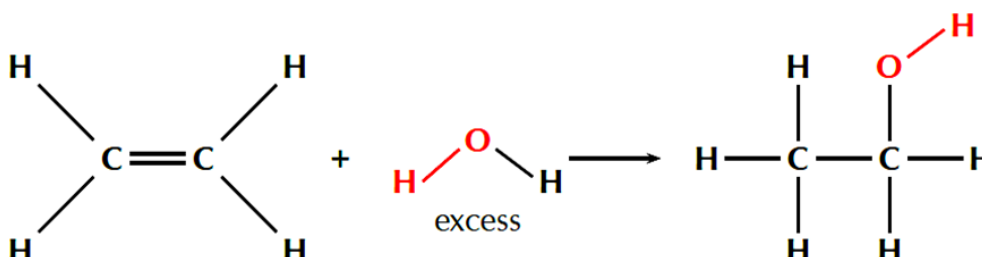
Example 2



Hydration reactions

A hydration reaction involves the addition of water (H_2O) to an unsaturated compound. This is one way of preparing an alcohol from the corresponding alkene.

Example 3





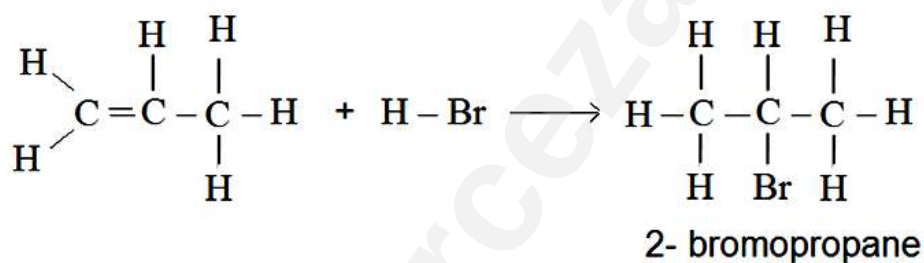
Reaction conditions:

- water must be present in excess
- an acid catalyst is needed for this reaction to take place
- the catalyst that is most commonly used is phosphoric acid (H_3PO_4)

Hydrohalogenation

Hydrohalogenation involves the addition of a hydrogen atom and a halogen atom to an unsaturated compound (containing a carbon-carbon double bond).

Example 4





GRADE	12	SUBJECT	Physical SCIENCES	Week	10
Topic	ORGANIC MOLECULES: ACTIVITIES				
ATP	<i>PRACTICE EXCERSIZES</i>				

Multiple-choice Questions

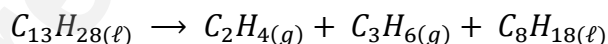
Four options are given as possible answers to the following questions.

Each question has only ONE correct answer.

1.1 Which ONE of the compounds below is an aldehyde?

- A CH_3CHO
 - B CH_3COCH_3
 - C CH_3COOH
 - D CH_3OH
- (2)

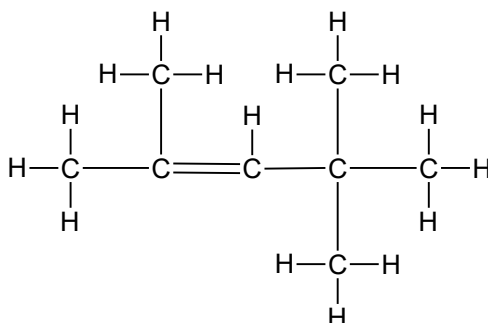
1.2 The reaction represented by the equation below takes place in the presence of a catalyst.



This reaction is an example of ...

- A addition.
 - B cracking.
 - C substitution.
 - D polymerisation.
- (2)

1.3 Consider the structural formula of an organic compound below.



Which ONE of the following is the correct IUPAC name of this compound?

- A 2,2,4-trimethylpent-2-ene
- B 2,2,4-trimethylpent-3-ene
- C 2,4,4-trimethylpent-2-ene
- D 2,4,4-trimethylpent-3-ene

(2)

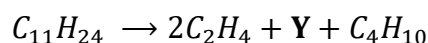
1.4 Which ONE of the following statements is CORRECT?

Alkenes ...

- A have the general formula C_nH_{2n+2} .
- B are unsaturated hydrocarbons.
- C readily undergo substitution reactions.
- D have one triple bond between two carbon atoms.

(2)

1.5 The following equation represents the cracking of a hydrocarbon at high temperature and pressure:



Which ONE of the following is the IUPAC name of product Y?

- A Prop-1-ene.
- B Propane.
- C Ethene.
- D Ethane.

(2)

1.6 When 2-chlorobutane is strongly heated in the presence of concentrated sodium hydroxide, the major product formed is ...

- A but-1-ene.
- B but-2-ene.

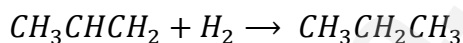


- C butan-1-ol.
D butan-2-ol. (2)

1.7 Which ONE of the following compounds is an aldehyde?

- A Pentanal
B Pentan-2-ol
C Pentan-2-one
D Ethyl propanoate (2)

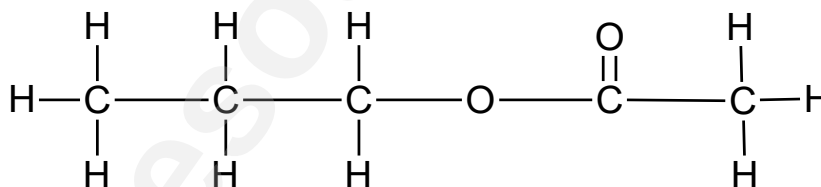
1.8 Consider the reaction represented by the equation below:



This reaction is an example of ...

- A hydration.
B dehydration.
C substitution.
D hydrogenation. (2)

1.9 Consider the structural formula of a compound below.



Which ONE of the following pairs of reactants can be used to prepare this compound in the laboratory?

- A Propanoic acid and ethanol
B Propanoic acid and methanol
C Ethanoic acid and propan-1-ol
D Methanoic acid and propan-1-ol (2)

1.10. Which ONE of the following compounds has dipole-dipole forces between its molecules?

- A Ethanal
B Ethane
C Ethene
D Ethyne (2)



Question 2

The letters **A** to **F** in the table below represent six organic compounds.

A	$ \begin{array}{c} & \text{H} & & \text{H} \\ & & \diagdown & / \\ & & \text{C} \\ & / & & \backslash \\ \text{H} - \text{C} & - & \text{C} & - \text{C} - \text{H} \\ & & & \\ \text{H} & & & \text{H} \end{array} $	B	2-methylbutanoic acid
C	$ \begin{array}{ccccccc} \text{H} & & \text{H} & & \text{O} & & \text{H} & & \text{H} \\ & & & & & & & & \\ \text{H} - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} - \text{H} \\ & & & & & & & & \\ \text{H} & & & & & & \text{H} & & \text{H} \\ & & & & & & & & \\ & & & & & & & & \text{H}_2\text{C}-\text{CH}_3 \end{array} $	D	$ \begin{array}{ccccccc} \text{H} & & \text{CH}_3 & & \text{H} & & \text{H}_2\text{C}\cdot\text{CH}_3 \\ & & & & & & \\ \text{H} - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} - \text{H} \\ & & & & & & \\ \text{H} & & \text{CH}_3 & & \text{H} & & \text{H}_2\text{C}-\text{CH}_3 \end{array} $
E	But-2-ene	F	

2.1 Write down the:

2.1.1 NAME of the functional group of compound **B** (1)

2.1.2 Homologous series to which compound **C** belongs. (1)

2.1.3 Type of polymerisation reaction that produces compound **F** (1)

2.2 Write down the IUPAC name of:

2.2.1 The monomer used to prepare compound **F** (1)

2.2.2 Compound **C** (2)

2.2.3 Compound **D** (2)

2.3 Write down the NAME or FORMULA of each product formed during the complete combustion of compound **D**. (2)

2.4 Write down the structural formula of:

2.4.1 Compound **B** (2)



- 2.4.2 A CHAIN ISOMER of compound **A** (2)
- 2.5 A laboratory assistant uses bromine water to distinguish between compounds **D** and **E**. She adds bromine water to a sample of each in two different test tubes. She observes that the one compound decolourises the bromine water immediately, whilst the other one only reacts after placing the test tube in direct sunlight.

Write down the:

- 2.5.1 Letter (**D** or **E**) of the compound that will immediately decolourise the bromine water. (1)
- 2.5.2 Name of the type of reaction that takes place in the test tube containing compound **D** (1)
- 2.5.3 Structural formula of the organic product formed in the test tube containing compound **E** (2)

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Question 3

The letters **A** to **D** in the table below represents four organic compounds.

A	$ \begin{array}{ccccccc} & \text{H} & & \text{H}_3\text{C} & & \text{H} & & \text{H} \\ & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} \equiv \text{C} - & \text{C} - \text{H} \\ & & & & & & & \\ & \text{CH}_3 & & \text{H} & & \text{CH}_2\text{CH}_3 & & \text{H} \end{array} $	B	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{O} & & \text{H} \\ & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} - \text{H} \\ & & & & & & & \\ & \text{H} & & \text{H} & & & & \text{H} \end{array} $
C	CH ₃ CH ₂ CHO	D	Butane

Use the information in the table to answer the questions that follow.

3.1 Write down the:

- 3.1.1 Letter that represents a ketone. (1)
- 3.1.2 Structural formula of the functional group of compound **C**. (1)
- 3.1.3 General formula of the homologous series to which compound **A** belongs. (1)
- 3.1.4 IUPAC name of compound **A**. (3)
- 3.1.5 IUPAC name of compound **B**. (2)
- 3.2 Compound **D** is a gas used in cigarette lighters.
- 3.2.1 To which homologous series does compound **D** belong? (1)



3.2.2 Write down the STRUCTURAL FORMULA and IUPAC NAME of a structural isomer of compound **D**. (4)

3.3 Compound **D** reacts with bromine (Br_2) to form 2-bromobutane.
Write down the name of the:

3.3.1 Homologous series to which 2-bromobutane belongs. (1)

3.3.2 Type of the reaction that takes place. (1)

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Questions 4 to 5 are Examples of Questions on the Properties of Organic Compounds and Intermolecular Forces.

Question 4

The table below shows the results obtained from experiments to determine the boiling point of some alkanes and alcohols of comparable molecular masses.

Compound	Relative molecular mass	Boiling point ($^{\circ}\text{C}$)
CH_3CH_3	30	-89
CH_3OH	32	65
$\text{CH}_3\text{CH}_2\text{CH}_3$	44	-42
$\text{CH}_3\text{CH}_2\text{OH}$	46	78
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	58	0
$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	60	97
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$	72	36
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$	74	117

4.1 Define the term *boiling point*. (2)

4.2 Consider the boiling points of the four alkanes in the above table.

4.2.1 Describe the trend in their boiling points. (1)

6.2.2 Fully explain the trend in QUESTION 4.2.1. (3)



- 4.3 The boiling point of each alcohol is much higher than that of the alkane. of comparable relative molecular mass. Explain this observation by referring to the type and strength of the intermolecular forces in alkanes and alcohols. (2)

[8]

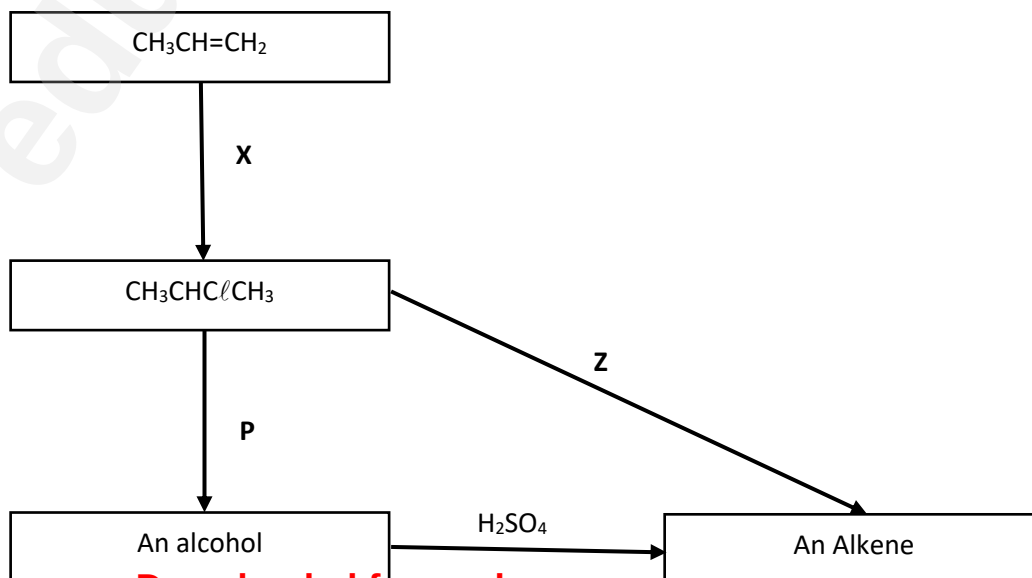
Question 5

- 5.1 Give a reason why alkanes are *saturated* hydrocarbons. (1)
- 5.2 Write down the structural formula of:
- 5.2.1 The functional group of alcohols. (1)
- 5.2.2 A tertiary alcohol that is a structural isomer of butan-1-ol. (2)
- 5.3 Learners investigate factors that influence the boiling points of alkanes. and alcohols. In one of the investigations, they determine boiling points of the first three alkanes.
- 5.3.1 Write down an investigative question for this investigation. (2)
- 5.3.2 Fully explain why the boiling point increases from methane to propane. (3)
- 5.4 The learners find that the boiling point of propan-1-ol is higher than that of propane. Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)

Questions 6 to 7 are Examples of Questions on Types of Organic Reactions.

Question 6

The flow diagram below shows the preparation of the organic compounds using $\text{CH}_3\text{CH}=\text{CH}_2$ as starting material. **X**, **Y**, **Z** and **P** represent different organic reactions.



- 6.1 To which homologous series does $\text{CH}_3\text{CH}=\text{CH}_2$ belong? (1)



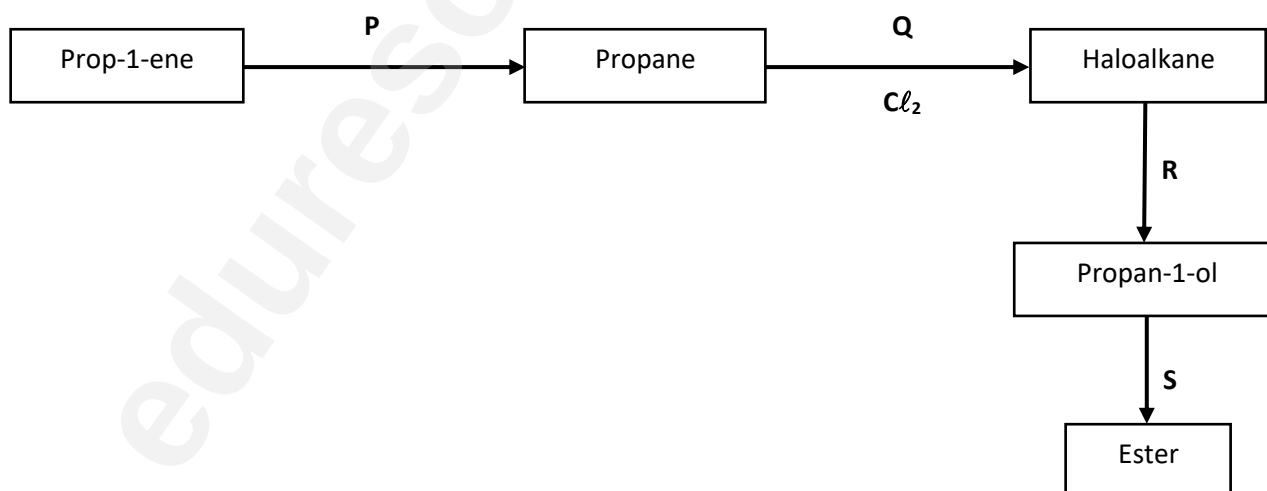
- 6.2 Write down the:
- 6.2.1 Type of reaction of which **X** is an example. (1)
- 6.2.2 Structural formula and IUPAC name of the alcohol produced during reaction **P**. (3)
- 6.2.3 The type of reaction of which **Y** is an example. (1)
- 6.2.4 Function of the acid in reaction **Y**. (1)
- 6.3 For reaction **Z**, write down:
- 6.3.1 The NAME of the inorganic reagent needed. (1)
- 6.3.2 TWO reaction conditions needed. (2)
- 6.3.3 A balanced equation for the production of the alkene, using structural formulae. (5)

[15]

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Question 7

The diagram below shows the preparation of an ester using prop-1-ene as a starting reagent. **P**, **Q**, **R** and **S** represent different organic reactions.



- 7.1 Write down the type of reaction represented by:
- 7.1.1 **Q** (1)
- 7.1.2 **R** (1)
- 7.2 For reaction **P** write down the:
- 7.2.1 Type of addition reaction (1)
- 7.2.2 Balanced equation using structural formulae (3)



- 7.3 Write down the structural formula of the haloalkane formed in reaction **Q**.(2)
- 7.4 In reaction **S** propan-1-ol reacts with ethanoic acid to form the ester.
For this reaction write down the:
- 7.4.1 Name of the reaction that takes place (1)
- 7.4.2 FORMULA or NAME of the catalyst needed (1)
- 7.4.3 Structural formula of the ester formed (2)
- 7.4.4 IUPAC name of the ester formed (2)
- 7.5 The propan-1-ol formed in reaction **R** can be converted to prop-1-ene.
Write down the FORMULA or NAME of the inorganic reagent needed. (1)
- 15]**