COURSE SCHEDULES

Semester: First Semester

Year : 1st & 2nd Year (Including Carry-Over Students)

Topics :- Classification of Organic Compounds
- Homologous Series
- Fullerenes as Fourth allotrope of Carbon
  * Uses as Nanotubes, Nanostructures & Nanochemistry.

Course : Organic Chemistry.

Semester : First Semester

Year : 2nd Year (Only Regular Students)

Topic : Qualitative & Quantitative Analysis

Cours: : Practical Chemistry / Inorganic Chemistry.

ORGANIC COMPOUNDS

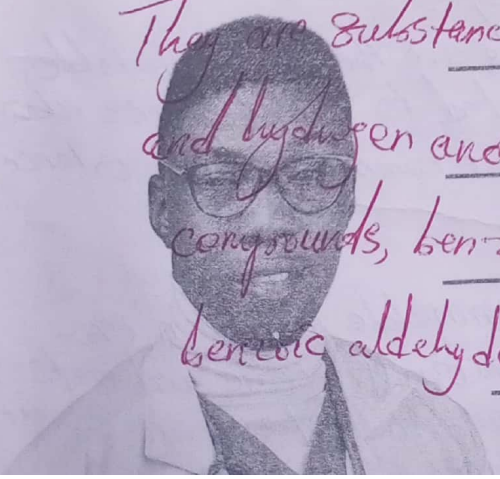
Organic chemistry originally applied only to the study of substances of plant or animal origin, such as substances formed only by living organisms. But currently, most of these substances can be synthesized from inorganic materials in the laboratory.

Therefore, organic chemistry can be defined as the chemistry of carbon compounds.

However, Organic Compounds are large classes of chemical compounds in which one or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen or nitrogen.

OR

They are substances that contain covalently-bonded carbon and hydrogen and often with other elements, eg aromatic compounds, benzoic acid, heterocyclic compounds, amines, benzoic aldehyde, propanoic, butanoic acids, etc.



CONGRATULATIONS

Difference b/w Organic & Inorganic Compounds

The distinction between organic and inorganic is not clearly defined, but generally, organic compounds are compounds that include carbon atoms, while inorganic compounds are compounds that don't contain carbon. Organic compounds are usually insoluble in water while inorganic compounds are soluble in water, and insoluble in a few organic solvents. Organic Compds mainly have carbon to hydrogen bonds, while inorganic Compds lack carbon to hydrogen bonds.

Characteristics Features of Organic Compounds

(1) Covalent Nature: Carbon atoms form stable covalent bonds with one another, this is because of the strong carbon-carbon bonds. Since they have a covalent nature, do not ionize in solution and are non-conductors of electricity.

(2) Polarity and Solubility: Carbon-hydrogen bonds are non-polar, like the carbon-carbon bonds. This is because of the almost equal electronegativities of the two elements. Most organic compounds are non-polar unless the compounds consist of very electronegative elements like chlorine or groups like the hydroxyl group.

(3) Low Melting and Boiling Points: Organic compounds generally have lower melting and boiling points than inorganic compounds. This is because these compounds possess relatively weak intermolecular bonds which can be easily broken by heat energy.

(4) Thermal Instability: Many organic compounds are thermally unstable, decomposing into simpler molecules when heated to temperatures above 300°C. However, this property is sometimes of commercial importance as in the cracking of petroleum.

(5) Flammability:- Most organic compounds are flammable and burn exothermically in a plentiful supply of air to yield carbon (IV) oxide and water. Thus, most fuels such as wood, coal, oil, petrol and natural gas are organic and their combustion provides our main source of heat energy.

6, Reactivity:- Reactions involving organic compounds tend to be much slower than the ionic reactions commonly encountered in inorganic chemistry. They usually require heating, thorough mixing and catalyst to speed up the reactions.

Homologous Series

This is a family of organic compounds which follows a regular structural pattern, in which each successive member differs in its molecular formula by $-CH_2-$ group.

Examples:- The alkanes are a series of hydrocarbons with a general molecular formula of C_nH_{2n+2}, where n is a whole number with a value of one or more.
Other homologous series include the alkenes - C_nH_{2n}, the alkynes - C_nH_{2n-2}, the alkanols - $C_nH_{2n+1}OH$ and the carboxylic acids - $C_nH_{2n+1}COOH$.

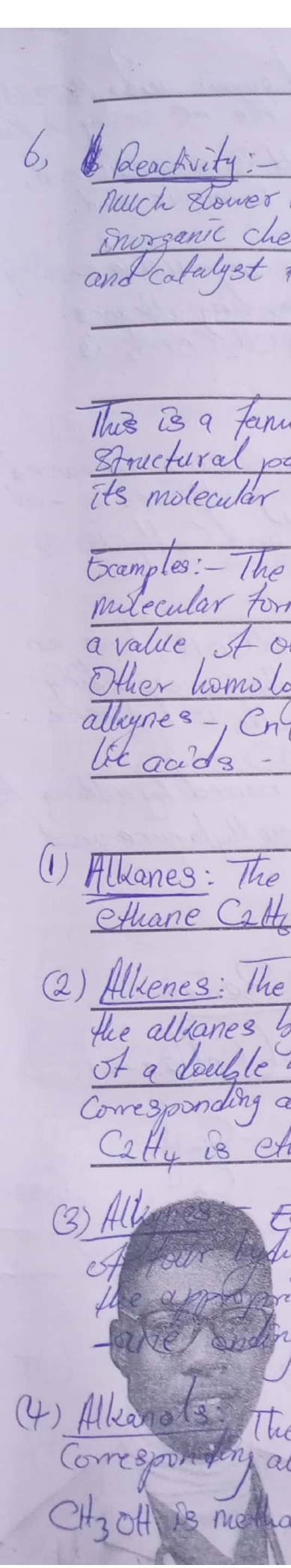
Features of Homologous Series

(1) Alkanes: The names of alkanes end with -ane, eg. Methane CH_4, ethane C_2H_6 and propane C_3H_8, etc.

(2) Alkenes: The members of the alkenes series are formed from the alkanes by the removal of two hydrogen atoms and the introduction of a double bond in the carbon chain. They are named after the corresponding alkanes by changing the -ane ending to -ene, (eg) C_2H_4 is ethene, C_3H_6 is propene and C_4H_8 is butene.

(3) Alkynes: Each member of this series is formed by the removal of four hydrogen atoms and the introduction of a tripple bond in the appropriate alkane molecule. They are named by replacing the -ane ending by -yne, (eg) C_2H_2 is ethyne and C_3H_4 is propyne.

(4) Alkanols: The members of this series, ROH, are named after the corresponding alkanes by replacing the -e ending with -ol, (eg) CH_3OH is methanol and C_3H_7OH is propanol.



CONGRATULATIONS

(5) Alkanoic acids:- Also known as carboxylic and organic acids, RCOOH the members of this series are named by replacing the -e ending of the corresponding alkanes by -oic acid, (eg) CH_3COOH is ethanoic acid, C_2H_5COOH is propanoic acid and C_3H_7COOH is butanoic acid.

(6) Amides: Members of this series, $RCONH_2$, have an -amide ending in their names, instead of the -e in the corresponding alkanes. For example, CH_3CONH_2 is methanamide and $C_2H_5CH_2CONH_2$ is butanamide.

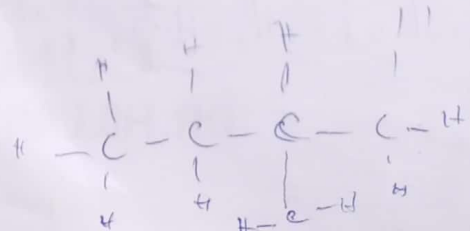
(7) Alkanals or Aldehydes: The members of the series, RCHO, are named by replacing the -e ending in the corresponding alkanes by -al. For example, HCHO is methanal, CH_3CHO is ethanal and C_4H_9CHO is pentanal.

(8) Ketones or Alkanones: The members of this series, RCOR', have an -one ending in their names, instead of the -e in the corresponding alkanes, (eg) CH_3COCH_3 is propanone and $CH_3COC_2H_5$ is butanone.

(9) Amines:- The members of this series, RNH_2, are named by adding the -amine ending to the alkyl group, (eg) CH_3NH_2 is methylamine and $C_2H_5NH_2$ is ethylamine.

Some General Molecular Formula of Homologous Series

For Alkanes (C_nH_{2n+2})	Alkenes (C_nH_{2n})	Alkynes (C_nH_{2n-2})
(1) Methane - CH_4	—	—
(2) Ethane - C_2H_6	Ethene - C_2H_4	Ethyne - C_2H_2 } Gases
(3) Propane - C_3H_8	Propene - C_3H_6	Propyne - C_3H_4 } Gases
(4) Butane - C_4H_{10}	Butene - C_4H_8	Butyne - C_4H_4 } Gases
(5) Pentane - C_5H_{12} } Liquids		
(6) Hexane - C_6H_{14} } Liquids		
(7) Heptane - C_7H_{16} } Liquids		
(8) Octane - C_8H_{18} } Liquids		
(9) Nonane - C_9H_{20} } Liquids		
(10) Decane - $C_{10}H_{22}$ } Liquids		



Basic Rules for Naming Organic Compounds

(1) Take the longest continuous carbon chain as the root hydrocarbon and name it according to the number of carbon atoms it contains, adding the appropriate suffix to indicate the principal substituent group.

(2) Number the carbon atoms in the root hydrocarbon from the end which will give the lowest number to the suffix, and then the prefix(es).

(3) Indicate the other substituents by prefixes preceded by numbers to show their positions on the carbon chain.

Examples

(1) $\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H(\overset{1}{C}H_3)-CH_3$ = 2-methylbutane

(2) $\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H\equiv\overset{1}{C}H$ = but-1-yne

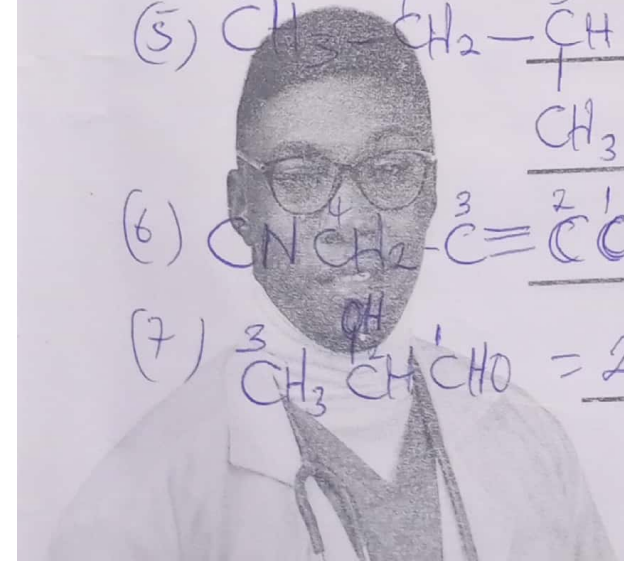
(3) $Cl\overset{3}{C}H_2-\overset{2}{C}H_2-\overset{1}{C}H_2OH$ = 3-chloropropan-1-ol

(4) $\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}O\overset{1}{C}H_3$ = Butanone

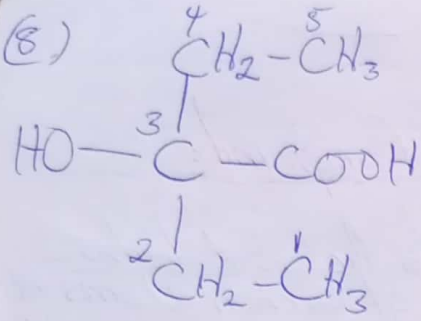
(5) $\overset{5}{C}H_3-\overset{4}{C}H_2-\overset{3}{C}H(\overset{1}{C}H_3)-\overset{2}{C}H=\overset{1}{C}H_2$ = 3-Methyl-pentene

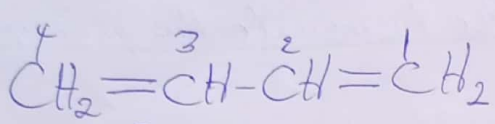
(6) $CN\overset{4}{C}H_2-\overset{3}{C}\equiv\overset{2}{C}\overset{1}{C}H_3$ = 4-Cyano-but-2-yne

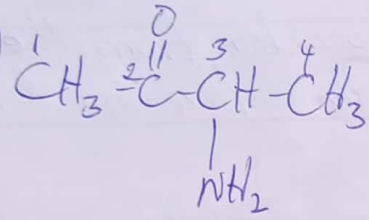
(7) $\overset{3}{C}H_3\overset{2}{C}H(OH)\overset{1}{C}HO$ = 2-Hydroxy-propanal

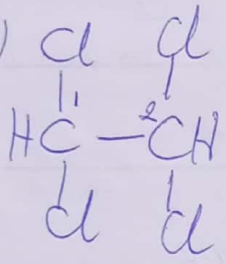


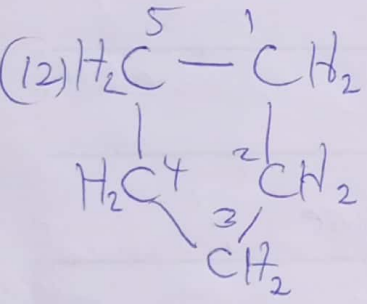
CONGRATULATIONS
DR. HILLARY NKEM OKEKE, MBBS

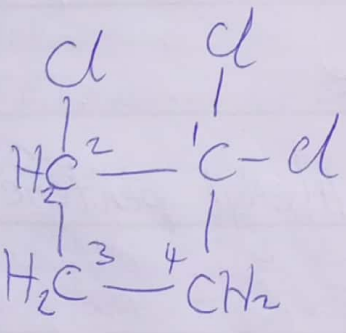
(8)  = 3-Carboxy-3-hydroxy-pentanoic acid

(9)  = Buta-1,3-diene

(10)  = 3-Amino-butan-2-one

(11)  = 1,1,2,2-Tetra-chloro ethane

(12)  = Cyclopentane

(13)  = 1,1,2-Trichloro-cyclobutane

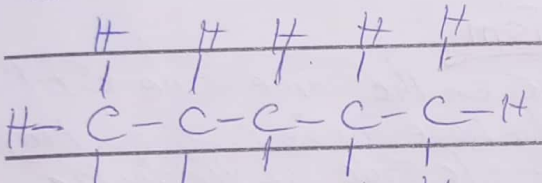
Isomerism

This is the existence of two or more compounds (known as isomers) with the same molecular formula but different molecular structures.

Example

Pentane has the following three possible isomers. As the number of carbon atoms in a molecule increases, the number of isomers also increases.

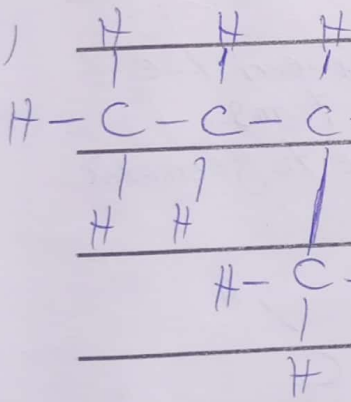
(1)



$= CH_3(CH_2)_3CH_3$

(pentane)

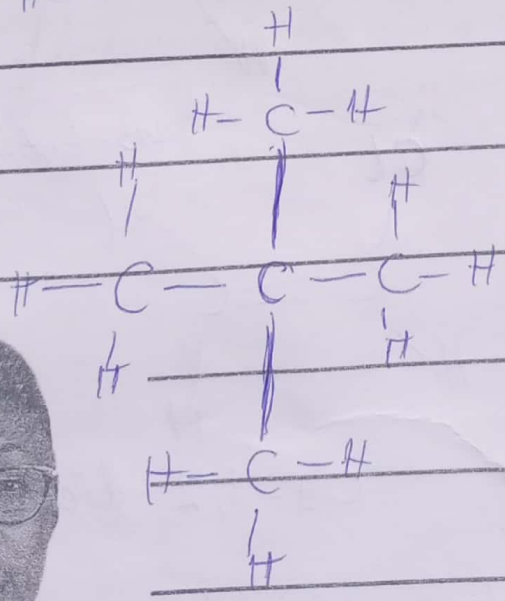
(2)



$= CH_3CH_2CH(CH_3)CH_3$

(2-methylbutane)

(3)

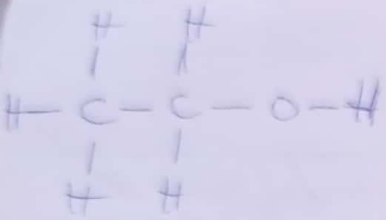


$= C(CH_3)_4$

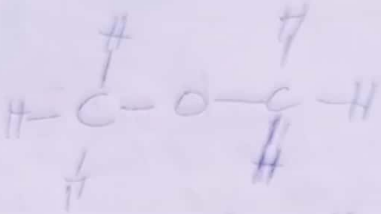
$CH_3C(CH_3)_2CH_3$

(2,2-Dimethyl-propane)

For Ethanol



CH_3CH_2OH
(ethanol)



CH_3OCH_3
(methoxymethane)

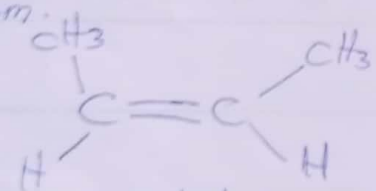
Geometric Isomerism

When two bulky or large groups are on the same side of the double bond, the molecule is said to have a cis configuration but when two such groups lie on the opposite side of the double bond, the molecule is said to possess a trans configuration.

Example

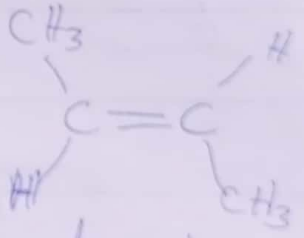
In but-2-ene, the presence of the double bond between the carbon atoms hinders free rotation. So the two forms, cis- and trans- are locked in shape, giving rise to geometric isomerism.

(1)



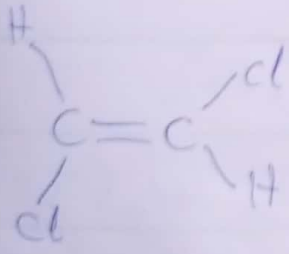
cis-but-2-ene

and



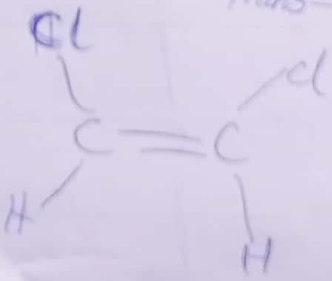
trans-but-2-ene

(2)



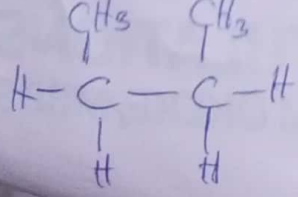
trans-1,2-dichloroethene

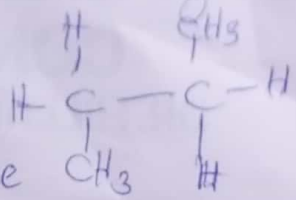
and



cis-1,2-dichloroethene

(3) However, only one form of butane exists because there is free rotation about the C–C single bond





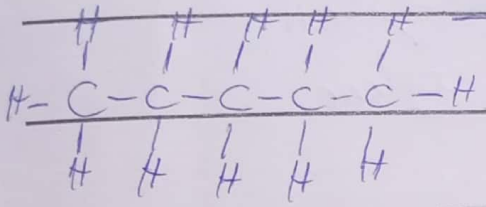
butane

Classification of Organic Compounds

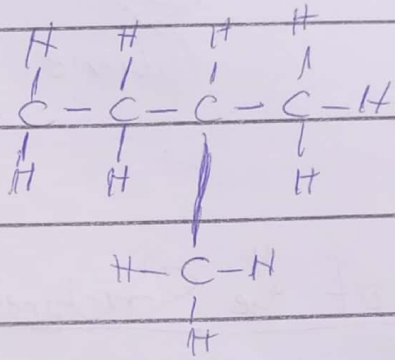
Organic Compounds can be classified into aliphatic and aromatic compounds according to their molecular structures, i.e the arrangement of atoms in the molecules.

(A) **Aliphatic Compounds**:- They are compounds whose molecules are composed of chains of carbon atoms.

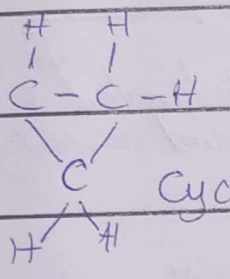
Examples

(1) 

(pentane)

(2) 

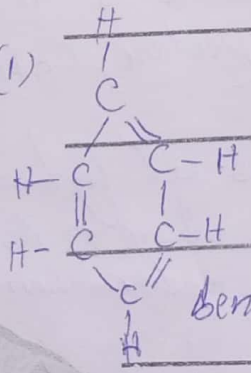
2-methylbutane.

(3) 

Cyclopropane

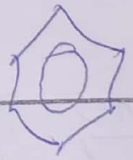
(B) **Aromatic Compounds**:- They are a special class of cyclic compounds based on benzene, C_6H_6, a 6-carbon ring compound. All other aromatic compounds are derivatives of benzene, (eg) phenylamine(aniline) and phenol.

Examples

(1) 

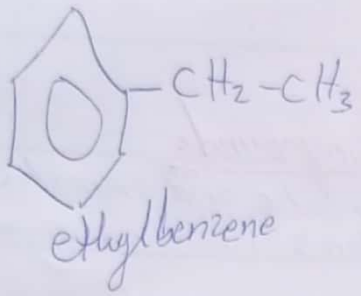
Benzene

(2) 

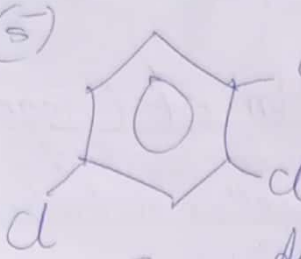
(3) 

(The three representatives of benzene structure)

CONGRATULATIONS

(4) 

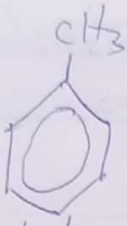
ethylbenzene

(5) 

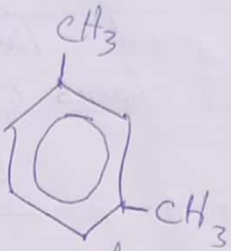
2,4-dichloro-benzoic acid

(6) 

phenol

(7) 

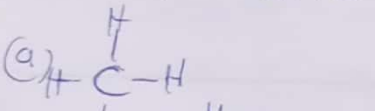
toluene

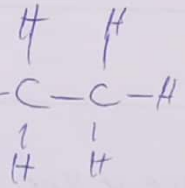
(8) 

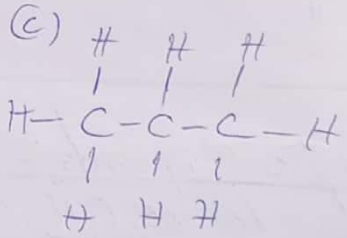
xylene

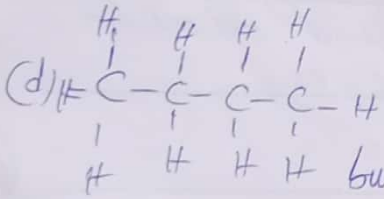
Some of the Structures of Aliphatic Compounds

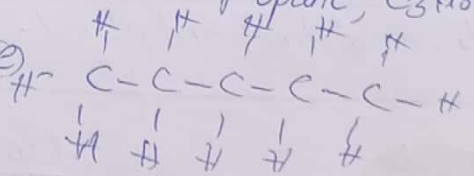
(1) For Alkanes:- They form a homologous series of saturated hydrocarbons, which can be represented by the general molecular formula, C_nH_{2n+2}.

(a) 
methane, CH_4

(b) 
ethane, C_2H_6

(c) 
Propane, C_3H_8

(d) 
butane, C_4H_{10}

(e) 
pentane, C_5H_{12}

(2) Alkenes: These are homologous series of hydrocarbons with a general molecular formula of C_nH_{2n}, where n is a positive whole number which is equal to or greater than 2 (CH_2 does not exist).

(a) C_2H_4 $CH_2=CH_2$ Ethene
(b) C_3H_6 $CH_2=CHCH_3$ Propene
(c) C_4H_8 $CH_2=CHCH_2CH_3$ But-1-ene
(d) C_4H_8 $CH_3CH=CHCH_3$ But-2-ene
(e) C_5H_{10} $CH_2=CH(CH_2)_2CH_3$ Pent-1-ene

(3) Alkynes:- These are the homologous series of unsaturated hydrocarbons with a general molecular formula of C_nH_{2n-2}, where n is a positive whole number which is equal to or greater than 2.

(a) C_2H_2 $CH\equiv CH$ Ethyne

(b) C_3H_4 $CH\equiv CCH_3$ propyne

(c) C_4H_6 $CH\equiv CCH_2CH_3$ But-1-yne

(d) C_4H_6 $CH_3C\equiv CCH$ But-2-yne

(e) C_5H_8 $CH\equiv C(CH_2)_2CH_3$ pent-1-yne

(4) Alkanols:- They are compounds in which hydroxyl groups are linked to alkyl groups. Most common aliphatic alkanols contain only one hydroxyl group on each molecule.

(a) CH_4O CH_3OH Methanol

(b) C_2H_6O CH_3CH_2OH Ethanol

(c) C_3H_8O $CH_3(CH_2)_2OH$ propan-1-ol

(d) C_3H_8O $CH_3CHOHCH_3$ Propan-2-ol

(e) $C_4H_{10}O$ $CH_3(CH_2)_3OH$ Butan-1-ol