WEEK FOUR –HYDROCARBONS

Specific objectives: At the end of the students should be able to

1. Explain the following
   a. Hydrocarbon
   b. Homologous series
   c. Isomerism
2. Draw the structure of different isomers
3. Differentiate between aliphatic and aromatic hydrocarbon
4. Give the IUPAC names of hydrocarbons

HYDROCARBONS

Hydrocarbons are the compounds produced by the chemical combination of carbon and hydrogen atoms only. Examples include: methane, CH_4, propane, C_3H_8, benzene, C_6H_6, butane,C_4H_{10} etc. the main source of hydrocarbon is crude oil.

STRUCTURES AND VALENCY OF CARBON ATOM

Hydrocarbons are brought about by the fact that carbon, being a group four element has six electrons with four electrons in its outer shell which enables carbon to have and use valency of four. But carbon cannot lose the four outermost electron to form C^{4+} neither can it gain four electrons to form C^{4-} ion.So carbon cannot form ionic bond. The only option for it is to form covalent bond and because of its many valency electrons, because of its many valency electrons, the covalent bonds it can form with other atoms are three type and their structures are thus:

i. Four single bonds ----- SP^3
ii. One double bond with two single bonds ------SP^2
iii. One triple bond with one single bond ------SP

CLASSIFICATION OF HYRDOCARBONS

There are two classes of hydrocarbons

1. Aliphatic hydrogens
2. Aromatic hydrogens
   Aliphatic hydrocarbons can be acyclic or cyclic. In acyclic form the carbon chains are straight or branch e.g. Alkanes, alkenes and alkynes. The cyclic form consists of closed chain of the hydrogen which joined end to end to form a ring.

Aromatic hydrocarbons are all in cyclic form. The simplest form is the benzene ring with three double bond, six carbon atoms and six hydrogen atoms.

HOMOLOGOUS SERIES

A homologous series is a family of organic compound with the same general formular and which each successive member differs in its molecular formular by a-CH^2 group. Each member is called a homologue. Example of homologous series with their general formular are:

Alkanes ----C_nH_{2n}+2

Alkenes -----C_nH_{2n}

Alkynes -----C_nH_{2n-2}

Alkanols-----C_nH_{2n+IOH}

Alkanoic carbonic acid-----$C_nH_{2n}HCOOH$

Characteristics of homologous series

1. All members of the series can be represented by a general molecular formular
2. The molecular formular of a member differs from that of the next by a $–CH_2$ group
3. Each successive member differs in its molecular mass by an increase of 14 units
4. The chemical properties of the member are very much similar
5. The physical properties of the members are in graduation i.e. its changes gradually as the number of carbon atoms per molecule increases
6. Members of the same series can be prepared by the same general method

NAMING HYDROCARBONS-THE IUPAC SYSTEM

The international union of pure and applied chemistry (IUPAC) has put forward a system hydrocarbon which relates the name of the compound to its molecular structure. The IUPAC system is to number all the carbon atoms in the longest chain starting from the end that Is close to the branch chain of the substituent

RULES GUIDING THE IUPAC NOMENCLATURE

1. Select t the longest continuous carbon chain as the root hydrocarbon
2. Number the carbon atom in the root hydrocarbon from the end close substituent. This gives the lowest number of suffix and then prefixes

3. If a subsistent is present two or more times in a molecule, indicate the number of time by a prefix di (2), tri (3), tetra (4) etc.
4. If there more than one type of substituent in a molecule, it is named according to alphabetical order but when there are mixed, the inorganic and named first.
5. In selecting and numbering the longest continuous chain, the functional groups are given preference over substituent i.e. the functional group is given the smallest possible number

Examples

1. 4 3 2 1
   CH_3----CH_2------CH--------CH_3
   |
   CH_3
   2 methyl butane
2. 4 3 2 1
   CH_3----CH_2-----CH= CH but-1-yne
3. 3 2 1
   CH_2---CH_2------CH_2-----OH
   |
   CL
   3-chloropropan-1-01

4. CH_3 CL
   $^6CH_3$-------^{5}CH----$^4CH_2$---^{3}CH----^{2}C-----$^1CH_3$
   BR CL
   3-bromo-2,2-dichloro-4-methyl hexane

5. CLCL
   $^1CH_3$----^{2}CH=^{3}C---^{4}CH---$^5CH_3$
   3,4-dichloropent-2-ene

6. CH_3
   $^5CH_3$---$^4CH_2$---^{3}C---$^2CH_2$----$^1CH_3$
   CH_3
   3,3-dimethyl pentane

ISOMERISM

Isomerism is the occurrence of two or more different compounds (known as isomers) with the same molecular formula but different structural

formula. As the number of carbon atom in a molecule increases, the number of isomers also increases. Isomers with the same molecular formula and belonging to the same homologous series have similar chemical properties but slightly different physical properties as a result of their structural differences.

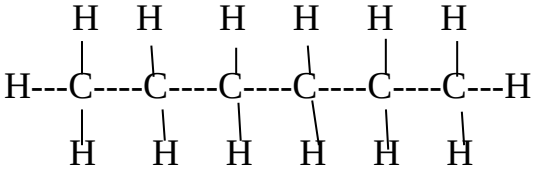
Examples

1. n-butane has one isomer
   molecular formula ------C_4H_{10}
   CH_3-CH_2-CH_2-CH_2 n-butane

   CH_3---CH---CH_3
   |
   CH_3

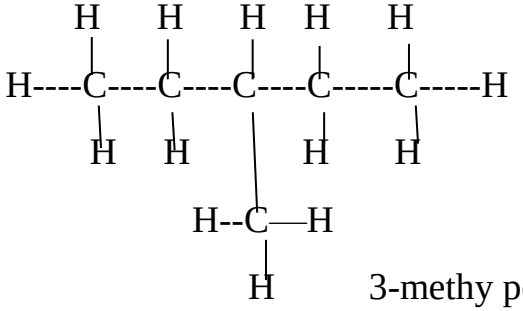
   2-methylpropane
2. Butene, C_4H_8
   i. CH_3---CH=CH---CH_3
   but-2-ene

   CH_2=CH---CH_2----CH_3but-1-ene
3. Hexane have five possible isomers
   i.



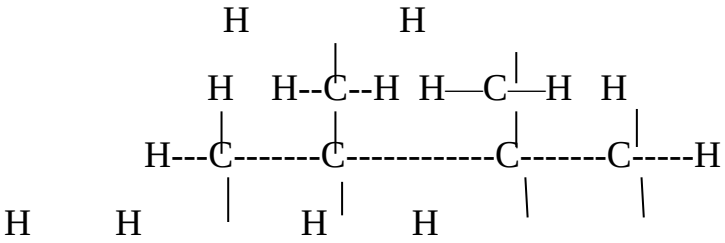
   hexane

   ii.



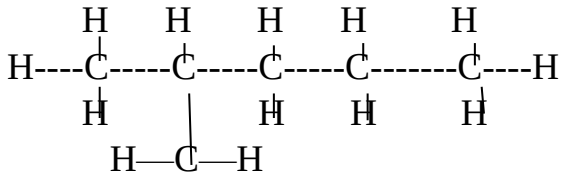
   3-methy pentane

   iii.



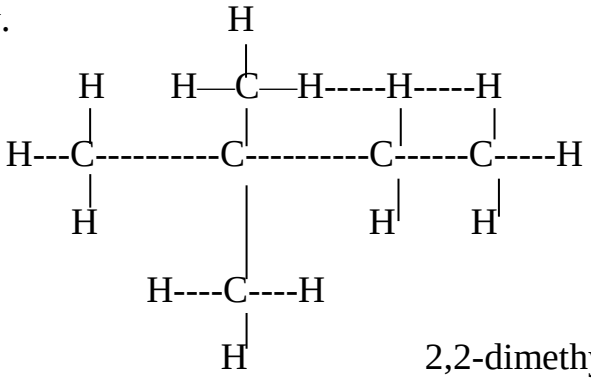
   2,3-dimethyl butane

iv.



2-methyl pentane

v.

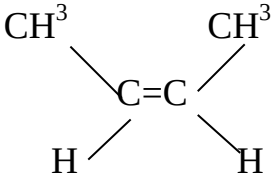


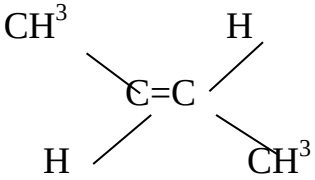
2,2-dimethyl butane

GEOMETRIC ISOMERISM

Geometric isomerism is the existence of compounds with the same molecular formula but differs in their arrangement of the component atoms.

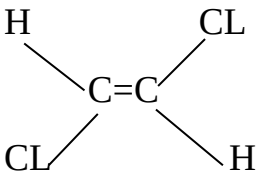
Examples:

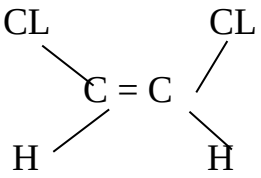




Cis-but-2-ene

trans-but-2-ene





Trans-1,2-dichloroethane

cis-1,2-dichloroethane

Evaluation:

1. Define hydrocarbon

2. Mention two natural sources of hydrocarbon
3. Which class of hydrocarbon is saturated
4. Give one example of unsaturated hydrocarbon
5. State four characteristics of homologous series
6. Define:
    a. Isomerism
    b. Functional group
    c. Homologous series

Assignment:

Explain in detail, the classification of hydrocarbon on the basis of

1. Aliphatic and Aromatic
2. Saturated and Unsaturated
3. Cyclic and alicyclic