THE VILLAGE
INTERNATIONAL SCHOOL
"We Nurture Dreams"

CHAPTER-4-CARBON AND ITS COMPOUNDS

- Carbon is found in the atmosphere, inside the earth's crust and in all living organisms.
- Carbon is present in fuels like wood, coal, charcoal, petroleum, coke, natural gas, biogas etc.
- Carbon is present in compounds like carbonates and hydrogen carbonates.
- Carbon is found in free state as diamond, graphite and fullerenes.
- Earth's crust contains **0.02%** of carbon as minerals
- Atmosphere has **0.03%** of carbon dioxide gas.

CARBON (NON-METAL)
Atomic no.- 6

Electronic configuration– K L
2 4

4 electrons in the outer shell and needs to gain or lose 4 electrons to attain stability.

- Carbon cannot gain 4 electrons. The nucleus with 6 protons cannot hold 10 electrons.so it cannot form C^{4-}
- Carbon cannot lose 4 electrons. large amount of energy is required to remove 4 electrons. So, it cannot form C^{4+}
- Carbon can share its valence electrons with other carbon atoms or with atoms of other elements.

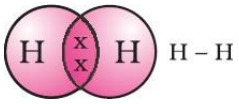
COVALENT BOND

- The bond which is formed by the sharing of electrons is known as covalent bond.
- The compounds which are formed by the sharing of electrons are called covalent compounds.

Examples for simple covalent molecules

1. H_2

   Atomic number-1, Electronic configuration- K
   1



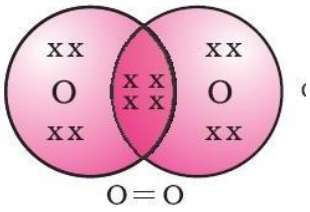
It requires one more electron to fill the K shell. So, sharing of one pair of electrons.

The covalent bond which is formed by the sharing of one pair of electrons is known as a **single bond(-)**

2. **Oxygen molecule**

Atomic no- 8, K L
2 6

Two more electrons are required (sharing of two pairs of electrons)

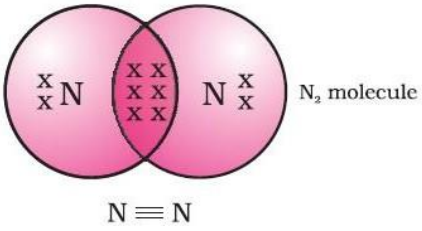


Double bond- The covalent bond which is formed by the sharing of two pairs of electrons.

3. **Nitrogen molecule**

Atomic no-7, K L
2 5

Three more electrons are required (sharing of 3 pairs of electrons)



Triple bond- The covalent bond which is formed by the sharing of 3 pairs of electrons.

Properties of covalent compounds

1. They have strong bonds within the molecule. But intermolecular forces are weak.
2. Low melting and boiling points.

3. Generally poor conductors of electricity.

Versatile nature of carbon (Reason for the formation of large number of carbon compounds)

The two properties of carbon element which leads to the formation of large number of carbon compounds are: -

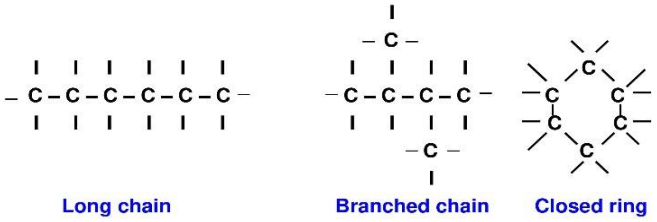
1. Catenation and
2. Tetravalency

1. **Catenation** (self-linking)

The property of carbon element due to which its atoms can join with one another to form long carbon chains is called catenation.

Three types of chains can be formed:

- Straight chains (long chains)
- Branched chains
- Rings



The carbon – carbon bond is very strong and stable. (This gives large number of compounds)

Silicon also exhibits catenation. Only up to 7/8 atoms join together to form compounds. These silicon compounds are unstable and very reactive.

Tetravalency

Due to its large valency of 4, carbon can form covalent bonds with other four carbon atoms or atoms of other elements like Hydrogen, Oxygen, Nitrogen, Sulphur, Chlorine and many more atoms.

- Because of small size, carbon can form strong bonds with other atoms and these compounds are stable.

HYDROCARBONS

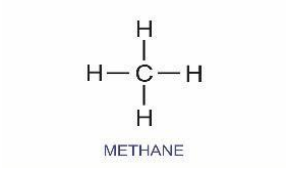
A compound made up of carbon and hydrogen only is called a hydrocarbon.

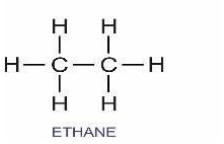
The most important natural source of hydrocarbons is petroleum or crude oil.

- Two types of hydrocarbons– saturated and unsaturated.

Saturated hydrocarbons (Alkanes)

A hydrocarbon in which the carbon atoms are connected by only single bonds is called a saturated hydrocarbon.

Eg:- methane CH_4, 

Ethane C_2H_6 

Unsaturated hydrocarbons

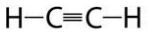
A hydrocarbon in which two carbon atoms are joined by a double bond or triple bond. These are of two types--- **Alkenes and Alkynes**

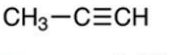
Alkenes- An unsaturated hydrocarbon in which 2 carbon atoms are connected by a double bond.

Eg:- Ethene (CH_2= CH_2),
Propene (CH_3-CH=CH_2)

Alkynes-

An unsaturated hydrocarbon in which 2 carbon atoms are connected by a triple bond.

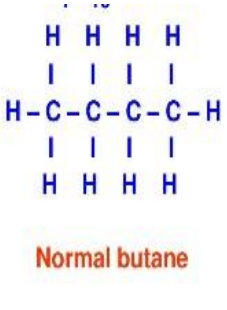

Ethyne C_2H_2

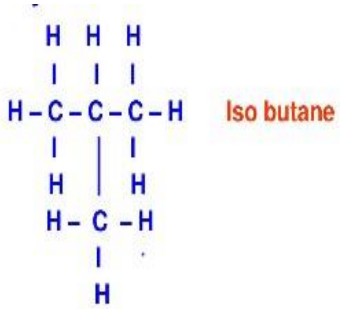

Propyne C_3H_4

ISOMERS

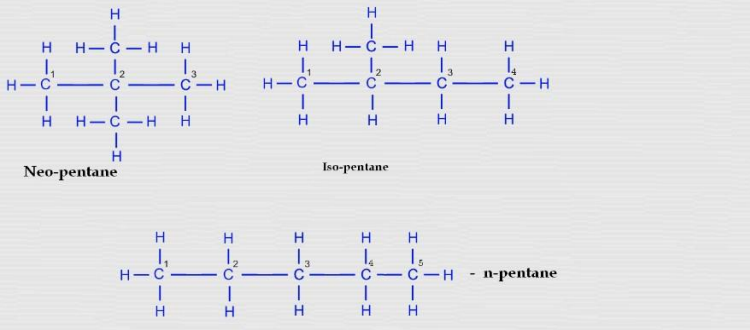
Organic compounds having the same molecular formula and different structures are known as isomers. Isomerism is possible with hydrocarbons having 4 or more carbon atoms.

Isomers of butane, C_4H_{10}


Normal butane


Iso butane

Isomers of pentane C_5H_{12}

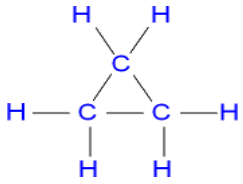


CYCLIC HYDROCARBONS

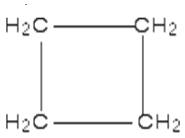
Hydrocarbons in which the carbon atoms are arranged in the form of a ring are called cyclic hydrocarbons.

- Cyclic hydrocarbons may be saturated or unsaturated.
- Examples for saturated cyclic hydrocarbons: -

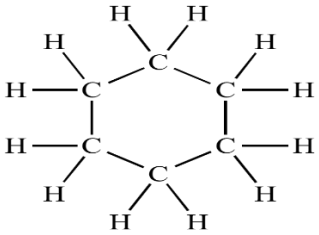
1. Cyclopropane



2. Cyclobutane



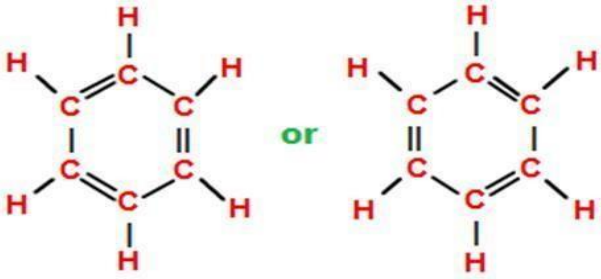
3. Cyclohexane



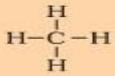
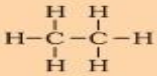
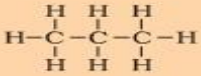
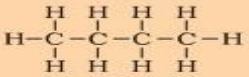
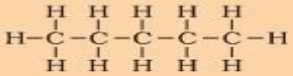
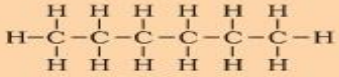
Example for unsaturated cyclic hydrocarbon:-

Benzene- C_6H_6

- Benzene contains alternate single and double bonds.



Formulae and structures of saturated compounds of carbon and hydrogen

No. of C atoms	Name	Formula	Structure
1	Methane	CH_4	
2	Ethane	C_2H_6	
3	Propane	C_3H_8	
4	Butane	C_4H_{10}	
5	Pentane	C_5H_{12}	
6	Hexane	C_6H_{14}	

HOMOLOGOUS SERIES

Homologous series is a group of organic compounds having similar structures and similar chemical properties in which the successive compounds differ by CH_2 unit.

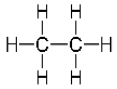
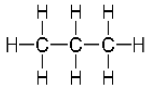
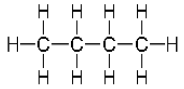
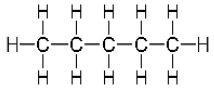
Characteristics of homologous series

- All members can be represented by the same general formula.
- Adjacent members differ by CH_2 unit.
- Adjacent members differ by a molecular mass of 14 u
- Show a gradual change in physical properties (chemical properties are same)

Examples of homologous series

1. Alkanes
   (General formula- CnH2n+2)

Eg:- CH_4, C_2H_6, C_3H_8

ALKANE	CARBON NUMBER	FORMULA	STRUCTURE
METHANE	1	CH_4	
ETHANE	2	C_2H_6	
PROPANE	3	C_3H_8	
BUTANE	4	C_4H_{10}	
PENTANE	5	C_5H_{12}	

2. Alkenes

General formula-(CnH2n)

Eg:- C_2H_4, C_3H_6, C_4H_8

ALKENE	No. of Carbons	Structure	Formula
Ethene	2	$CH_2=CH_2$	C_2H_4
Propene	3	$CH3-CH=CH_2$	C_3H_6
Butene	4	$CH_3-CH_2-CH=CH_2$	C_4H_8
Pentene	5	$CH_3-CH_2-CH_2-CH=CH_2$	C_5H_{10}

3. Alkynes

General formula- (CnH2n-2)

C_2H_2, C_3H_4, C_4H_6

ALKYNE	No. of Carbons	Structure	Formula
Ethyne	2	$HC\equiv CH$	C_2H_2
Propyne	3	$CH_3-C\equiv CH$	C_3H_4
Butyne	4	$CH_3-H_2C-C\equiv CH$	C_4H_6
Pentyne	5	$CH_3-CH_2-CH_2-C\equiv CH$	C_5H_8