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*By: Uttam Singh*

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**Sample Preview  
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# QUESTION PAPER

( June - 2019 )

( Solved )

## ORGANIC CHEMISTRY

Time: 2 Hours ]

[ Maximum Marks : 50

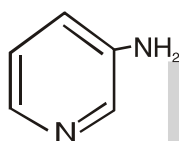
Note: Answer all the four questions.

1. Answer the following parts :

(a) Write the structure of the following compounds :

(i) 4-Aminopyridine

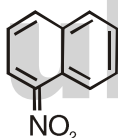
Ans.



Chemical Formula is  $C_5H_6N_2$

(ii) 1-Nitronaphthalene

Ans.



Chemical Formula is  $C_{10}H_7NO_2$

(b) Give the IUPAC name of the following :

(i)  $CH_3CH_2OCH_2CH_2CH_3$

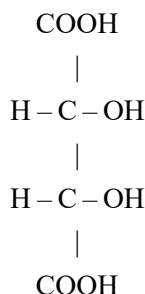
Ans. 1-Ethoxy Propane.

(ii)  $HCONH_2$

Ans. 1-Methanamide

(c) Write the structure of meso-tartaric acid.

Ans.



(d) Which one of the following compounds will be miscible with water?

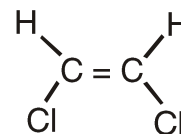
(i) Diethyl ether

(ii) Glycol

Ans. Diethyl ether is partially miscible with water while glycol is completely miscible with water. As glycol (ethylene glycol), despite being an organic compound is quite polar because of the differing electronegativities of the oxygen and carbon atoms it contains. Water is also polar because of the different electronegativities of hydrogen and oxygen.

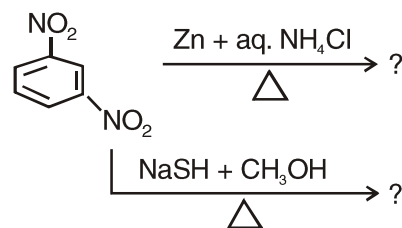
(e) Why does trans-1,2-dichloroethene have zero dipole moment?

Ans. Trans -1, 2-dichloroethene will have zero dipole moment because if we see the structure of the compound the two chlorine and hydrogen atoms orient in opposite way on adjacent carbons and cancel each other. Hence, it have zero dipole moment.



Q. 2. Answer the following parts:

(a) Complete the following reactions :





# **Sample Preview of The Chapter**

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# ORGANIC CHEMISTRY

## FUNDAMENTAL CONCEPTS

### Bonding, Functional Group Classification and Nomenclature



#### INTRODUCTION

Organic compounds are vital for sustaining life on earth and include complex molecules like genetic information bearing Deoxyribonucleic Acid (DNA) and proteins that constitute essential compounds of our blood, muscles and skin. Organic chemicals appear in materials like clothing, fuels, polymers, dyes and medicines. These are some of the important areas of application of these compounds.

Science of organic chemistry is about two hundred years old. Around the year 1780, chemists began to distinguish between organic compounds obtained from plants and animals and inorganic compounds prepared from mineral sources.

The pioneering synthesis of acetic acid by Kolbe (1845) and that of methane by Berthelot (1856) showed conclusively that organic compounds could be synthesised from inorganic sources in a laboratory.

#### CHAPTER AT A GLANCE

##### THE COVALENT BOND

A covalent bond is the chemical bond that involves the sharing of pairs of electrons between atoms. The stable balance of attractive and repulsive forces between atoms when they share electrons is known as covalent

bonding. Formed from sharing of two electrons, usually one donated from each of the two bonding atoms. Sharing electrons is one way that atoms can satisfy the "Octet Rule" which as stated by Gilbert Lewis "atoms, by sharing electrons to form an electron-pair bond, can acquire a stable, noble-gas structure".

Bonds between the same type of atom are covalent bonds, and bonds between atoms whose electronegativity differs by a little (say 0.7) are also predominant covalent in character. There is also some covalent character between ions of what we usually call ionic solids.

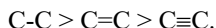
Distances between centres of bonded atoms are called bond lengths, or bond distances. Bond lengths vary depending on many factors, but in general, they are very consistent. Of course the bond orders affect bond length, but bond lengths of the same order for the same pair of atoms in various molecules are very consistent. Thus, there are tables of interatomic distances or bond lengths in some standard handbooks. The bondlengths ranges from the shortest of 74 pm for H-H to some 200 pm for large atoms, and the bond energies depends on bond order and lengths. Half of the bond length of a single bond of two similar atoms is called covalent radius. The sum of two covalent radii of two atoms is usually the single bond length. For example, the covalent radii of H and C are 37 and 77 pm

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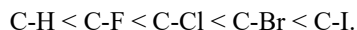
respectively. The C-H bond is thus (37+77) 114 pm. Note that 77 pm = 154/2 pm.

**Important Points**

Bond length decreases with the increase in multiplicity of the bond. The decreasing order for bond lengths for carbon – carbon bonds is:

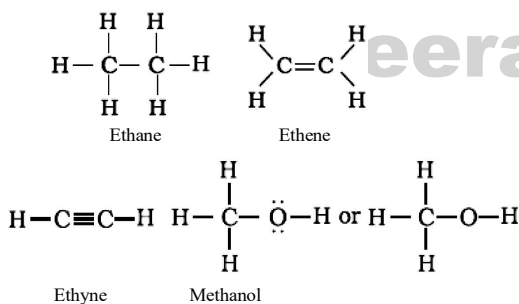


Bond lengths increase with the increasing size of the bonded atoms, i.e., the increasing order of bond lengths is:

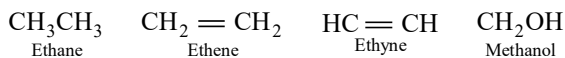


**STRUCTURAL FORMULAS**

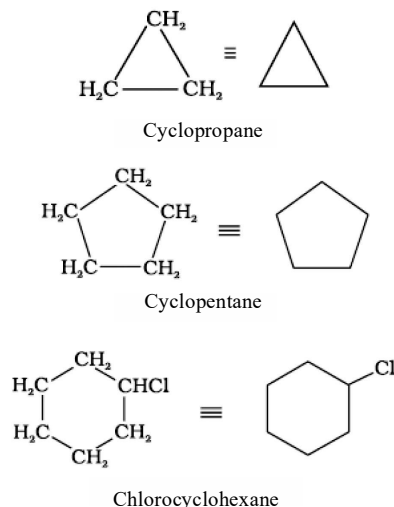
Structures of organic compounds are represented in several ways. The Lewis structure or dot structure, dash structure, condensed structure and bond line structural formulas are some of the specific types. The Lewis structures, however, can be simplified by representing the two-electron covalent bond by a dash (-). Such a structural formula focuses on the electrons involved in bond formation. A single dash represents a single bond, double dash is used for double bond and a triple dash represents triple bond. Lone pairs of electrons on heteroatoms (e.g., oxygen, nitrogen, sulphur, halogens etc.) may or may not be shown. Thus, ethane (C<sub>2</sub>H<sub>6</sub>), ethene (C<sub>2</sub>H<sub>4</sub>), ethyne (C<sub>2</sub>H<sub>2</sub>) and methanol (CH<sub>3</sub>OH) can be represented by the following structural formulas. Such structural representations are called complete structural formulas.



These structural formulas can be further abbreviated by omitting some or all of the dashes representing covalent bonds and by indicating the number of identical groups attached to an atom by a subscript. The resulting expression of the compound is called a condensed structural formula. Thus, ethane, ethene, ethyne and methanol can be written as:



In cyclic compounds, the bond-line formulas may be given as follows:



**ORBITAL HYBRIDISATION**

In order to explain the characteristic geometrical shapes of polyatomic molecules like CH<sub>4</sub>, NH<sub>3</sub> and H<sub>2</sub>O etc., Pauling introduced the concept of hybridisation. According to him the atomic orbitals combine to form new set of equivalent orbitals known as hybrid orbitals. Unlike pure orbitals, the hybrid orbitals are used in bond formation. The phenomenon is known as hybridisation which can be defined as the process of intermixing of the orbitals of slightly different energies so as to redistribute their energies, resulting in the formation of new set of orbitals of equivalent energies and shape. For example, when one 2s and three 2p-orbitals of carbon hybridise, there is the formation of four new sp<sup>3</sup> hybrid orbitals.

**Salient features of hybridisation:** The main features of hybridisation are as under:

1. The number of hybrid orbitals is equal to the number of the atomic orbitals that get hybridised.
2. The hybridised orbitals are always equivalent in energy and shape.
3. The hybrid orbitals are more effective in forming stable bonds than the pure atomic orbitals.
4. These hybrid orbitals are directed in space in some preferred direction to have minimum repulsion between electron pairs and thus a stable arrangement. Therefore, the type of hybridisation indicates the geometry of the molecules.

**Important conditions for hybridisation**

- The orbitals present in the valence shell of the atom are hybridised.
- The orbitals undergoing hybridisation should have almost equal energy.
- Promotion of electron is not essential condition prior to hybridisation.
- It is not necessary that only half filled orbitals participate in hybridisation. In some cases, even filled orbitals of valence shell take part in hybridisation.

 **$sp^3$ -Hybridisation**

This type of hybridisation can be explained by taking the example of  $CH_4$  molecule in which there is mixing of one  $s$ -orbital and three  $p$ -orbitals of the valence shell to form four  $sp^3$  hybrid orbital of equivalent energies and shape. There is 25%  $s$ -character and 75%  $p$ -character in each  $sp^3$  hybrid orbital. The four  $sp^3$  hybrid orbitals so formed are directed towards the four corners of the tetrahedron. The angle between  $sp^3$  hybrid orbital is  $109.5^\circ$  as shown in Fig. 1.1.

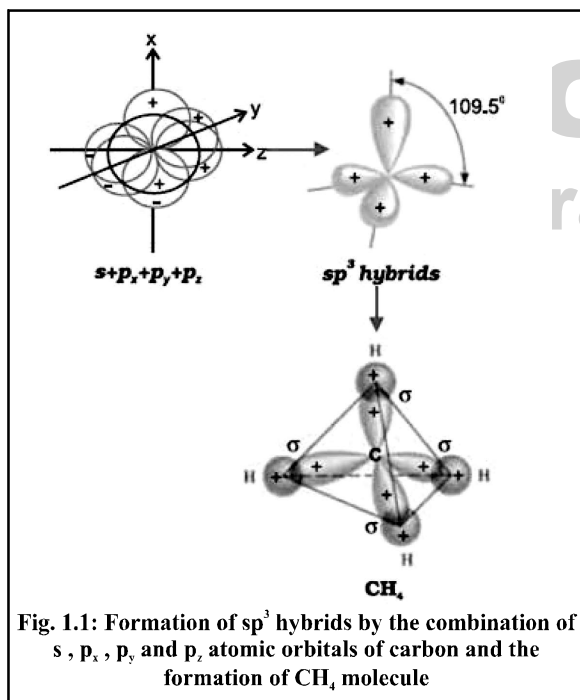


Fig. 1.1: Formation of  $sp^3$  hybrids by the combination of  $s, p_x, p_y$  and  $p_z$  atomic orbitals of carbon and the formation of  $CH_4$  molecule

 **$sp^2$ -Hybridisation**

In this hybridisation there is involvement of one  $s$  and two  $p$ -orbitals in order to form three equivalent  $sp^2$  hybridised orbitals. For example, in  $BCl_3$  molecule, the ground state electronic configuration of central boron atom is  $1s^2 2s^2 2p^1$ . In the excited state, one of the  $2s$  electrons is promoted to vacant  $2p$  orbital as a result boron has three unpaired electrons. These three orbitals (one  $2s$  and two  $2p$ ) hybridise to form three  $sp^2$  hybrid orbitals. The three hybrid orbitals so formed are oriented in a trigonal planar arrangement and overlap with  $2p$  orbitals of chlorine to form three B-Cl bonds. Therefore, in  $BCl_3$  where is the figure, the geometry is trigonal planar with ClBCl bond angle of  $120^\circ$ .

 **$sp$ -Hybridisation**

This type of hybridisation involves the mixing of one  $s$  and one  $p$  orbital resulting in the formation of two equivalent  $sp$  hybrid orbitals. The suitable orbitals for  $sp$  hybridisation are  $s$  and  $p_z$ , if the hybrid orbitals are to lie along the  $z$ -axis. Each  $sp$  hybrid orbitals has 50%  $s$ -character and 50%  $p$ -character. Such a molecule in which the central atom is  $sp$ -hybridised and linked directly to two other central atoms possesses linear geometry. This type of hybridisation is also known as diagonal hybridisation.

The two  $sp$  hybrids point in the opposite direction along the  $z$ -axis with projecting positive lobes and very small negative lobes, which provides more effective overlapping resulting in the formation of stronger bonds.

**FUNCTIONAL GROUP CLASSIFICATION**

The functional group may be defined as an atom or group of atoms joined in a specific manner which is responsible for the characteristic chemical properties of the organic compounds. The examples are hydroxyl group ( $-OH$ ), aldehyde group ( $-CHO$ ) and carboxylic acid group ( $-COOH$ ), etc.

Compounds having the same functional group undergo similar reactions. For example,  $CH_3OH$ ,  $CH_3CH_2OH$ , and  $(CH_3)_2CHOH$ - all having  $-OH$  functional group liberate hydrogen on reaction with sodium metal. The presence of functional groups enables systematisation of organic compounds into different classes. Examples of some functional groups with their prefixes and suffixes along with some examples of organic compounds possessing these are given in Table 1.1 below:

Table 1.1: Some Functional Groups and Classes of Organic Compounds

Class of Compounds	Functional Group Structure	IUPAC Group Prefix	IUPAC Group Suffix	Example
Alkanes	-	-	-ane	Butane, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>3</sub> But-1-ene
Alkenes	>C=C<	-	-ene	CH <sub>2</sub> =CHCH <sub>2</sub> CH <sub>3</sub> But-1-yne
Alkyner	-C≡C-	-	-yne	CH≡CCH <sub>2</sub> CH <sub>3</sub>
Arenes		-	-	Benzene,
Halides	-X (X=F,Cl,Br,I)	halo-	-	1-Bromobutane, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> Br
Alcohols	-OH	hydroxy-	-ol	Butane-2-ol, CH <sub>3</sub> CH <sub>2</sub> CHOHCH <sub>3</sub>
Aldehydes	-CHO	formyl, or oxo	-al	Butanal, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CHO
Ketones	>C=O	oxo-	-one	Butan-2-one, CH <sub>3</sub> CH <sub>2</sub> COCH <sub>3</sub>
Nitriles	-C≡N	cyano	nitrile	Pentanenitrile, CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CN
Ethers	-R-O-R-	alkoxy-	-	Ethoxyethane, CH <sub>3</sub> CH <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>
Carboxylic acids	-COOH	carboxy	-oic acid	Butanoic acid, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CO <sub>2</sub> H
Carboxylate ions	-COO <sup>⊖</sup>	-	-oate	Sodium butanoate, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CO <sub>2</sub> -Na <sup>+</sup>
Esters	-COOR	alkoxycarbonyl	-oate	Methyl propanoate, CH <sub>3</sub> CH <sub>2</sub> COOCH <sub>3</sub>
Acyl halides	-COX (X=F,Cl,Br,I)	halocarbonyl	-oyl halide	Butanoyl chloride, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> COCl
Amines	-NH <sub>2</sub> , >NH,>N-	amino-	-amide	Butan-2-amide, CH <sub>3</sub> CHNH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
Amides	-C(=O)NH <sub>2</sub> , -CONHR, -CONR <sub>2</sub>	-carbamoyl	-amide	Butanamide, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CONH <sub>2</sub>
Nitro compounds	-NO <sub>2</sub>	nitro	-	1-Nitrobutane, CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> NO <sub>2</sub>
Sulphonic acids	-SO <sub>3</sub> H	sulpho	sulphonic acid	Methylsulphonic acid CH <sub>3</sub> SO <sub>3</sub> H