BASIC PRINCIPLES OF ORGANIC CHEMISTRY:

The basic organic compounds in organic chemistry are hydrocarbons. Hydrocarbon compound comprises of carbon and hydrogen. Many organic compounds contain elements like nitrogen, oxygen, sulphur and halogen over and above carbon and hydrogen. Variety of organic compounds is obtained by replacing one or more hydrogen atoms of hydrocarbons by elements like nitrogen, oxygen, sulphur, and halogen or by functional groups. Thus the chemistry of hydrocarbons and their derivatives obtained by replacement of hydrogen by variety of functional groups constitutes organic chemistry.

Tetra-valency of Carbon:

Atomic number of carbon is 6. Consequently it will have six electrons, the arrangement of which is 1 5 *2 s* $2p_x$ *2 p* $2p_z$. Here the number of electrons in its outermost orbital is four. In order to attain a stable electronic configuration of an inert gas, carbon atom should either lose four electrons or gain four electrons.

To achieve this very large amount of energy is required. Consequently it cannot form ions C^{4+} or C^4~. However the carbon atom shares four electrons with some elements and forms four covalent bonds. Thus carbon atom exhibits a valency of four i.e. tetra-valency.

The tetra-valency of carbon can be explained as follows:

Carbon atom on being excited will result in new electronic arrangement as $1s^z$ 2 s^1 $2p^1 2p^l_y$ $2p^1_z$ in its excited state.

All the four electrons in the outer most orbital carbon atom in an excited state are unpaired. These four electrons are present in two different types of the orbitals viz. *s* and *p* orbitals. If these four unpaired electrons are to form four covalent bonds.

These four bonds cannot be considered equivalent. However, it has been experimentally established that the four bonds formed by carbon in the molecules like methane or carbon tetrachloride are equivalent. The equivalence of these four bonds can be explained by the hybridization of these four unpaired electrons.

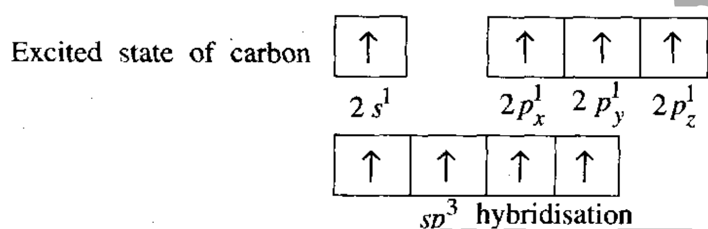
Hybridization and Hybrid Orbits:

When, in a given atom there is a mixture of two or more different types of nearby orbitals having much less difference in their energies, there will be formation of same number of the orbitals of similar shapes and similar energies. This process of formation of same number of orbitals of similar energies and shapes is known as hybridization and the orbitals so formed are called hybrid orbitals.

Hybridization in Carbon Atom and Shapes of Organic Molecules

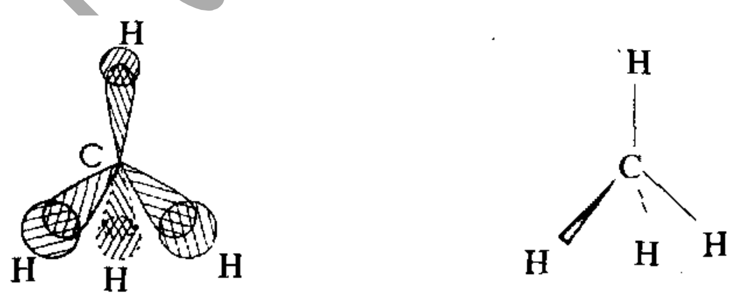
Shape of sp^3 Hybrid Orbits and sigma Bond:

As there is one C-C bond in compounds of alkane series, the sp^3 hybridization taking place in them can be explained as follows. In the excited state of carbon atom, a mixture of four orbitals is formed from the electronic arrangement of its outermost orbitals each orbital containing one unpaired electron, the mixture containing one *s* and three *p* orbitals. The newly formed orbitals have similar shape and energy. This type of hybridization is called sp^3 hybridization. The energy of all the four unpaired electron of sp^3 hybrid orbital is same.



Shape of Methane Molecule:

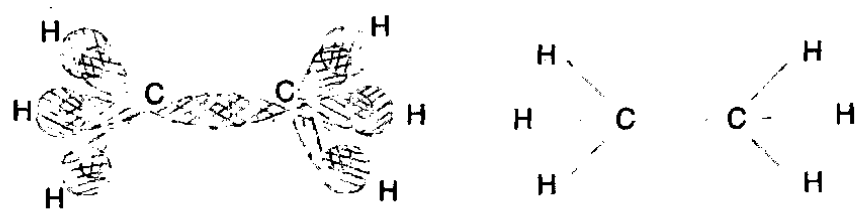
The four equivalent orbitals in a carbon atom of the methane, CH_4 formed as a result of sp^3 hybridization and four unpaired electrons are arranged in a tetrahedral form. Here the angle between any two adjacent orbitals is 109° 28', when each of the four orbitals formed from the sp^3 hybridization of carbon atom combine with each of the four l.v orbitals of hydrogen atoms containing unpaired electron having the opposite spin, there forms four covalent bonds of equal strength. Thus, if a bond is formed by sharing of the electrons of two orbitals containing unpaired electrons of the opposite spin, the bond so formed is called a o bond. Hence, the shape of methane molecule is tetrahedral and there are four C-H **a** bonds having equal energy. Further the bond lengths of four*C-H bonds are also the same. The bond angle is 109° 28'.



14.1 The shape of methane molecule

Shape of Ethane Molecule:

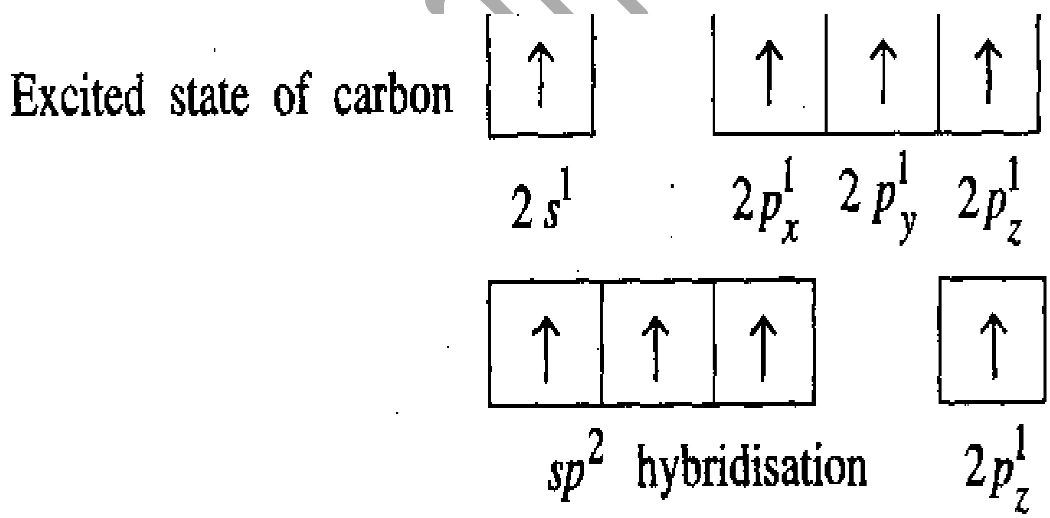
The molecular Formula of ethane is C_2H_6 and its molecular structure is CH_3 - CH_3. One of the sp^3 hybrid orbitals on each of two carbon atoms overlap - 241 - each other by sharing of the unpaired electrons to form C bond. This leaves three hybrid orbitals (of the type sp^3) on each carbon atom. These three hybrid orbitals contain three unpaired electrons, one in each orbital, which combine with three unpaired electrons of opposite spin of Is orbitals of hydrogen atoms. This will result in formation of six C-H bonds of equal energy and of equal bond lengths.



14.2 The shape of Ethane molecule

The Shape of sp^2 Hybrid:

As the compounds of Alkene series contain carbon-carbon double bond, C = C, sp hybridization taking place among them can be explained as follows. A carbon atom in an excited state, contains three unpaired electrons in its outermost orbitals of which one orbital is of type 2s and two orbitals of type *2p,* totally three. This can mix to form a set of three orbitals having same shape and equal energy. Such a mix is called sp^2 hybridization. The unpaired electrons in these three sp^2 hybrid orbitals have same energy. The $2p_z$ orbital of the carbon atom which does not participate in the formation of sp^2 hybridization has one unpaired electron whose energy is not same as those of the unpaired electrons of the sp^2 hybrid orbitals,



Three orbitals formed due to sp^1 hybridization are arranged in a planar triangular shape. The angle between any two orbitals is of 120°.