Chemistry Study Materials for Class 11 (NCERT Based Notes of Chapter- 04)

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CHEMICAL BONDING AND MOLECULAR STRUCTURE

Types of hybridisation

1. **sp^3 hybridisation:** It is the process of inter mixing of one s-orbital and three p-orbitals to form four new orbitals having equivalent energy and shape. The 4 new orbitals formed are called sp^3 hybrid orbitals. They are directed to the four corners of a regular tetrahedron with bond angle $109^0 28^l$.

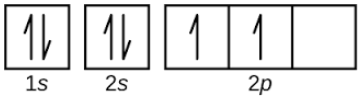
   Each sp^3 hybrid orbitals has 25% s-character and 75% p- character.

e.g. i) . *Formation of methane (CH_4)*

In CH_4, the central atom C has the electronic configuration

$_6C - 1s^2 2s^2 2p_x^1 2p_y^1$

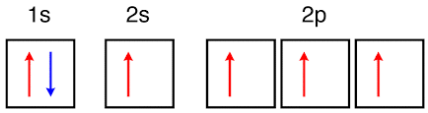
C (ground state) –



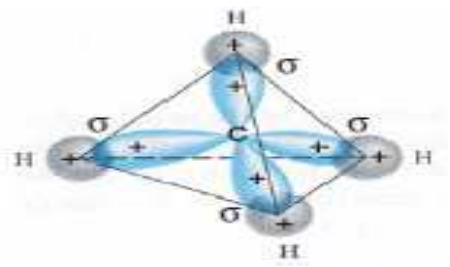
In order to explain the tetra valency of C, it is suggested that one of the electrons of 2s orbital is promoted

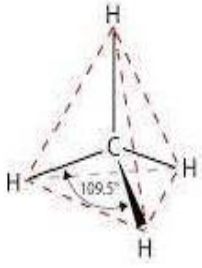
$_6C - 1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$

C (excited state) –



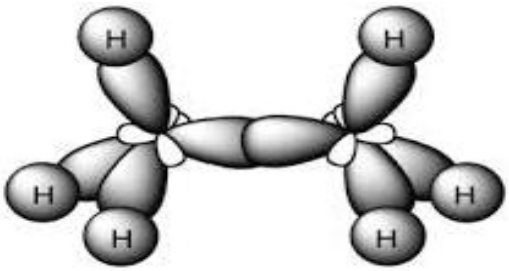
Now, one s-orbital and three p orbitals undergo sp^3 hybridisation. These sp^3 hybrid orbitals are directed to the four corners of a regular tetrahedron with bond angle $109^0 28^l$. each of these sp^3 hybrid orbitals overlap with 1s orbital of H to form four C-H σ bonds.

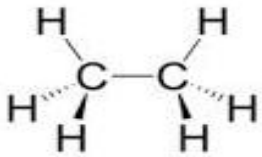




ii)Formation of ethane (C_2H_6)

In ethane, each C atom undergoes sp^3 hybridisation. Out of the 4 sp^3 hybrid orbitals, one of each C- atom overlaps axially to form a C-C σ - bond. The remaining 3 sp^3 hybrid orbitals of each C - atom overlap with 1s orbital of H - atom to form 6 C-H σ - bonds.

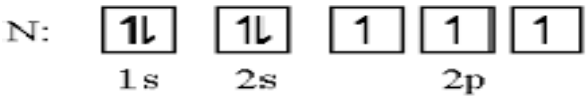




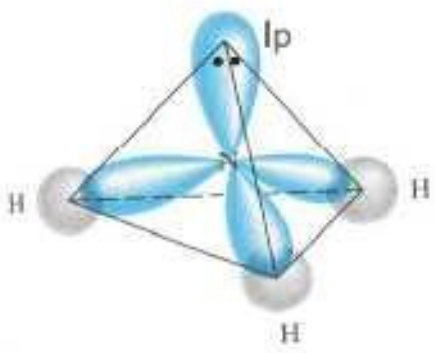
iii)Formation of Ammonia (NH_3) molecule

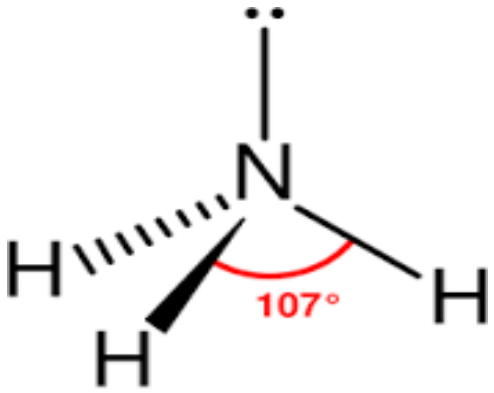
In NH_3, the central atom N has the electronic configuration

$_7N$ – $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$



The one s-orbital and three p-orbitals of N undergo sp^3 hybridisation to form 4 sp^3 hybrid orbitals. One of this sp^3 hybrid orbitals is occupied by a lone pair and the other three sp^3 hybrid orbitals overlap with 1s orbital of hydrogen to form 3 N-H bonds. Due to the greater repulsion between lone pair and bond pairs, the shape is distorted **to pyramidal** and the bond angle becomes **107^0**.

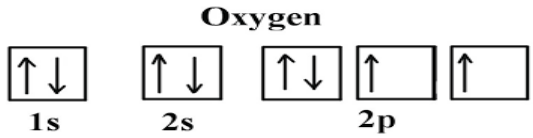




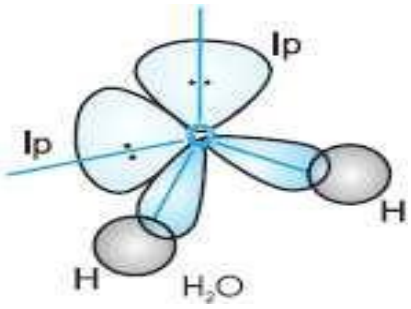
Iv) Formation of water (H_2O) molecule

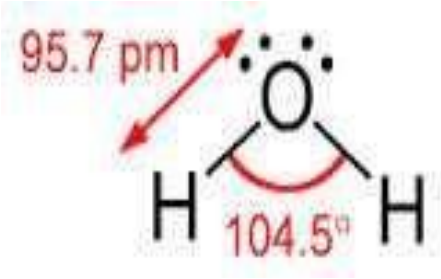
In H_2O, the central atom O has the electronic configuration

$_8O - 1s^2\ 2s^1\ 2p_x^2\ 2p_y^1 2p_z^1$



Now the one s-orbital and three p-orbitals of O undergo sp^3 hybridisation to form 4 sp^3 hybrid orbitals. Two of these sp^3 hybrid orbitals are occupied by lone pairs and the other two sp^3 hybrid orbitals overlap with 1s orbital of hydrogen to form 2 O-H bonds. Due to the greater repulsion between lone pairs, the shape is distorted to angular shape or bent structure or inverted 'v' shape and the bond angle becomes 104.5^0.





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