

## UNIT 4

# CHEMICAL BONDING AND MOLECULAR STRUCTURE

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### $sp^3$ hybridisation:

Mixing of one 's' orbital and three 'p' orbitals to form four  $sp^3$  hybrid orbitals.

- Each  $sp^3$  hybrid orbital possess 25% s – character and 75% p – character.
- $sp^3$  hybrid orbitals arrange in space to give tetrahedral geometry.

Ex.  $CH_4$  molecule.

C – Ground state –  $1s^2 2s^2 2p^2$

Excited state –  $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$

- s,  $p_x$ ,  $p_y$  &  $p_z$  orbitals intermix to form four  $sp^3$  hybrid orbitals.
- The  $sp^3$  hybrid orbitals overlap with s-orbitals of hydrogen to form  $CH_4$  molecule.

### Structures of few molecules:

1.  $NH_3$  – Ground state –  $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$ .

$\rightarrow (s + p_x + p_y + p_z \rightarrow sp^3 \text{ hybrid}).$

- Three hybrid orbitals of nitrogen overlap with s – orbitals to form  $NH_3$  molecule.

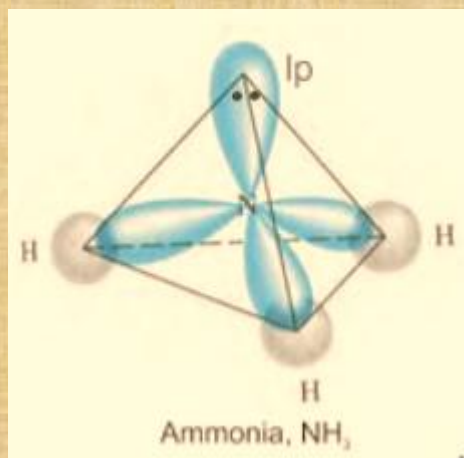


*Fig. Formation of  $\text{NH}_3$  molecule*

### **$\text{C}_2\text{H}_4$ molecule:**

C – Ground state –  $1s^2 2s^2 2p^2$

- Undergoes  $sp^2$  hybridisation to give three  $sp^2$  hybrid orbitals.
- The empty p – orbitals of each carbon overlap sidewise to form pi bond.

### **$\text{C}_2\text{H}_2$ molecule:**

Both carbons undergo  $sp$  – hybridisation.

$sp$  – hybrid orbitals overlap to form sigma bond.

Unhybridised p – orbitals overlap side wise to form two pi bonds.

### **$\text{PCl}_5$ molecule:**

p – Ground state –  $3s^2 3p^3$

Excited state –  $3s^1 3p^3 3d^1$

- One s – orbital three p orbitals & one d –orbital intermix to give  $sp^3d$  hybridisation and trigonal bipyramidal geometry.

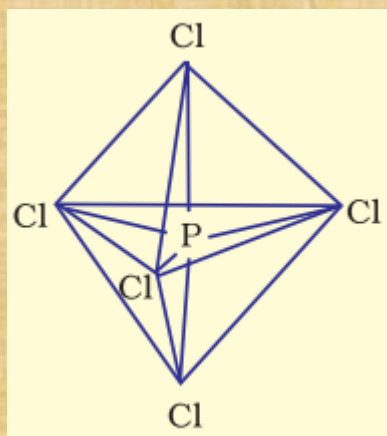


Fig. Trigonal bipyramidal ge