1. **sp Hybridization**

sp hybridization is observed when one s and one p orbital in the same main shell of an atom mix to form two new equivalent orbitals. The new orbitals formed are called sp hybridized orbitals. It forms linear molecules with an angle of 180°. This type of hybridization involves the mixing of one ‘s’ orbital and one ‘p’ orbital of equal energy to give a new hybrid orbital known as an sp hybridized orbital. sp hybridization is also called diagonal hybridization. Each sp hybridized orbital has an equal amount of s and p character, i.e., 50% s and p character. Example is All compounds of beryllium like BeF2, BeH2, BeCl2

**sp2 Hybridization**

sp2 hybridisation is observed when one s and two p orbitals of the same shell of an atom mix to form 3 equivalent orbital. The new orbitals formed are called sp2 hybrid orbitals. sp2 hybridization is also called trigonal hybridization. It involves mixing of one ‘s’ orbital and two ‘p’ orbital’s of equal energy to give a new hybrid orbital known as sp2. A mixture of s and p orbital formed in trigonal symmetry and is maintained at 1200. All the three hybrid orbitals remain in one plane and make an angle of 120° with one another. Each of the hybrid orbitals formed has 33.33% s character and 66.66% ‘p’ character. The molecules in which the central atom is linked to 3 atoms and is sp2 hybridized have a triangular planar shape. Example is All the compounds of Boron i.e. BF3, BH3

**sp3 Hybridization**

When one ‘s’ orbital and 3 ‘p’ orbitals belonging to the same shell of an atom mix together to form four new equivalent orbital, the type of hybridization is called a tetrahedral hybridization or sp3. The new orbitals formed are called sp3 hybrid orbitals. These are directed towards the four corners of a regular tetrahedron and make an angle of 109°28’ with one another. The angle between the sp3 hybrid orbitals is 109.280. Each sp3 hybrid orbital has 25% s character and 75% p character.

Example of sp3 hybridization: ethane (C2H6).

**sp3d Hybridization**

sp3d hybridization involves the mixing of 3p orbitals and 1d orbital to form 5 sp3d hybridized orbitals of equal energy. They have trigonal bipyramidal geometry. The mixture of s, p and d orbital forms trigonal bipyramidal symmetry. Three hybrid orbitals lie in the horizontal plane inclined at an angle of 120° to each other known as the equatorial orbitals. The remaining two orbitals lie in the vertical plane at 90 degrees plane of the equatorial orbitals known as axial orbitals.

Example: Hybridization in Phosphorus pentachloride (PCl5)

**sp3d2 Hybridization**

sp3d2 hybridization has 1s, 3p and 2d orbitals, that undergo intermixing to form 6 identical sp3d2 hybrid orbitals .These 6 orbitals are directed towards the corners of an octahedron.They are inclined at an angle of 90 degrees to one another. Example is iodine hectafluoride.

2. Types of overlapping

 i) S-S overlapping: overlapping between s-s orbital’s of two similar or dissimilar atoms is known as s-s overlapping and forms a single covalent bond.

(ii) S-P overlapping: overlapping between s- and p –orbital’s is known as s-p overlapping. NH\_3 is formed by the overlapping between 3 orbital’s of nitrogen (p\_x, p\_y \text{and} p\_z) with 3 orbital’s of 3 hydrogen atoms (s).

(iii) P-P overlapping: p-p overlapping is produced by the overlapping of the p-orbitals of the atoms. In the case of chlorine molecule, it is produced by the overlapping of the 3p\_z orbitals of two chlorine atoms.

3. **I)** Sigma bond is stronger than pi bonds because of the more effective overlap of orbitals in the former

Ii) the double bond consists of a sigma and pi bond ,each with its own bond strength. The sum of the strengths of both bonds will be expected to be greater than that of a single (sigma) bond

Iii) By the same argument , the triple bond with a sigma bond and two pi bonds will be expected to have the highest energy

4. I) CO

 

II) NO2-



III) CO2

 :..O=C=..O:

5. i) Bond angle

 1. Write the Lewis dot structure for the molecule.

Assume that you must determine the bond angles in BF3

B is less electronegative than F, so B becomes the central atom.

If we have three F atoms, that means that we are going to use all three electrons from the B

This gives us three bonding pairs of electrons and 0 nonbonding pairs. Thus, the steric number, SN — the number of non-bonding and bonding electron groups (Note: single, double, and triple bonds all count as one electron group).The SN is also known as the number of ELECTRON DOMAINS.

2. Use the steric number and VSEPR theory to determine the electron domain geometry of the molecule To get the VSEPR geometry, imagine that there is a sphere around the central atom. This is how two to six electron domains arrange themselves on the surface of a sphere. Three electron groups arrange themselves evenly around the equator of the sphere to give a trigonal planar shape.

3. Use the VSEPR shape to determine the angles between the electron domains. From elementary math, we know that a circle is composed of 360 °.We divide this number by the number of electron domains and get 360° 3 =120°

Thus, the bond angles in BF3 are 120 °

ii) Bond length

The length of the bond is determined by the number of bonded electrons (the bond order). The higher the bond order, the stronger the pull between the two atoms and the shorter the bond length. Generally, the length of the bond between two atoms is approximately the sum of the covalent radii of the two atoms. Bond length is reported in picometers. Therefore, bond length increases in the following order: triple bond < double bond < single bond.

iii) Bond enthalpy

Any bond enthalpy formula is given at 298 K by convention to standardize the equation. This is approximately room temperature, equal to 25 °C or 77 °F. In reality, the reaction above is most often hypothetical, as most molecules do not exist as monatomic gases at 298 K. If you have a simple reaction between two molecules and know the bond enthalpies of the individual bonds, you can use the following relationship to calculate the total enthalpy change for the reaction. If it is negative, heat is released, and the reaction is exothermic; if positive, the reaction is endothermic (and will not proceed without the addition of energy). **Hrxn=ΣΔHbroken+ ΣΔHmade**

**5. i)The shape of a molecule depends upon the number of valence shell electron pairs.**

 **ii)Pairs of electrons in the valence shell repel one another since their electron clouds are negatively charged.**

 **iii)These pairs of electrons tend to occupy such positions in space that minimise repulsion and thus maximize distance between them.**

 **iv)Multiple bond is treated as if it is a single electron pair and the two or three electron pairs of a multiple bond I treated as a single super pair.**

 **v)The valence shell is take another sphere with the electron there's localizer on the special surface at maximum distance from one another.**

 **vi)Where two or more resonance structures can represent a molecule, the VSEPR model is applicable to any structure**