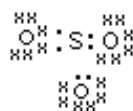
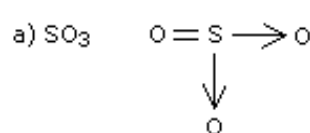


Chapter 4. Chemical Bonding and Molecular Structure

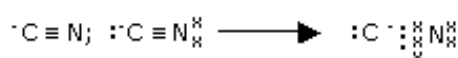
Question-1

Write Lewis dot structure of SO_3 , CN^- , peroxide ion.

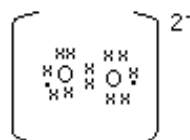
Solution:



b) CN^-



c) peroxide ion - $\text{O}_2^{2-}; \quad \text{O} - \text{O};$



Question-2

Discuss the shapes of the following molecules using the VSEPR model:

(a) SF_6 , (b) XeF_2 , (c) NH_4^+ , (d) ICl_4^- , (e) BrF_3 .

Solution:

(a) SF_6 : Number of electrons around S

= (Valence electron of S + electrons donated by Fluoride)

$$= 6 + 6 = 12$$

$$\therefore \text{Number of bond pairs} = 12/2 = 6$$

To have minimum repulsion between bond pairs structure of SF_6 is octahedron. Shape: Octahedral, Hybridisation = sp^3d^2 .

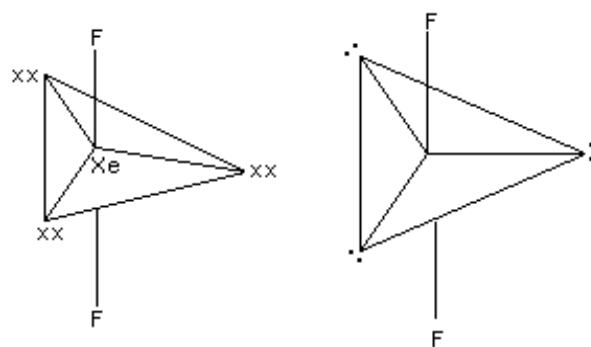
(b) XeF_2 : Number of bond pairs = $(8+2)/2 = 5$ pairs

Bond pairs = 2

Lone pairs = 3

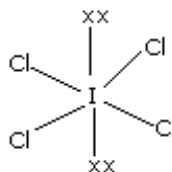
Hence molecule has trigonal bipyramidal structure.

$\therefore$ Shape: trigonal bipyramidal



(c) NH_4^+ : Electrons $(5+4-1)=8$; Bond pairs $=8/2=4$

Hence tetra hedral:



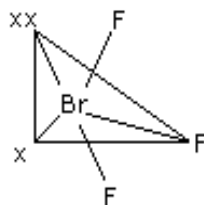
(d) ICl_4^- : $(7+4+1)=12/2=6$ pairs: octahedral structure

only four bond pairs: (i.e.) shape=square planar

(e) BrF_3 : $7+3=10$ electrons; 5 pairs: 3 bond pairs; 2 lone pairs.

5 pairs: trigonal bipyramidal structure: Sp^3d hybridization.

Shape (To have minimum repulsion, it has bent T shape)



To get structure or hybridization, bonds formed by bond pairs with central atoms and the lone pairs should be considered.

Question-3

Discuss the shape of following molecule through valence bond theory.

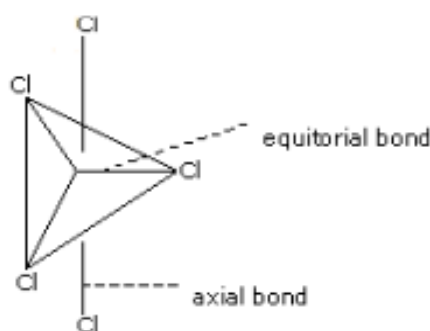
PCl_5 .

Solution:

(PCl_5) Electronic configuration of P in ground state = $1s^2 2s^2 3s^2 3p^3$

In excited state = $1s^2 2s^2 3s^1 3p^3 3d^1$.

Five orbitals, one 3s, three 3p orbitals, one 3d hybridizes to give sp^3d orbitals. Five Cl atoms, each gives one electron to the sp^3d orbitals and forms a covalent bond. sp^3d orbitals are directed towards a corner of a trigonal bipyramidal structure.



Axial bonds are longer than equatorial bonds to have minimum repulsion between axial and equatorial bonds.

Question-4

Write order of reactivity of HF, HBr, HCl and HI.

Solution:

Greater the difference in electro negativity between two atoms, stronger will be the bond strength. Difference in electro negativity is as per following order

$\text{HF} > \text{HBr} > \text{HCl} > \text{HI}$

Hence, lesser the difference in electro negativity, greater will be bond strength reactivity is of the following order

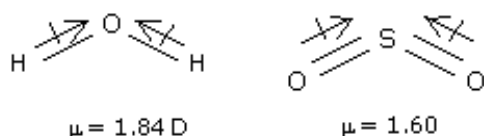
$\text{HI} > \text{HCl} > \text{HBr} > \text{HF}$.

Question-5

H₂O and SO₂ have dipole moments. Explain the shape.

Solution:

A molecule having two bonds, has certain dipole moment indicates that the two bond dipoles do not cancel each other but add up to give a net dipole moment to the molecule. Such molecule is unsymmetric. It has bent structures.

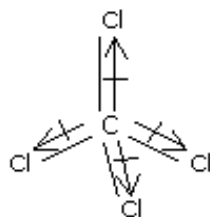


Question-6

Why does CH₄, CCl₄, SiF₄ and SnCl₄ have zero dipole moments?

Solution:

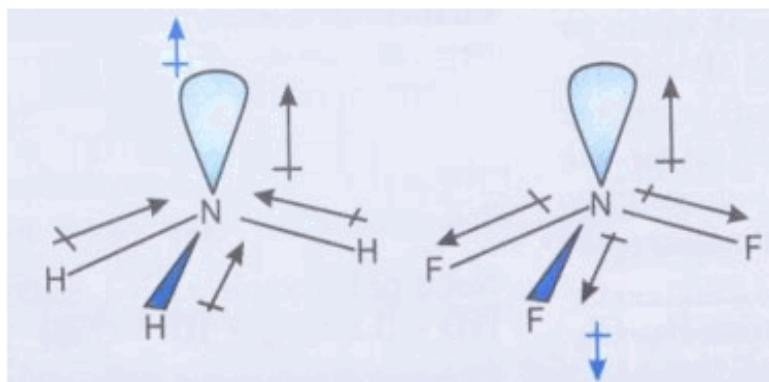
All of the above molecules have polar bonds. Due to symmetrical structure, dipole moment of one bond is cancelled by the opposite dipole moment of the other bonds.



Question-7

Why NF_3 has less dipole moment than NH_3 ?

Solution:



In N-H bond direction of dipole moment is towards hydrogen. Resultant dipole moment is in the same direction of dipole moment due to lone pair of N. But in NF_3 , resultant dipole moment is in opposition direction to that of dipole moment due to lone pair of N. Hence dipole moment of NF_3 has less dipole moment than NH_3 .

Question-8

Why AlCl_3 is largely covalent while aluminium fluoride is largely ionic?

Solution:

Fluoride is more electronegative than chlorine. Hence the difference in electro negativity of Al and Fluorine is more (2.31), above 2. Hence H - F bond is ionic. In AlCl_3 , the difference in electro negativity between Al and chlorine is 1.55, which is less than two, and then bond will be more covalent than ionic.

Question-9

Why is Pi bond weaker than a sigma bond?

Solution:

Pi bonds between atoms are formed due to lateral overlap of atomic orbitals. Which involves effective overlap results in the formation of weaker bond.

Sigma bonds are formed due to axial overlap of atomic orbitals, which involves effective overlapping. Hence sigma bonds are stronger.

Question-10

Why compounds with $C = C$ double bonds have geometrical isomerism?

Solution:

Double bonds consist of one sigma and one Pi bond. Free rotation about a sigma bond is possible because the electron densities lies along the inter nuclear axis. But free rotation about a Pi bond is hindered as the two carbon atoms are connected above and below an axis. Thus positions of groups in carbon compounds contain double bonds are fixed. This leads to geometrical isomerism.



Rotation about π - bond is not possible because it would break the π - bond.