III. Long Answer Type Questions

Question 1. (a) Explain the formation of ionic bond with two examples.

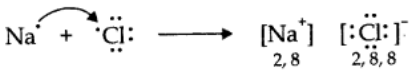
(b) Discuss the conditions which favour the formation of ionic bond.

Answer:

(a) An ionic or electrovalent bond is formed by the complete transference of one or more electrons from one atom to another.

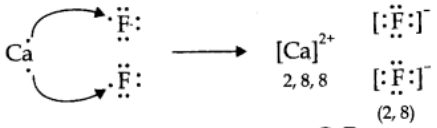
Examples:

(*i*) Formation of (NaCl)



or NaCl

(*ii*) Formation of (CaF_2)



or CaF_2

(b) Conditions favourable for the formation of ionic bond:

(i) Lesser the ionization enthalpy, easier will be the removal of an electron i.e., formation of a positive ion and hence greater the chances of formation of ionic bond.

(ii) Higher is the electron affinity, more is the energy released and stabler will be the negative ion produced. Consequently, the probability of formation of ionic bond will be enhanced.

Question 2. (a) Define dipole moment. What are the units of dipole moment?

(b) Dipole moment values help in predicting the shapes of covalent molecules. Explain.

Answer:

(a) Dipole moment: In a polar molecule, one end bears a positive charge and the other has a negative charge. Thus, the molecule has two poles with equal magnitude of the charges. The molecule is known as dipolar molecule and possesses dipole moment.

It is defined as the product of the magnitude of the positive or negative charge and the distance between the charges. (dipole moment) = q x d

SI unit of dipole moment is coulomb metre (m) or Debye.

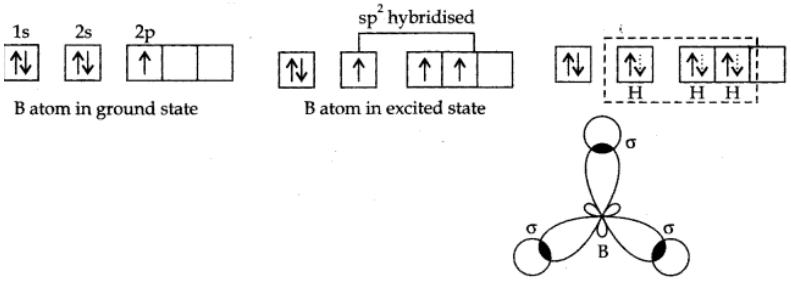
(b) The dipole moment values are quite helpful in determining the general shapes of molecules.

For molecules with zero dipole moment, shapes will be either linear or symmetrical. For Example. BeF_2 CO_2 etc. Molecules that possess dipole moments, their shape will not be symmetrical.

Question 3. Discuss the orbital structures of the following molecules on the basis of hybridisation, (i) BH_3 (ii) C_2H_2

Answer:

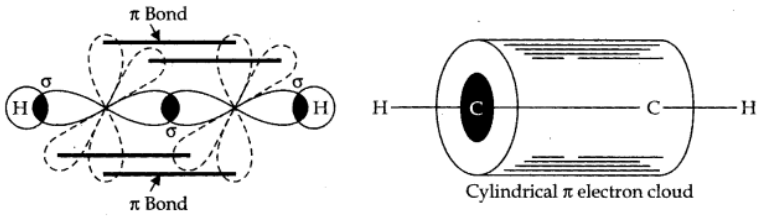
(*i*) **Formation of BH_3** (atomic No. of B is 5.)



Orbital picture of BH_3 molecule

B atom gets hybridised to form three equivalent hybrid orbitals directed towards three comers of equilateral triangle with B atoms in the centre. Bond angle = 120°.

(*ii*) C_2H_2



Orbital picture of ethyne

Both the carbon atoms are sp hybridised. Both the carbon atoms have also two unhybridised orbitals which overlap sidewise with the similar orbitals of the other carbon atom to form two Jt bonds.

Question 4. (a) How many a and n bonds are present in

(b) Why Hf is more stable than H_2?

(c) Why is B_2 molecule paramagnetic?

Answer:

(a) No. of c bonds = 7

(*b*) **Both the ions have the same bond order (0.5) but they differ in their configuration.**
H_2^+ ion = $[\sigma 1s]^1$,
H_2^- ion = $[\sigma 1s]^2 [\sigma^* 1s]^1$
Since, H_2^- ion has an electron in the antibonding molecular orbital, it is therefore less stable.

(*c*) **The molecular orbital configuration of B_2 is given**

$$B_2: [\sigma 1s]^2[\sigma^* 1s]^2[\sigma 2s]^2[\sigma^* 2s]^2[\pi 2p_x]^1[\pi^* 2p_y]^1$$

Since, B_2 has two unpaired electrons, it is paramagnetic.

IV. Multiple Choice Questions

Question 1. A co-ordinate bond is formed by:
(a) sharing of electrons contributed by both the atoms
(b) complete transfer of electrons
(c) sharing of electrons contributed by one atom only
(d) none of these

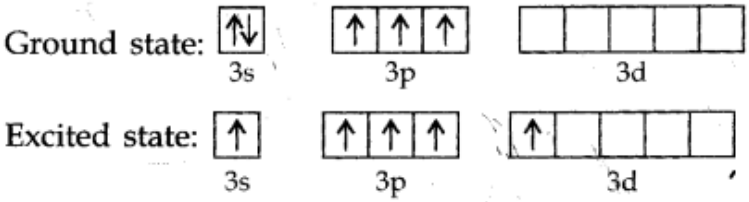
Question 2. The species CO, CN^- and N_2 are:
(a) isoelectronic
(b) having coordinated bond
(c) having polar bond
(d) having low bond energies

Question 3. The axial overlap between the two orbitals leads to the formation of a:
(a) sigma bond
(b) pi bond
(c) multiple bond
(d) none of these

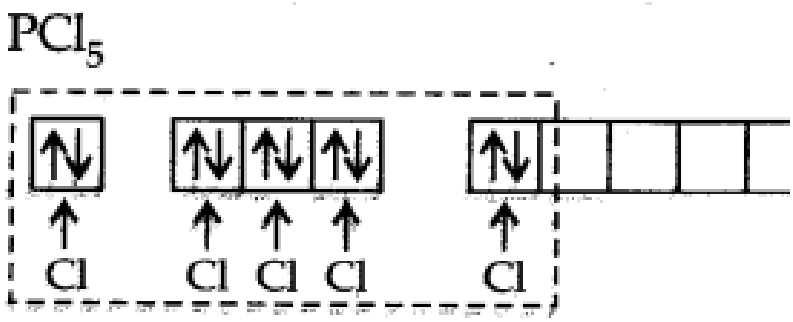
Question 4. In SO_2 molecule, S atom is:
(a) sp^3 hybridized
(b) sp hybridized
(c) sp^2 hybridized
(d) d sp^2 hybridized
Question 5. A molecule or ion is stable if:
(a) Nb = Na
(b) Nb < Na
(c) Na < Nb
(d) Na - Nb = +ve
Question 6. The molecule Ne2 does not exist because
(a) Nb > Na
(b) Nb = Na^+
(c) Nb < Na
(d) None of these
Question 7. Which one is diamagnetic among NO^+, NO and NO ?
(a) NO^+
(b) NO
(c) NO^-
(d) None of these
Question 8. In sp^3, sp^2 and sp hybridized carbon atom, the p character is maximum in:
(a) sp^3
(b) sp^2
(c) sp
(d) all of the above have same p-character
Question 9. Out of the following, intramolecular hydrogen bonding exists in:
(a) water
(b) H_2S
(c) 4-nitrophenol
(d) 2-nitrophenol
Answer:
1. (c)
2. (a)
3. (a)
4. (c)
5. (c)
6. (b)
7. (a)
8. (a)
9. (d)

V. Hots Questions

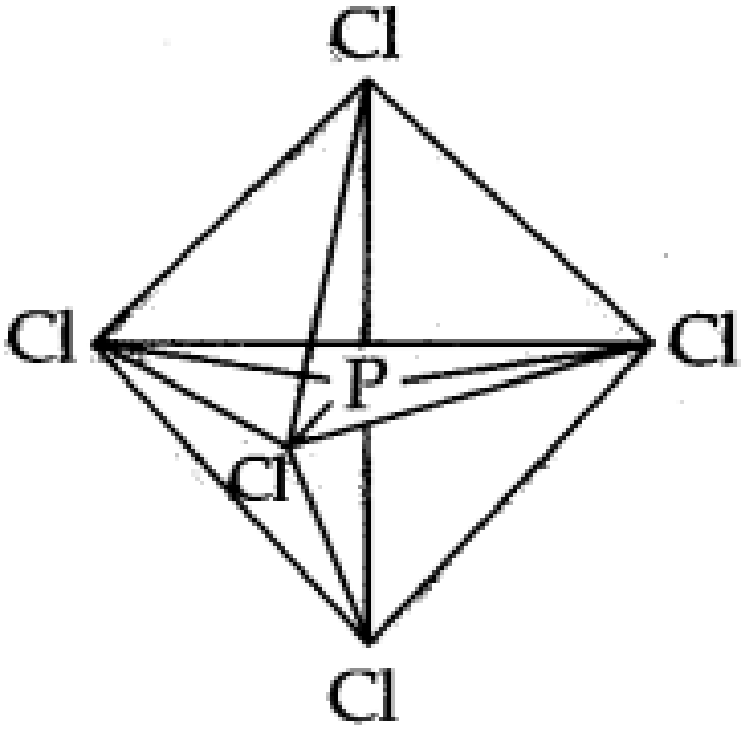
Question 1. Describe the hybridisation in case of PCl_5. Why are the axial bonds longer as compared to equatorial bonds?
Answer: The ground state and excited state outer electronic configurations of phosphorus (Z = 15) are:



Phosphorus atom is sp^3 d hybridized in the excited state. These orbitals are filled by the electron pairs donated by five Cl atoms as:



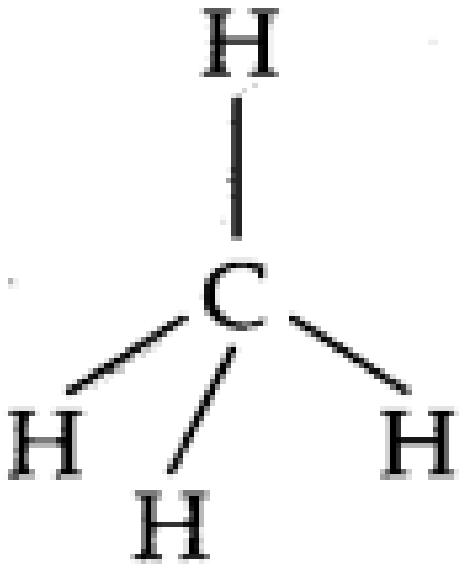
The five sp^3 d hybrid orbitals are directed towards the five comers of the trigonal bipyramidal. Hence, the geometry of PCl_5 can be represented as:
There are five P-Cl sigma bonds in PCl_5. Three P-Cl bonds lie in one plane and make an angle of 120° with each other.



These bonds are called equatorial bonds. The remaining two P-Cl bonds lie above and below the equatorial plane and make an angle of 90° with the plane. These bonds are called axial bonds.
As the axial bond pairs suffer more repulsion front the equatorial bond pairs, axial bonds are slightly longer than equatorial bonds.

Question 2. Apart from tetrahedral geometry, another possible geometry for CH_4 is square planar with the four H atoms at the comers of the square and the C atoms at its centre. Explain why CH_4 is not square planar?
Answer: Electronic configuration of carbon atom: C:
sigma $1s^2$ $2s^2$ $2p^2$.
In the excited state, the orbital picture of carbon can be represented as:

Hence, carboh atom undergoes sp3 hybridization in CH4 molecule and takes a tetrahedral shape.



For a square planar shape, the hybridization of the central atom has to be dsp^3. However, an atom of carbon does not have d-orbitals to undergo dsp^3 hybridization. Hence, the structure of CH_4 is tetrahedral.

Question 3. Explain why BeH_2 molecule has a zero dipole moment although the Be-H bonds are polar.
Answer: The Lewis structure for BeH_2 is as follows:

There is no lone pair at the central atom (Be) and there are two bond pairs. Hence,BeH_2 is of the type AB2. It has a linear structure,

Dipole moments of each H —Be bond are equal and are in opposite directions. Therefore, they nullify each other. Hence, BeH_2 has a zero dipole moment.

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