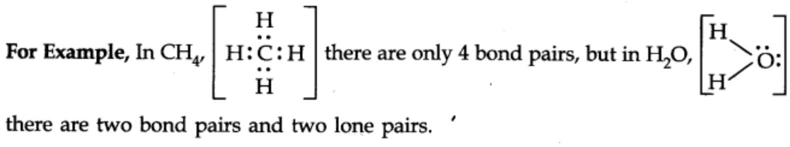
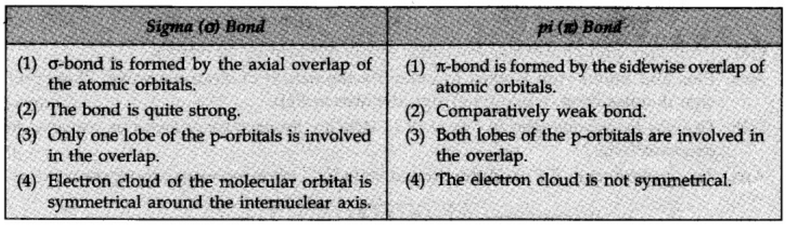
Question 31. What do you understand by bond pairs and lone pairs of electrons? Illustrate by giving one example of each type.
Answer: The electron pair involved in sharing between two atoms during covalent bonding is called shared pair or bond pair. At the same time, the electron pair which is not involved in sharing is called lone pair of electrons.



For Example, In CH_4, there are only 4 bond pairs, but in H_2O, there are two bond pairs and two lone pairs.

Question 32. Distinguish between a sigma bond and a pi bond.
Answer:



Sigma (σ) Bond	pi (π) Bond
(1) σ-bond is formed by the axial overlap of the atomic orbitals.	(1) π-bond is formed by the sidewise overlap of atomic orbitals.
(2) The bond is quite strong.	(2) Comparatively weak bond.
(3) Only one lobe of the p-orbitals is involved in the overlap.	(3) Both lobes of the p-orbitals are involved in the overlap.
(4) Electron cloud of the molecular orbital is symmetrical around the internuclear axis.	(4) The electron cloud is not symmetrical.

Question 33. Explain the formation of H_2 molecule on the basis of valence bond theory.
Answer: Let us consider the combination between atoms of hydrogen H_A and H_B and eA and eB be their respective electrons. As they tend to come closer, two different forces operate between the nucleus and the electron of the other and vice versa. The nuclei of the atoms as well as their electrons repel each other. Energy is needed to overcome the force of repulsion. Although the number of new attractive and repulsive forces is the same, but the magnitude of the attractive forces is more. Thus, when two hydrogen atoms approach each other, the overall potential energy of the system decreases. Thus, a stable molecule of hydrogen is formed.

Question 34. Write the important conditions required for the linear combination of atomic orbitals to form molecular orbitals.
Answer:

- The combining atomic orbitals should have comparable energies.
  For example, Is orbital of one atom can combine with Is atomic orbital of another atom, 2s can combine with 2s.
- The combining atomic orbitals must have proper orientations. So that they are able to overlap to a considerable extent.
- The extent of overlapping should be large.

Question 35. Use molecular orbital theory to explain why the Be_2 molecule does not exist.
Answer:

$$\text{E.C. of Be} = 1s^2\ 2s^2$$

$$\text{M.O.E.C. of Be}_2 = \sigma^2 1s\ \sigma^{*2} 1s\ \sigma^2 2s\ \sigma^{*2} 2s$$

$$\text{Bond order} = \frac{1}{2}(4-4)$$

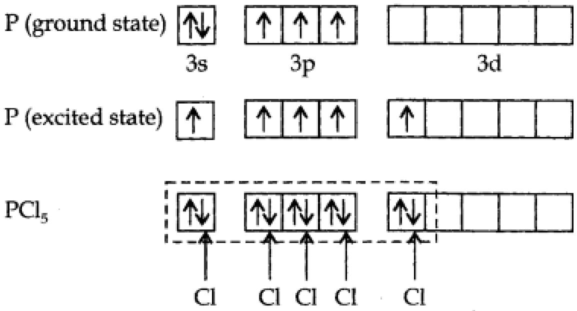
$$= 0$$

Hence, Be_2 does not exist.

Question 36. Compare the relative stability of the following species and indicate their magnetic properties: O_2, O_2,
O_2^- (Superoxide),O_2^{2-} (peroxide)
Answer:
O_2— Bond order = 2, paramagnetic
O_2^+— Bond order = 2.5, paramagnetic
O_2^-— Bond order = 1.5, paramagnetic
O_2^{2-} — Bond order = 1, diamagnetic
Order of relative stability is
$O_2^+ > O_2 > O_2^- > O_2^{2-}$
(2.5) (2.0) (1.5) (1.0)

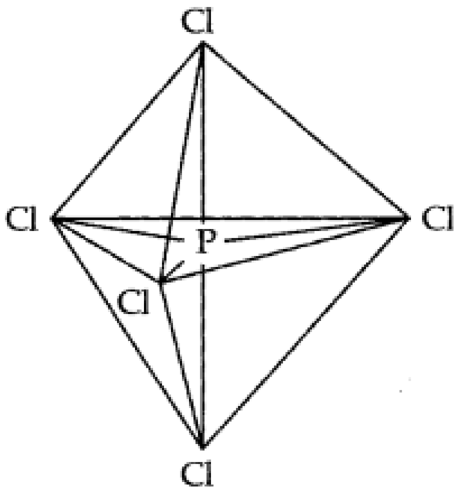
Question 37. Write the significance of plus and minus sign in representing the orbitals,
Answer: Plus and minus sign is used to indentify the nature of electrons wave. Plus (+ve) sign denotes crest, while (-ve) sign denotes trough.

Question 38. Describe the hybridisation in case of PCl_5. Why are the axial bonds longer as compared to equatorial bonds?
Answer: The ground state E.C. and the excited state E.C. of phosphorus are represented as:



sp³ hybrid orbitals filled by electron pairs donated by five Cl atoms

The one s, three-p and one d-orbitals hybridise to yield five sets of SP^3 d hybrid orbitals which are directed towards the five corners of a trigonal bipyramidal as in Fig.



Trigonal bipyramidal geometry of PCl_5 molecule

Because axial bond pairs suffer more repulsive interaction from the equatorial bond pairs, therefore axial bonds have been found to be slightly longer and hence slightly weaker than equatorial bonds.

Question 39. Define hydrogen bonds. Is it weaker or stronger than the van der Waals forces?
Answer: When hydrogen is attached with highly electronegative element in a covalent bonding the electrons of the covalent bond are shifted towards the more electronegative atom. Thus, partially positively charged hydrogen atom forms a bond with the other more electronegative atom. This bond is known as hydrogen bond. Hydrogen bond is stronger than the van der Waals forces.

Question 40. What is meant by the term bond order? Calculate the bond order of N_2, O_2, O_2^+,O_2^-
Answer: Bond order is defined as the half of the difference between the number of electrons present in bonding and antibonding molecular orbitals.

$$\text{Bond order} = \frac{1}{2}(N_b - N_a)$$

$$\text{E.C of } N_2 = 1s^2\, 2s^2\, 2p_x^{\,1} 2p_y^{\,1} 2p_z^{\,1}$$

(*i*) M.O. configuration of $N_2 = [\sigma 1s]^2[\sigma * 1s]^2[\sigma 2s]^2[\sigma * 2s]^2[\pi 2p_x]^2[\pi 2p_y]^2[\sigma 2p_z]^2$

$$\text{Bond order (B.O.)} = \frac{1}{2}(N_b - N_a)$$

$$= \frac{1}{2}[8-2] = 3$$

(*ii*) M.O. configuration of $O_2 = [\sigma 1s]^2[\sigma * 1s]^2[\sigma 2s]^2[\sigma * 2s]^2[\sigma 2p_z]^2$

$$\text{B.O} = \frac{1}{2}[N_b - N_a]$$

$$= \frac{1}{2}[8-4] = 2$$

(*iii*) M.O. configuration of $O_2^+ = KK[\sigma 2s]^2\,[\sigma * 2s]^2\,[\sigma 2p_z]^2\,[\pi 2p_x]^2\,[\pi 2p_y]^2\,[\pi * 2p_x]^1$

$$\text{B.O.} = \frac{1}{2}[8-3] = 2.5$$

(*iv*) M.O. configuration of O_2^-

$$= KK[\sigma 2s]^2\,[\sigma * 2s]^2\,[\sigma 2p_z]^2\,[\pi 2p_x]^2\,[\pi 2p_y]^2\,[\pi * 2p_x]^2\,[\pi * 2p_y]^1$$

$$\text{B.O.} = \frac{1}{2}[8-5] = 1.5$$

*********** END **********