CBSE Class 11 Chemistry

Important Questions

Chapter 4

Chemical Bonding and Molecular Structure

1 Marks Questions

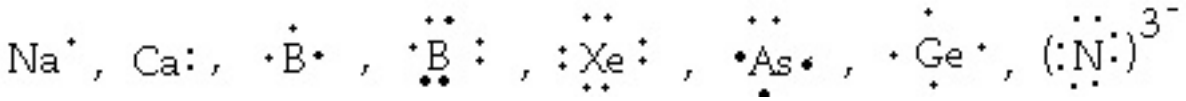
1.Define a chemical bond.

Ans. The attractive force which holds various constituents (atoms, ions etc.) together in different chemical species is called a chemical bond.

2.Give the main feature of Lewis approach of chemical bonding.

Ans. Lewis postulated that atoms achieve the stable octet when they are linked by chemical bonds. He assured that atoms are positively charged centre and the outer shell that could accommodate a maximum of eight electrons. These electrons occupy the corners of a cube which surrounds the centre. Lewis introduced simple notations to represent valence electrons in an atom called Lewis symbol

3.Write electron dot structure (Lewis structure) of Na, Ca, B, Br, Xe, As, Ge, N^{3-}.



4.Give the octet rule in short.

Ans. The atoms tend to adjust the arrangement of their electrons in such a way that they (except H and He) achieve eight electrons in their outermost shell. This is known as the octet rule.

5.Define an ionic bonding. [?]

Ans. An ionic bond (or electrovalent bond) is formed by a complete transfer of one or more of outer most electrons from the atom of a metal to that of a non – metal.

6.Which one of the following has the highest bond order?N_2, N_2^+ or N_2^-.

Ans. N_2 has the highest bond order.

7.Define bond order.

Ans. Bond order is defined as number of bonds between two atoms in a molecule.

8.What type of bond is formed when atoms have high difference of electornegativity?

Ans. Electrovalent or ionic bond.

9.Define dipole moment.

Ans. Dipole moment is defined as the product of the magnitude of the charge and the distance between the centers of positive and negative charge.

10.Give the mathematical expression of dipole moment.

Ans. Mathematically dipole moment is expressed as dipole moment (M) = charge (Q) x distance of separation (r). Dipole moment is usually expressed in Debye units (D).

11.Why is dipole moment of CO_2, BF_3, CCl_4 is zero?

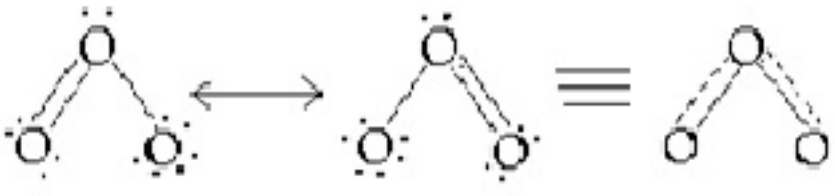
Ans. Because there molecules have symmetrical shapes and thus the dipoles gets cancelled and the net dipole moment is zero.

12.Why is BF_3 non – polar?

Ans. Because BF_3 has symmetrical shape, the net dipole moment is zero and thus it is non – polar.

13. Write the resonating structure of O_3 molecule.

Ans.



14.What is sigma bond?

Ans.A covalent bond formed due to the overlap of orbitals of the two atoms along the line going the two nuclei (orbital axis) is called sigma (s) bond.

15.What is pi – bond?

Ans. A covalent bond formed between the two atoms due to the sideways overlap of their p – orbitals is called a pi (π) bond.

16.How many s – and π - bond are there in a molecule of C_2H_4 (ethene)?

Ans. In a molecule of ethene, there are 5 s - bonds (one between C-C , and four between C-H and one π - bond.

17.How many s - and π - bonds are there in a molecule of $CH_2 = CH – CH = CH_2$?

Ans. There are 9 s - bonds (three between C – C and 6 between C – H) and 2 π - bonds.

18.What type of bond exists in multiple bond (double / triple)?

Ans. pi (p) – bond is always present in molecules containing multiple bond.

19.What type of bond are formed due to orbital overlap?

Ans. Covalent bonds are formed due to the overlap of certain orbitals that are oriented favourably in the space.

20.How do covalent bonds form due to orbital overlapping?

Ans. According to orbital overlap concept, the formation of a covalent bond between two atoms results by pairing of electrons present in the valence shell having opposite spins.

21.Define hybridisation.

Ans. Hybridisation is defined as the process of intermixing of the orbitals of slightly different energies so as to redistribute their energies, resulting in the formation of new set of orbitals of equivalent energies and shape.

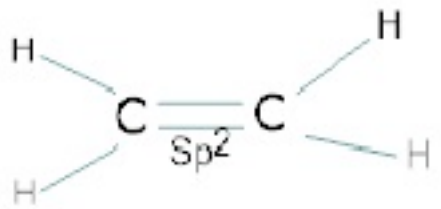
22.State the hybrid orbitals associated with B in BCl_3 and C in C_2H_4

Ans. (i) Sp^2hybridization **(ii)** Sp^2hybridization.

23.What is the state of hybridization of carbon atoms in diamond and graphite?

Ans. In Diamond it is Sp^3

In graphite it is Sp^2



24.What type of hybridisation takes place in (i) p in PCL_5 and (ii) S in S F_6?

Ans. (i) Sp^3d

(ii) Sp^3d^2.

25.Define bonding molecular orbital.

Ans. The molecular orbital formed by the addition of atomic orbitals is called bonding

molecular orbital.

$$\sigma = \Psi A + \Psi B$$

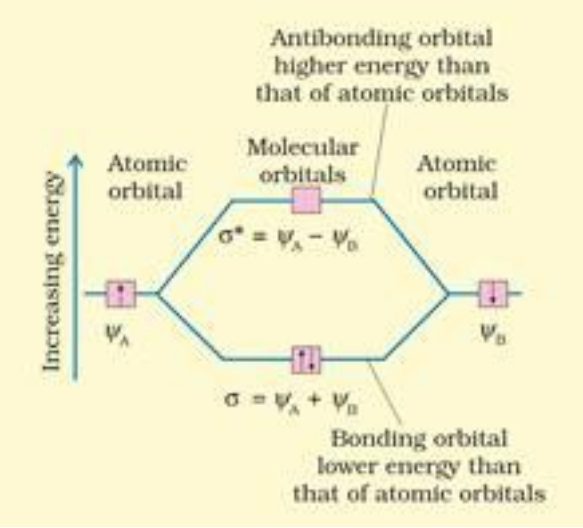
26.Define antibonding molecular orbital.

Ans. The molecular orbital formed by the subtraction of atomic orbitals is called antibonding molecular orbital.

$$\sigma^{*} = \Psi A - \Psi B \cdot$$

27.Explain diagrammatically the formation of molecular orbital by LCAO.

Ans. The molecular orbital formed by subtraction of atomic orbital is called antibonding molecular orbital.



28.Which one O_2^- and O_2^{2-}, may exhibit paramagnetism?

Ans. O_2 would exhibit paramagnetism because it contains one unpaired electron in its Mo configuration.

29.Why are bonding molecular orbitals more stable than antibonding molecular orbitals?

Ans. Bonding molecular orbital has lower energy and hence greater stability than the

corresponding antibonding molecular orbital.

30.Define bond order.

Ans. Bond order (b.o) is defined as one half the difference between the number of electrons present in the bonding and the antibonding orbitals i.e;

Bond order (b.o) = $\frac{1}{2}(N_b - N_a)$

If $N_b > N_a$, molecule is stable and

If $N_b < N_a$, molecule is unstable.

31.Define hydrogen bonding

Ans. Hydrogen bond can be defined as the attractive force which binds hydrogen atom of one molecule with the electronegative atom (F, O or N) of another molecule.

32.What are the types of H-bonding? Which of them is stronger?

Ans. (i)Inter-molecular H-bonding

(ii) Intra molecular H-bonding. Inter molecular H-bonding is stronger than intra-molecular H-bonding.

33. NH_3 has higher boiling point than PH_3. Give reason.

Ans.In NH_3, there is hydrogen bonding whereas in PH_3 there is no hydrogen bonding.

34.Define electrovalent bond.

Ans. The bond formed, as a result of the electrostatic attraction between the positive and negative ions are termed as the electrovalent bond.

CBSE Class 12 Chemistry
Important Questions
Chapter 4
Chemical Bonding and Molecular Structure

2 Marks Questions

1.Give the main feature of Kossel's explanation of chemical bonding.

Ans. Kossel in relation to chemical bonding drew attention to the following facts –

(i) In the periodic table, the highly electronegative halogens and the highly electropositive alkali metals are separated by the noble gases.

(ii) In the formation of a negative ion from a halogen atom and a positive ion from an alkali metal, atom is associated with a gain and loss of an electron by the respective atoms.

(iii) The negative and positive ions so formed attain stable noble gas electronic configurations. The noble gases have particularly eight electrons, $ns^2\ np^6$.

The –ve and +ve ions are stabilized by electrostatic attraction.

2.How can you explain the formation of NaCl according to kossel concept?

Ans. The formation of NaCl from sodium and chlorine can be explained as

$Na \rightarrow Na^+ + e^-$

$[Ne]\ 3s^1 \rightarrow [Ne]$

$Cl + e^- \rightarrow Cl^-$

$[Ne]\ 3s^2\ 3p^5$. $[Ne]\ 3s^2\ 3p^6$ or [Ar]

$Na^+ + Cl^- \rightarrow Na^+\ Cl^-$ or NaCl.

3.Write the significance of octet rule.

Ans. Octet rule signifies –

(i) It is useful for understanding the structures of most of the organic compounds.

It mainly applies to the second period elements of the periodic table.

4.Write the Lewis structure for CO molecule

Ans. (i) The outer (valence) shell configurations of carbon and oxygen atoms are

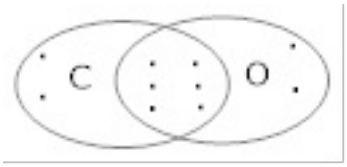
Carbon : (6) – $1s^2\ 2s^2\ 2p^2$

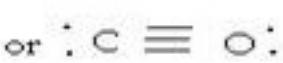
Oxygen : (8) – $1s^2\ 2s^2\ 2p^4$.

The valence electrons (4 + 6 = 10)

But it does not complete octet, thus multiple bond is exhibited.

Thus,

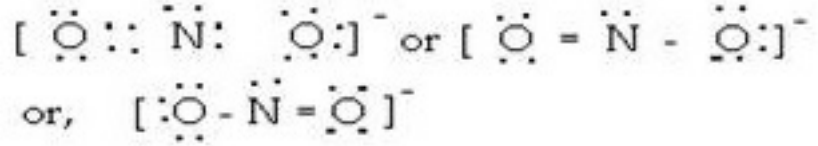




(ii) N ($2s^2\ 2p^3$), O ($2s^2\ 2p^4$)

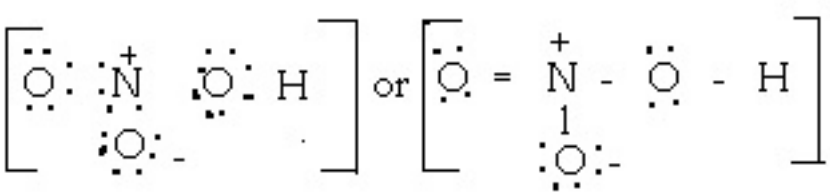
5 + (2 x 6) + 1 = 18 electrons.

Thus,



5.Give the Lewis dot structure of HNO_3

Ans. HNO_3 ®



6.What changes are observed in atoms undergoing ionic bonding?

Ans. Due to the electron transfer the following changes occurs –

(i) Both the atoms acquire stable noble gas configuration.

(ii) The atom that loses electrons becomes +vely charged called cation whereas that gains electrons becomes –vely charged called anion.

(iii) Cation and anion are held together by the coulombic forces of attraction to form an ionic bond.

7.Mention the factors that influence the formation of an Ionic bond.

Ans. Ionic bond formation mainly depends upon three factors –

(i) Low ionization energy – elements with low ionization enthalpy have greater tendency to form an ionic bonds.

(ii) High electron gain enthalpy – high negative value of electron gain enthalpy favours ionic bond.

(iii) Lattice energy – high lattice energy value favours ionic bond formation.

8.Give reason why H_2^+ ions are more stable than H_2^- though they have the same bond order.

Ans. In H_2^- ion, one electron is present in anti bonding orbital due to which destabilizing effect is more and thus the stability is less than that of H_2^+ ion.

9.How would the bond lengths vary in the following species? C_2, C_2^- C_2^{2-}.

Ans. The order of bond lengths in C_2 , C_2^- and C_2^{2-} is $C_2 > C_2^- > C_2^{2-}$.

10.Out of covalent and hydrogen bonds, which is stronger.

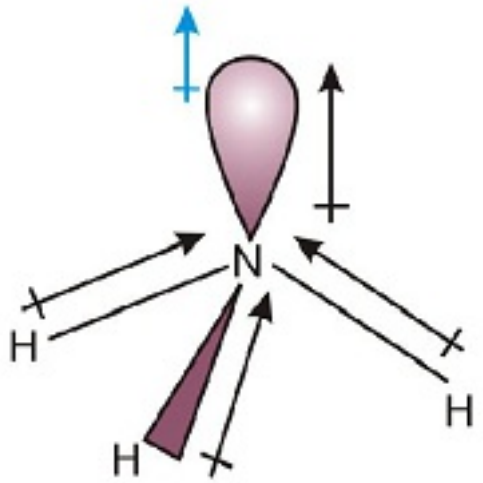
Ans. Covalent bond.

11.Define covalent radius.

Ans. The covalent radius is measured approximately as the radius of an atom's core which is in contact with the core of an adjacent atom in a bonded situation.

12.Why NH_3 has high dipole moment than NF_3 though both are pyramidal?

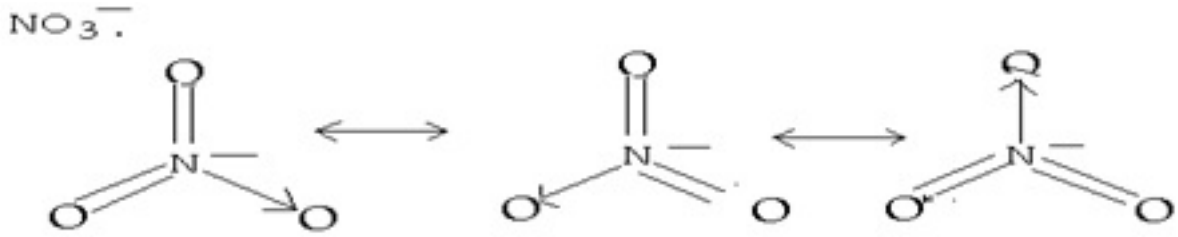
Ans. In case of NH_3 the orbital dipole due to lone pair is in the same direction as the resultant dipole moment of the N-H bonds, whereas in NF_3 the orbital dipole is in the direction opposite to the resultant dipole moment of the three N-F



bonds. The orbital dipole become of lone pair decreases, which results in the low dipole moment.

13.Draw the resonating structure of NO_3^-

Ans.

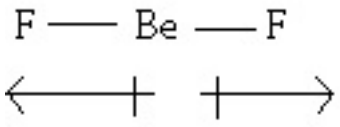


14.On which factor does dipole moment depend in case of polyatomic molecules.

Ans. The dipole moment of the polyatomic molecule depends on individual dipole moments of bonds and also on the spatial arrangement of various bonds in the molecule.

15.Dipole moment of Be F_2 is zero. Give reason.

Ans. In BeF_2 the dipole moment is zero because the two equal bond dipoles point in opposite directions and cancel the effect of each other.



16.Bond dipoles in Be F_2

Give the main features of VSEPR Theory.

Ans. The main postulates of VSEPR theory are as follows :

(i) The shape of a molecule depends upon the number of valence shell electron pairs around the central atom.

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

(iii) There pairs of electrons tends to occupy such position in space that minimize repulsion and thus maximize distance between them.

(iv) The valence shell is taken as a sphere with the electron pairs localizing on the sphere at maximum distance from one another.

(v)A multiple bond is treated as it is a single electron pair and two or three electron pairs of a multiple bond is treated as super pair.

(vi) When two or more resonance structures can represent a molecule, the VSEPR nodal is applicable to any such structure.

17.What's difference between lone pair and bonded pair of electrons?

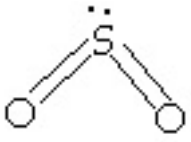
Ans. Lone pair electrons do not take part in bond formation whereas bond pair electrons take part in bond formation.

18.CO_2 is linear whereas SO_2 is bend – shaped. Give reason.

Ans. In CO_2, the bond electron are furtherest away from each other forming180^0 angle. Thus,

CO_2 is linear.

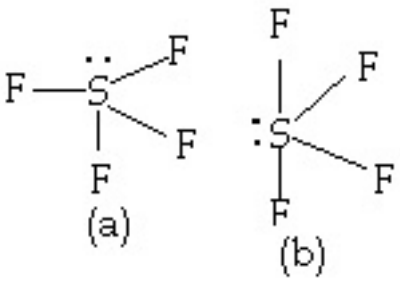
In SO_2, the number of bonding pairs is 4 where it has an lone pair of electron which does not participate in bond formation thereby repulsive strain is experienced.



19.Why does H_2O have bent structure?

Ans. In water molecule, there are two bonding pairs and two lone pairs of electrons. The shape should have been tetrahedral if there were all bp but two lp are present. Thus the shaped is distorted to an angular shape. Because lp – lp repulsion is more than lp – bp repulsion.

20.For the molecule,



Why is structure (b) more stable than structure (a)?

Ans. In (a) the lp is present at axial position so there are three lp – bp repulsions at 90^0 . Whereas in (b) the lp is in an equatorial position are there are two lp – bp repulsions. Hence, arrangement (b) is more stable than (a).

21.How would you attribute the structure of PH_3 molecule using VSEPR model?

Ans. Phosphorus atom has 5 electrons in its outermost orbit. H – atoms contribute one electron each to make in all 8 electron around P – atom. Thus 4 pairs of electrons would be distributed in a tetrahedral manner around the central atom. Three pairs from three P – H

bonds while the fourth pair remains unused. Due to repulsion between the bp and lp, the shape is not of tetrahedral but trigonal pyramidal molecule.

22.In SF_4 molecule, the lp electrons occupies an equatorial position in the trigonal bipyramidal arrangement to an axial position. Give reason.

Ans. In SF_4 molecule, the lp electrons occupies an equatorial position because, lp – bp repulsion is minimum.

23.How is VBT different from Lewis concept?

Ans. In Lewis concept, bond formation is explained in terms of sharing of electron pairs and the Octet rule whereas in VBT bond formation is described in terms of hybridization and overlap of the orbitals.

24.S – orbital does not show any preference for direction. Why?

Ans. S – Orbital does not show any preference for direction because it is spherically symmetrical.

25.Why is s– bond stronger than π - bond?

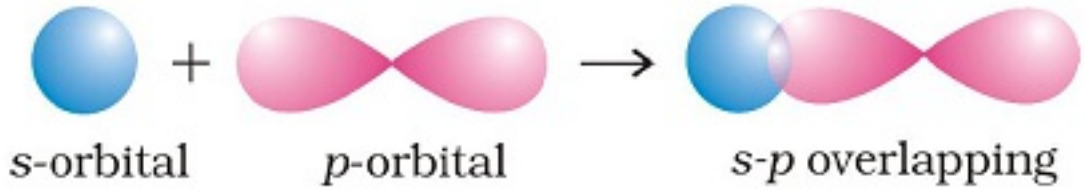
Ans. Orbitals can overlap to a greater extent in a s - bond due to axial orientation, so s - bond is strong. Whereas, in a pi – bond sideways overlapping is not to an appreciable extent due to the presence of s - bond which restricts the distance between the involved atoms.

26.What are the different types of s - bond formation?

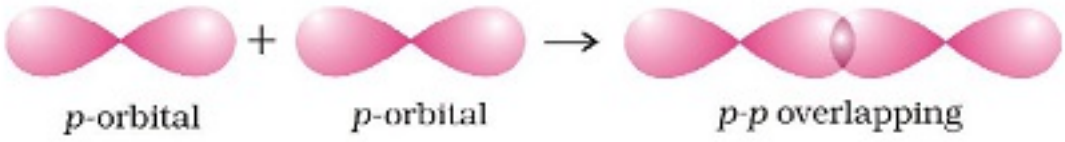
Ans. s - bond can be formed by any of the following types of combinations of atoms orbitals.

(a) S – S – overlapping : In this case, there is a overlap of two half – filled S – orbitals along the inter nuclear axis.

(b) S- P overlapping : This type of over lapping occurs between half – filled s-orbitals of one atom and half-filled p-orbitals of another atom.



(c) P – P overlapping : This type of overlap takes place between half-filled p-orbitals of the two approaching atoms.



27. What is zero over lap?

Ans. The unsymmetrical overlap of orbitals results in zero overlap i-e; between px-s and px-py orbital

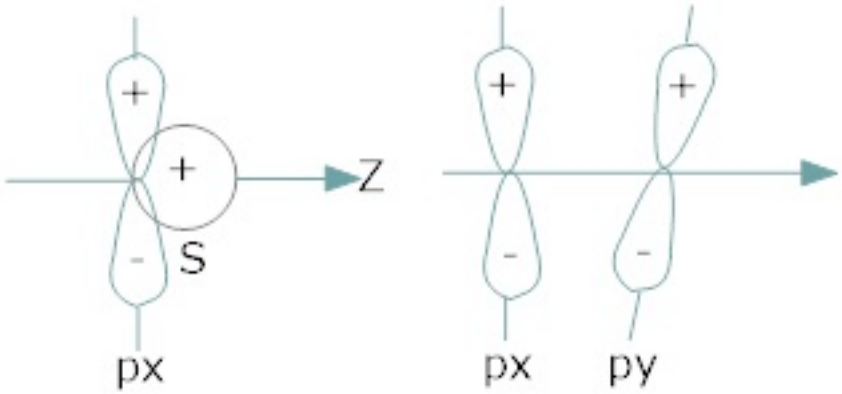


fig. zero overlap.

28. the features of hybridisation.

Ans. The main features of hybridization are

(i) The number of hybrid orbitals is equal to number of the atomic orbitals that get hybridized.

(ii) The hybridized orbitals are always equivalent in energy and shape.

(iii) The hybrid orbitals are more effective in forming stable bonds than the pure atomic orbitals.

(iv) The hybrid orbitals orient in a manner to minimize repulsion resulting in a particular geometrical shape.

29.What are the important consolations for hybridisation?

Ans. (i) The orbitals present in the valence shell of the atom are hybridised.

(ii) The orbitals undergoing hybridization should have almost the same energy.

(iii) It is not essential that electrons get promoted prior to hybridization.

It is necessary that only half filled orbitals participate in hybridisation even filled orbitlals can take part.

30.Describe the shape of sp, sp^2 and sp^3 hybrid orbital?

Ans. (i) Sp-hybrid orbital is oriented to an angle 180^0.

(ii) Sp^2-hybrid orbital lie in a plane and is directed towards the corners of equilateral triangle making an angle of 120^0.

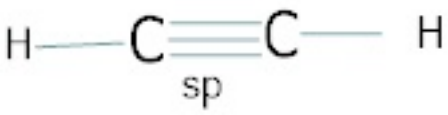
(iii) Sp^3-hybrid orbitals are directed towards the four corners of tetrahedron making an angle of $109^0\,28'$

31.Ethylene is a planar molecule whereas acetylene is a linear molecule. Give reason.

Ans. In case of ethylene, $C_2H_4, show\ Sp^2$ hybridization where the four hydrogen atoms

are placed in four corners of a plane sharing 120^0

Whereas acetylene shows sp hybridization and shares an angle of 180^0 and thus it is linear.



32.In H_2O, H_2S, H_2Se, H_2Te, the bond angle decreases though all have the same bent shape. Why?

Ans. In all the four cases, the molecules undergo Sp^3 hybridization forming four hybrid orbitals, two of which are occupied by lp of electrons and two by bp electrons. Thus they are expected to have $109^028'$ angle but this does not happen. In case of H_2O molecule, as oxygen is small in size and has high electronegativity value, the bp are closer due to which it is subjected to larger repulsion (bp-bp). In case of H_2S as S atom is larger than O, bp-bp repulsion is less as compared to H_2O and it is true for H_2Se and H_2Te as well.

33.Out of p-orbital and sp-hybrid orbital which has greater directional character and Why?

Ans. Sp-hybrid orbital has greater directional character than p-orbital. Because in case of p-orbitals, the two lobes are equal in size and equal electron density is distributed whereas in Sp-hybrid orbital, electron density is greater on one side.

34. He_2 does not exist. Explain in terms of LCAO.

Ans. The electronic configuration of helium atom is $1s^2$. Each helium atom contains 2 electrons, therefore, in He_2 molecule there would be 4 electrons. These electrons will accommodated in $\sigma 1s$ snd $\sigma^* 1s$ molecular orbitals leading to electronic configuration :

$$He_2 : (\sigma 1s)^2(\sigma^* 1s)^2$$

$$Bond \text{ order of } He_2 is \frac{1}{2}(2-2) = 0$$

He_2 molecule is there unstable and does not exist.

35.Dipole moment is a scalar or a vector quantity?

Ans. Dipole moment is a vector quantity and is depicted by a small arrow with tail on the +ve centre and head pointing towards the negative centre.