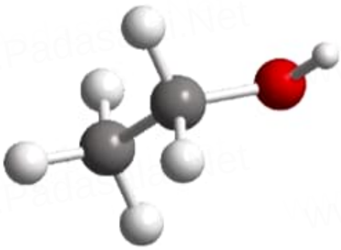
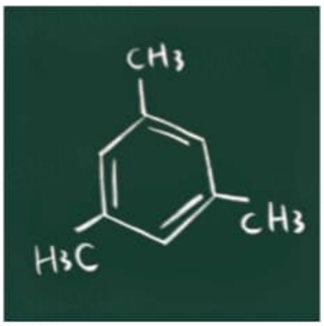
11th Chemistry Volume - 2 Unit - 10 Book Back Questions With Answers





Prepared By
V.Durga Prasad

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energy of CaO is ……… .

(a) U

(b) 2U

(c) U/2

(d) 4U

Answer:

(d) 4U

Samacheer Kalvi 11th Chemistry Chemical Bonding Short Answer Questions.

Question 31.

Define the following

1. Bond order
2. Hybridisation
3. a- bond

Answer:

1. Bond order:

Bond order $= \frac{N_b - N_a}{2}$

The number of bonds formed between the two bonded atoms in a molecule is called bond order.

2. Hybridisation:

It is a process of mixing of atomic orbitais of the same atom with. comparable energy to form equal number of new equivalent orbitais pairs and lone pairs arc not same.

3. Bond pair-Bond pair < Bond pair – Lone pair < Lone pair – Lone pair So due to the varying repulsive force the bond pairs and lone pairs are distorted from regular geometry and organise themselves in such a way that repulsion will be minimum and stability will be maximum.

4. In case of CH_4, there are 4 bond pairs and no lone pair of electrons. So it remains in its regular geometry. i.e., tetrahedral with bond angle 109° 28'.

5. H_2O has 2 bond pairs and 2 lone pairs. There is large repulsion between lp – lp. Again repulsion between lp – bp is more than that of 2 bond pairs. So 2 bonds are more restricted to form inverted V shape (or) bent shape molecule with a bond angle of 104° 35'.

6. NH_3 has 3 bond pairs and 1 lone pair. There is repulsion between lp – bp. So 3 bonds are more restricted to form pyramidal shape with bond angle equal to 107° 18'.

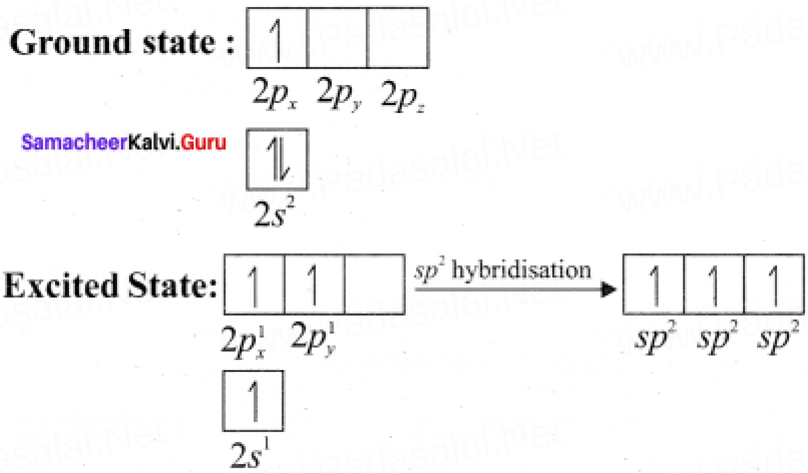
Question 34.

Explain sp^2 hybridisation in BF_3

Answer:

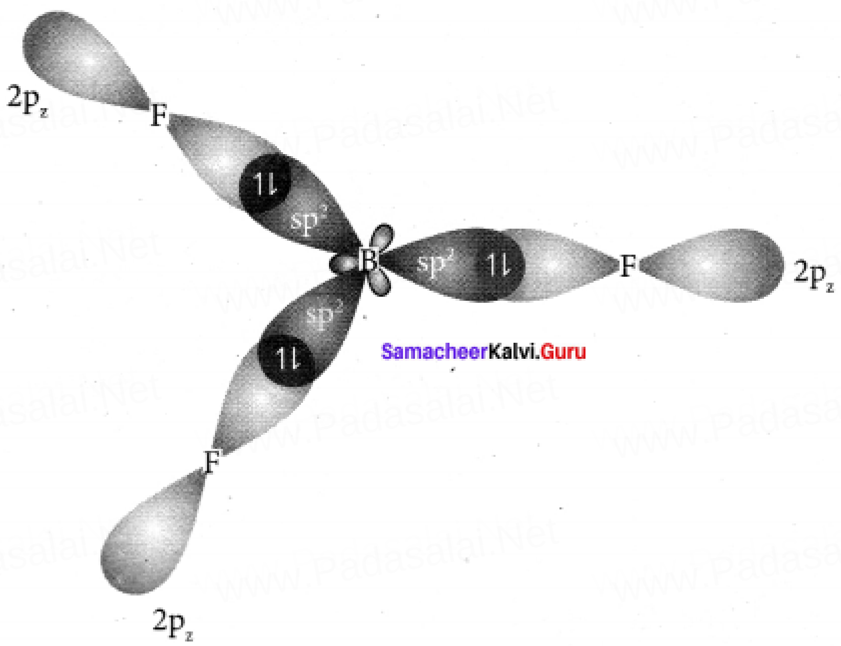
1. sp^2 hybridisation in boron trifluoride – Boron atom – B. Electronic

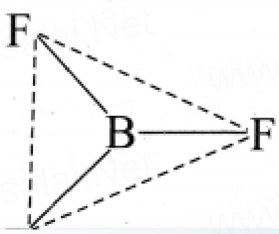
configuration $[H_2]2s^22p^2$.



2. In boron, the s orbital and two p orbitals in the valence shell hybridises to generate three equivalent sp^2 orbitais. These 3 orbitals lie in the same xy plane and the angle between any two orbitals is equal to 120°.

3. The 3 sp^2 hybridised orbitais of boron now overlap with the $2p_z$ orbitais of fluorine (3 atoms). This overlap takes place along the axis.





with same energy. The resultant orbitais are called hybridised orbitals and they possess maximum symmetry and definite orientation in space so as to minimise the force of repulsion between their electrons.

3. σ – bond:

When two atomic orbitais overlap linearly along the axis, the resultant bond is called sigma (σ) bond.

Question 32.

What is a pi bond?

Answer:

Pi – bond:

When two atomic orbitals overlap sideways, the resultant covalent bond is called a pi (π) bond.

Question 33.

In CH_4, NH_3 and H_2O, the central atom undergoes sp^3 hybridisation-yet their bond angles are different, why?

Answer:

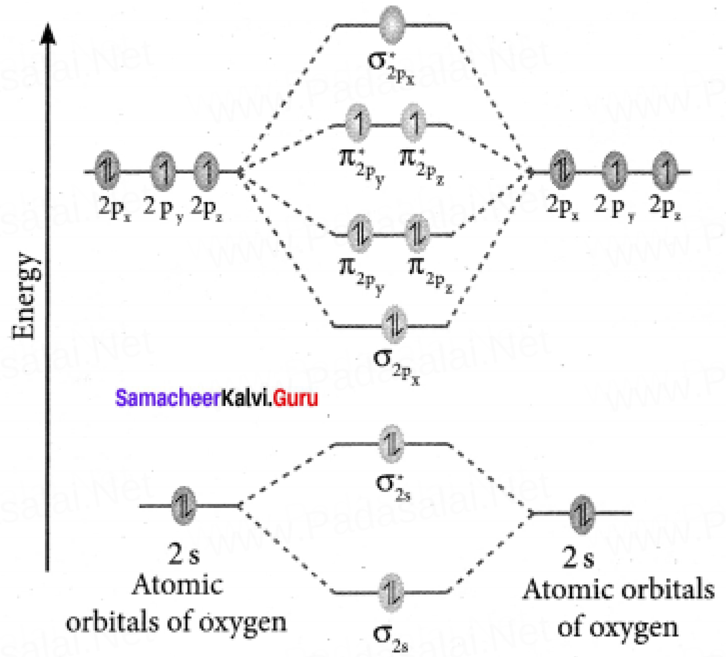
1. In CH_4, NH_3 and H_2O the central atom undergoes sp^3 hybridisation. But their bond angles are different due to the presence of lone pair of electrons.

2. It can be explained by VSEPR theory. According to this theory, even

Question 35.

Draw the M.O diagram for oxygen molecule and calculate its bond order and show that O_2 is paramagnetic.

Answer:



Molecular orbitals of O_2

1. Electronic configuration of O atom is is $1s^2\ 2s^2\ 2P^4$
2. Electronic configuration of O, molecule is

$$\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\ \sigma 2p_x^2\ \pi 2p_y^2\ \pi 2p_z^2\ \pi^*2p_y^1\ \pi^*2p_z^1$$

3. Bond order = $= \frac{N_b - N_a}{2} = \frac{10-6}{2} = 2$
4. Molecule has two unpaired electrons, hence it is paramagnetic.

Question 36.

Draw MO diagram of CO and calculate its bond order.

Schrodinger wave equation is too complex, a most common method linear combination of atomic orbitais (LCAO) is used to obtain wave function for molecular orbitals.

2. Atomic orbitais are represented by wave functions ψ. Consider two atomic orbitals represented by the wave functions ψ_A and ψ_B with comparable energy that combines to form two molecular orbitals.

3. One is bonding molecular orbitai (ψ bonding) and the other is anti-bonding molecular orbital (ψ anti-bonding).

4. The wave function for molecular orbitais, ψ_A and ψ_B can be obtained by the LCAO as shown below:

$\psi_{bonding} = \psi_A + \psi_B$

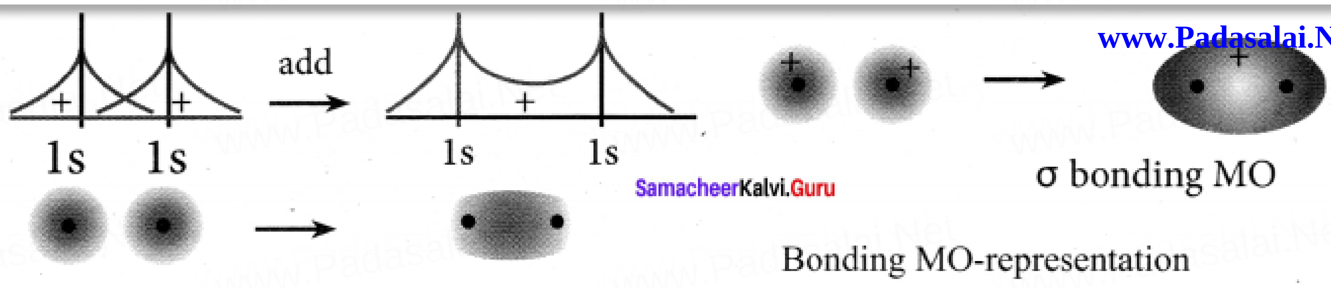
$\psi_{anti\text{-}bonding} = \psi_A - \psi_B$

5. The formation of bonding molecular orbital can be considered as the result of constructive interference of the atomic orbitais and the formation of anti-bonding molecular orbital can be the result of the destructive interference of the atomic orbitais.

6. The formation of two molecular orbitals from two is orbitals is show below.

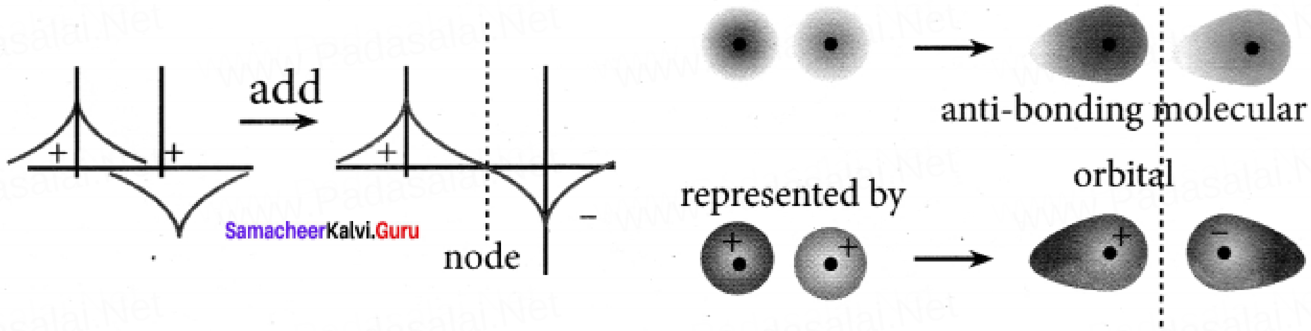
Constructive interaction:

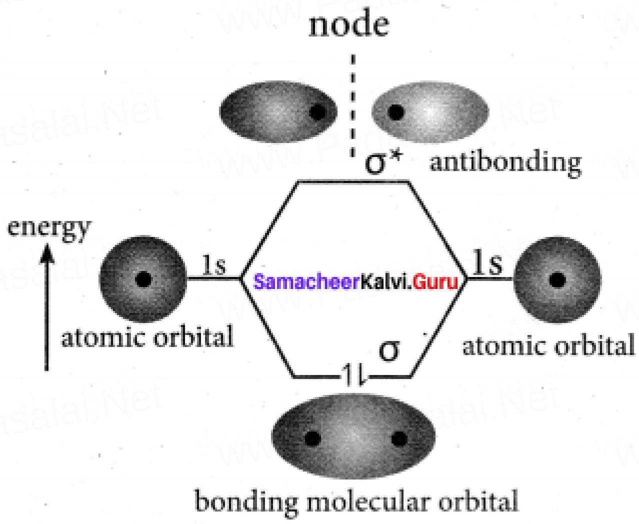
The two is orbitals are in phase and have the same signs.



Destructive interaction:

The two is orbitals are out of phase and have opposite signs

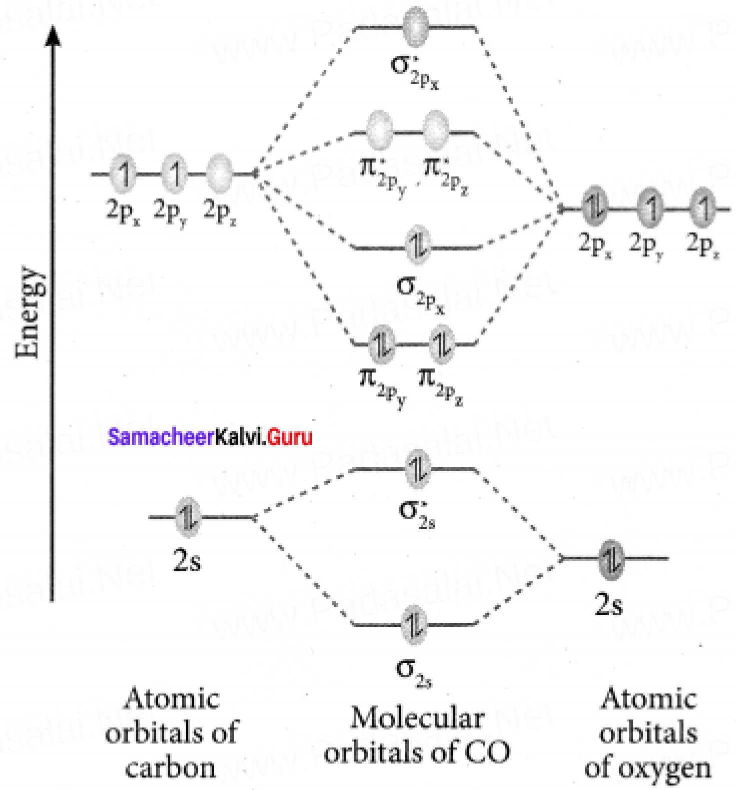




Question 38.

Discuss the formation of N_2 molecule using MO Theory.

Answer:



1. Electronic configuration of C atom: $1s^2\ 2s^2\ 2p^2$

   Electronic configuration of O atom: $1s^2\ 2s^2\ 2p^4$

2. Electronic configuration of CO molecule is: $\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2^2$

   $\pi 2p_y^{\,2}\ \pi 2p_z^{\,2}\ \sigma 2p_x^{\,2}$

3. Bond order $= \frac{N_b - N_a}{2}\ \frac{10-4}{2} = 3$

4. Molecule has no unpaired electron, hence it is diamagnetic.

Question 37.

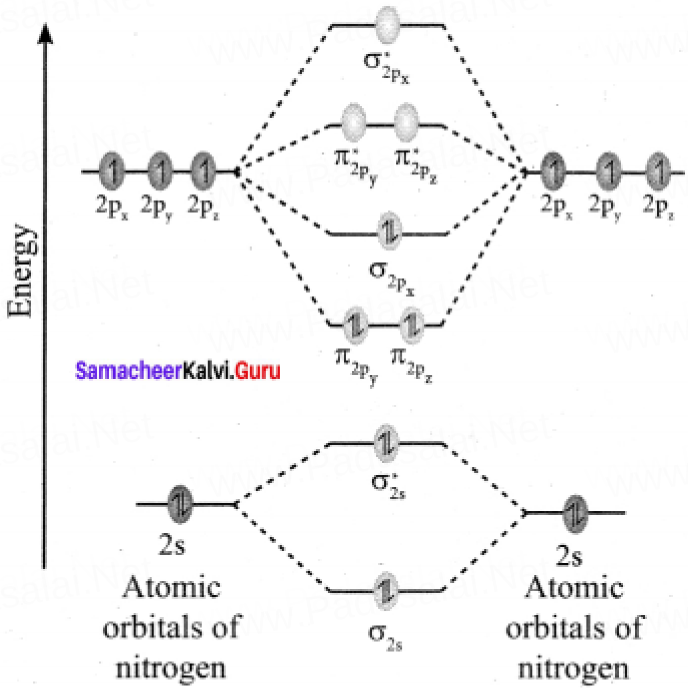
What do you understand by Linear combination of atomic orbitais in MO theory?

Answer:

Linear combination of atomic orbitais (LCAO):

1. The wave functions for the molecular orbitais can be obtained by

Answer:



Molecular orbitals of N_2

1. Electronic configuration of N atom $1s^2\ 2s^2\ 2p^3$.
2. Electronic configuration of N, molecule is: $\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2^2$ $\pi 2p_y{}^2\ \pi 2p_z{}^2\ \sigma 2p_x{}^2$
3. Bond order $= \frac{N_b - N_a}{2}\ \frac{10-4}{2} = 3$
4. Molecule has no unpaired electrons hence, it is diamagnetic.

Question 39.

What is dipole moment?

Answer:

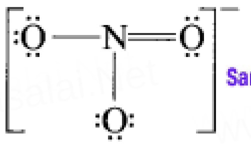
1. The polarity of a covalent bond can be measured in terms of dipole moment which is defined as: μ = q x 2d, where μ is the dipole moment, q is the charge, 2d is the distance between the two charges.

2. The dipole moment is a vector quantity and the direction of the dipole moment points from the negative charge to positive charge.

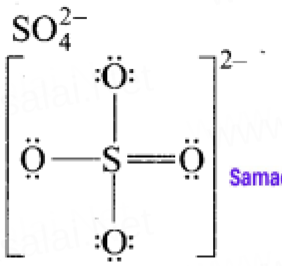
4. O_3

Answer:

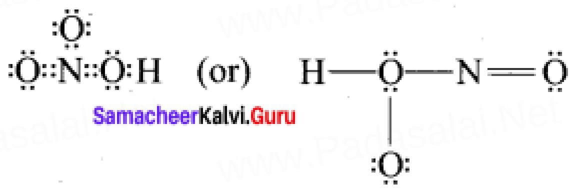
1. NO_3^-



2. SO_4^{2-}



3. HNO_3



4. O_3

Question 42.

Explain the bond formation in $BeCl_2$ and $MgCl_2$. $BeCl_2$ bond formation:

Answer:

1. Electronic confiuration of Be(Z = 4) is $1s^2\ 2s^2$ and electronic configuration of Cl (Z = 17) is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$.

2. Beryllium has 2 electrons in its valence shell and chlorine atoms (2) have 7 electrons in their valence shell.

3. By losing two electrons, Beryllium attains the inert gas configuration of Helium and becomes a dipositive cation, Be^{2+} and each chlorine atom accepts one electron to become (Cl^-) uninegative anion and attains the stable electronic configuration of Argon.

4. Then Be^{2+} combine with $2Cl^-$ ions to form an ionic crystal in which they are held together by electrostatic attractive forces.

5. During the formation of 1 mole of $BeCl_2$, the amount of energy released is – 468 kJ/mol. This favours the formation of BeCl, and its stabilisation.

$MgCl_2$ bond formation:

1. Electronic configuration of Mg (z = 12) is $1s^2\ 2s^2\ 2p^6\ 3s^2$.

Electronic configuration of Cl (z = 17) is $1s^2\ 2p^6\ 3p^6\ 3p^5$

2. Magnesium has 2 electrons in its valence shell and chlorine has 7 electrons in its valence shell.

3. By losing two electrons, magnesium attains the inert gas configuration of Neon and becomes a dipositive cation (Mg^{2+}) and two chlorine atoms accept these electrons to become two uninegative anions [$2Cl^-$] by attaining the stable inert gas configuration of Argon.

4. These ions, Mg^{2+} and $2Cl^-$ combine to form an ionic crystal in which they are held together by electrostatic attractive forces.

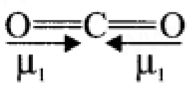
3. The unit of dipole moment is Coulomb metre (C m). It is usually expressed in Debye unit (D).

4. 1 Debye = 3.336×10^{-30} Cm

Question 40.

Linear form of carbon dioxide molecule has two polar bonds. yet the molecule has zero dipole moment, why?

Answer:

1. The linear form of carbon dioxide has zero dipole moment, even though it has two polar bonds.
2. In CO_2, there are two polar bonds [C = O], which have dipole moments that are equal in magnitude but have opposite direction.
3. Hence the net dipole moment of the CO_2 is $\mu = \mu_1 + \mu_2 = \mu_1 + (-\mu_1) = 0$
4. 

5. In this case $\mu = \vec{\mu}_1 + \vec{\mu}_2 = \vec{\mu}_1 + (-\vec{\mu}_1) = 0$

Question 41.

Draw the Lewis structures for the following species.

1. NO_3^-
2. SO_4^{2-}
3. HNO

5. The energy released during the formation of 1 mole of $MgCl_2$ is 783 kJ/mole. This favours the formation of $MgCl_2$ and its stabilisation.

Question 43.

Which bond is stronger or π? Why?

Answer:

σ bond is stronger than π bond. A sigma bond is formed by head-on overlapping of orbital is more effective. Hence it is a stronger bond. But pi bonds are formed by sidewise overlapping of orbitals. The sidewise overlapping of orbitals is less effective than head-on overlapping. Hence it is a weaker bond.

Question 44.

Define bond energy.

Answer:

Bond energy:

Bond energy (or) Bond enthalpy is defined as the minimum amount of energy required to break one mole of a bond in molecules in their gaseous state. The unit of bond energy is kJ mol^{-1}

Question 45.

Hydrogen gas is diatomic whereas inert gases are monoatomic – explain on the basis of MO theory.

Answer:

1. Hydrogen gas is diatomic. According to MO theory. which is based

2. Example – HF – Hydrogen fluoride:

The electronegativities of hydrogen and fluorine on Pauling's scale are 2.1 and 4 respectively. It means that fluorine attracts the shared pair of electrons approximately twice as much as hydrogen which leads to partial negative charge on the fluorine atom and partial positive charge on hydrogen atom. Hence, the H – F bond is said to be a polar covalent bond.

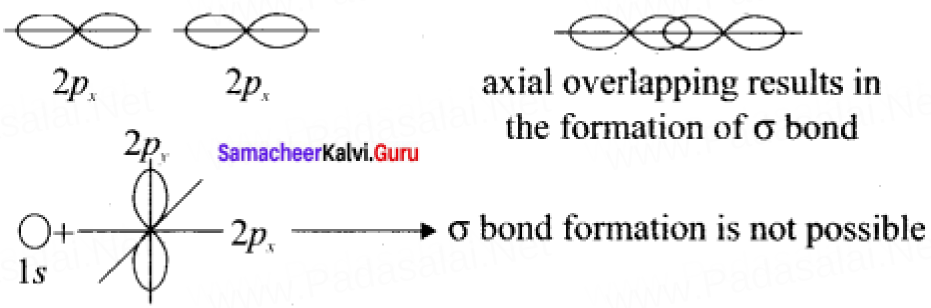
Question 47.

Considering x-axis as molecular axis, which out of the following will form a sigma bond.

1. 1s and $2p_y$
2. $2p_x$ and $2p_x$
3. $2p_x$ and $2p_z$
4. 1s and $2P_z$

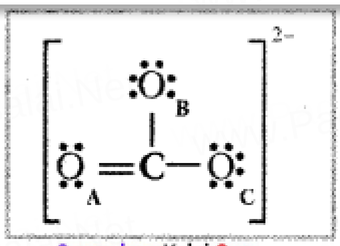
Answer:

Along X-axis as molecular axis, only 2p and 2p can form a sigma bond



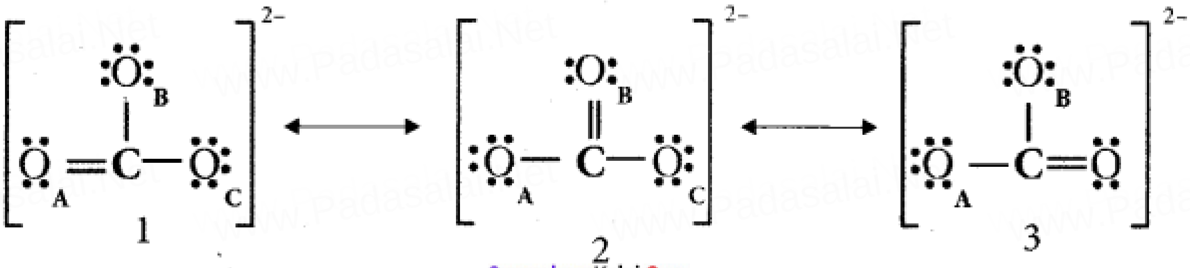
Question 48

Explain resonance with reference to carbonate ion



Lewis structure of CO_3^{2-}

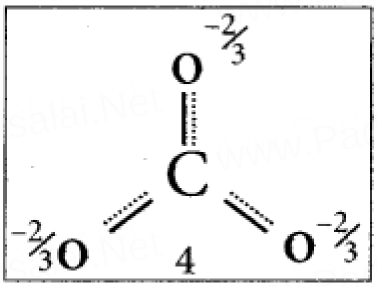
1. For the above structure, we can draw two additional lewis structures by moving the lone pairs from the other two oxygen atoms O_B and O_C. and thus creating three similar structures in which the relative positive of the atoms are same.



Resonance structure of CO_3^{2-}

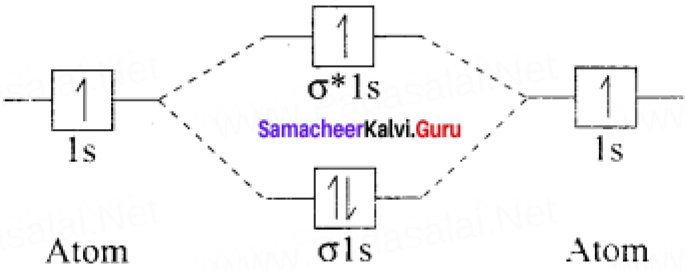
2. They only differ in the position of bonding and lone pair of electrons. Such structures are called resonance structures and this phenomenon is called resonance.

3. It is evident from the experimental results that all carbon-oxygen bonds in carbonate ion are equivalent. The actual structure of the molecule is said to be a resonance hybrid, an average of these 3 resonance forms. The following structure gives a qualitative idea about the correct structure of CO_3^{2-} (carbonate) ion.



on quantum mechanics H_2 molecule can be represented in terms of

the following diagram called M.O. diagram.



H – H. i.e.. H_2 molecule has two atoms which are connected by 1 σ bond. So it is diatomic.

2. But in the case of inert gases. the valence shell is fully filled i.e.. an octet (8 electrons) (or) duplet (2 electrons) in case of Helium, due to which they are in monoatomic state and remain stable. So they do not combine with any atom (neither of same or of different elements). Due to this they do no exist in diatomic state and always exist in mono – atomic state.

Question 46.

What is Polar Covalent bond? Explain with example.

Answer:

1. If a covalent bond is formed between atoms having different electronegativities. the atom with higher electronegativity will have greater tendency to attract the shared pair of electrons towards itself than the other atom. As a result, the cloud of shared electron pair gets distorted and polar covalent bond is formed.

Question 49.

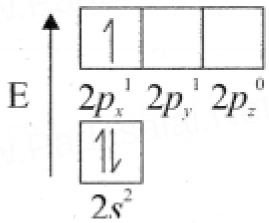
Explain the bond formation in ethylene and acetylene.

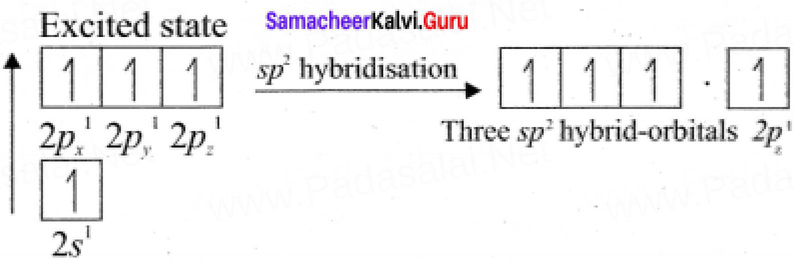
Answer:

Bonding in Ethylene, C_2H_4

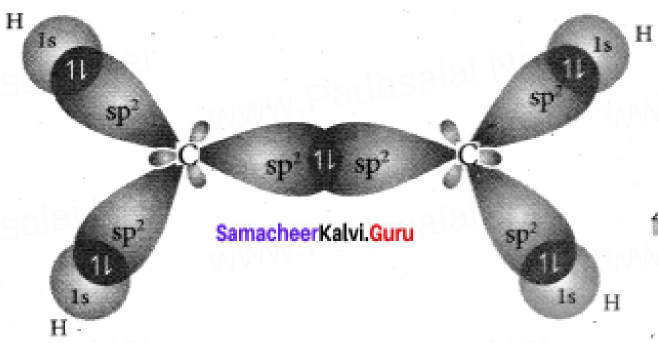
1. Bonding in ethylene can he explained by hybridisation concept.

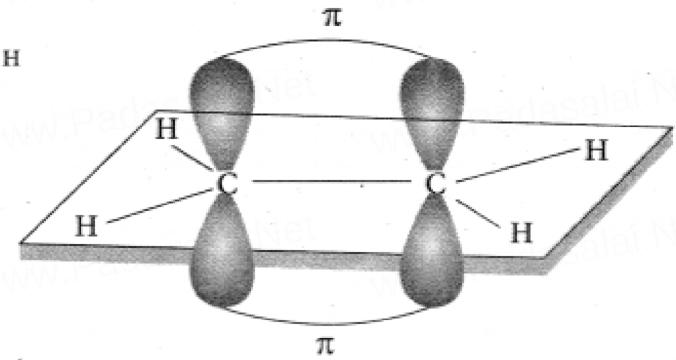
2. The valency of carbon is 4. The electronic configuration of carbon is $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^0$. One electron from 2s orbital is promoted to $2p_z$. orbital in the excited state to satisfy the valency of carbon.

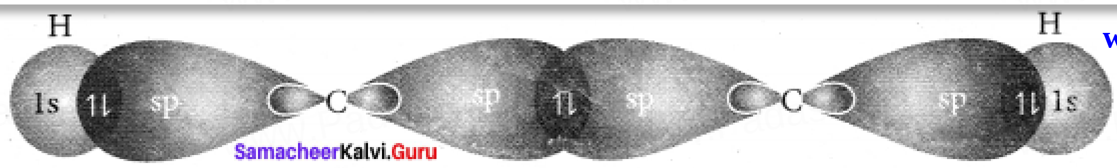


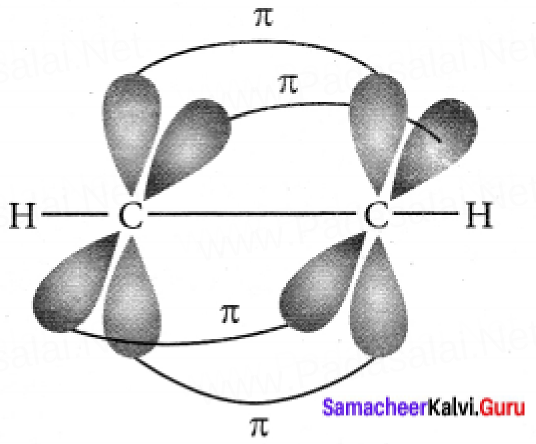


3. In ethylene both the carbon atoms undergo sp^2 hybridisation involving 2s, $2p_x$ and sp_y orbitals resulting in 3 equivalent sp^2 hybridised orbitals lying in the XY plane at an angle of 120^0 to each other. The unhybridised $2p_z$ orbital lies perpendicular to the xy plane.









3. One of the two sp hybridised orbitals of each carbon atom linearly overlaps with each other resulting in the formation of a C – C sigma bond. The other sp hybridised orbital of both carbon atoms linearly overlap with the two is orbitals of two hydrogen atoms leading to the formation of one C – H sigma bond on each carbon atom.

4. The unhybridised $2p_y$ and $2p_z$ orbitals of each carbon atom overlap sideways. This lateral overlap results in the formation of two pi bonds. $(p_y - p_y)$ and $(p_z - p_z)$ between the two carbon atoms.

Question 50.

What type of hybridisations are possible ¡n the following geometeries?

1. octahedral
2. tetrahedral
3. square planar.

Answer:

1. Octahedral geometry is possible by sp^3d^2 (or) d^2sp^3 hybridisation.
2. Tetrahedral geometry is possible by sp^3 hybridisation.
3. Square planar geometry is possible by dsp^2 hybridisation.

Question 51.

Explain VSEPR theory. Applying this theory to predict the shapes of F_7 and SF_6.

Answer:

VSEPR theory:

1. The shape of the molecules depend on the number of valence shell electron pair around the central atom.

2. There are two types of electron pairs namely, bond pairs and lone pairs.

3. Each pair of valence electrons around the central atom repel each other and hence they are located as far away as possible in three dimensional space to minimise the repulsion between them.

4. The repulsive interaction between the different types of electron pairs is in the following order:

$lp - lp > lp - bp > bp - bp$

lp : lone pair, bp : bond pair

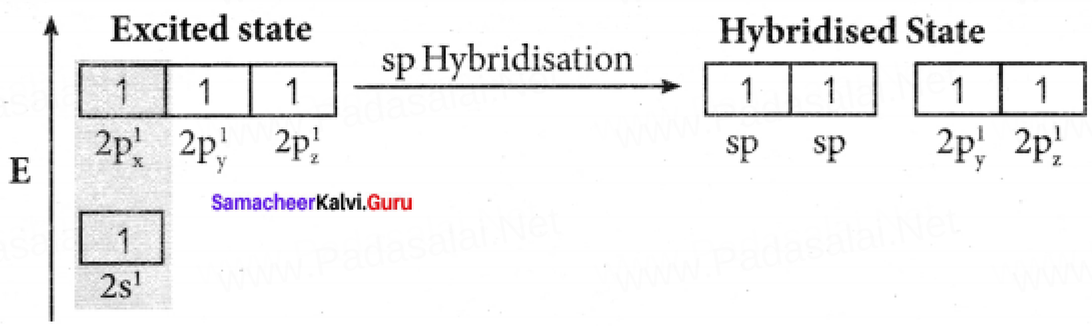
4. One of the sp^2 hybndised orbitals of each carbon atoms lying along the X – axis linearly overlaps with each other resulting in the formation of C – C sigma bond. The other two sp^2 hybridised orbitals of both carbon atom linearly overlap with the four is orbitals of four hydrogen atoms leading to the formation of two C – H sigma bonds on each carbon atom.

5. The unhybridised $2p_z$ orbital of both carbon atoms can overlap only sideways as they are not in the molecular axis. This lateral overlap results in the formation of a pi bond between the two carbon atoms.

Bonding in acetylene (C_2H_2):

1. The electronic configuration of valence shell of carbon atom in the ground state is [He] $2s^2\ 2p_x^1\ 2p_z^0$. One electron from 2s orbital is promoted to $2p_z$ orbital in the excited state to satisfy the valency of carbon.

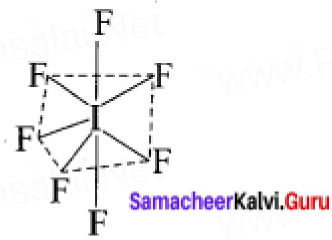
2. In acetylene molecule, both the carbon atoms are in sp hybridised state. The 2s and $2p_x$ orbitals resulting in two equivalent sp hybridised orbitals are formed lying in a straight line along the X – axis. The unhybridised $2p_y$, and $2p_z$ orbitais lie perpendicular to the X-axis.



5. The lone pair of electrons are localised only on the central atom and interact with only one nucleus whereas the bond pairs are shared between two atoms and they interact with two nuclei. Because of this, the lone pairs occupy more space and have greater repulsive power than the bond pairs in a molecule.

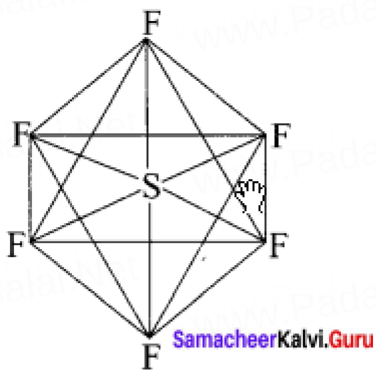
IF_7:

It is an AB_7 type molecule. This molecule has 7 bond pair of electrons and no lone pair of electrons. Due to bond pair-bond pair interaction of electrons, IF_7 has pentagonal bipyramidal shape.



SF_6:

It is an AB_6 type molecule. This molecule has 6 bond pairs of electrons and no lone pair of electrons. Due to bond pair-bond pair interaction of electrons, SF_6 has octahedral shape.



Question 52.

CO_2 and H_2O both are triatomic molecules but their dipole moment

Bond order = 2.5, $B.O. = \frac{N_b - N_a}{2} = \frac{9-4}{2} = 2.5$ SamacheerKalvi.Guru

N_2^-(15 electrons)

$$B.O. = \frac{N_b - N_a}{2} = \frac{10-5}{2} = 2.5$$ SamacheerKalvi.Guru

So N_2 has the highest bond order.

Question 54.

Explain the covalent character in ionic bond.

Answer:

1. Ionic compounds like lithium chloride shows covalent character and it is soluble in organic solvents such as ethanol.

2. The partial covalent character in ionic compounds can be explained on the basis of a phenomenon called polarisation.

3. In an ionic compound, there is an electrostatic attractive force between the cation and anion. The positively charged cation attract the valence electrons of anion while repelling the nucleus.

This cause a distortion in the electron cloud of the anion and its electron density drills towards the cation, which results in some sharing of valence electrons between these ions. Thus, a partial covalent character is developed between them. This phenomenon is called polarisation.

4. Thus due to polarisation, ionic compounds shows covalent character.

Question 55.

Describe Fajan's rule.

Answer:

(i) To show greater covalent character, both the cation and anion should have high charge on them. The higher the positive charge on the cation, greater will be the attraction on the electron cloud of the anion. Similarly higher the magnitude of negative charge on the anion, greater is its polarisability. Hence, the increase in charge on cation or in anion increases the covalent character.

Let us consider three ionic compounds aluminum chloride, magnesium chloride and sodium chloride. Since the charge of the cation increase in the order $Na^+ < Mg^{2+} < Al^{3+}$ the covalent character also follows the same order $NaCl < MgCl_2 < AlCl_3$.

(ii) The smaller cation and larger anion show greater covalent character due to the greater extent of polarisation. Lithium chloride is more covalent than sodium chloride. The size of Li^+ is smaller than Na^+ and hence the polarizing power of Li^+ is more. Lithium iodide is more covalent than lithium chloride as the size of I^- is larger than the Cl^-. Hence I^- will be more polarized than Cl^- by the cation, Li^+.

(iii) Cations having $ns^2\ np^6\ nd^{10}$ configuration show greater polarizing power than the cations with $ns^2\ np^6$ configuration. Hence, they show greater covalent character. CuCl is more covalent than NaCl.

Answer:

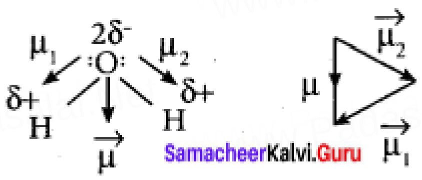
1. Linear form of carbon dioxide has zero dipole moment. In CO_2 the dipole moment of two polar bonds are equal in magiitude but have opposite direction. Hence, the net dipole moment of the CO_2 molecule is

$\mu = \mu_1 + \mu_2$

$\mu = \mu_1 + (-\mu_1) = 0$

In this case $\mu = \vec{\mu}_1 + (-\vec{\mu}_1) = 0$

2. But in the case of water, net dipole moment is the vector sum $\mu_1 + \mu_2$ as follows:



Dipole moment in water is found to be 1.85 D.

3. CO_2 and H_2O both are triatomic molecules but their dipole moment values are zero and 1.85 D respectively.

Question 53.

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

Answer:

N_2 (14 electrons)

Bond order = 3, $\text{B.O.} = \frac{N_b - N_a}{2} = \frac{10-4}{2} = 3$

N_2^+ (13 electrons)