

Chapter -3

Chemical Bonding

Q.1.(a) Explain why? Bond energy of F_2 is lower than Cl_2 .

F_2 की बन्ध ऊर्जा Cl_2 से कम होती है?

2012

Ans. F is highly electronegative while Cl_2 is low electronegativity is 3.0 instead of F = 4 electronegativity so bond energy of F_2 is lower than Cl_2 .

Q.2.(a) What is lattice energy? and how it is determined using Born Haber Cycles? Which have high Lattice energy NaF or MgO?

2002,2014,16

जालक ऊर्जा क्या है? वॉर्न हॉबर चक्र द्वारा यह कैसे ज्ञात की जाती है? NaF तथा MgO में किसकी जालक ऊर्जा अधिक होगी।

or

Discuss in details the Born-Haber Cycle for calculating lattice energy.

2004,2010

or

What is lattice energy ? How is lattice energy of ionic solid evaluated by Born Haber Cycle?

2006

or

Short Notes - Born - Haber Cycles.

2007,2011

or

What is lattice energy? How does the solubility of an ionic solid depends upon its lattice energy?

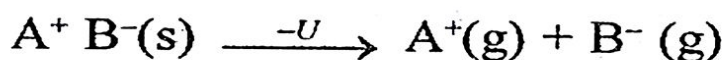
2003

Ans. **Lattice energy :** The amount of energy released when cations and anions in their gaseous state are brought from infinity to their respective lattice sites in crystal to form one mole of the ionic solid.



U = Lattice energy with negative sign as energy is released in the process (exothermic).

Lattice energy of an ionic crystal can also be defined as the amount of energy needed to break one mole of the ionic solid into its constituent gaseous ions. Thus.



U = Lattice energy with positive sign as energy is absorbed in the process (endothermic)

Lattice energy is determined by Born-Landé equation.

$$u = \frac{N_0 A Z^+ Z^- e^2}{r_0} \left(1 - \frac{1}{n} \right)$$

Where N_0 = Avogadro number

A = Madelung constant

n = Born exponent

e = Electronic charge

$Z^+ Z^-$ = Charge of ions

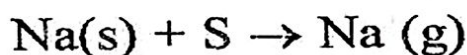
r_0 = Inter-ionic distance

Since n is always more than 1, U would be negative.

Lattice energy is determined indirectly by thermo cyclic process known as Born-Haber Cycle.

The various steps of Born-Haber Cycle can be taken the example of NaCl -

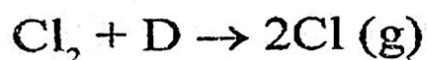
- (i) Conversion of metallic sodium into gaseous chlorine atom.



1 mole

S = Sublimation energy

- (ii) Dissociation of gaseous Cl_2 into gaseous chlorine atom.



1 mole

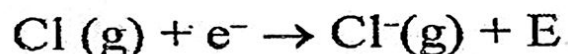
D = Dissociation energy

For one mole of Cl atom energy required = $\frac{1}{2} D$

- (iii) Conversion of gaseous Na into Na^+ ion.



- (iv) Conversion of gaseous Cl atom to Cl^- ion.



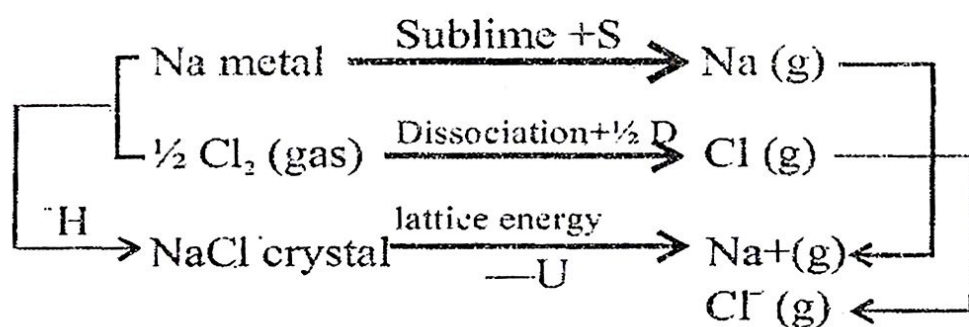
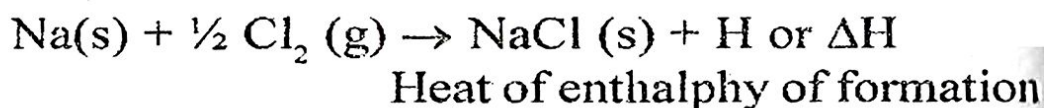
E = electron affinity.

- (v) Combination of gaseous ions to form solid NaCl crystal.



U = Lattice energy

Overall change



$$-H = S + \frac{1}{2} D + I - E - U$$

$$\text{or } +\Delta H_g = S + \frac{1}{2} D + I + E + U$$

For a solid to be able to dissolve in a particular solvent its solvation energy must be greater than its lattice energy so that the lattice may be overcome by the former.

The higher the charge on cation and anion the greater would be the magnitude to lattice energy and therefore, the greater would be the stability of the crystal.



Q.2.(b) What are Fajan's rules? Which of the following has greater polarising power?

फजान के नियम क्या है? निम्न में से किसकी ध्रुवीकरण शक्ति अधिक है।

(i) K or Ag (ii) Li or Be^{+2} 2002, 2015, 17

or

What are Fajan's rules of polarization of ions? Comment on the thermal stability of alkaline earth metal carbonates on the basis of Fajan's rules. 2005

or

What are the factors of favouring the formation of covalent bond between two atoms. 2006

Ans. A polar covalent bond is more stable than a pure covalent bond or a pure ionic bond. The higher the degree of ionic polarisation. The greater is the stability of the polar covalent bond. The rules regarding polarisation are known as Fajan's rules.

(1) **The cation with small size :** Cause polarisation of electron charge cloud of an anion to a greater extent (higher polarising power). The covalent character of molecules of chlorides of (IIA) group in the order -



BeCl_2 is largely covalent while others are largely ionic due to small size or maximum polarising power of Be^{2+} .

Alkaline earth metal carbonates decompose on heating evolving CO_2 . However their thermal stability increases in the order-



(iii) **The anion with large size have high polarization :**

Such anions will get polarised by cations relatively easily ex. covalent character of CaF_2 , CaCl_2 , CaBr_2 and CaI_2 molecules increase in the following order-



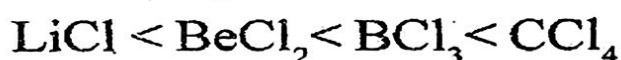
Thus CaF_2 is largely ionic.

Covalent character of hydrogen halide



(iii) **For effective polarisation charge on cation or anion should be high.**

e.g. covalent character of LiCl , BeCl_2 , BCl_3 , CCl_4 with cations of same period is in the order.



(iv) **Cation with 18 electron valence shell configuration have high polarising power.**

CuCl is more covalent than NaCl .

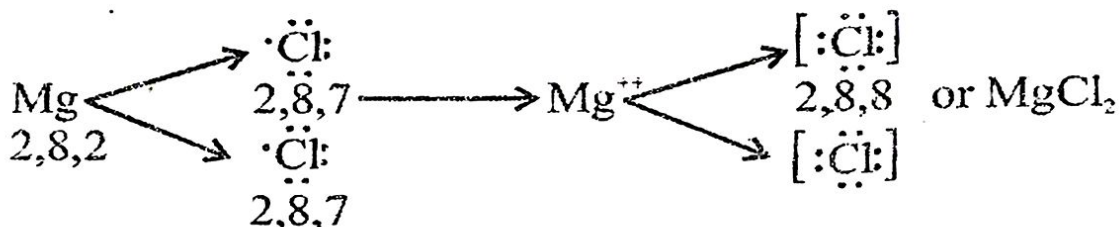
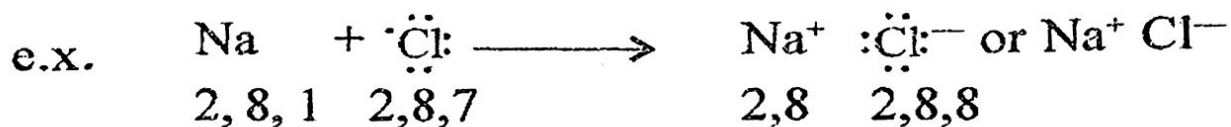
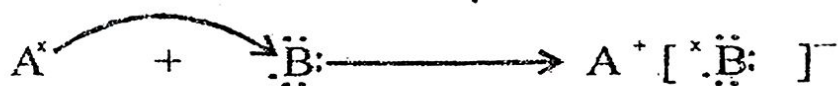
AgI is covalent while NaI is ionic.

Q.3(a) What is an ionic bond? Give conditions for the formation of ionic bond. 2003,2007,2008,2015

आयनिक बंध क्या है? आयनिक बंध बनने के शर्तों को बतलाइए।

Ans. A ionic bond is formed when one or more electron are transferred from one atom to complete the orbitals of another atom. In this way, both the atoms acquire the electronic configurations of the nearest gases. The atom which loses electrons acquire positive charge where as the other atom, gain one electron becomes negative ion. The electrostatic attrac-

tion between the oppositely charged ions results is ionic bond

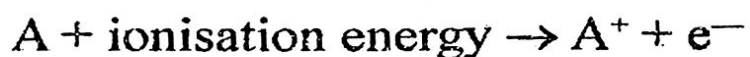


Condition for forming Ionic bond : The following conditions favour the formation of a ionic bond.

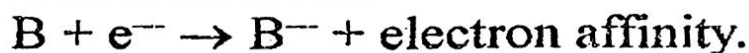
(i) **Number of valency electrons:** One atom should possess 1, 2 or 3 valency electrons while the other atom should have 5, 6 or 7 valency electrons. The atom which changes in cations should have 1, 2 or 3 valency electrons i.e. it should belong to group IA, IIA or IIIA. It should be metallic or electropositive in nature. The other atom which changes its anion should possess 5, 6 or 7 electrons in the valency shell i.e. it should belong to group VIA or VIIA it should be non-metallic or electronegative in nature.

(ii) **Difference in electronegativity :** The formation of an electrovalent bond will be easier if the difference in the electronegativities of two atoms is high. A difference about 2 is necessary for the formation of an electrovalent bond.

(a) Lower the value of ionisation energy of an atom greater will be the ease of formation of the cation form i.e. One atom should have low value of ionisation energy.



(b) Energy equivalent to electron affinity is released when an electron is added to a neutral isolated gaseous atom to make it univalent anion.



Higher the value of electron affinity of the atom, greater the ease of formation of the anion from it. i.e. other atom should have high value of electron affinity.

(II) Covalent and Brief Idea of Other Bonds.

- Q. 1(a) Discuss the effect of hydrogen bond on the physical of molecules. 2002, 2015, 17

हाइड्रोजन बन्ध का अणुओं के भौतिक गुणों पर पड़ने वाले प्रभाव की विवेचना कीजिए।

or

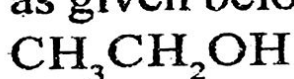
Explain the nature, consequence and importance of hydrogen bonding. 2004

Ans. The concept of the hydrogen bonding has introduced by Latimer and Rodebush (1920) Hydrogen bonding is said to be formed when slightly acidic hydrogen attached to a strongly electronegative atom such as F, N and O is held with weak electrostatic force by the non-bonded pair of electrons of another atom. The co-ordination number of hydrogen in such cases is two. It acts as a bridge between two atoms, to one of which it is covalently bonded and to the other attached through electrostatic forces, also called hydrogen bond. of all electronegative donor atoms only F, N and O atoms enter into stable hydrogen bond formation.

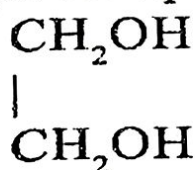
The weak electrostatic interaction leading to the hydrogen bond formation is shown by two $++$ (.....) lines, thus $X-H \cdots Y$ represents hydrogen bonding between hydrogen and Y atom.

Effect of Hydrogen bonding :

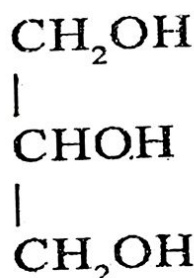
- (a) Due to H-bonding boiling points of Water, ammonia hydrofluoric acid abnormally high (fig)
- (b) Solubility of the organic compounds in water is due to H-bond formation.
- (c) Due to hydrogen bonding viscosity (η) of the liquid increase as given below (in centipoise (P))



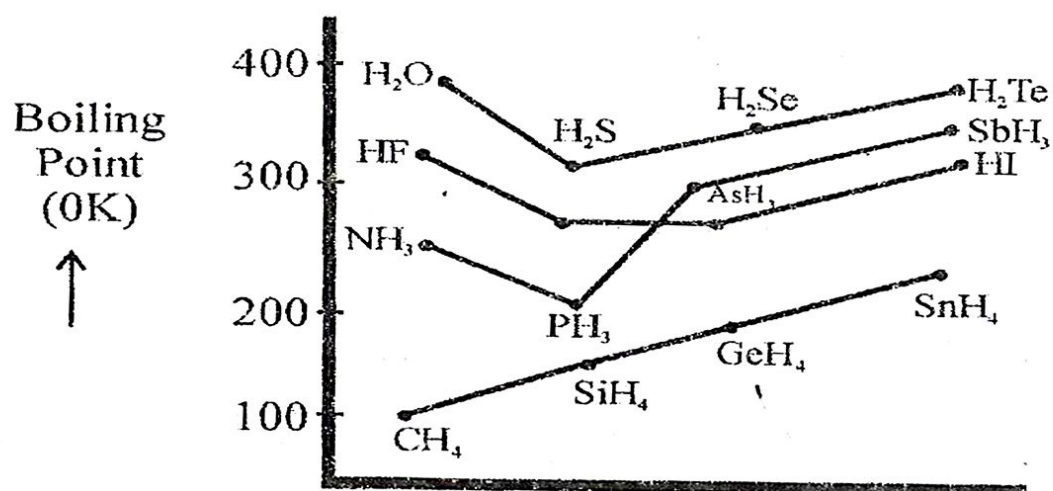
$$\eta = 1.2 \text{ cp}$$



$$\eta = 17 \text{ cp}$$



$$\eta = 10.70 \text{ cp}$$



Q.1(b) Determine the geometries of H_3O^+ , SF_4 , ClF_3 , ICl_3 , SF_4 , I_3^- , BCl_3 , I_3^+ on the basis of VSEPR theory. 2002,16
 VSEPR सिद्धान्त के आधार पर H_3O^+ , SF_4 , ClF_3 , ICl_3 , SF_4 , I_3^- , BCl_3 तथा I_3^+ की ज्यामिति ज्ञात कीजिए।

or

Discuss the geometries of H_3O^+ , I_3^- , ClF_3 , SF_4 , ICl_3 —
 2011,2010,2009,2008,2004,2004,2014,2015

or

What is meant by hybridization of atomic orbitals? Write down the shape of any two of the following molecules and indicate the hybrid orbital used by central atom in them.

PH_3 , PCl_3 , SF_6 , XeF_2 , BF_2

2005, 2007

or

Deduce the shape of the following on the basis of VSEPR theory.

XeF_4 , SF_4 , ICl_3 , PCl_3

2005,16

or

Describe VSEPR theory and discuss the shape of ClF_3 and ICl_3 .

2006, 2011

or

Indicate the type of hybridization of central atom and geometry of the following molecules XeF_4 , SF_4 , BCl_3 .

2006

or

Predict the bond angle in ClF_3

2010

or

How does its geometry change in the following transformation. 2010



Explain

(i) H_2O is V-shape molecules

(ii) ClF_3 is T-shaped molecules. 2011

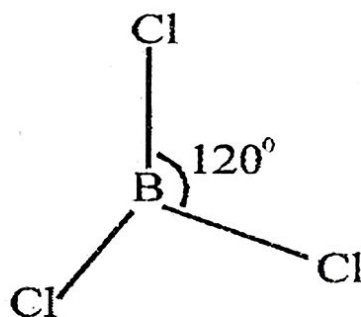
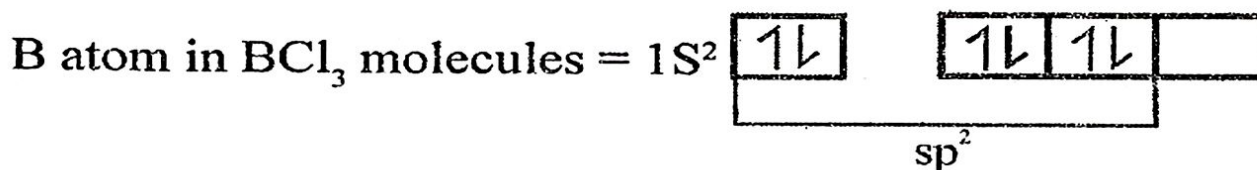
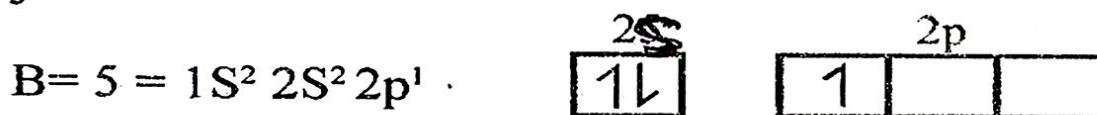
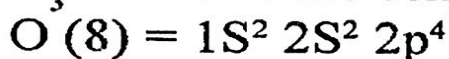
Ans. According to VSEPR theory—

- (1) Electron pairs tend to minimize repulsion. Ideal geometries are—
 - (a) For two electron pairs, Linear.
 - (b) For three electron pair, trigonal.
 - (c) For four electron pair, tetrahedral
 - (d) For five electron pairs, trigonal bipyramidal
 - (e) For six electron pairs, octahedral.
- (2) Repulsions are of the order

$$\text{LP} - \text{LP} > \text{LP} - \text{BP} > \text{BP} - \text{BP}$$
 - (a) When lone pairs are present, the bond angles are smaller than predicted.
 - (b) Lone pairs choose the largest site eq. equatorial in trigonal bipyramid.
 - (c) If all sites are equal, lone pairs will be trans to each other.
- (3) Double bonds occupy more space than single bonds.
- (4) Bonding pairs to electronegative substituents occupy less space than those to more electropositive substituents.

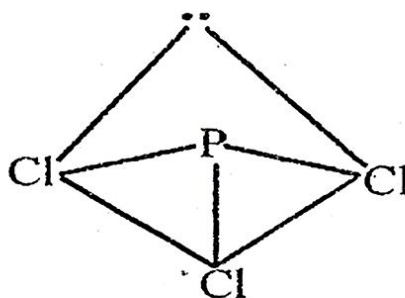
Number of BPs and LPs, type of hybridisation and geometry of various covalent molecules.

No. of BPs + LPs	Hybridisation	Type of electron pairs	Geometry	Example
3	sp^2	3BP	Trigonal Planar	$\text{BCl}_3, \text{BF}_3$
4	sp^3	3BP+1LP	Pyramidal	$\text{H}_3\text{O}^+, \text{PCl}_3$
5	sp^3d	4BP+1LP	Distorted trigonal bipyramid	SF_4
	sp^3d	3BP + 2 LP	T-shaped	$\text{ClF}_3, \text{ICl}_3$
	sp^3d	2BP + 3 LP	Linear	$\text{I}_3^-, \text{XeF}_2, \text{ICl}_2^-$
	sp^3d	5BP	Trigonal bipyramid	PCl_5
6	sp^3d^2	6BP	Octahedral	SF_6

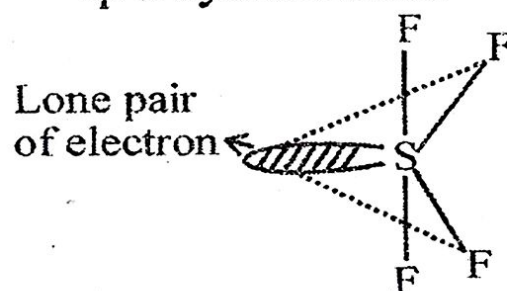
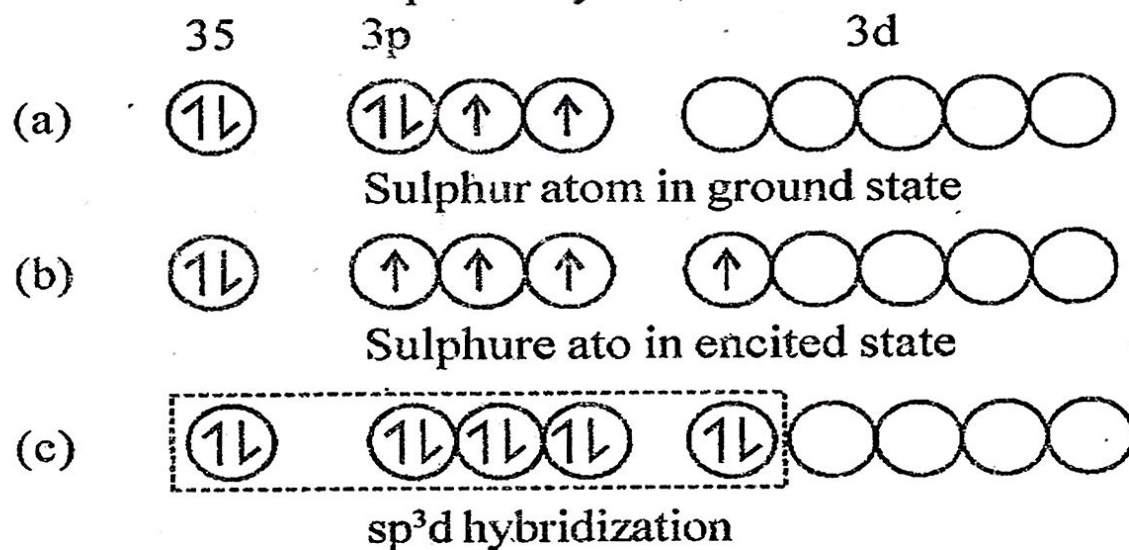
(i) BCl_3 Fig BCl_3 trigonal planer(ii) H_3O^+ $\text{O} = \text{O}$ is the central atom

Sp^3 hybridisation

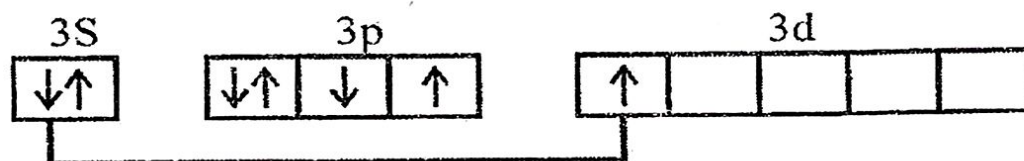
One 2s and three 2p atomic orbitals undergo hybridization to give four sp^3 hybrid orbitals of equivalent energy. The two sp^3 hybrid orbitals overlap with two H-atoms but remaining two hybrid orbitals contain two lone pairs of electrons, one of them overlaps with hydrogen ion (H^+). According to VSEPR theory the distribution of these 4-hybrid orbitals should be pyramidal in order to keep the force of repulsion minimized. Hence structure of H_3O^+ on the basis of VSEPR theory will be pyramidal with bond angle 107° .

(iii) $\text{PCl}_3 = 3\text{B.P.} + 1\text{LP} = \text{sp}^3$ pyramidal shaped(iv) SF_4 (2015) It has trigonal bipyramidal in structure due to a

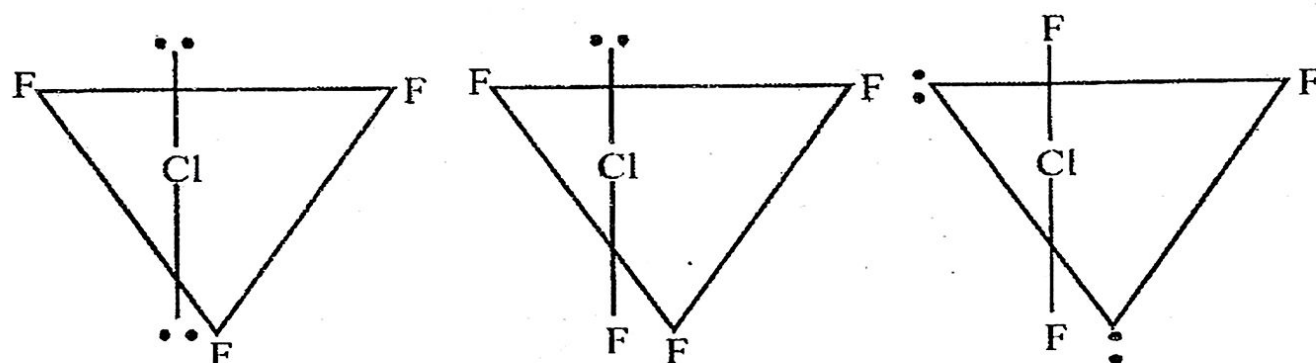
lone pair of electron. There is distortion in the molecules and the bond angle is 89° and 177° instead of normal bond angles of 90° and 180° respectively.



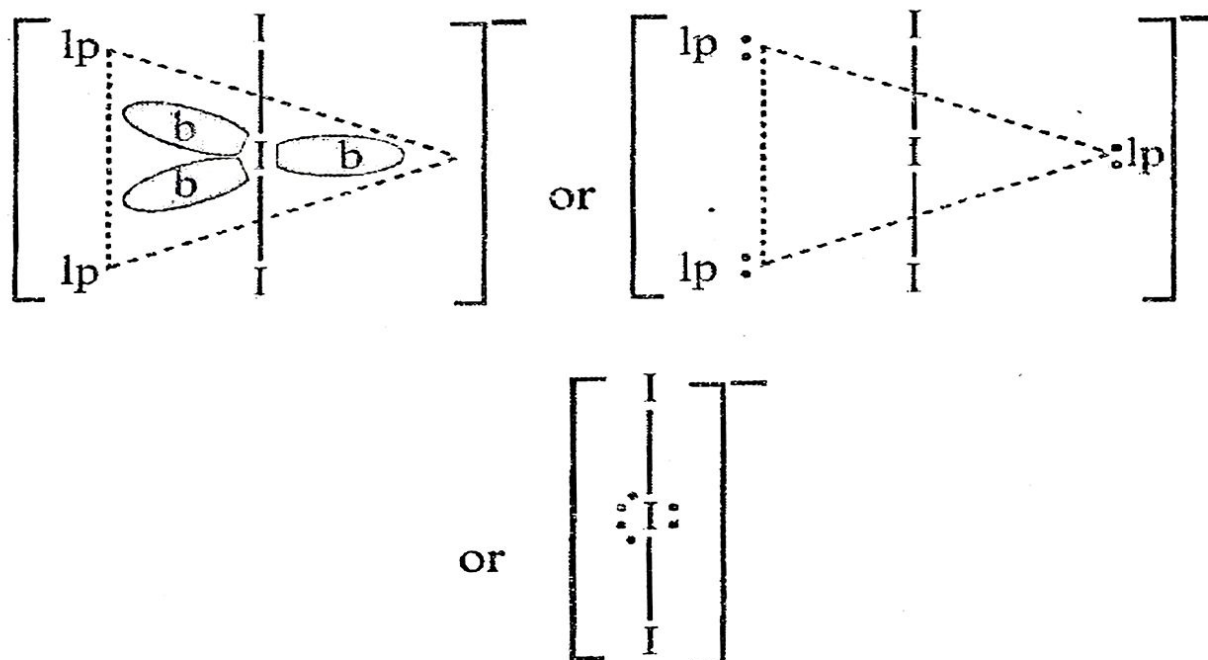
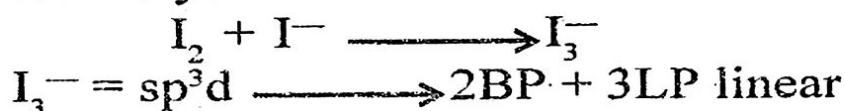
ClF₃ (2014,17): The molecule is T-shaped with bond angle of $87^\circ 40'$. The distortion from 90° is because of repulsion between the lone pairs. Equatorial bonds are different from axial bonds. The electronic structure of central chlorine atoms in ClF₃ excited state.



Three unpaired electrons form bonds with three fluorine atoms, sp^3d hybridisation trigonal bipyramid with two occupied by lone pairs.



I_3^- (2015) : This is stable both in aqueous solution and in ionic crystals



ICl_2^- ion :

The two axial hybrid orbitals, each of which has one electron, overlaps with the $3p_x$ orbitals of two Cl atom to form two $I-Cl$ σ bonds. Due to the presence of lbs ICl_2^- ion assumes linear (symmetrical shape)

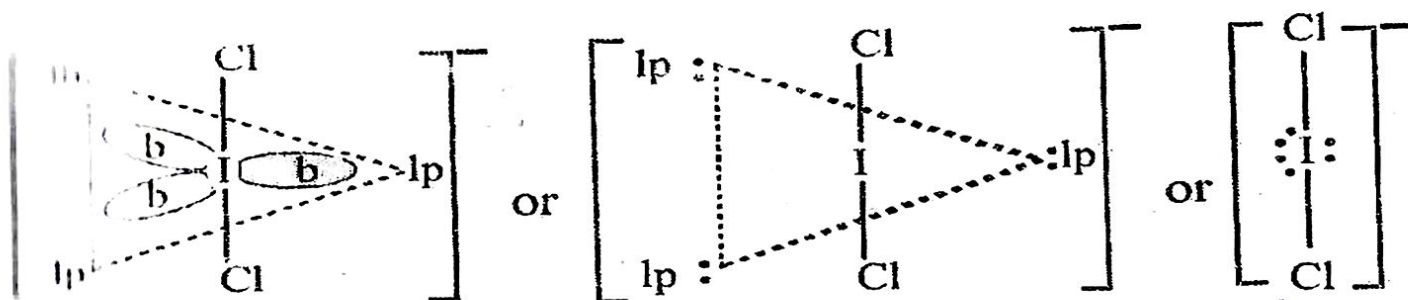
ICl_2^- ion $\Rightarrow sp^3d$ hybridization $\Rightarrow 2 BP + 3LP \Rightarrow$ Linear

Electronic structure of Iodine atom in ground state



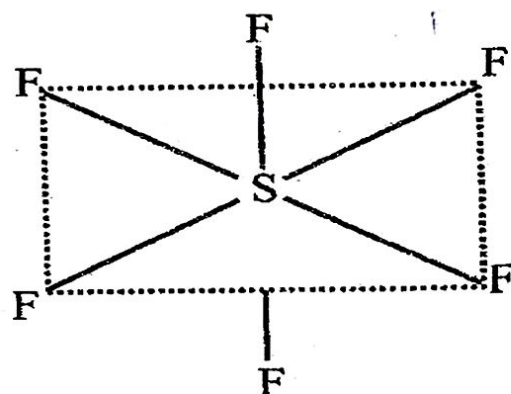
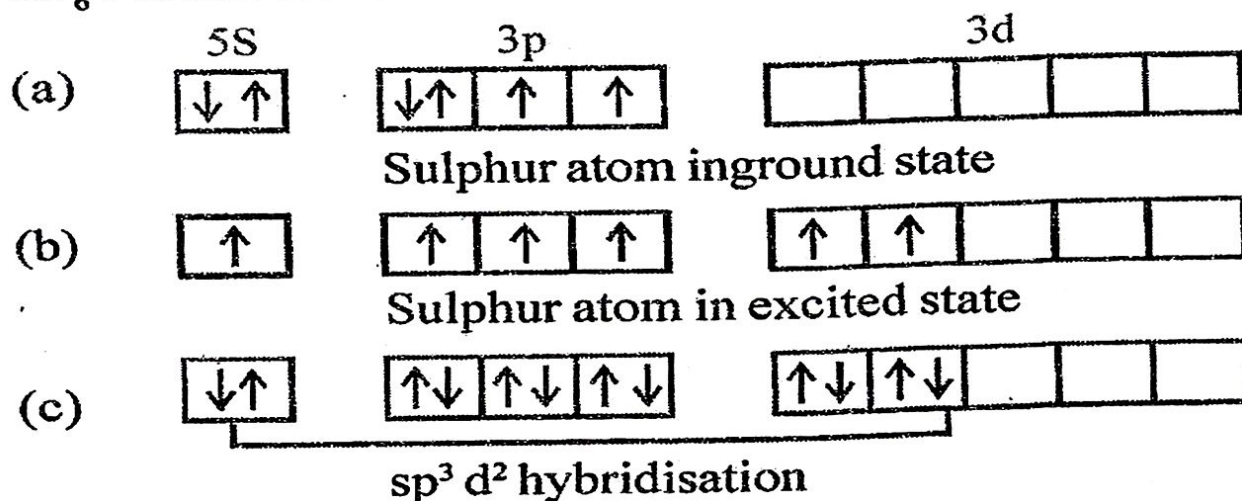
Structure of iodine having formed one covalent and one coordinate bond in $[ICl_2]^-$.





SF_6 : It has an octahedral structure

2015



Q.2. Short notes:

- Metallic bonds (धात्विक बन्ध) 2016
- Covalency Maximum (सह-संयोजकता अधिकतम)
- Three Centred Bond (त्रिकेन्द्रक बन्ध)

2011, 2010, 2008, 2002, 2003, 2004, 2014, 2015

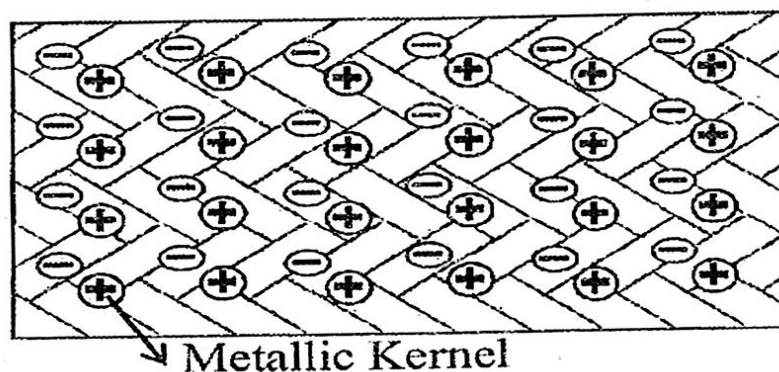
Ans.: (a) **Metallic Bond** :- Metals are characterised by electrical and thermal conductivity, high luster, malleability and high tensile strength. It has been observed that metals, generally, have low ionisation energies because the valency electron (is the electron in the outer shell). can be taken out relatively easily. The simplest than valency electron in metals are

weakly bound to the Kernel.

Consider the case of Li, It has one valency electron. The electronic configuration being $1S^2 2S^1$. The X-ray examination of a crystal of Li shows that such lithium atom is surrounded by eight other Li atoms. It is not possible for one lithium atom to get bonded to eight other atoms through covalence bonds. i.e. electron pair bonds as it contains only one valency electron. But it has other valency orbitals ($2S$, $2P_x$, P_y , $2P_z$) available. Hence besides its own valency electron the valency electrons of the neighboring atoms can also come quite close to its nucleus. In other words there can be complete freedom of movement of electrons in the vacant valency orbitals around the nucleus of each lithium atom. The valency electrons of metallic atom, thus are not localized at each atom. They do not belong to one atom in particular. They are mobile and move about from one kernel to another in the crystal. They are in effect a common property of all the atoms present in a metallic crystal, from the above.

- (i) Metals have low Ionization energies which means that the valency electrons are weakly held by the Kernels.
- (ii) Metals have a large number of vacant orbitals in valency shells of their atoms.

To account for the nature of bonding in metal. Lorentz proposed a model known as electron sea model. According to this model, a metal consists of an assemblage of positive ions Kernels, immersed in a sea of mobile electrons. Alternatively, it may be imagined that there is a sea of valence electrons in which the Kernels are arranged in a regular and therefore they move freely throughout the crystal. As a result these electrons are called mobile electrons.



The force of attraction which binds a metal atom Kernel to a number of electron with in its sphere of influence is known as metallic bond.

- (b) **Maximum Covalency** : From ^{pauli} ~~puly~~ chemicals evidence sidgwick obtained that every elements has certain maximum covalency and depends on atomic number. Sidnick's tabe of maximum Covalency of elements of different periods is given.

Atomic No.	Element	Maxmum	Maximum No of Shared electrons
1	H	1	2
3-9	II period (Li to F)	4	8
11-35	III and IV period (Na to Be)	6	12
37-87	V and VI period (Sr to At)	8	16

The maximum Covalency for any particular element is not always attained. It is generally shown by meny elements maximum covalency explain on the basis of vacant -d-orbitals. The covalent of an element whose atoms do not contain d-orbitals is generally equal to the number of unpaired s and p electrons present in its outer most shell. In case vacant d-orbitals are present in an atom if sufficient energy is relased in the formation of a covalent bond. The sand p electron are promoted to the vacant d-orbitals. The unpairing of electron increase the covalency of these element example.

- (i) The oxygen atom in groud state has $1S^2 2S^2 2p^2$ configuration. There are no d-orbitals present. the encitation is not possible.
- (ii) But in case of sulphure atom $3S^2 2p^4$ outer shell configuration 2, 4 and 6 unpaired 6 respectively.
- The maximum covalency is generally equal to the number of 5 and p electrons present in the valency shell/
1. Hydrogen has only one stable in complete orbitals (1s) which can take up 2 electrons and is limited to a valency 1.
 2. The element of first period (Li to F) has on 2S and three 2p

orbitals and show a covalency of 1.

Q.3.(a) What do you mean by hybridization? Explain with examples taking the cases of sp^3d and sp^3d^2 hybridization.

2003,2008,16,17

कक्षकों के संकरिकरण से क्या तात्पर्य है? sp^3d तथा sp^3d^2 संकरों को उदाहरण सहित स्पष्ट कीजिए।

or

Discuss sp , sp^2 , sp^3d and sp^3d^2 types of hybridization giving one example of each.

sp , sp^2 , sp^3d और sp^3d^2 प्रकार के संकरणों की प्रत्येक के एक उदाहरण द्वारा समझाइए।

2014

or

Discuss Sp , Sp^2 , Sp^3 and Sp^3d^2 types of hybridization giving one examples of each.

2006,2011

or

Giving one example discuss the hybridization in octahedral compound.

2010

Ans. Hybridisation: The mixing of atomic orbitals belonging to same atom but having slightly different energies so that a redistribution of energy takes place between them resulting in the formation of new orbitals of equal energy and identical shape is known as hybridisation and the new orbitals formed are known as hybrid orbitals.

Sp hybridisation: Two hybrid orbitals are collinear with an angle of 180° each hybrid orbital has 50% S and 50% p character. It is involved in-

- (i) All compounds of beryllium like BeF_2 , BeH_2 , $BeCl_2$ etc.
- (ii) All compounds of carbon containing $-C \equiv C-$ type bond like ethyne (C_2H_2)

Sp^2 hybridisation : All the three hybrid orbitals remain in the same plane (trigonal planar) making an angle of 120° with one another. Each hybrid orbital has 33% S and 67% p character. It is involved in-

- (i) All compound of boron eq BF_3 , BH_3 , BCl_3 etc.
- (ii) All compounds of carbon containing $>C = C<$ double bond like ethylene (C_2H_4)

Sp^3 hybridisation : The four hybrid orbitals are directed towards

the four corners of a regular tetrahedron and made an angle of $109^\circ 28'$. Each hybrid orbital has 25% involved in the compounds like CH_4 , C_2H_6 , CH_3Cl , SiCl_4 , NH_4^+ , BF_4^- etc.

The ability of the hybrid orbitals to overlap is in the order $sp^3 > sp^2 > sp$ i.e. greater is the p-character greater is the ability to overlap.

The bond angles formed by different hybrid orbitals are in order $sp(180^\circ) > sp^2(120^\circ) > sp^3(109.5^\circ)$ i.e. greater the s character greater is the bond angle.

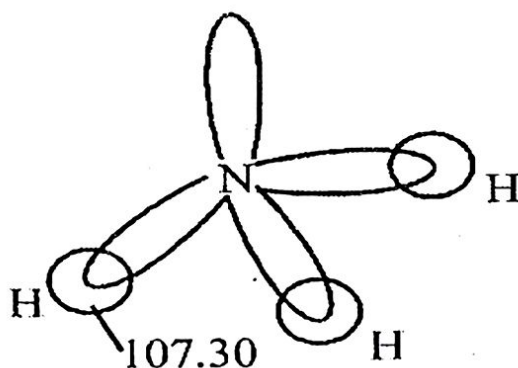
sp^3d hybridisation : Trigonal bipyramid with bond angle 120° and 90° eg. PCl_5

sp^2d^2 hybridisation : Octahedral with bond angle 90° eg. SF_6

sp^2d^3 hybridisation : Pentagonal bipyramid with bond angle 72° and 90°

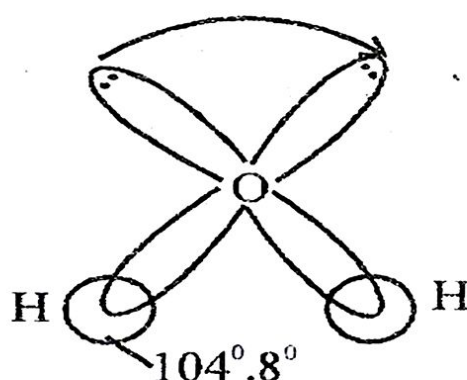
Q.4.(a) Why the bond angle in CH_4 , NH_3 and H_2O are different although an atom have sp^3 hybridization. 2004
 CH_4 , NH_3 और H_2O में बन्धन कोणों का मान भिन्न होता है जबकि इन सबमें sp^3 संकरण है।

Ans. Ammonia molecules, nitrogen atom contains a lone pair of electron, since the lone pair is under the influence of only the nitrogen nucleus. Its electron cloud will be spread out in space to a greater extent than the electron cloud of bonding electron pairs which are under the influence of both the hydrogen and nitrogen nucleus. The greater spread over in space of the lone pair electrons causes a greater repulsion between the lone pair and the bond pair than would result between a bond pair and another bond pair. The net effect is that the lone pair causes the decrease the bond pairs to be pushed close together thereby bond angle form $109^\circ 28'$ to 107.3° .



In water molecules contains four electron pairs similar to nitrogen atom in ammonia molecules with the difference that two out of the four electron pairs in water molecules are lone pairs, while in NH_3 molecules, it has only one lone pair, since we know that $l-l > l-b > b-b$

Hence there will be a greater distortion in water molecules than in NH_3 molecules. The greater repulsion between two lone pairs of electron would cause a greater repulsion between a bond pair and bond pair. The net effect would be that the two lone pairs of electron in water molecule would cause the two C-H bonds to be pushed close together thereby making the HOH bond angle less than the tetrahedral angle. Thus the repulsion between lone pair-bond pair would be less than the lone pair-lone pair-lone pair in water molecule. The less repulsion would make the HNH bond angle in NH_3 molecule somewhat greater than the H-OH bond angle but less than the tetrahedral angle.



Q.4.(c) Explain odd electron bond with suitable example.

विषम इलेक्ट्रॉन आबन्ध को उपयुक्त उदाहरण के साथ व्याख्या कीजिए।

2004, 2007, 2014, 16

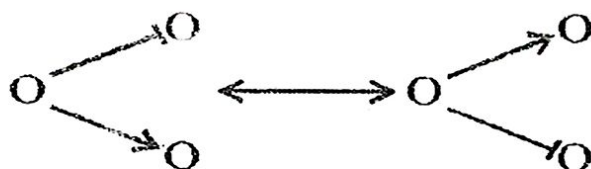
Ans. On electron bond : H_2^+ presents the example of one electron bond. It is described as a combination of the two resonance forms



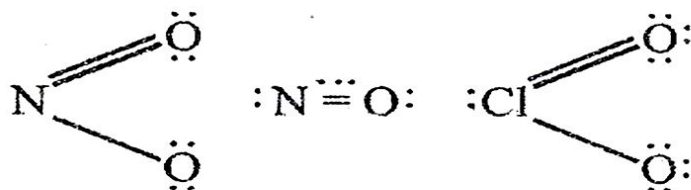
one electron bond is characterised by

- (i) It is possible only between 2 like atoms.
 - (ii) It is weaker than normal covalent bond.
 - (iii) The compound with one electron bond are paramagnetic.
- Three electron bond :** Ozone presents an example of three

electron bond. It has resonance structure.



each of these structures has two electron bond and one four electron bond. But the actual structure is said to have two 3 electron bond. Typical example of three electron bonds are NO_2 , NO and ClO_2 .



Three electron bond has the following characteristics.

- (i) It is four between atoms that are quite close in electronegativity.
- (ii) It is half as strong as a covalent bond.
- (iii) Odd electron molecules are very reactive and tend to dimerise.

Q.5(a) Nitrogen forms only trivalent halides while P , As and Sb form pentavalent halides also. 2005

नाइट्रोजन केवल त्रिसंयोजक हैलाइड्स बनाता है। जबकि P , As और Sb पंचम संयोजक हैलाइड भी बनाते हैं।

Ans. Nitrogen and their family elements directly combine with the halogen and form trihalides MX_3 . All the trihalides are stable except NCl_3 , NBr_3 and NI_3 . The unstable nature of the above halides is due to the large atomic size of the halogen atom. Except Nitrogen other elements of this family also form pentavalent halides due to the presence of vacant d-orbital whereas N atom does not have any contribution of d-orbitals. Hence it does not form any penta valent halides.

Q.5(b) There is a large difference in the melting point and boiling point of H_2O and H_2S . 2006, 2007

H_2O और H_2S के गलनांक और क्वथनांक में प्रत्यक्ष अंतर है।

Ans. Being one of the most electronegative atoms oxygen when attached to hydrogen enters bonding molecular association between water molecules takes place and accounts for the

liquid nature of H_2O . Whereas in H_2S there is no hydrogen bonding due to small electronegativity of sulphur atom.

Q.7(a) $LiCl$ is more soluble in ethanol than water? 200

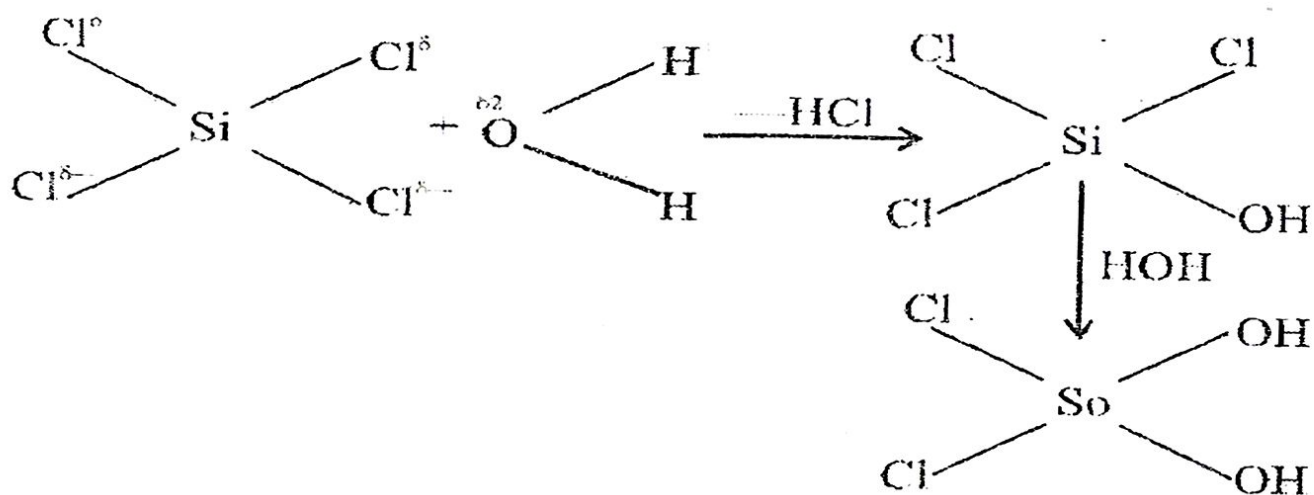
$LiCl$ की विलेयता ईथेनॉल में जल से अधिक है।

Ans. $LiCl$ has more covalent character according to Fajan's rule. It has a non-polar character that is why it is more soluble in a non-polar solvent like ethanol as compared to water.

Q.7(b) $SiCl_4$ is easily hydrolysed with water but CCl_4 not.

$SiCl_4$ जल द्वारा आसानी से जल अपघटित हो जाता है। परन्तु CCl_4 नहीं। 2006, 2008, 201

Ans. $SiCl_4$ is readily hydrolysed by water whereas CCl_4 does not. This is because the carbon atom in CCl_4 is exhibiting a maximum covalency of 4. Carbon atom in excited state is $2s^2 2p_x^1 2p_y^1 2p_z^0$. Whereas silicon and other members of the group IV have vacant d-orbitals into which H_2O molecules of group IV have vacant d-orbitals into which H_2O molecules are able to donate a lone pair of electron facilitating hydrolysis.



Q.7(c) O-nitro phenol has low melting and boiling point compared to m and p-nitrophenol.

आर्थो नाइट्रोफिनॉल का गलनांक एवं क्वथनांक मेटा और पैरा नाइट्रोफिनॉल से कम है। 200

Ans. O-nitrophenol has low melting and boiling point as compared to m & p-nitrophenol because of intramolecular hydrogen bonding. So O-nitrophenol has low melting boiling point.

Q.9.(a) Which of the following bond has the minimum covalent character? 2007

निम्न बंधों में सहसंयोजी आचरण किस बंध का सबसे कह है?

B—Cl, B—F, N—Cl, Cl—Cl.

Ans. The type of bond which may be formed between two atoms greater the difference in electronegative lesser is covalent character.

B—Cl, B—F, N—Cl, Cl—Cl.

1.0 2.0 0.0 0.0

Electronegativity difference

So B-F has minimum covalent character.

Q.9.(b) Why oxygen never forms more than divalent where elements S, Se and Te can form four or six bonds.

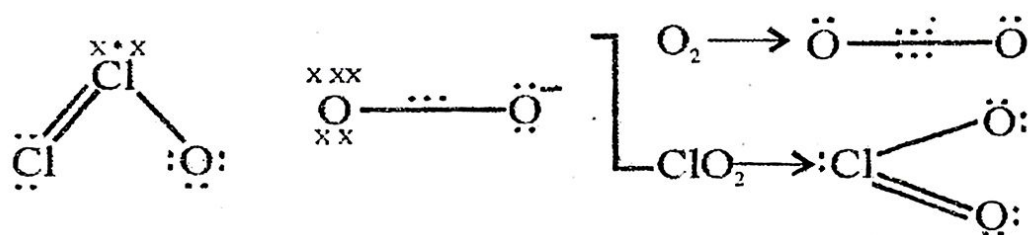
आक्सीजन कभी द्विसंयोजक से अधिक स्थिति नहीं दर्शाता है जबकि S, Se तथा Te चार तथा छः बन्ध बनने की क्षमता दर्शाते हैं? 2007

Ans. Oxygen shows oxidation No -2 to +2 because due to absence of empty d-orbitals, No expansion of electron occur into valency shell in oxygen where as S, Se and Te exhibit. The oxidation No -2, +2, +4 and +6 due to empty nd-orbitals.

Q.9.(c) Give Lewis dot structure of either ClO_2 or O_2^- and clearly indicate the number of electron used in bonding. 2009

ClO_2 और O_2^- का लेवीस बिन्दु संरचना है तथा बन्धन में प्रयुक्त होने वाले इलेक्ट्रॉन की संख्या बताइये।

Ans.

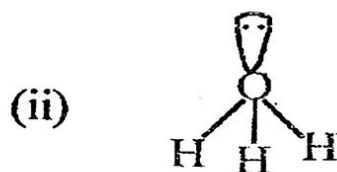


Q.9.(d) Discuss the shape of the following molecules and predict also the bond angle in each case. 2009

निम्नलिखित यौगिकों के आकृति का निर्धारण कीजिए एवं प्रत्येक में बन्ध कोण का भी निर्धारण कीजिए।

Ans. (i) $\text{H}-\text{B}-\text{H}$

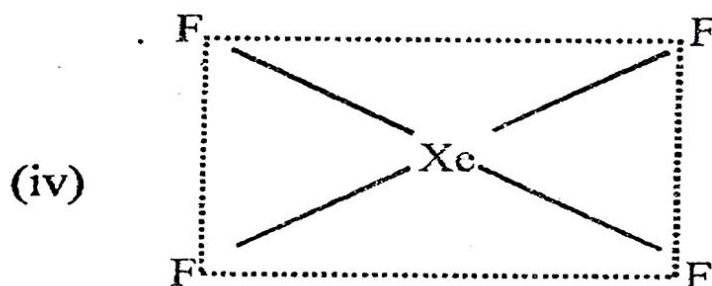
Linear (180°)



pyramidal (107°)



Bent shape (104°)



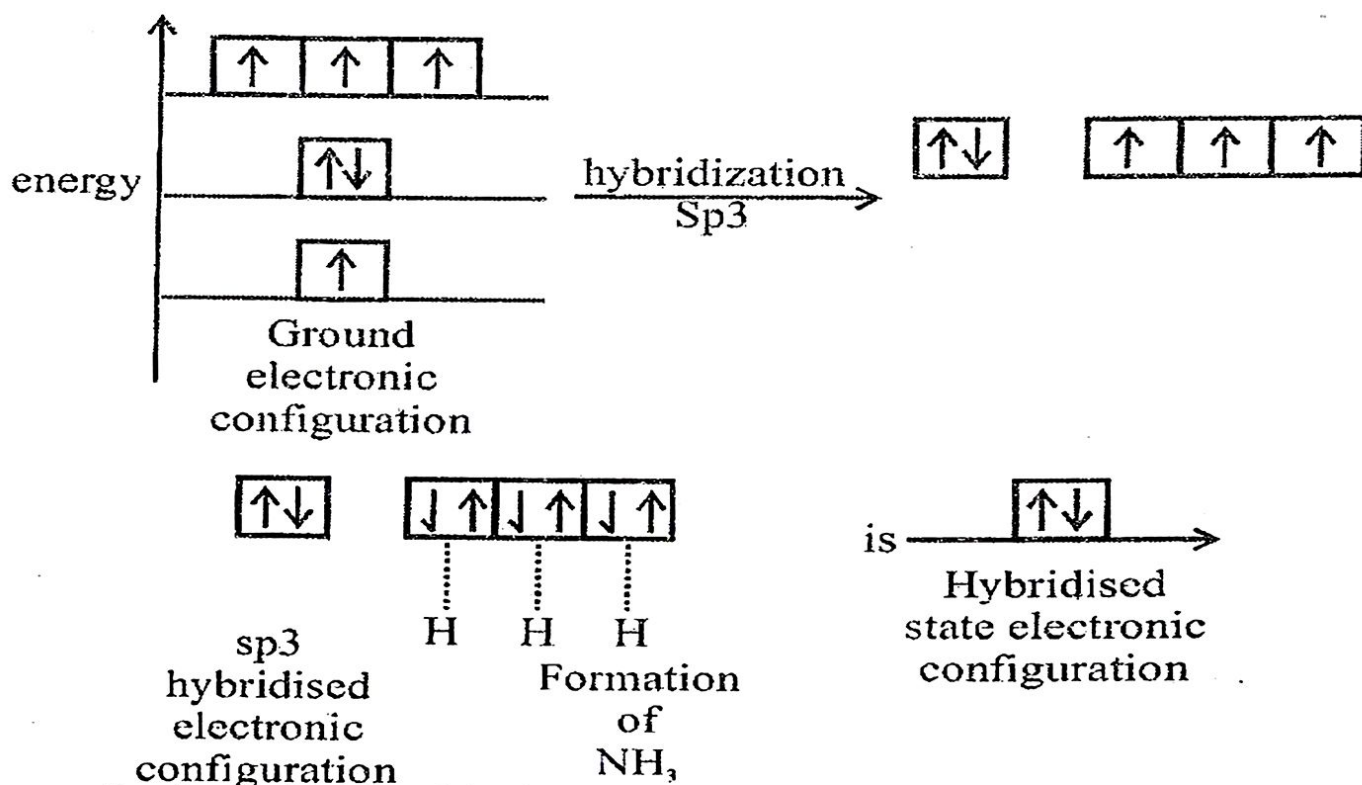
Square planar (90°)

Q.10(b) NH_3 is pyramidal through it involve sp^3 hybridization explain.

2010

NH_3 पिरमिडीय है। यद्यपि इसमें sp^3 संकरण हो समझाइए।

Ans.



In the hybrid orbital model of ammonia, the nitrogen atom is surrounded by three bond pairs and one lone pair of electrons. Since the repulsion between lone pair-bond pair is greater than the repulsion between bond pair-bond pair, the shape of the resulting molecule is

can not be regular tetrahedron. In fact the molecule gets distorted. The bond angle has been found to be 107° .

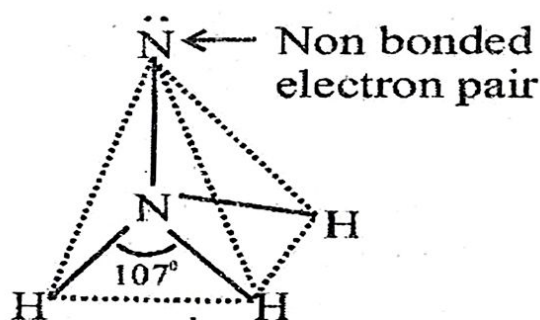


Fig. pyramidal structure of ammonia molecules.

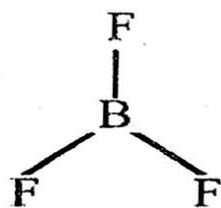
Q.11(c) NH_3 is pyramidal but BF_3 is planar. 2011,2014

NH_3 पिरमिडीय है। लेकिन BF_3 समतल है।

Ans. NH_3 have 3 bond pair and one lone pair so NH_3 is sp^3 hybridised and geometry will be tetrahedral but according to VSEPR theory it shows pyramidal geometry (3bp+1lp).



Where as BF_3 have 3 bond pair and zero lone pair, thus it shows sp^2 hybridised and geometry will be triangular.

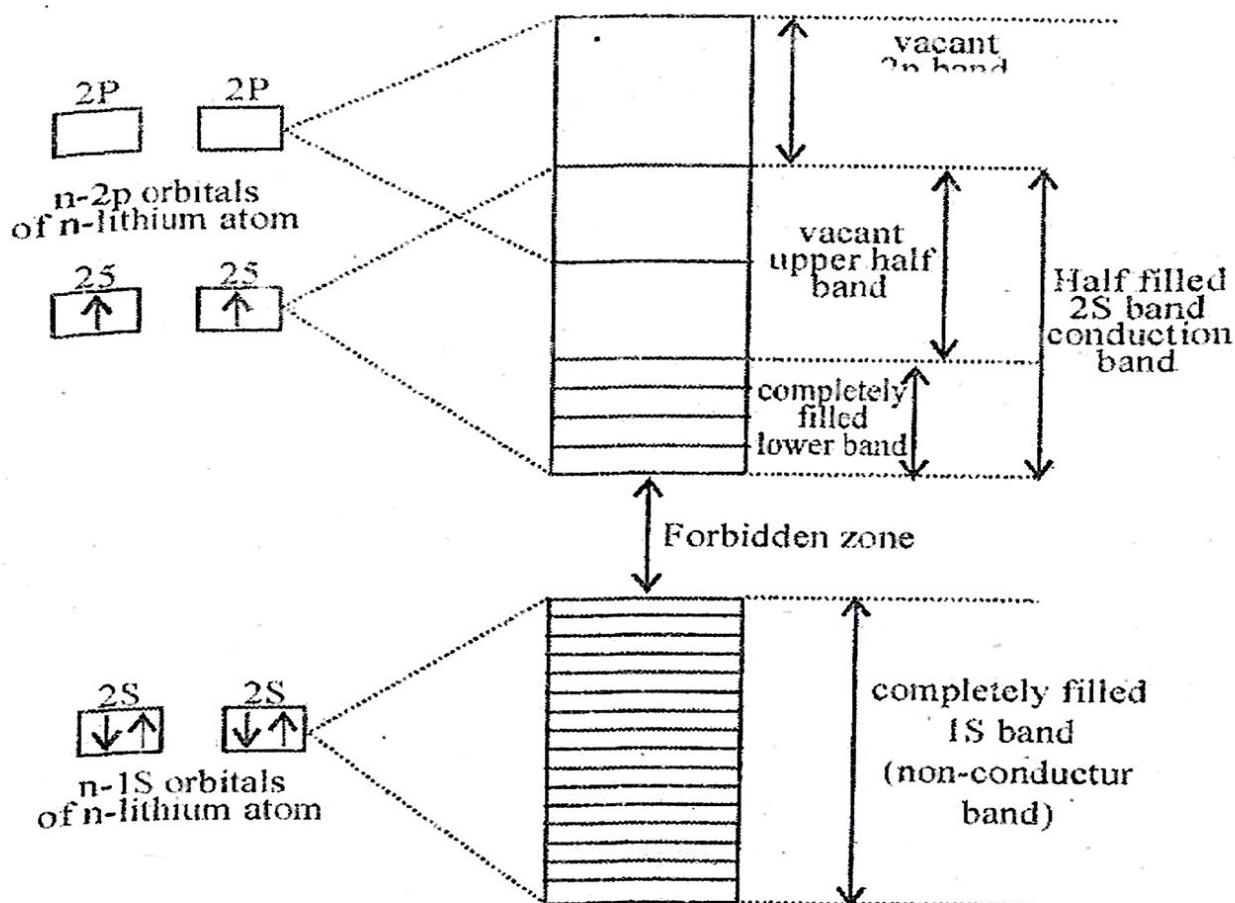


Triangular planar

Q.12. Discuss the Band theory for bonding in metals, Why are transition metals harder than alkali metals?

धातुओं के बन्धन के पट्ट सिद्धांत की विवेचना कीजिए। क्यों संक्रमण धातुएं क्षारीय धातुओं की तुलना में कठोर होती हैं? 2015

Ans. **Band theory** : With the help of band theory we can easily explain why some solid are good conductor (metals) of electricity and some are non-conductors or insulators (non-metals) as semi conductors (semi-metals).



Formation of energy band in Li.

- (1) **Conductors :** Generally, metals are good conductors of heat and electricity. Those material which contain plenty of electrons for electric conduction are called conductors.

The conductivity of the metal can be explained with the help of band theory. The conduction band is pastially filled and partially vacant. The electron can be transferred into this vaccant energy level due to ellectric and thermal energys. this is why metals are good conductors of heat & electricity.

- (2) **Non-conductors : (Insulators)** In insulators the valance band is completely filled. There is an appreciable difference in energy (band gap) between the valance band and the next empty band. Hence electron can not be promoted to an empty level where they could freely move. This explain the non-conductivity of non- metals.

- (3) **Semi-Conductors :** Semi-conductors are those materials whose electrical propesties lies between those of insulator and good conductors eq. Ge & Si.

The substances in which electric conduction is not possible at low temperature but on increasing the temp electric conduction is possible are called semi-conductors.