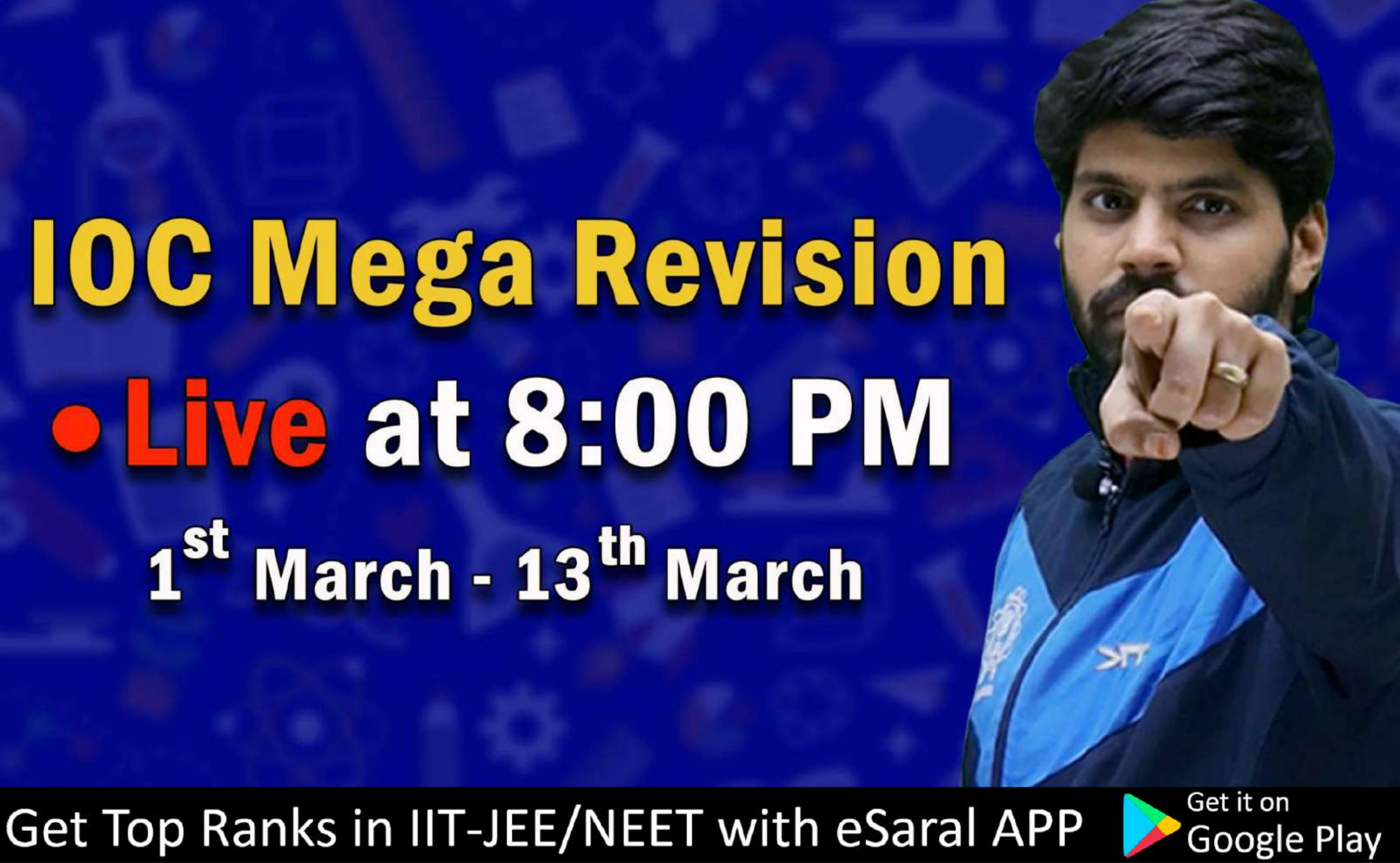
IOC Mega Revision
Live at 8:00 PM
1st March - 13th March
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Complete Chemistry Mega Revision Timetable

1 March	3 March	5 March	6 March
Coordination Compounds	Chemical Bonding	p–block (Class 12)	p–block (class 11) + Periodic Table

8 March	10 March	12 March	13 March
Metallurgy	s-block + Hydrogen	d & f-block	Surprise Gift

Complete Chemistry Mega Revision PYQs & Quiz Timetable

120-150+ ① Uditanshu ② Mehul ③ Lokendra

2 March	4 March	5 March	7 March
Coordination Compounds	Chemical Bonding	p–block (Class 12)	p–block (class 11) and Periodic Table
PYQs	PYQs	PYQs	PYQs
Quiz	**Quiz**	**Quiz**	**Quiz**

11 March	12 March	13 March
Metallurgy	s-block + Hydrogen	d & f-block
PYQs	PYQs	PYQs
Quiz	**Quiz**	**Quiz**


I Love Chemistry

Faculty of the Series

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eSaral Biology Faculty

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- Biology faculty at Rao Academy, Kota
- **7+ years** of Teaching Experience
- **Mentored** over thousands of doctors


SDX
Samjho, dekho & yaad karo

+8

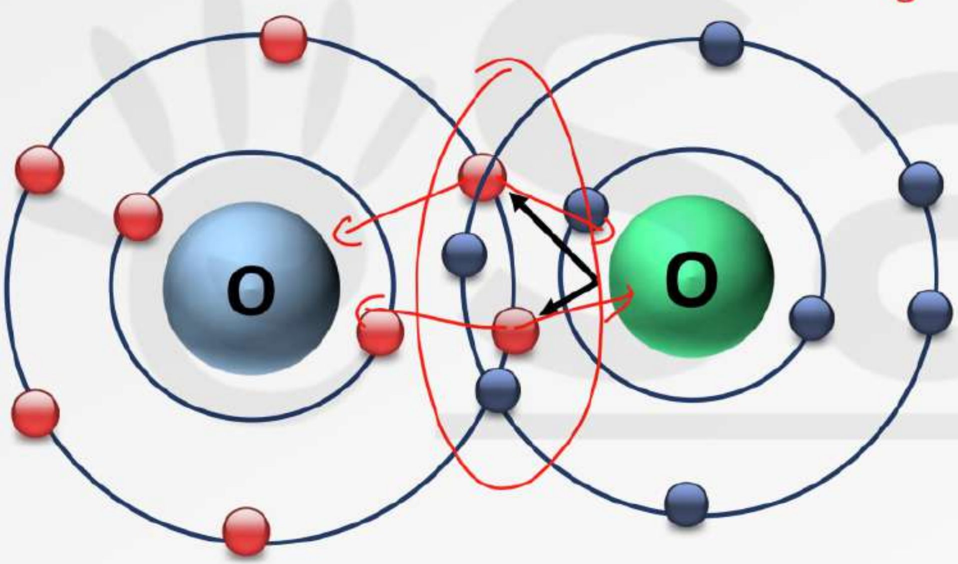
+8

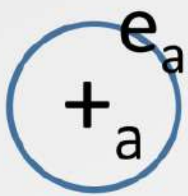
O_2

Overlapping

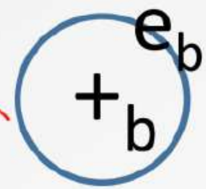
Hybr

$$\frac{KQ_1Q_2}{r}$$





// Bond Formation



By convention energy of a system at ∞ = zero

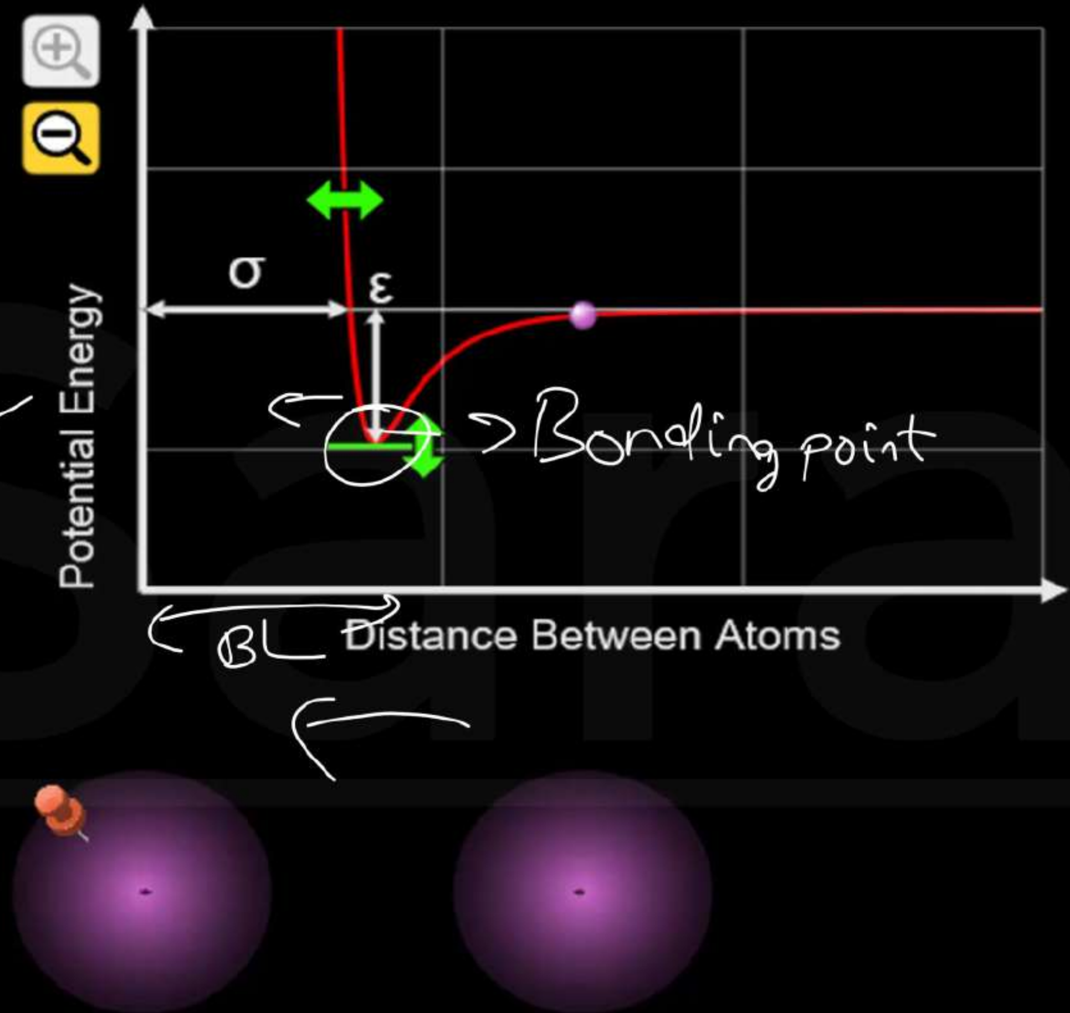
Chemical Bond: The attractive force which holds various constituents together in different chemical species is called a chemical bond.

$$\text{Stability} \propto \frac{1}{Energy}$$

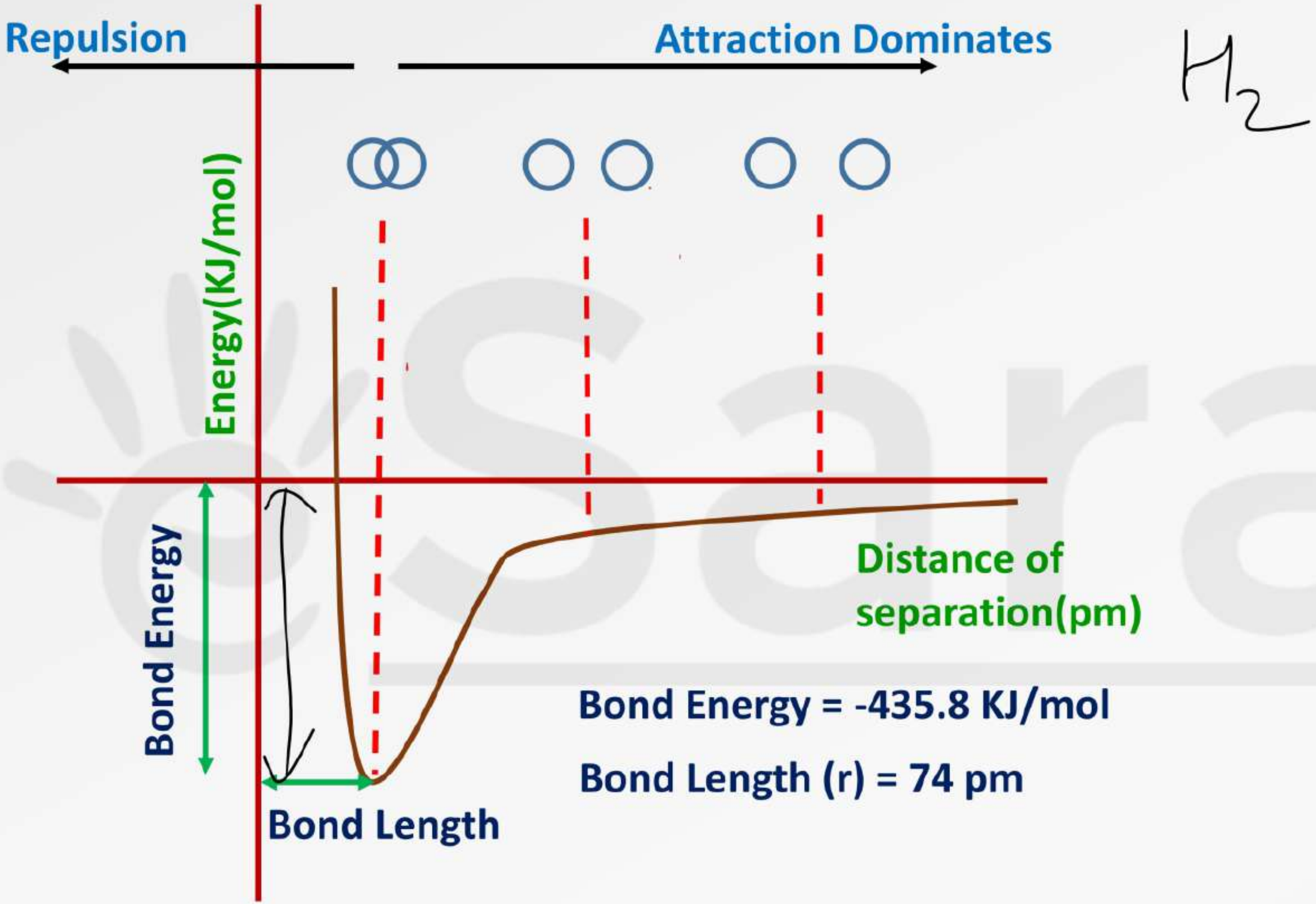
d_{n-e} ↓

++ d ↓

rep ↑



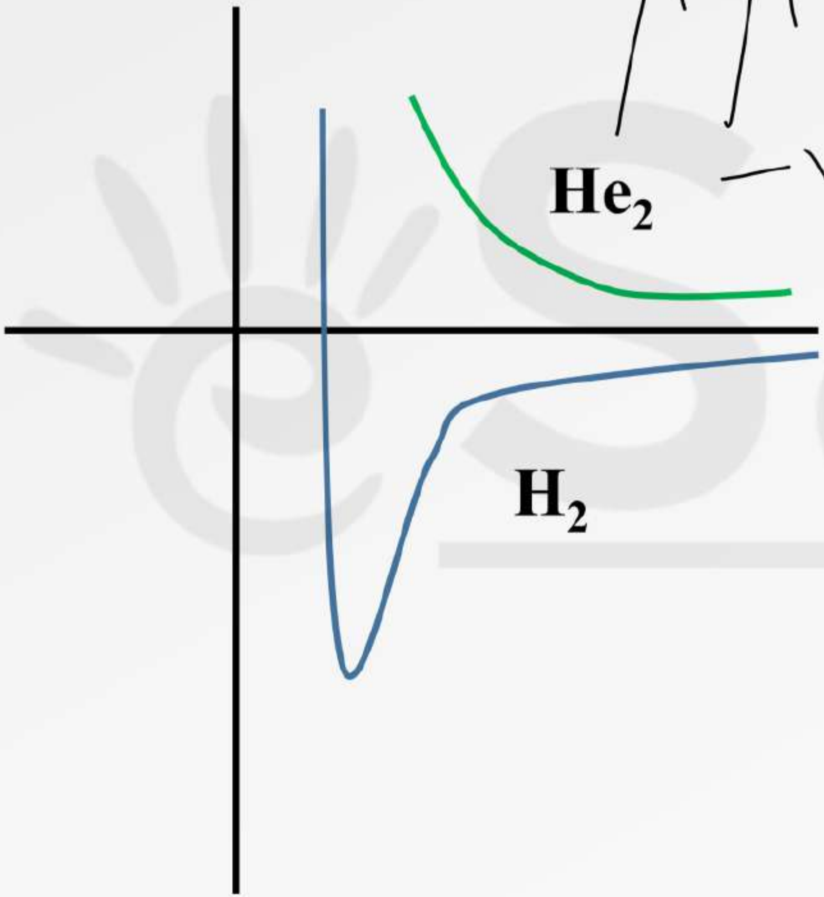
σ
ε
Potential Energy
Distance Between Atoms
Bonding point
BL



Bond Energy = -435.8 KJ/mol

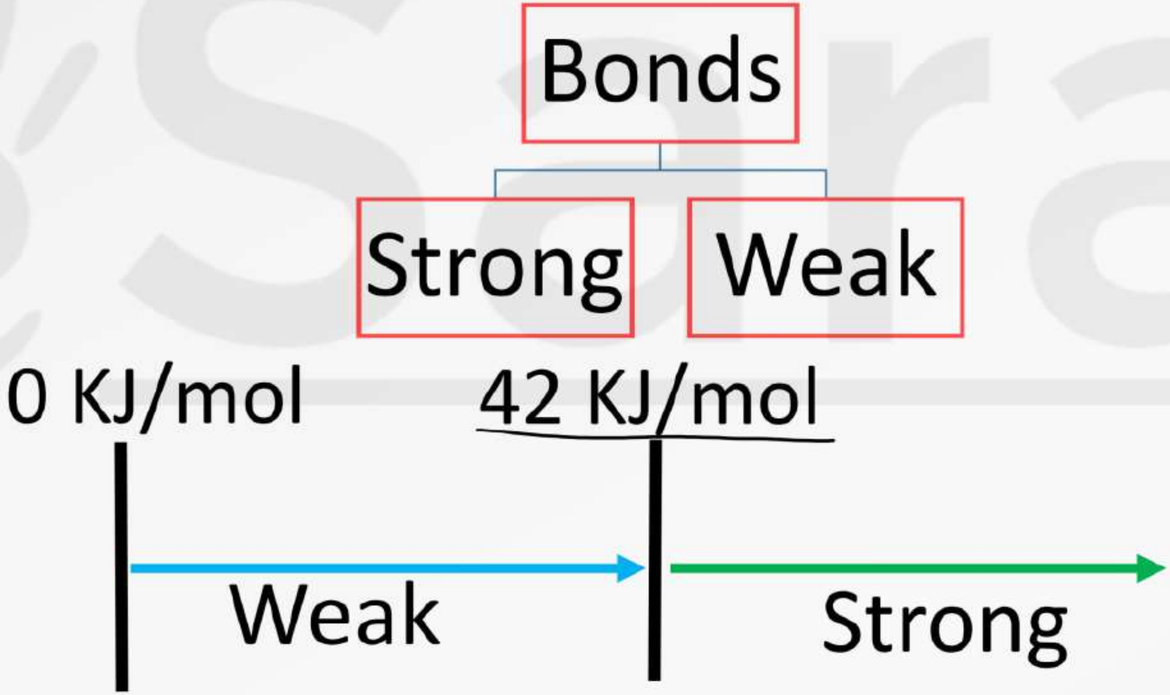
Bond Length (r) = 74 pm

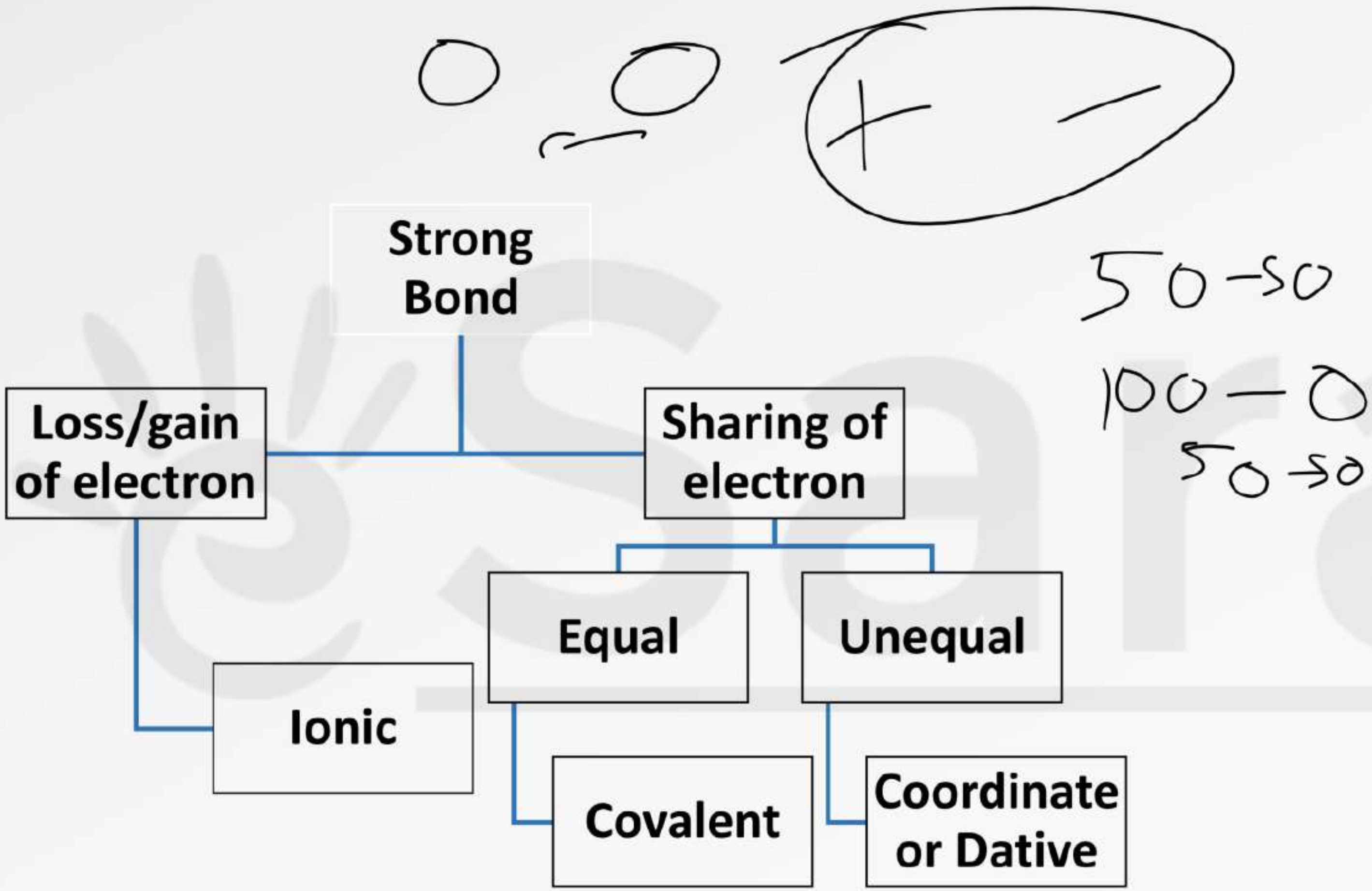
Q) H-forms H_2 but He doesn't form He_2?



Penetration Power

$$E \propto \frac{KQ_1Q_2}{r}$$


Bonds
Strong
Weak
0 KJ/mol
42 KJ/mol
Weak
Strong


Strong Bond
Loss/gain of electron
Sharing of electron
Equal
Unequal
Ionic
Covalent
Coordinate or Dative
50-50
100-0
50-50

Valence Electrons : Outer shell electrons that take part in chemical combination are known as valence electrons.

Octet Rule

O_2 H_2 N_2 H_2O

8 → stable VS−8

BF_3 → Hypo

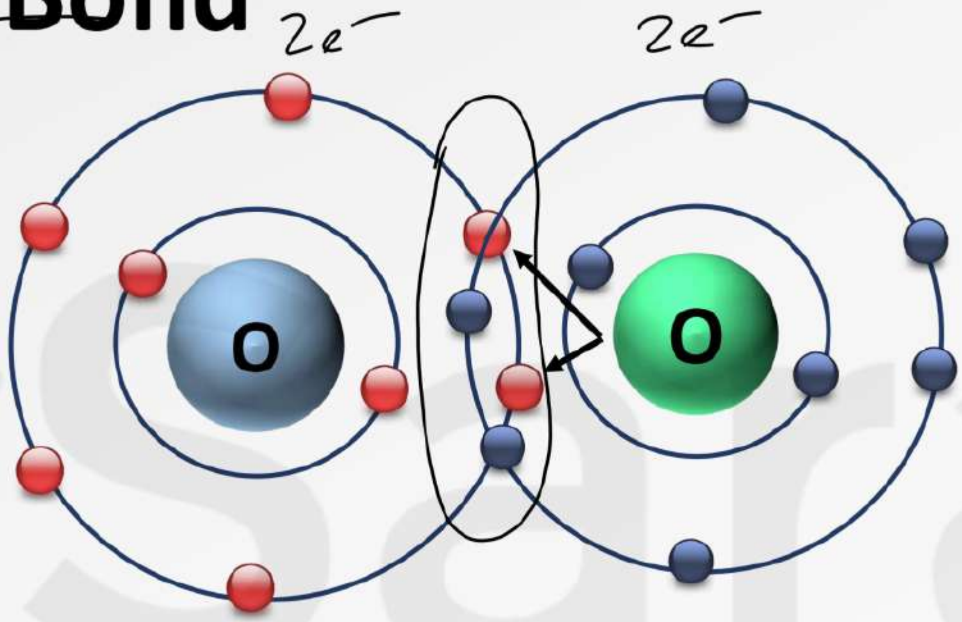
SO_2 → Hyper

SO_3

H_2SO_4

Atoms can combine either by transfer of electrons(Ionic bond) or by sharing of valence electron(covalent or co-ordinate bond) in order to have 8 electrons in their valence shell. This is known as octet rule.

Covalent Bond



It is the electrostatic force of attraction between the nucleus of one atom and electron cloud of another atom when electron pairs are shared equally between two atoms.

Conditions for formation of covalent bonds

(1) Similar Electronegativity

(2) The shared pair of electrons should have opposite spins and are localized between the two atoms concerned.

Properties

1) Physical state: Under the normal conditions of temperature & pressure these exist as gases or liquids of low boiling points. This is due to very weak forces of attraction (vander waal's forces). Some exist as soft solids if their molecular masses are high.

F_2, Cl_2(gases) Br_2(liquid) I_2(solid)

Properties of Covalent compounds

Melting and Boiling Points

Low MP, BP

CH_3CH_2OH $\xrightarrow{H_2O}$

With the exception of few which have giant 3-D structures such as diamond, carborundum (SiC), silica (SiO) ,others have realtively low melting and boiling points.

e^-

Ions

Electrical conductivity :

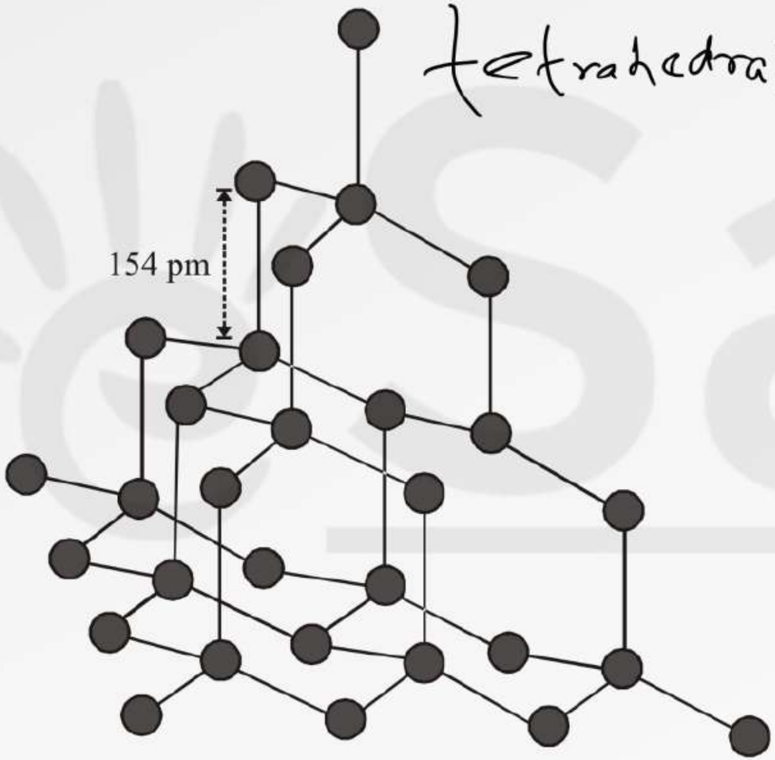
(a) In general covalent substances are bad conductors of electricity.

(b) Substances which have polar character like HCl in solution, can conduct electricity.

Graphite

Diamond

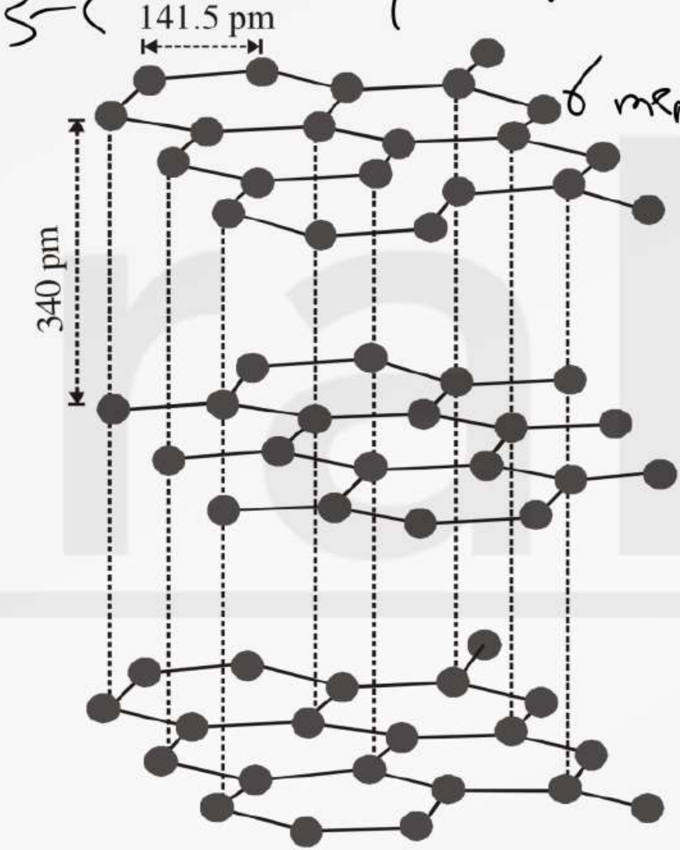
tetrahedral



1 free e^- Pencil/Graphite

3-C

6 membered



4)Solubility

Covalent compounds – non polar

like dissolves like

non-polar

Some of the covalent compounds like alcohols, amines dissolve in water due to hydrogen-bonding.

Isomerism: The covalent bond is rigid & directional. On account of this, there is a possibility of different arrangements of atoms in space. Covalent compounds can thus show isomerism.

Variable Valency

Imp

Sulphur

+2

+4 SO_2

+6 H_2SO_4

−2 H_2S

1. Variable valencies are shown by those elements which have empty orbitals in outermost shell.
2. 3rd and above period elements

Q) The maximum covalency is equal to? (excluding 1st and 2nd period)

(A) the number of unpaired p-electrons

(B) the number of paired d-electrons

(C) the number of unpaired s and p-electrons

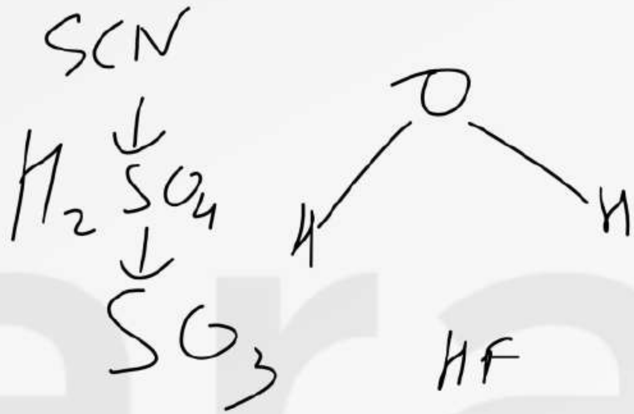
(D) the actual number of s and p-electrons in the outermost shell.

Imp Q

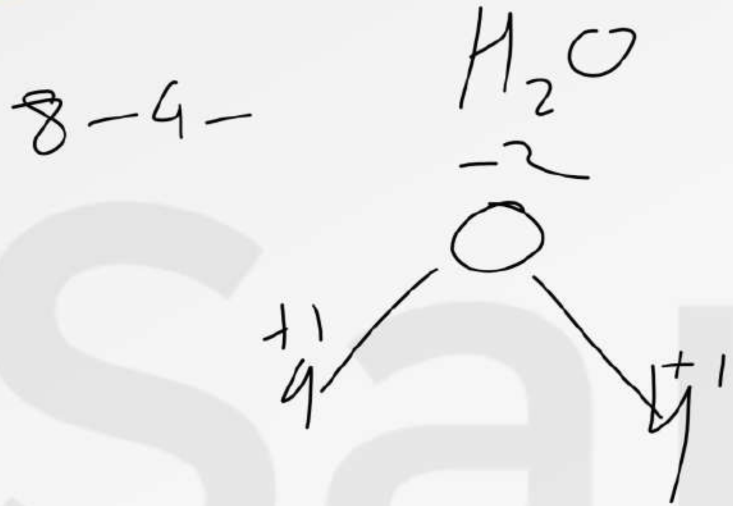
Ans D

How to draw the Lewis structure

1) Identify the central atom
   a. least electronegative atom
   b. less in number
   c. atom which can form maximum number of bonds
   d. Sometimes can't be decided on the basis of EN or number of atoms (less). In such cases, that atom is central atom which appears in central position of given formula of molecule/ion.



Formal Charge



Formal Charge (F.C.) on an atom in Lewis Structure	=	Total number of valence electrons in the free atom	−	Total number of non bonding (lone pair) electrons	−	½[Total number of bonding (shared) electrons]

Bond Parameters

1) **Bond Length** Nu–Nu distance 2

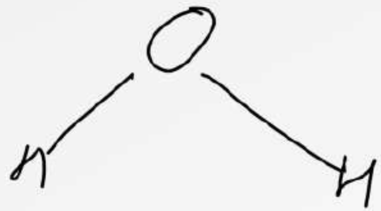
2) **Bond Angle**

3) **Bond Enthalpy**

4) **Bond Order**

e^- e^-

repulsion



4 → 3 → 1

Shape

VSEPR

Valence Shell Electron Pair Repulsion Theory

1 O :: C :: O

2 

Main Postulates of VSEPR

Stability ↑ Att ↑ Rep ↓

1. The shape of the molecules is determined by repulsions between all of the electron pairs present in the valence shell of central atom.
2. A lone pair of electrons takes up more space round the central atom than a bond pair, since the lone pair is attracted to one nucleus whereas the bond pair is shared by two nuclei.
3. It follows that repulsion between two lone pairs is greater than repulsion between a lone pair and a bond pair, which is greater than the repulsion between two bond pairs.

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

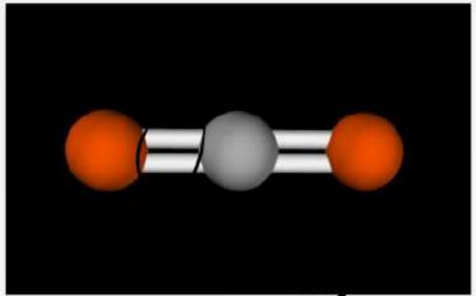
Stable r↓ F↑ $K\frac{q_1 q_2}{r^2}$

4) The magnitude of repulsions between bonding pair of electrons depends on the electronegativity difference between the central atom and the other atoms.

5) Double bond causes more repulsion than single bond, and triple bond causes more repulsion than a double bond.


109.5°
lp
104.5°

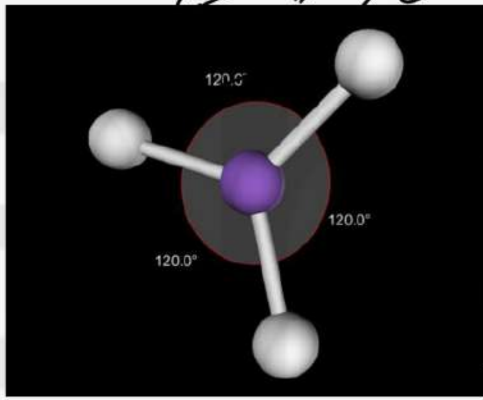
Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
2	0	Linear	180^0 Ex : CO_2
3	0	Trigonal Planar	120^0 Ex : BF_3
2	1	Bent, Angular or V-shape	$<120^0$ Ex : SO_2
4	0	Tetrahedral	109.5^0 Ex : CH_4



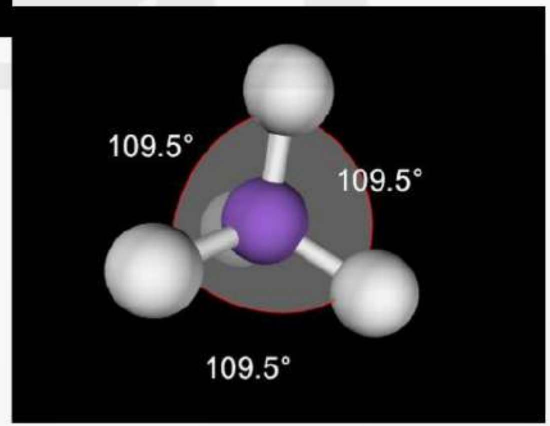
Most Important Table

Bent

BF_3

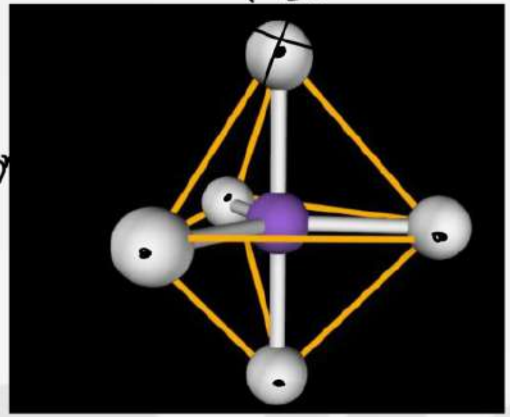


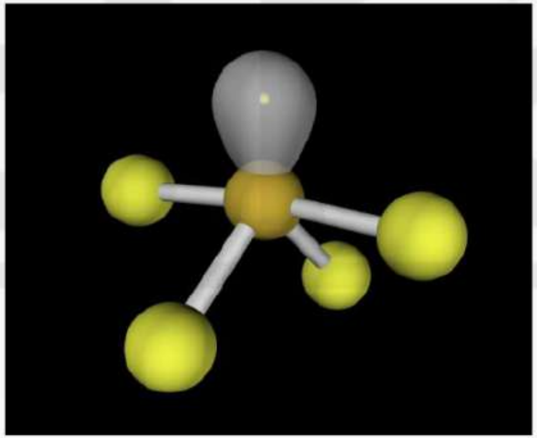
repl



Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
3	1	Tetrahedral	<109.5° Ex : NH_3
2	2	Bent	104.5° Ex : H_2O
5	0	Trigonal Bipyramidal	90°- 6 120° - 3 180°- 1 Ex : PCl_5
4	1	See-Saw	<120° <90° Ex : SF_4

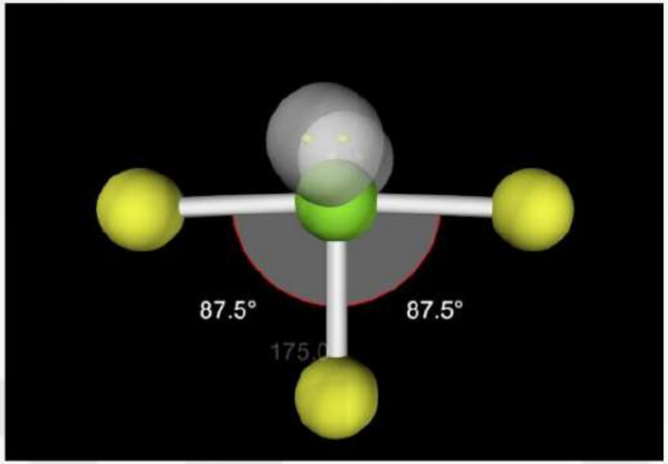
TBP

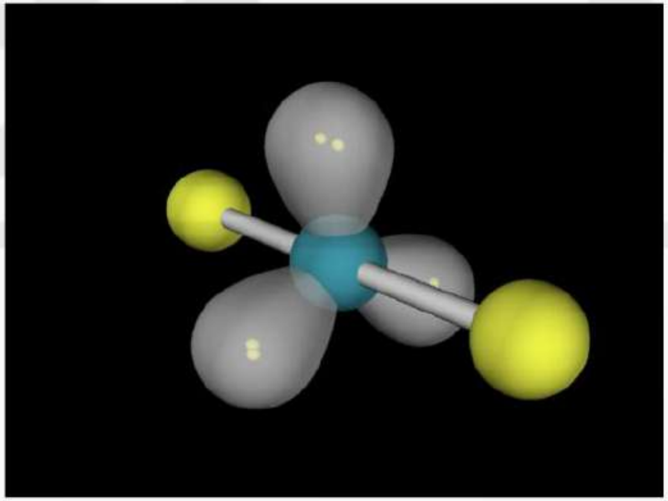




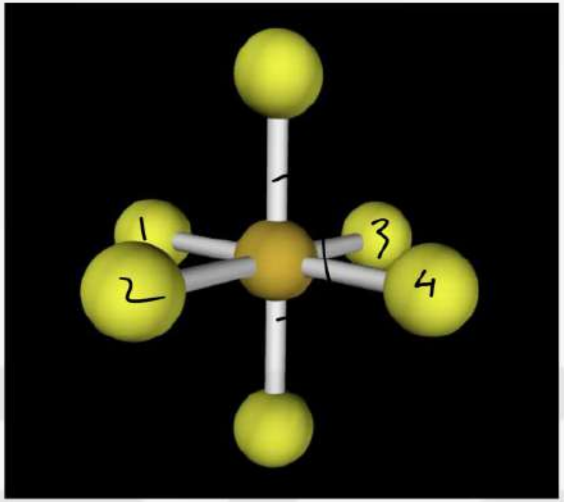
SF_4

Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
3	2	T shape	<90^0 Ex : ClF_3
2	3	Linear	180^0 Ex : XeF_2
6	0	Octahedral	90^0- 12 Ex : SF_6
5	1	Square Pyramidal	<90^0 Ex : BrF_5

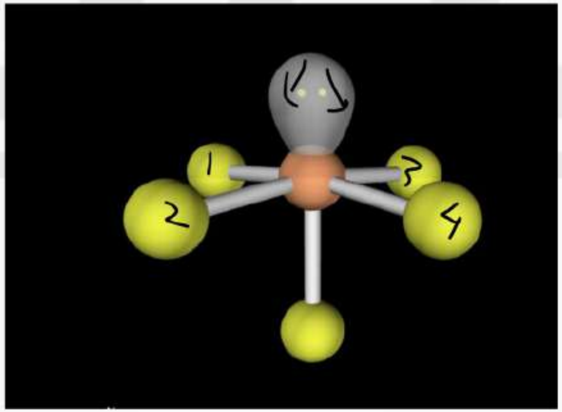




Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
3	2	T shape	$<90^0$ Ex : IF_3
2	3	Linear	180^0 Ex : XeF_2
6	0	Octahedral	90^0- 12 Ex : SF_6
5	1	Square Pyramidal	$<90^0$ Ex : IF_5



1, 2, 3, 4 same plane



Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
3	2	T shape	<90^0 Ex : ClF_3
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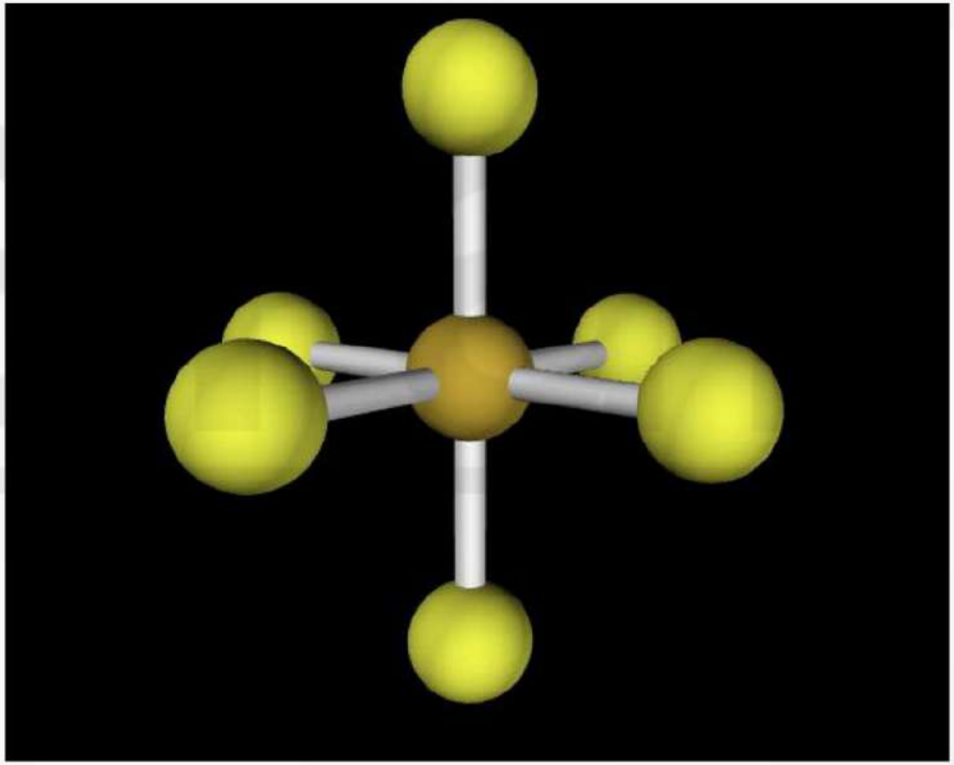
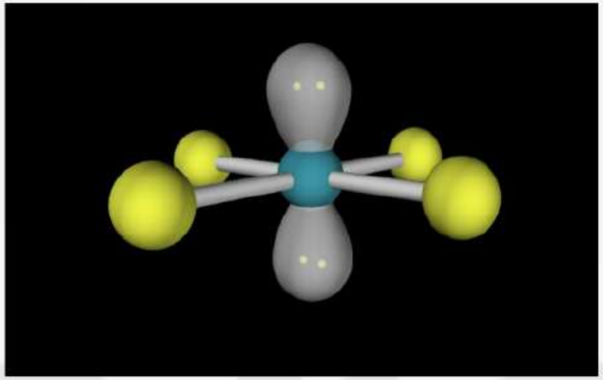
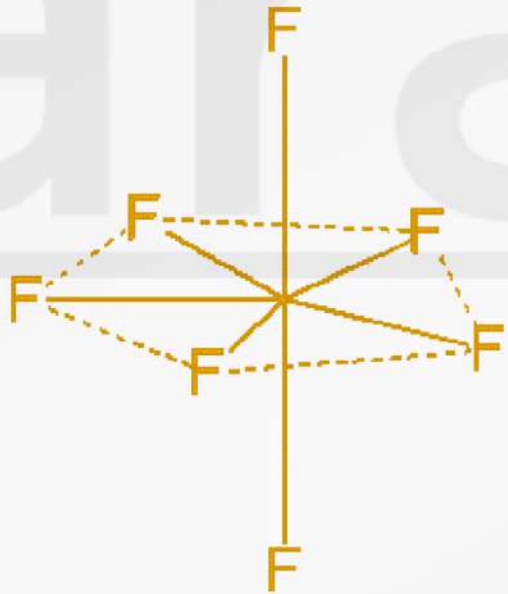
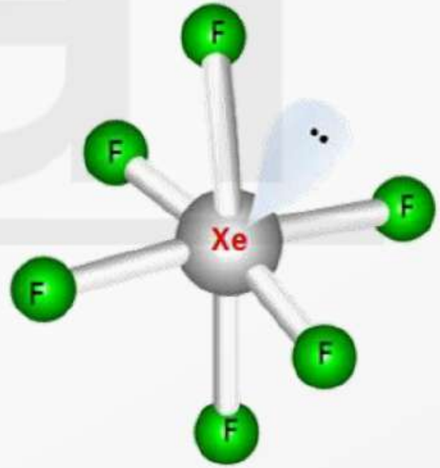


Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
4	2	Square Planar	90^{0} Ex : XeF_4
7	0	Pentagonal Bi Pyramidal	90^{0}-10 72^{0}- 5 180^{0}- 1 Ex : IF_7
6	1	Pentagonal Pyramidal or distorted octahedron	$<90^{0}$ $<72^{0}$ Ex : XeF_6
5	2	Pentagonal Planar	72^{0} Ex : $[XeF_5]^{-}$

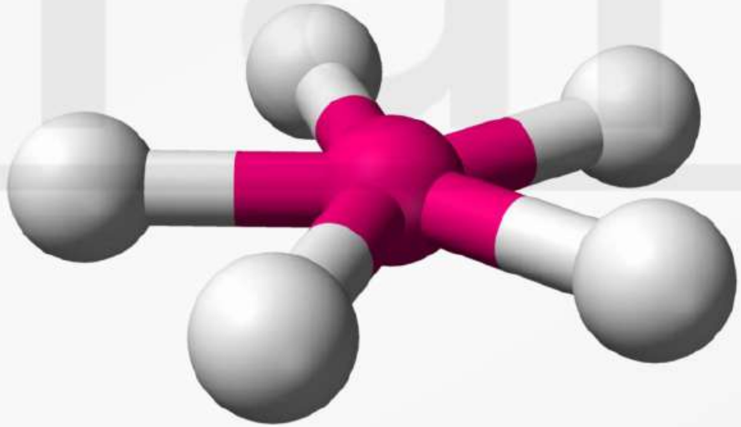


Octahedral





Number of bond pairs	Number of Lone pairs	Molecular Geometry	Bond Angle
4	2	Square Planar	90^0 Ex : XeF_4
7	0	Pentagonal Bi Pyramidal	90^0-10 72^0- 5 180^0- 1 Ex : IF_7
6	1	Pentagonal Pyramidal or distorted octahedron	$<90^0$ $<72^0$ Ex : XeF_6
5	2	Pentagonal Planar	72^0 Ex : $[XeF_5]^-$

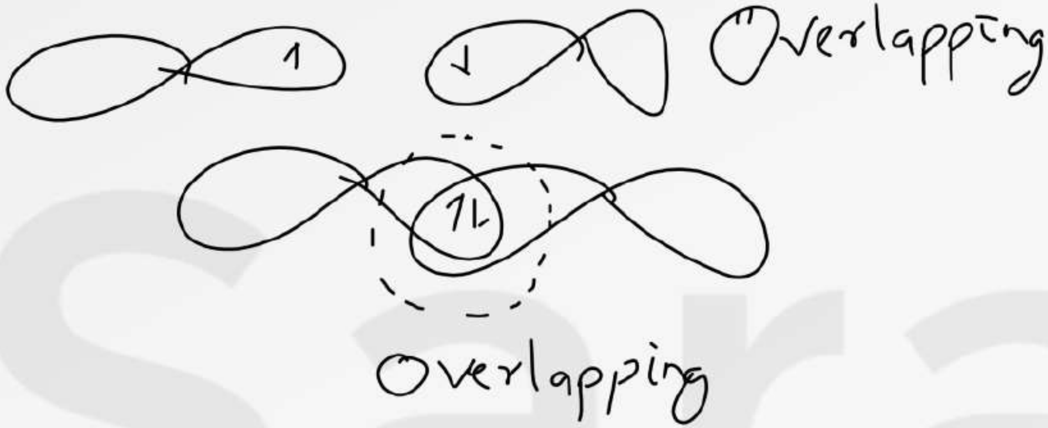


Bond Length of H_2 is 74 pm, Bond length of F_2 is 144 pm!

Bond Length of O_2 is 121 pm

VBT

Valence Bond Theory



(1) A minimum energy state when two hydrogen atoms are so near that their atomic orbitals undergo partial interpenetration.

(2) This partial merging of atomic orbitals is called overlapping of atomic orbitals which results in the pairing of electrons.

Overlapping

More the extent of overlapping, stronger is the bond.

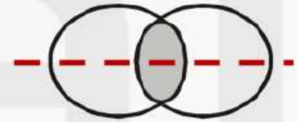
(1) Sigma (σ) bond

(2) Pi (π) bond

(3) Delta (δ) bond

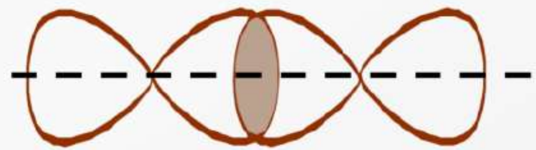
σ overlapping

1. s-s overlapping

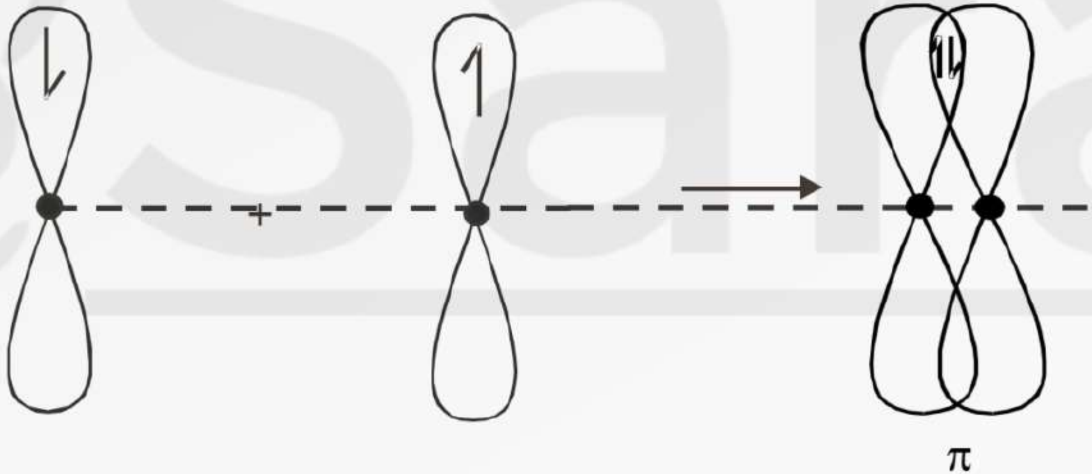


2. s-p overlapping

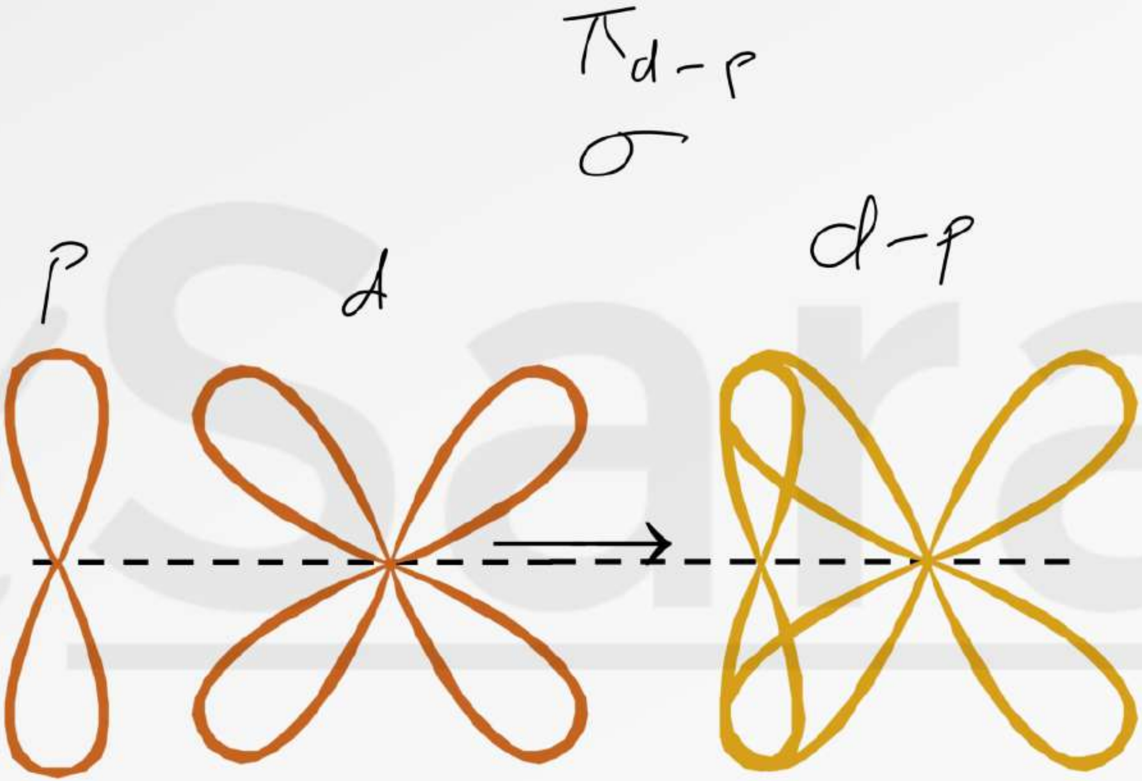
3. p-p overlapping



Pi (π) bond



Here we can see that bonding happens perpendicular to the inter-nuclear axis.


π_{d-p}
σ
p
d
d-p

Q) **If x is the inter-nuclear axis then which overlapping results in π bond?**

(1) $p_y - p_y$ ✓ π **(2) $s - s$** $\longrightarrow \sigma$

(3) $s - p_x$ σ **(4) $p_x - p_x$** σ

S can never make a π - bond

Ans. (1)

Sol. **$s - s \rightarrow \sigma$ bond**

$s - p_x \rightarrow \sigma$ bond

$p_x - p_x \rightarrow \sigma$ bond

$p_y - p_y \rightarrow \pi$ bond

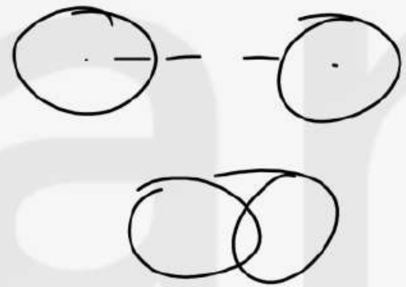
Q) Count the number of σ & π bond in acetylene (C_2H_2)

yaad

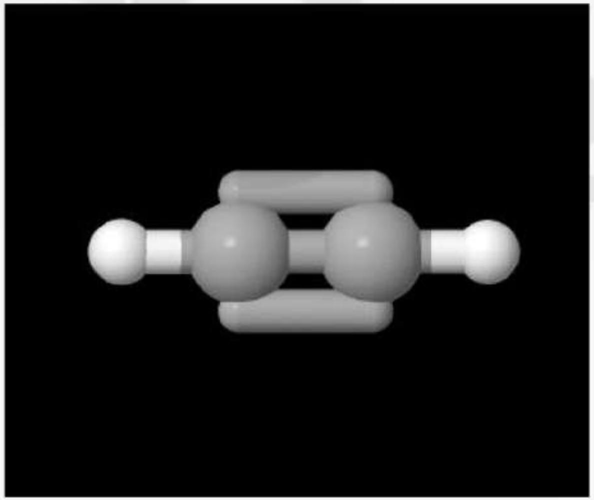
3 σ
2 π

1,2

1 σ, 2 π C-C



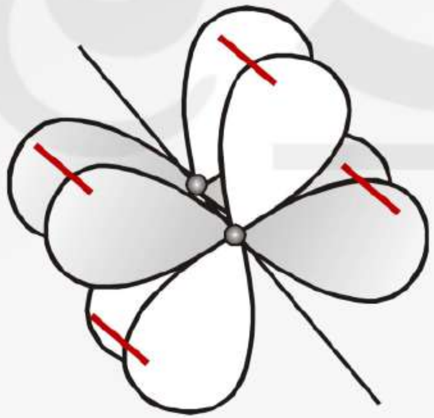
2 σ C-H



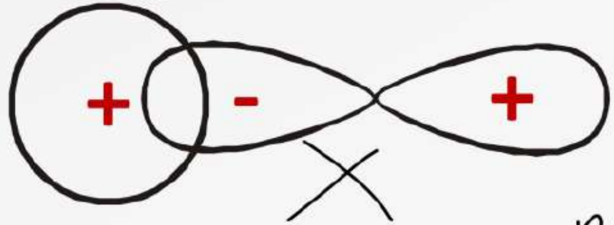
δ Bond

Raam ka nahi hai

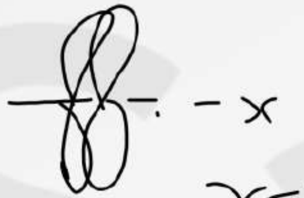
Four Lobe Interaction

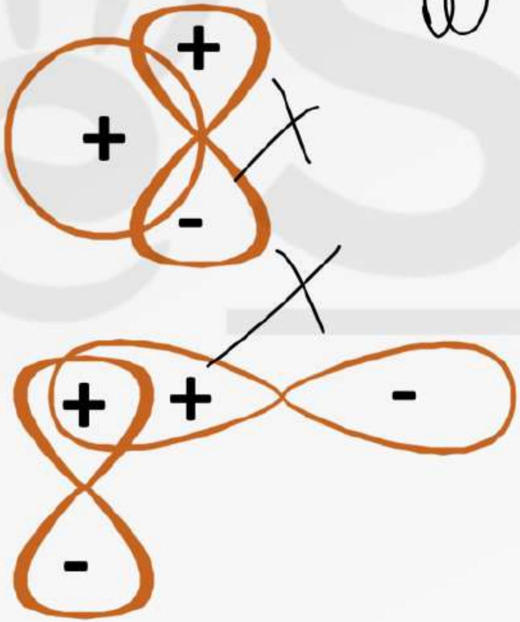


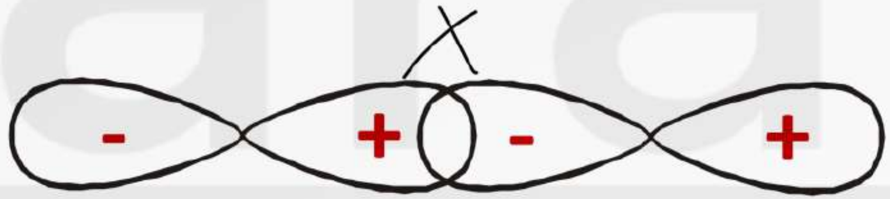
Cases where Bonding not allowed

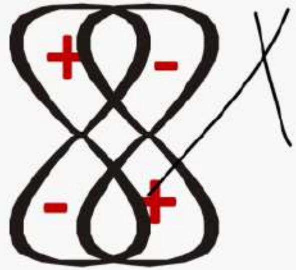


Zero Overlapping



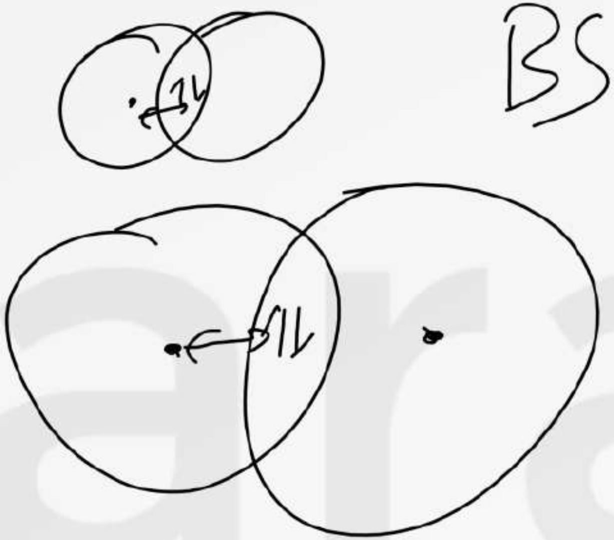






Bond Strength

KP



BS 1s – 1s > 2p – 2p

2s – 2p < 2p – 2p

$BS \propto \frac{1}{\text{size}}$

1s - 2p > 2s - 2p > 3s - 3p

(min)

BS ∝ directional nature

p - p > s - p > s – s

Sigma > Pi

Size is the dominant factor

Bond Energy

$$\mathbf{BE} \propto \frac{\mathbf{1}}{\mathbf{size}}$$

$BE \propto BS$

In the two, size is the dominant factor. When size is similar compare on the basis of lp-lp repulsion.

Q) What is the order of Bond Energy in the following single bonds?

C-C , N-N, O-O, F-F

Size similar

Period same

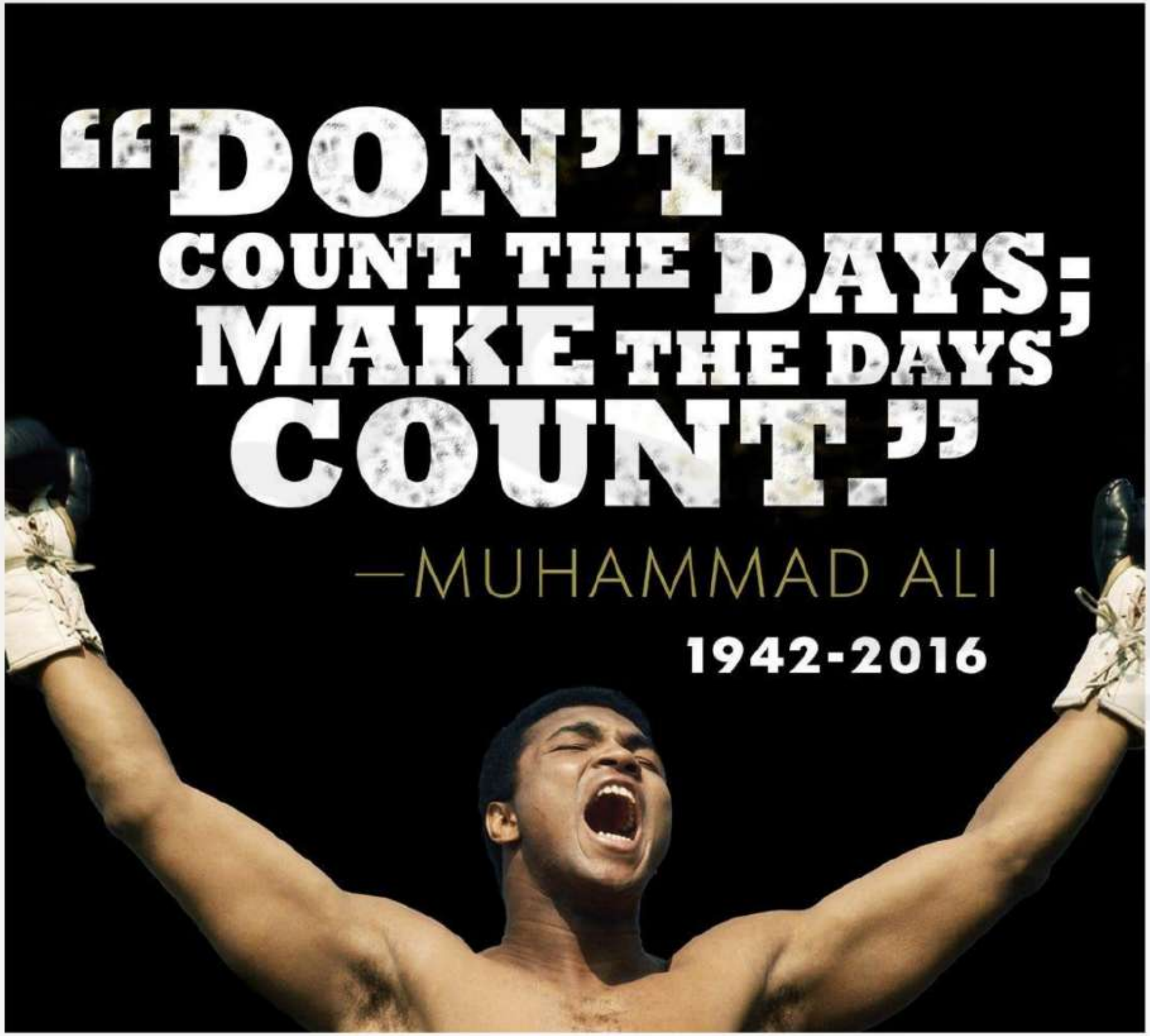
Ans) Bond Energy order for the above single bonds is

C-C > N-N > O-O > F-F

Imp

Here size is similar as all are of 2nd period.

Lone pair - lone pair repulsion is the dominant factor.


"DON'T
COUNT THE DAYS;
MAKE THE DAYS
COUNT."
—MUHAMMAD ALI
1942-2016

All bond angles in Methane are 109.5^o

All bond lengths are same

CH_4 4 C—H

3 → 90° ✗

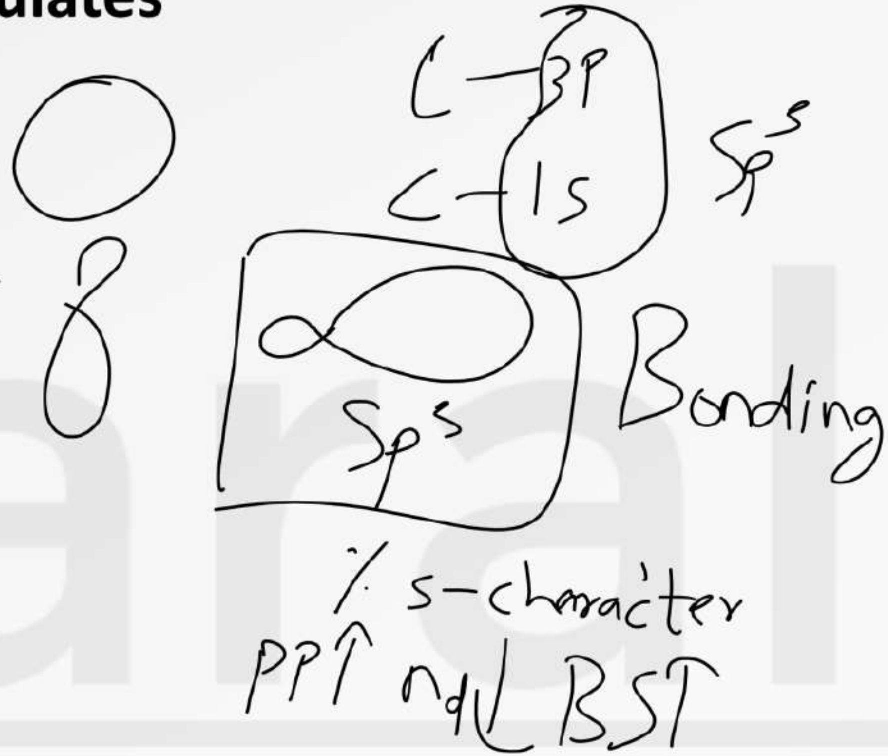
1 Bond – unexplained

Hybridisation

109.5°, BL exactly same

Definition : Mixing of different shapes and approximate equal energy atomic orbitals, and redistribution of energy to form new orbitals, of same shape & same energy. These new orbitals are called hybrid orbitals and the phenomenon is called hybridisation.

Postulates



(1) It is a hypothetical concept

(2) Only those orbitals can take part in hybridisation which have comparable (almost equal) energies.

(3) So, orbitals must be having same principal quantum number or there can be a maximum difference of unity (if d orbitals are involved).

(4) Hybridised orbitals will be generally used for making σ bond and for π bond pure p-orbitals will be used.

Nmber of hybrid orbitals required =
Number of σ-bond around that atom + Number of lone pair on that atom.

$BeCl_2$	sp
BF_3	sp^2
H_2O	sp^3
XeO_2	sp^3
PCl_5	sp^3d
XeO_2F_4	sp^3d^2
IF_7	sp^3d^3

Q) Hybridisation and shape in $XeOF_2$, XeO_2F_2 is respectively?

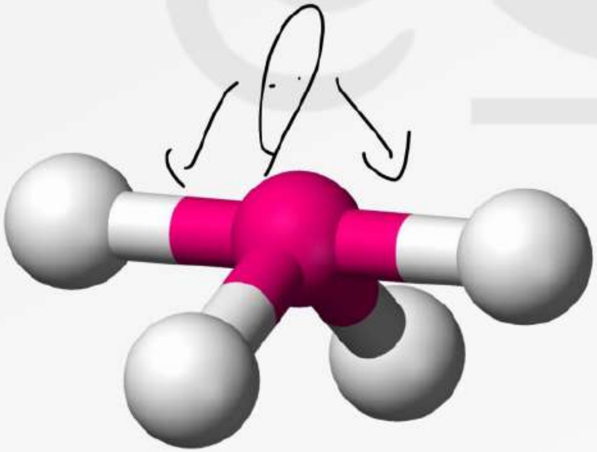
(1) sp^2, sp^3d T, 'V' shape

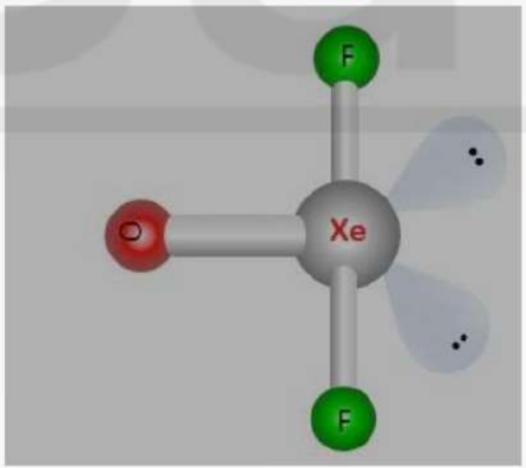
(2) sp^3d, sp^3d T shape, (See-Saw)

(3) sp^3d, sp^3d Both have T shape

(4) sp^3, sp^3d T shape, irregular octahedral

Ans B





Hybridisation of following species in specified state

wvvvv Imp

Learnt

Species	Cationic part	Anionic part
PCl_5	PCl_4^+ (sp^3)	PCl_6^- (sp^3d^2)
PBr_5	PBr_4^+ (sp^3)	Br^-
XeF_6	XeF_5^+ (sp^3d^2)	F^-
N_2O_5	NO_2^+ (sp)	NO_3^- (sp^2)
I_2Cl_6(liquid)	ICl_2^+ (sp^3)	ICl_4^- (sp^3d^2)
Cl_2O_6	ClO_2^+ (sp^2)	ClO_4^- (sp^3)

CH_4

$CH_3 \quad CH_2 \quad CH_4$

$PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$

2 P—Cl weak

3 P—Cl strong

$BeCl_2$ (sp hybrid).

Result, all bond equivalent.

BF_3 (sp^2 hybrid).

Result, all bond equivalent.

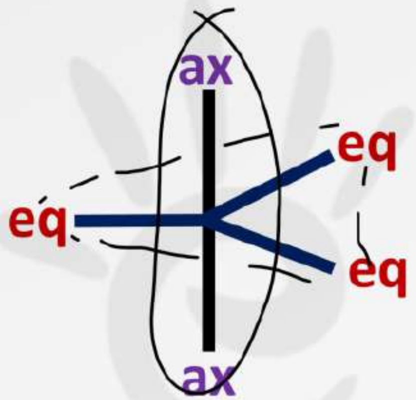
CH_4 (sp^3 hybrid).

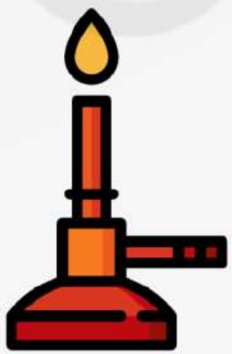
Result, all bond equivalent.

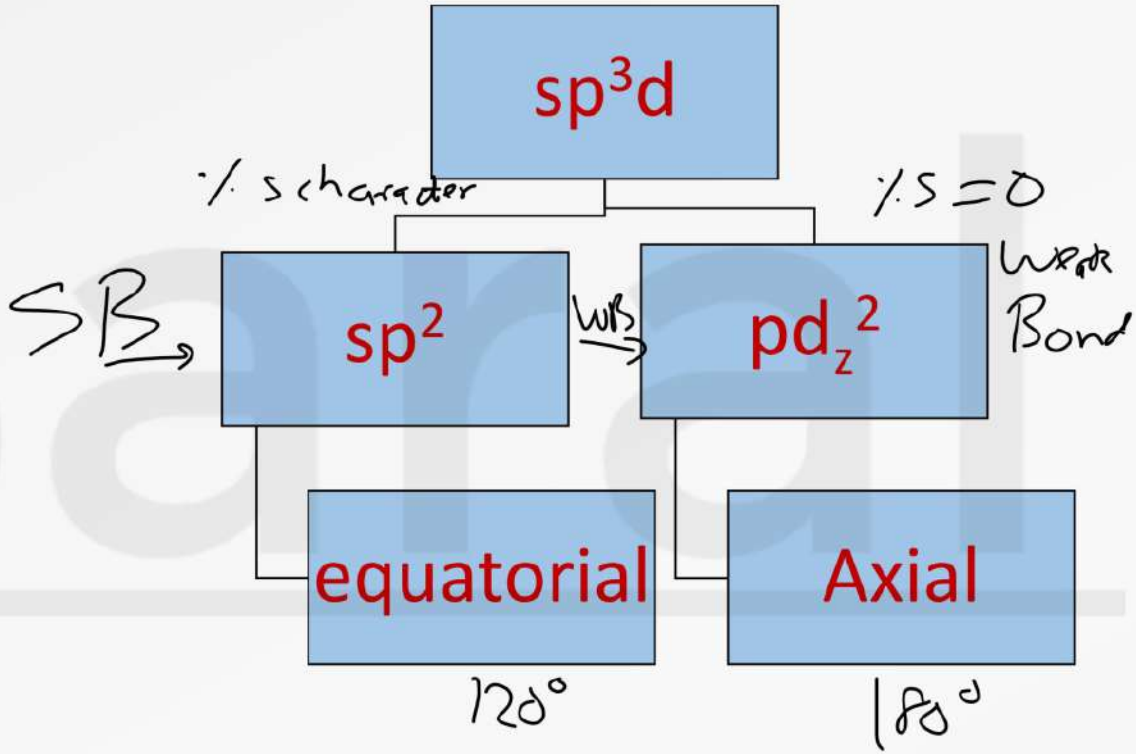
PCl_5 (sp^3d hybrid).

Result, unknown.

sp^3d





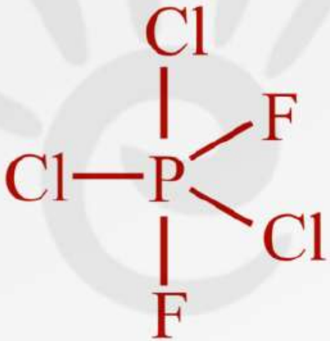


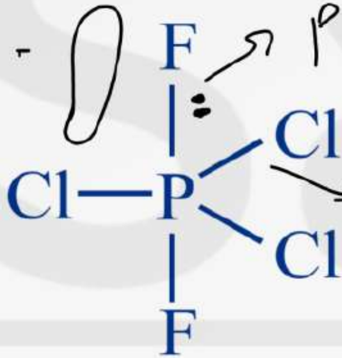
$$PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$$

In sp hybridisation, s = 0.5, p=0.5

In sp^2 hybridisation s = 1/3, p = 2/3.

In $pd_z{}^2$, s = 0





Correct Structure

Bent's Rule

CF_3H

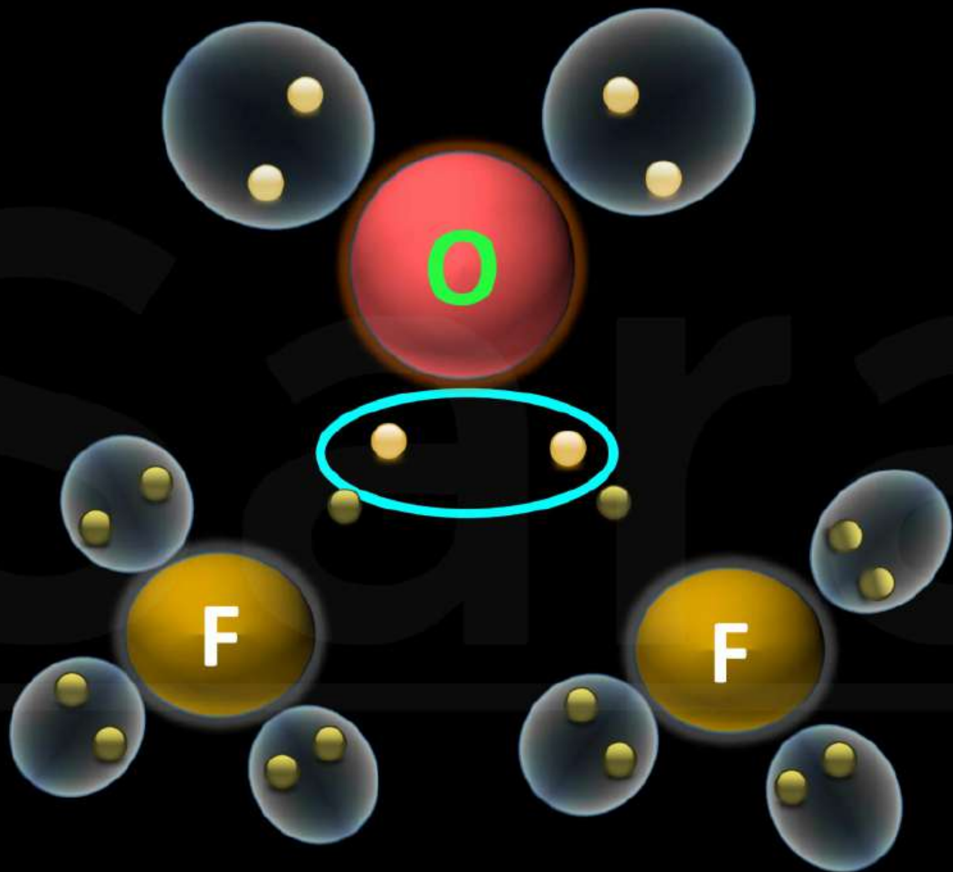
C—H % s ↑

sp 1s 1p $\frac{1}{2}$ 50%

sp^2 1s 2p $\frac{1}{3}$ 33%

pd^2 0s $\frac{0}{3}$ 0

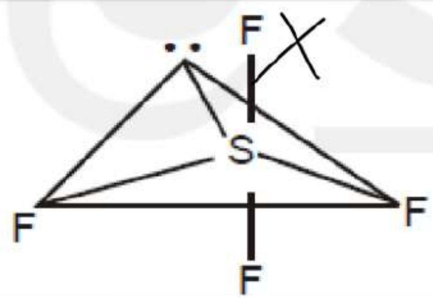
According to Bent when all the surrounding atoms are attached to the central atom by single bond than more electronegative surrounding atom prefers hybrid orbital with less s-character.


O
F
F

Q) Draw the correct structure of SF_4.

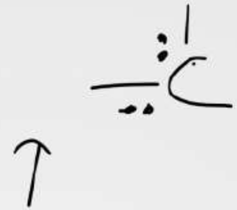
lp > triple bond > double bond

lp → close to nucleus



Seasaw

Sabse Imp KP



BS↑

BE

% s-character ∝ BDE ∝ BA ∝ 1/BL

Bent's Rule

EN atom ↓ %p ↑

lp, DB, TB ↓ %s ↑

Mathematical

Angle B/w 2 Bonds

$$\cos\theta = \frac{s}{s-1} \text{ or } \frac{p-1}{p}$$

In sp hybridisation, s = 0.5, p=0.5

In sp^2 hybridisation s = 1/3, p = 2/3.

Q) Compare the lewis base character in NH_3 & PH_3

Base ∝ LP donating ability

$PH_3 > NH_3$

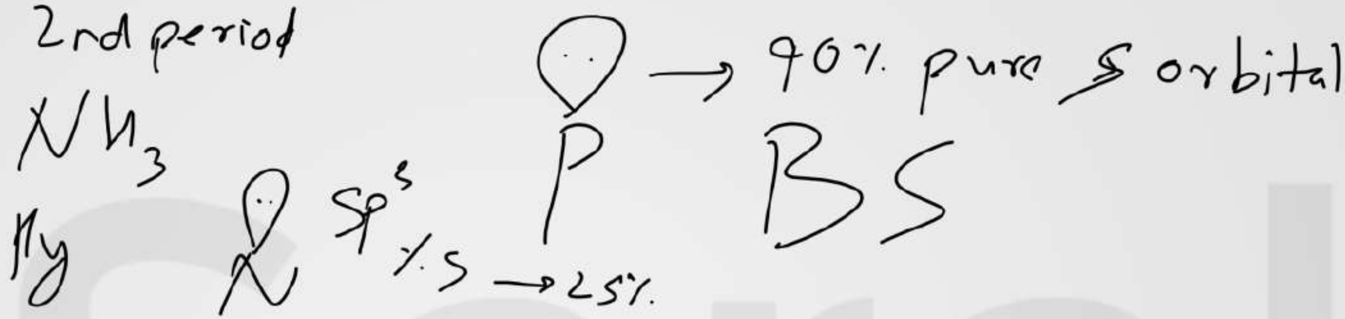
Sol. $NH_3 > PH_3$

Drago's Generalisation

Element of 3rd period (p-Block) and lower than 3rd period do not allow hybridisation in molecule when they form compound with less electronegative elements such as hydrogen

eg : PH_3, SiH_4, AsH_3 , H_2S do not undergo hybridisation

Q) Compare the lewis base character in NH_3 & PH_3

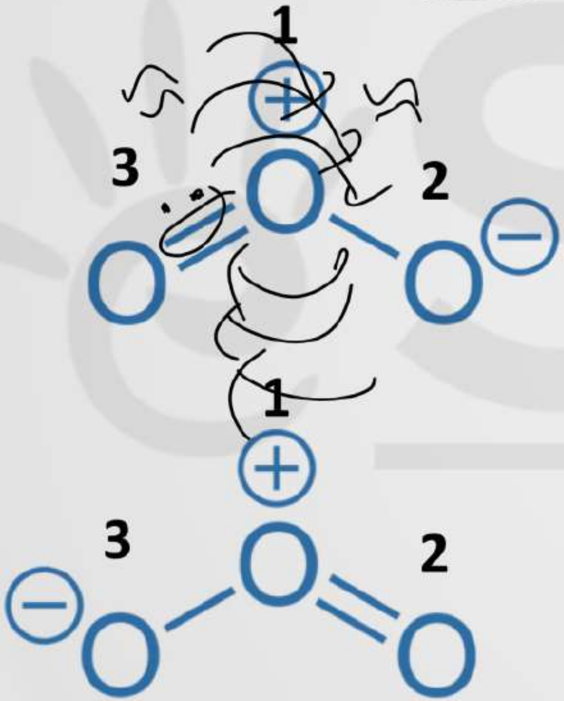


Sol. $NH_3 > PH_3$

Lone pair of N is in sp^3

Lone pair of P is in almost pure s orbital (94%)

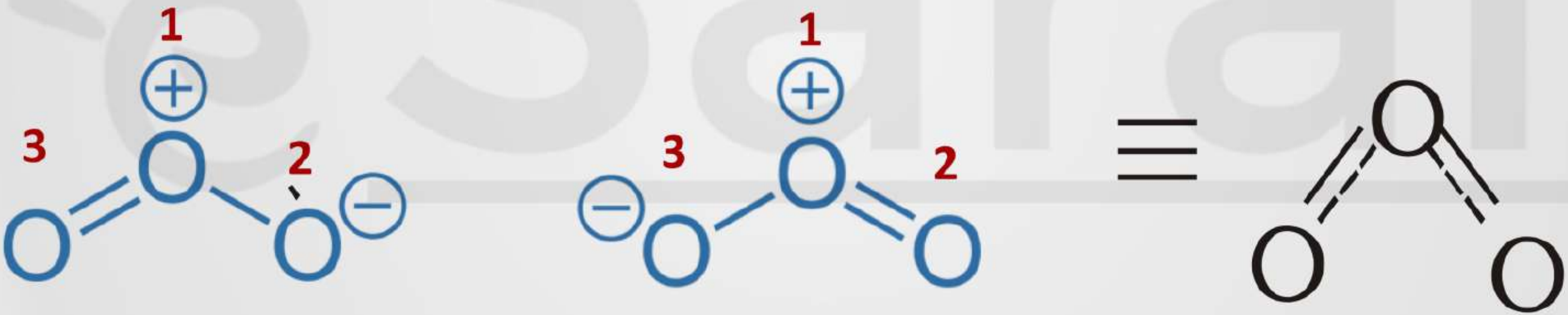
Resonance



In both structures we have a O-O single bond and a O = O double bond. The normal O-O and O = O bond lengths are 148 pm and 121 pm respectively.

Experimentally determined oxygen-oxygen bond lengths in the O_3 molecule are same (128 pm).

$$\text{Bond order} = \frac{\text{Total number of bonds in all canonical forms}}{\text{Total canonical Structures}} \quad \frac{3}{2}$$

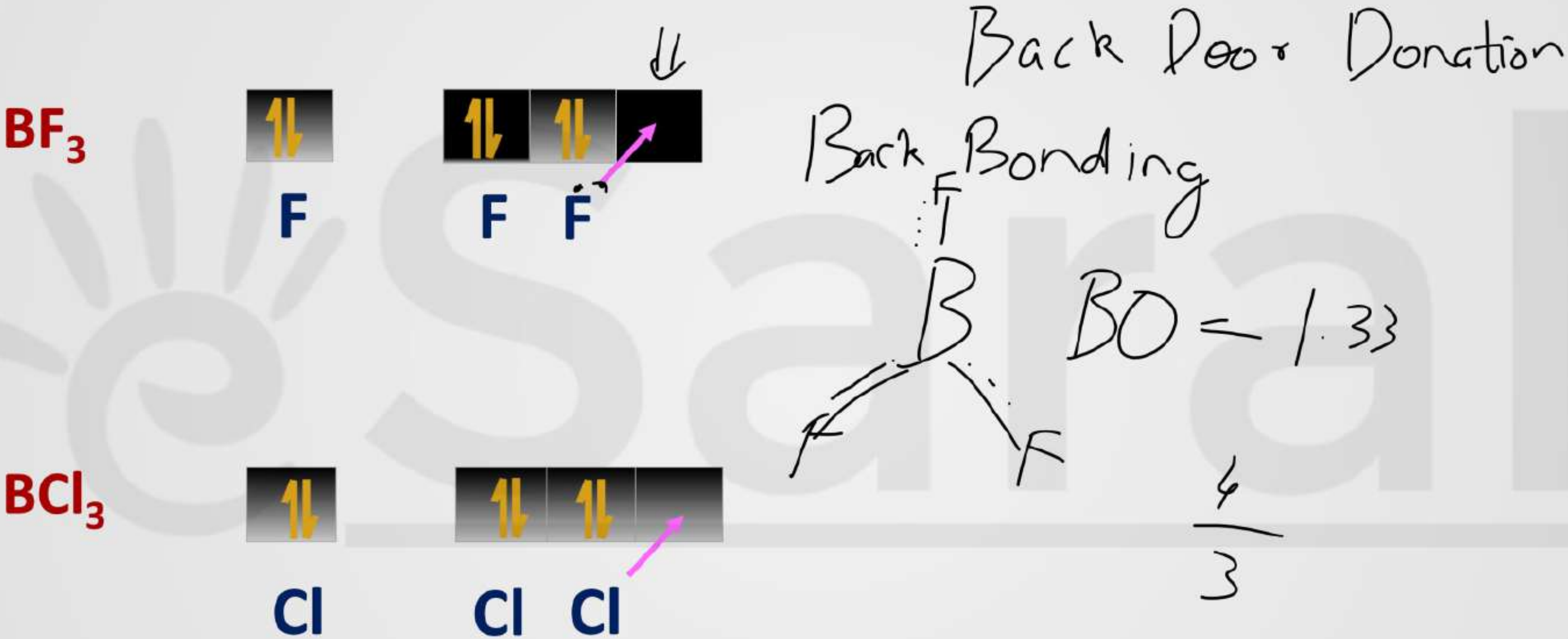


O– O Bond order = 3/2 = 1.5

BF_3 exists without obeying octet rule!!

Why??

The life of Boron Trihallides



Back Bonding

2nd, 3rd period → BB

4th size ↑

B F

vo lp

Back bonding generally takes place when

1) Out of two bonded atoms one of the atom has vacant orbitals (generally this atom is from second or third period)

2) The other bonded atom is having some non-bonded electron pair(generally this atom is from the second period)

Both the conditions must be satisfied simultaneously

Decrease in B – F bond length is due to delocalised $p\pi$–$p\pi$ back bonding between filled p-orbital of F atom and vacant p-orbital of B atom.

BF_3

$2p_\pi - 2p_\pi$

BCl_3 $2p_\pi - 3p_\pi$

The extent of back bonding is much larger if the orbitals involved in the back bonding are of small size, for example the extent of back bonding in boron trihalides is as follows :

$BF_3 > BCl_3 > BBr_3$ negligible

2p(in F) to 5p(in I).

Q) Order of Lewis acid of following?

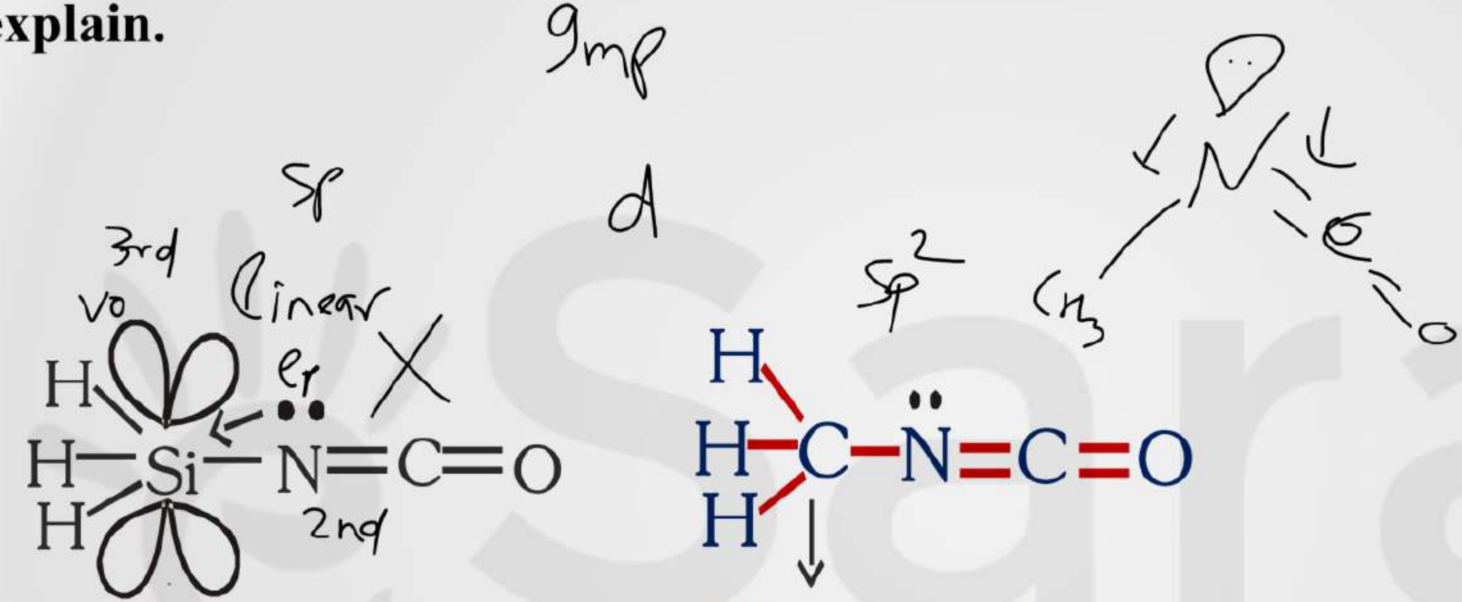
BF_3, BCl_3, BBr_3, BI_3

ep acceptor

Ans.

$BF_3 < BCl_3 < BBr_3 < BI_3$

Q) Silyl isocyanate (SiH_3NCO) is linear but methyl isocyanate (CH_3NCO) is bent explain.



vacant
d-orbitals

No vacant
orbitals

pπ–dπ back bonding

So back bonding can be of two types.

1. $p\pi - p\pi$ (as in BF_3)
2. $p\pi - d\pi$ (as in silyl isocyanate)

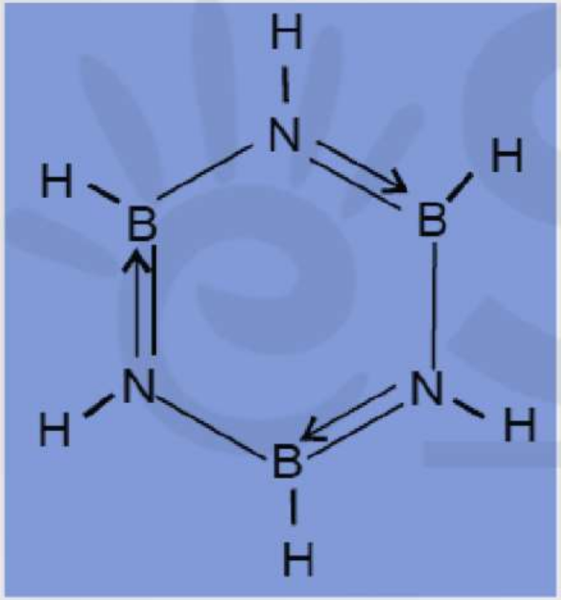
Effect of Back Bonding

1. **Bond length decreases (BF_3)**
2. **Bond angle may increase (same in BF_3. Increases in silyl isocyanate)**

3) Hybridisation of central atom may change (same in BF_3, for Nitrogen in silyl isocyanate it becomes sp from sp^2)

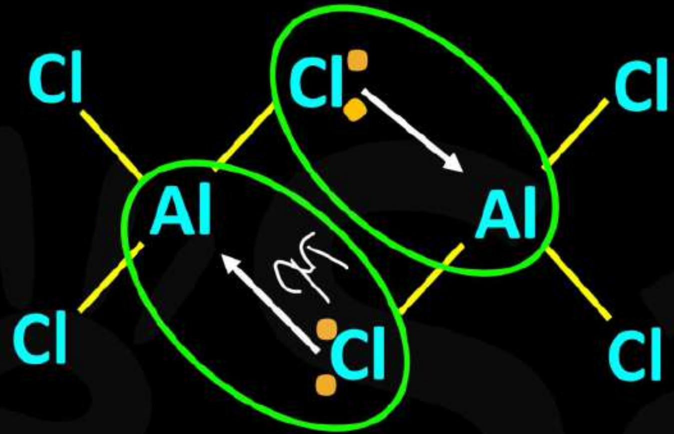
Inorganic Benzene

Imp



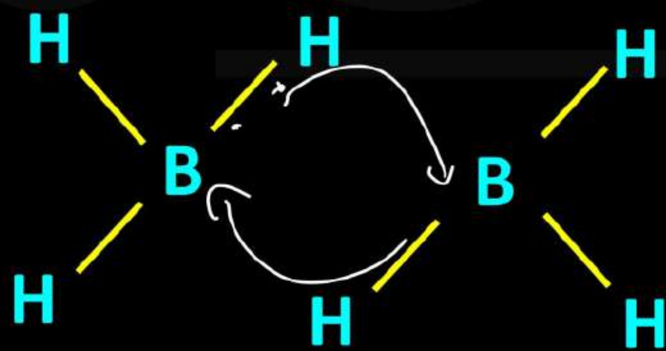
The life of $AlCl_3$

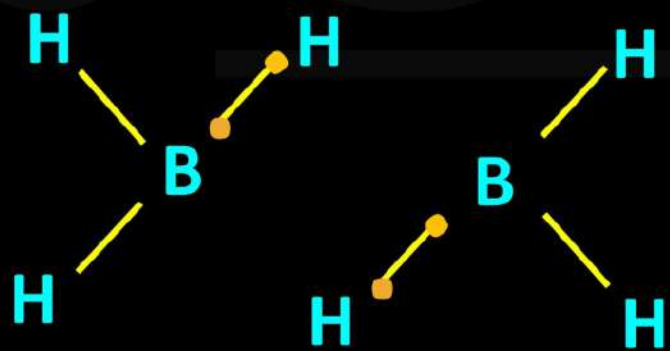
Bridge Bonding



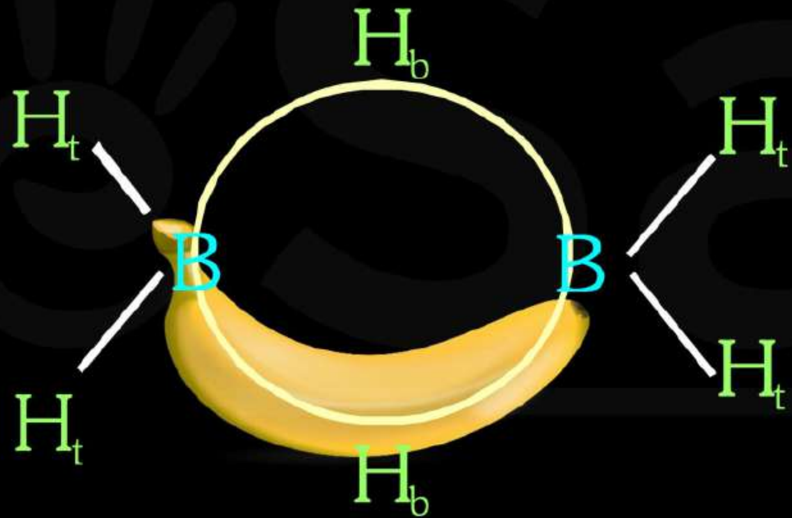
Bridge

Banana Bond





B_2H_6(DiBorane)



B_2H_6

AlCl$_3$

3 centered-4 electron

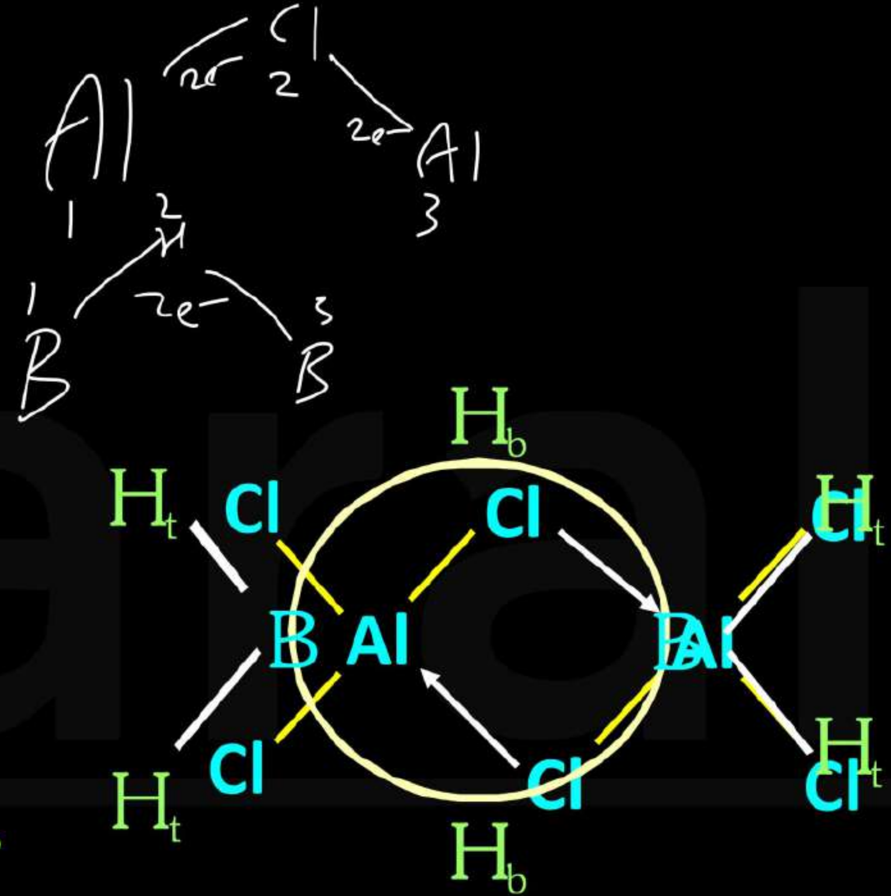
When lone pair involved.

Example Al_2Cl_6

3 centered- 2 electron

When lone pair not involved.

Example B_2H_6



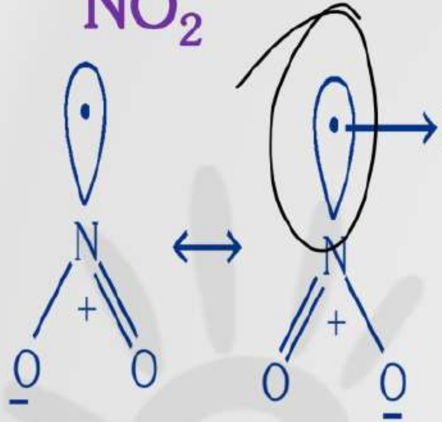
B_2H_6

Q) In the following find if Bridge bond is formed, if yes then which type?

$AlCl_3$	3c-4e ✓
AlI_3 ✓	Steric Repulsions
$AlBr_3$	3c-4e ✓
AlF_3	Ionic
$FeCl_2$	3c-4e ✓
$FeCl_3$	3c-4e ✓
BeH_2	3c-2e ✓
BF_3	Back Bonding
BCl_3	Back Bonding, Steric Repulsions

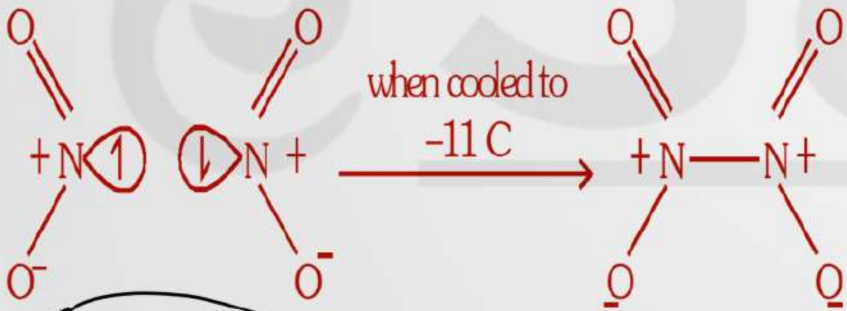
Odd electron molecule

NO_2



Free electron occupies the one sp^2 hybrid orbital.

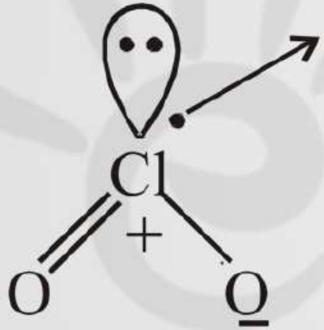
room temp stable



Paramagnetic (unpaired electron) Brown colour gas	Diamagnetic (no unpaired electron) white coloured solid

ClO_2

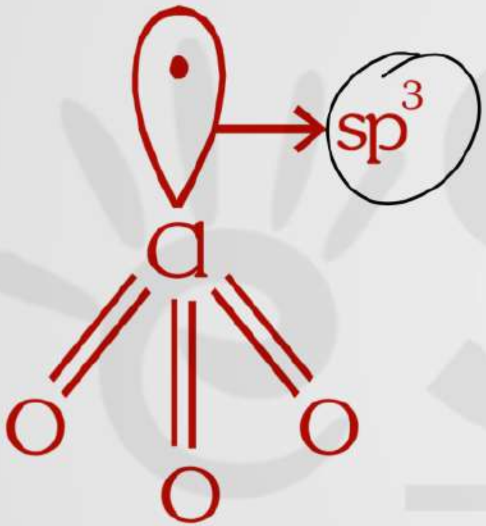
Stable



The free electron resides in the 3d-orbital of Cl-atom.

Since the free electron is delocalised in d-orbital, it's dimer formation tendency is very less as compared to NO_2.

ClO_3



Bond angle = 119°

Hybridisation = sp^3

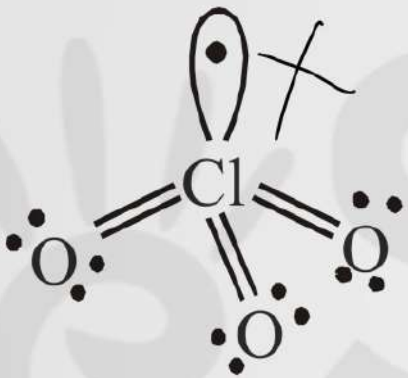
Shape = pyramidal

$\dot{C}H_3$

Bond angle = 120°
Hybridisation = sp^2
Shape = planar

Q) Find the number of lone pairs in ClO_3 molecule.

KP → Count lp of SA

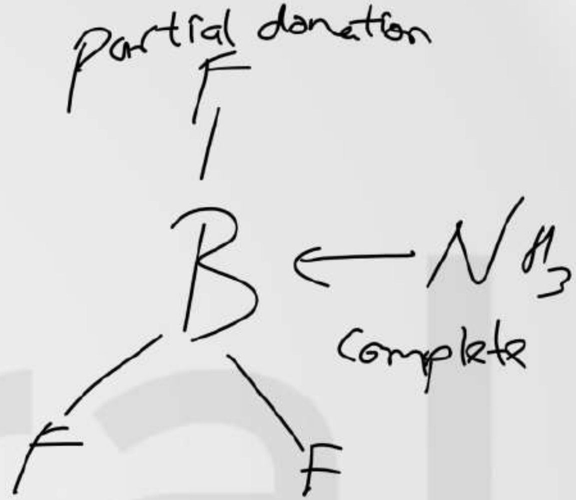


No. of lone pair = 6

(a) PH_5 is not possible but PCl_5 is possible. Why?

(b) SCl_6 does not exist but SF_6 is possible. Why ?

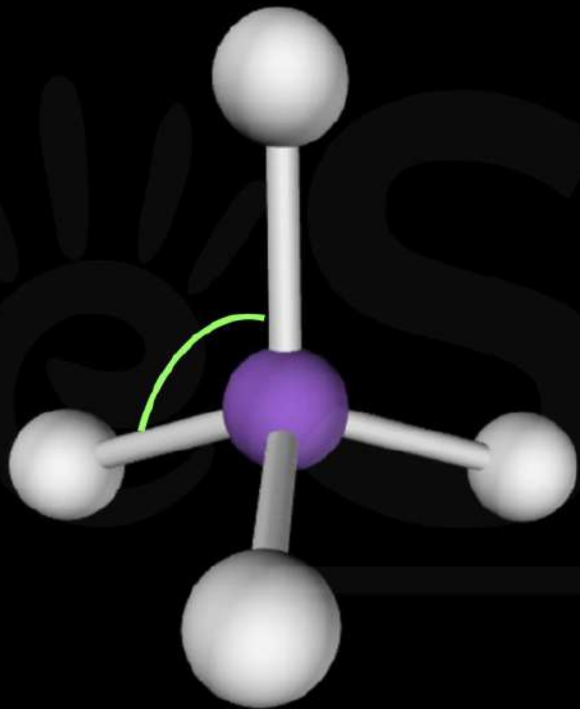
(c) The B-F bond length in $Me_3\ddot{N}$-BF_3 is 1.35 Å, much longer than 1.30 Å in BF_3. Explain.



(a) Drago's

(b) Steric Reasons

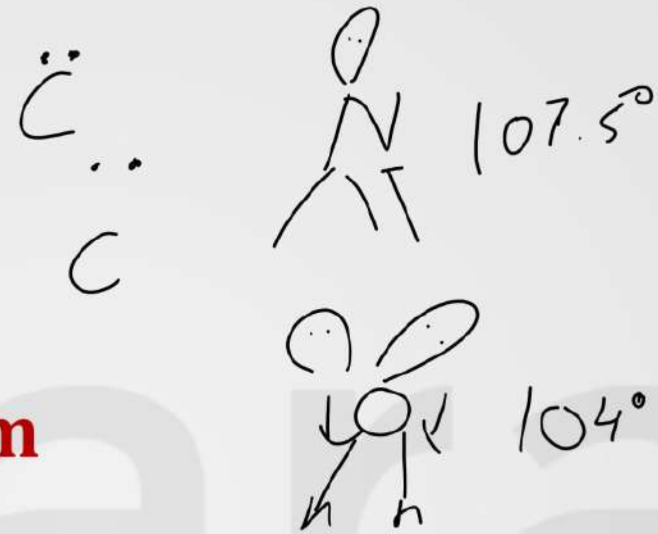
(c) No Back Bonding in Me_3N-BF_3



Bond Angle

BA ∝ % s-character

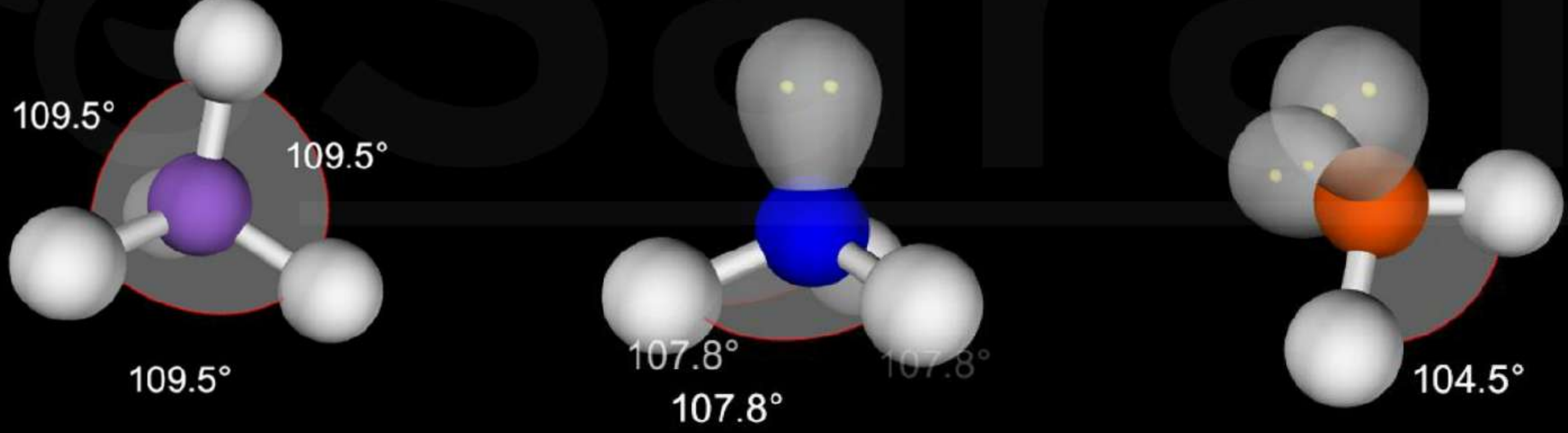
BA ∝ 1/presence of lp



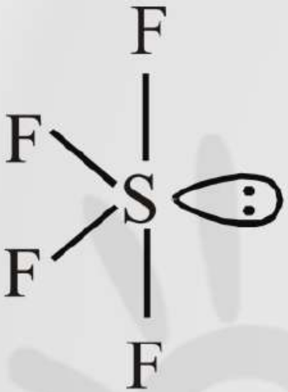
BA ∝ EN of Central Atom

$$BA \propto \frac{1}{\text{EN of surrounding atom}}$$

BA ∝ size of surrounding atom

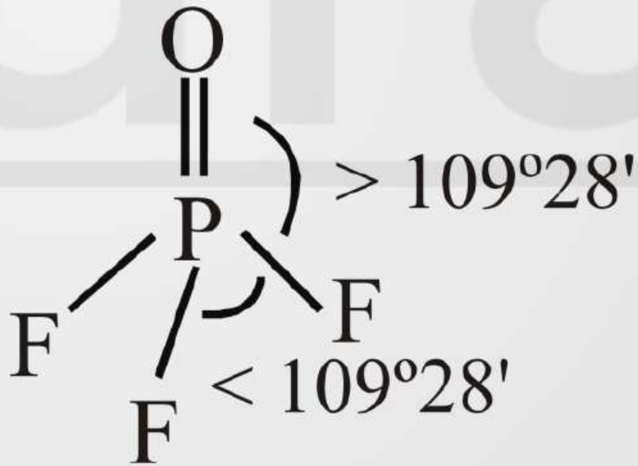

109.5°
109.5°
109.5°
107.8°
107.8°
107.8°
104.5°

SF_4



SeF_4

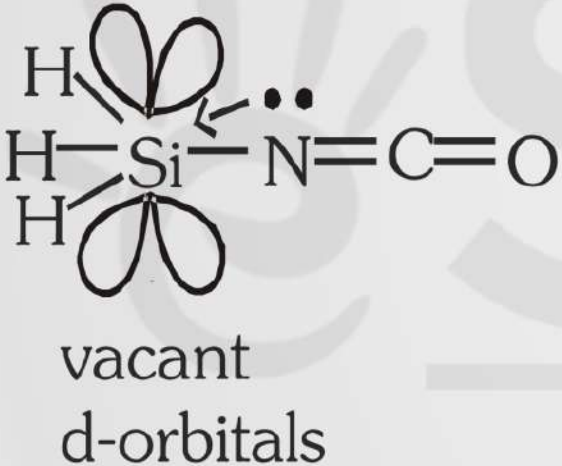
$SF_4 > SeF_4$

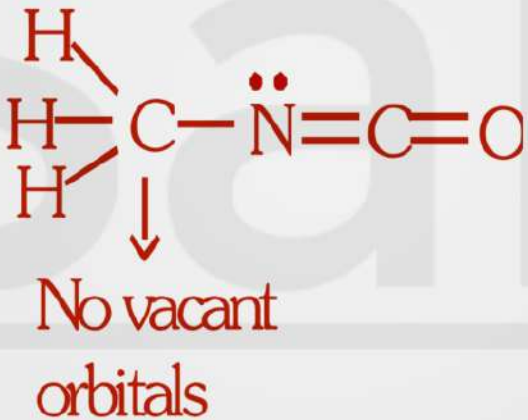


$NH_3 > NF_3$

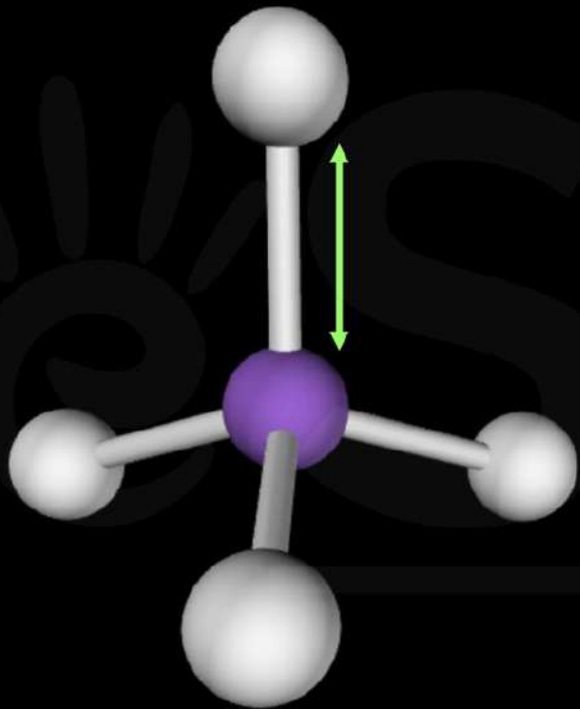
$OBr_2 > OCl_2$

Silyl isocyanate (SiH_3NCO) is linear but methyl isocyanate (CH_3NCO) is bent





pπ–dπ back bonding



Bond Length

BL ∝ 1/% s-character

% s character ↑ BS ↑ BL ↓

BL ∝ size

C=C ↓

BL ∝ 1/BO

C=C−C=C

BL ↓

BL ∝ resonance

 ↓

$$BL \propto \frac{1}{\text{EN difference}}$$

$HI > HBr > HCl > HF$ Size

C–C, C = C

154 pm 134 pm

$P–Cl_{(axial)} > P–Cl_{(eq)}$

Bond Energy

Q) Compare the bond energy in the following
F_2, Cl_2, Br_2 and I_2

Learn

Exception

Ans. $Cl_2 > Br_2 > F_2 > I_2$
Bond energy order (Experimental facts)

11-12 moving

MOT, Dipole, Ionic Bond, Weak Bond