

TOPICS TO BE COVERED



1. Octet Rule & VBT and VSEPR & Hybridisation

2. Resonance , Formal Charge , No of pi-pi Bonds

3 Bond Parameters , Back and Bridge Bonding

4 MOT , IMF , H- Bonding , Ionic Bonding



Strong Bond

- Covalent Bond
- Co-ordinate Bond
- Ionic Bond
- Metallic Bond

Weak Bond

- Hydrogen Bond
- Vander waal FOA



No. of electrons in Valence Shell

								He
Li	Be		B	C	N	O	F	Ne
Na	Mg		Al	Si	P	S	Cl	Ar
K	Ca		Ga	Ge	As	Se	Br	Kr
Rb	Sr		In	Sn	Sb	Te	I	Xe
Cs	Ba		Tl	Pb	Bi	Po		δ_{e^-}



Octet Rule

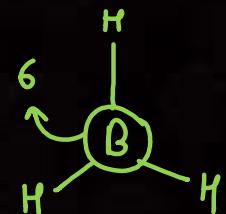
The octet rule dictates that atoms are most stable when their valence shells are filled with eight electrons.



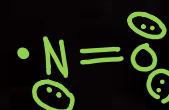
This rule is based on chemical inertness of noble gases.

Limitations of Octet rule

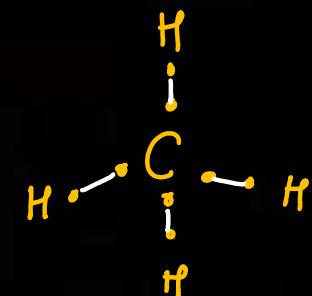
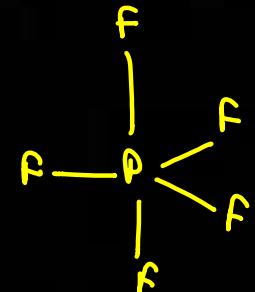
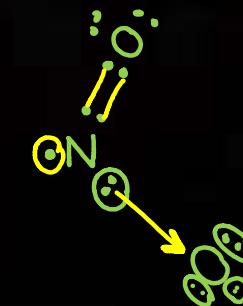
Incomplete Octet



Odd-electron molecules

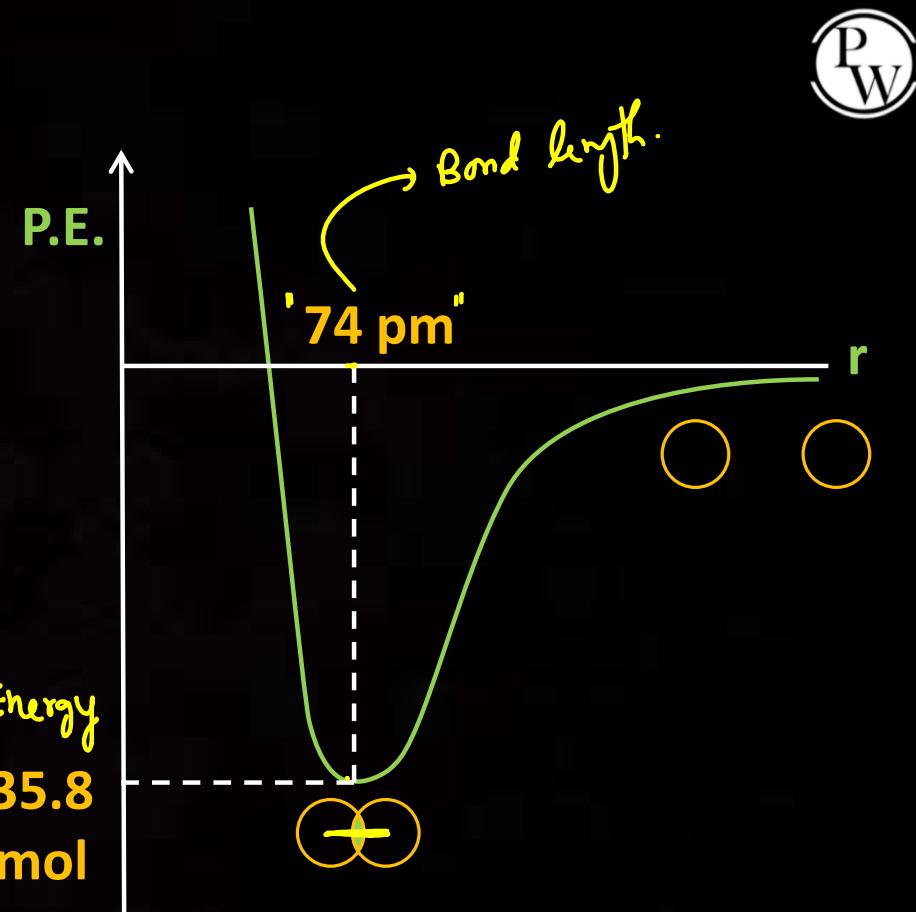
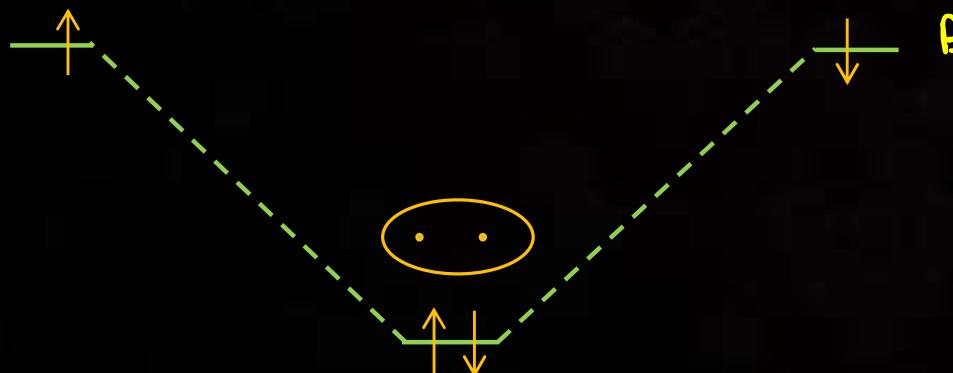
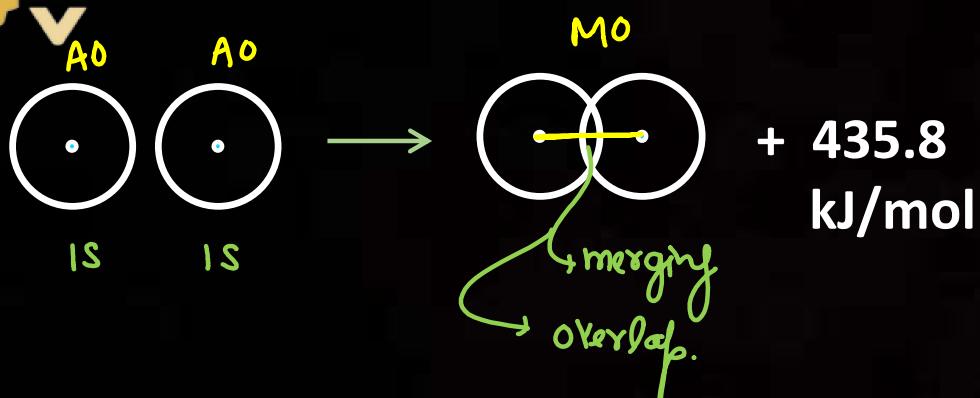


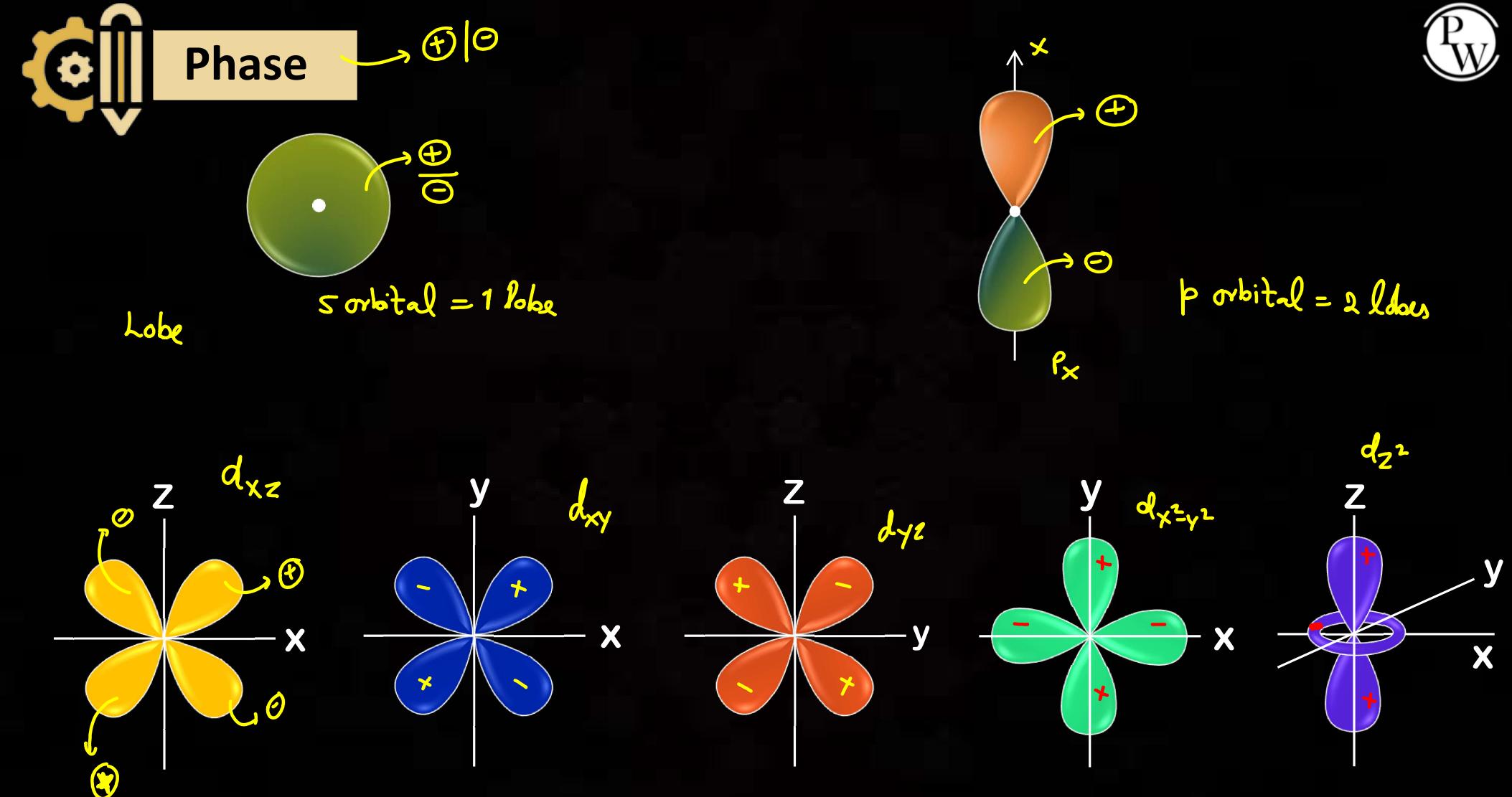
Expanded / Super / Hypervalent Octet





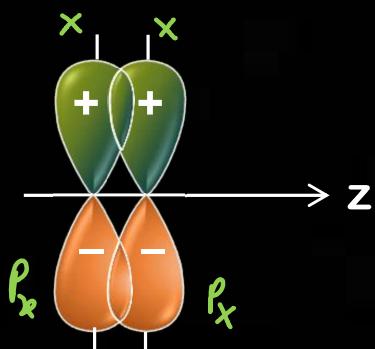
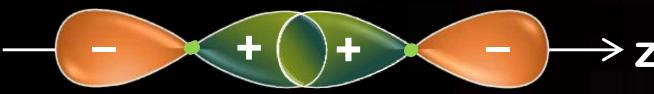
Valence Bond Theory





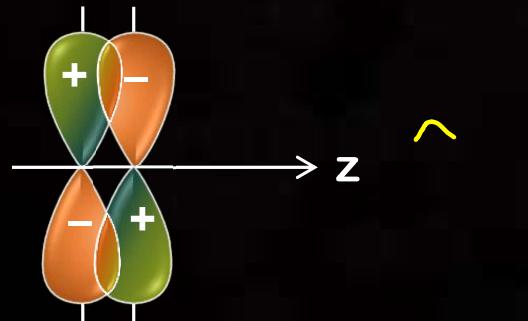
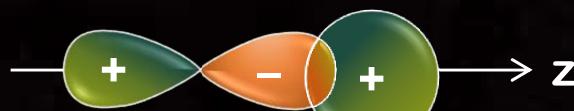
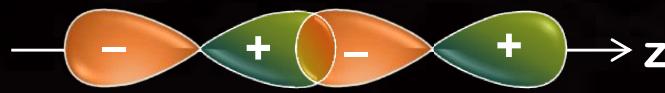
Positive Overlap

\oplus/\oplus \ominus/\ominus
Same phase overlap

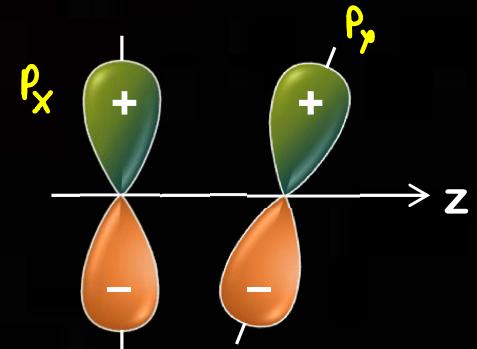
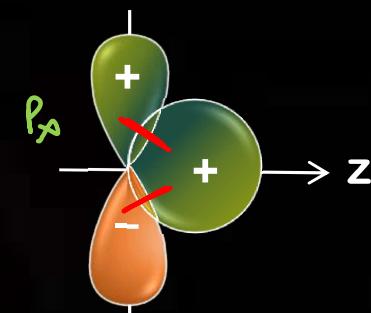


Negative Overlap

\oplus/\ominus
Opp. phase overlap



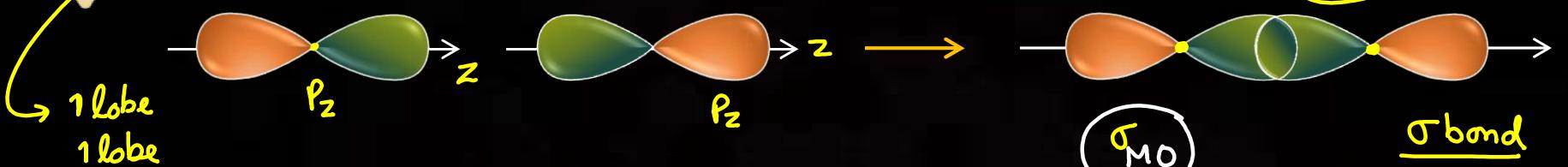
Zero Overlap





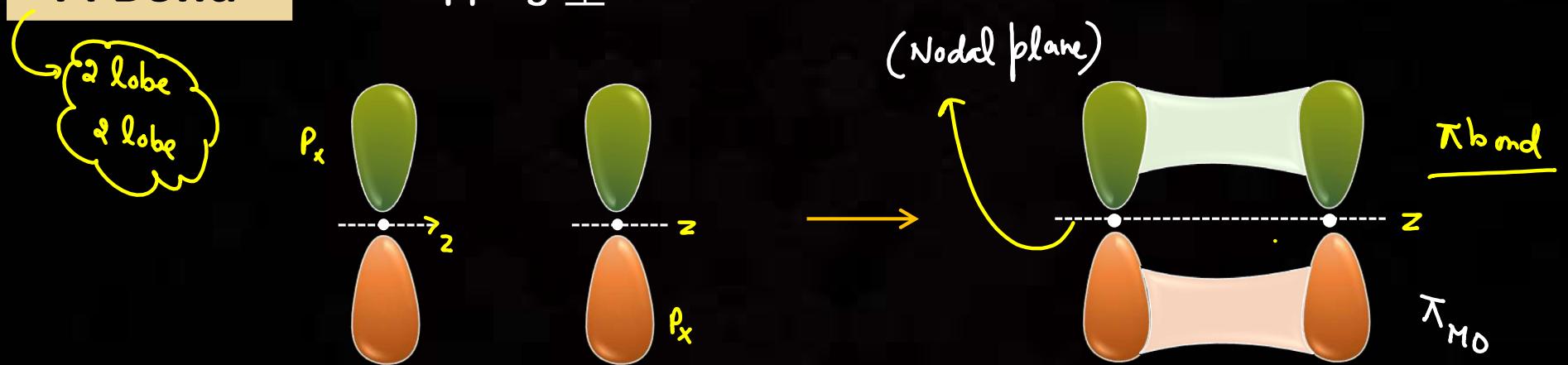
Sigma Bond

Overlapping along the *molecular axis*



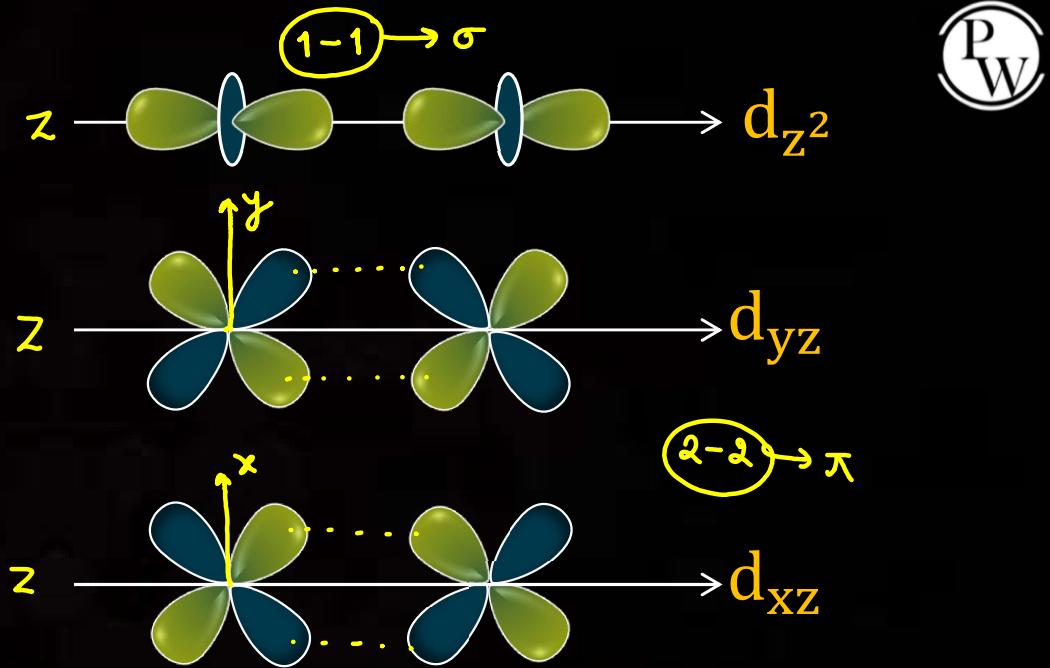
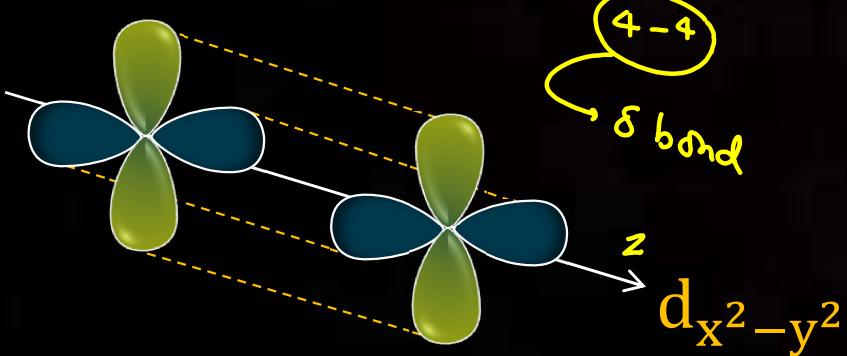
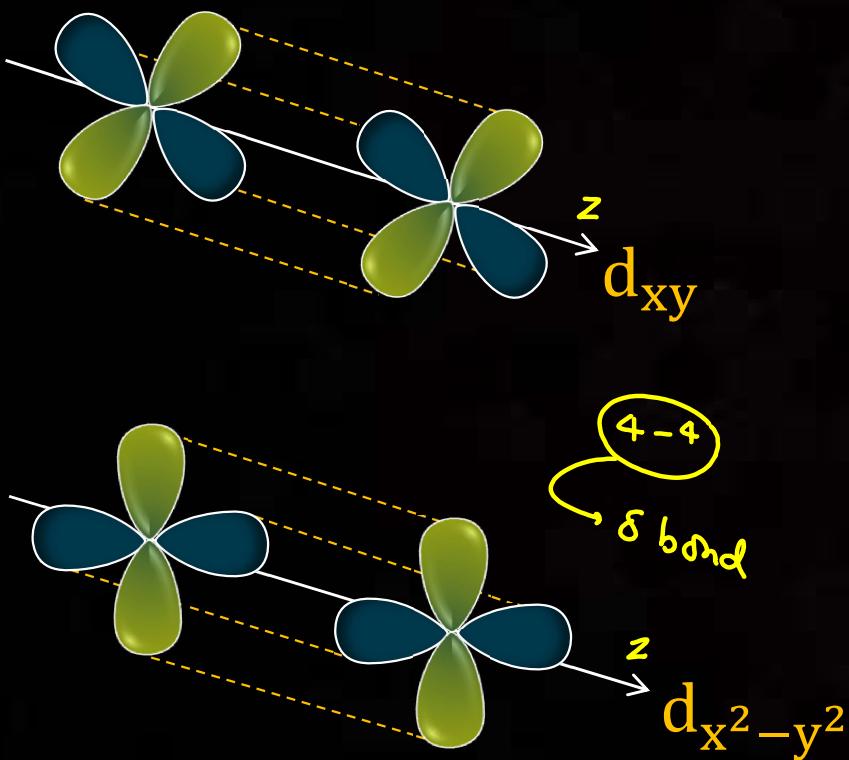
Pi Bond

Overlapping \perp^r to molecular axis



Strength : $\sigma > \pi$

Delta Bond



	σ	π	δ
s	✓	✗	✗
p	✓	✓	✗
d	✓	✓	✓

P
W



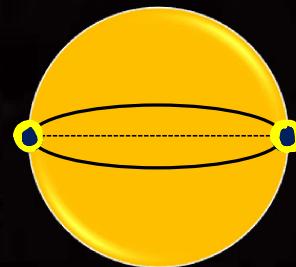
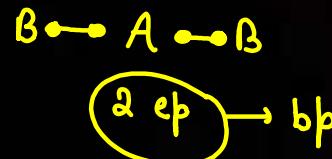
VSEPR Theory

Valence Shell Electron Pair Repulsion Theory

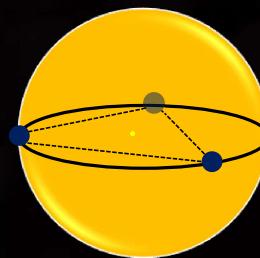
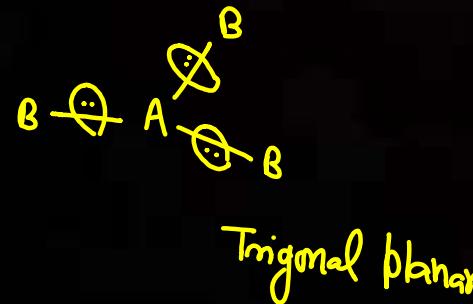


$b\text{p}$ / $l\text{p}$

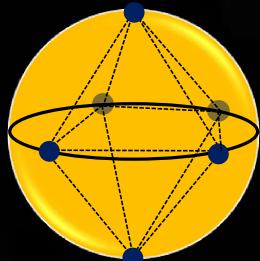
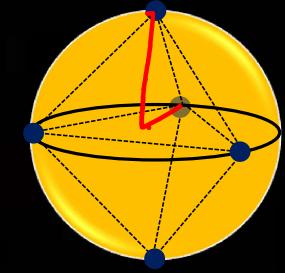
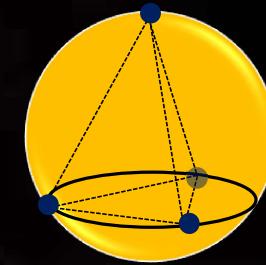
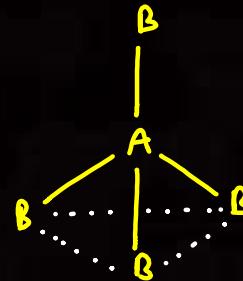
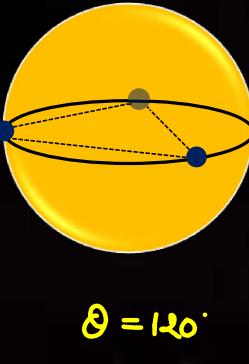
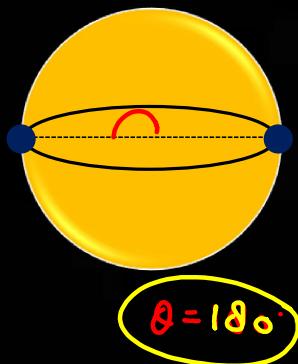
Minimum Repulsion between pair of electrons at valence shell



$\text{B} - A - \text{B}$
Linear

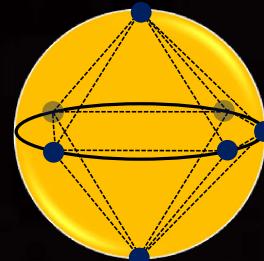


The valence shell is taken as a sphere with the electron pair localizing on the spherical surface at maximum distance from one another.



Octahedral

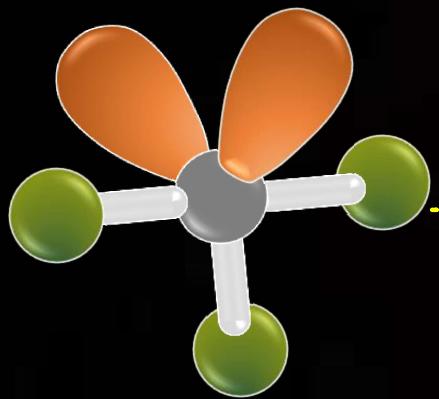
Pentagonal
bi-pyramidal





Order of repulsive interaction

Lone pair – Lone pair > Lone pair – Bond pair > Bond pair – Bond pair

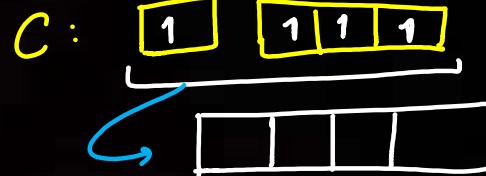
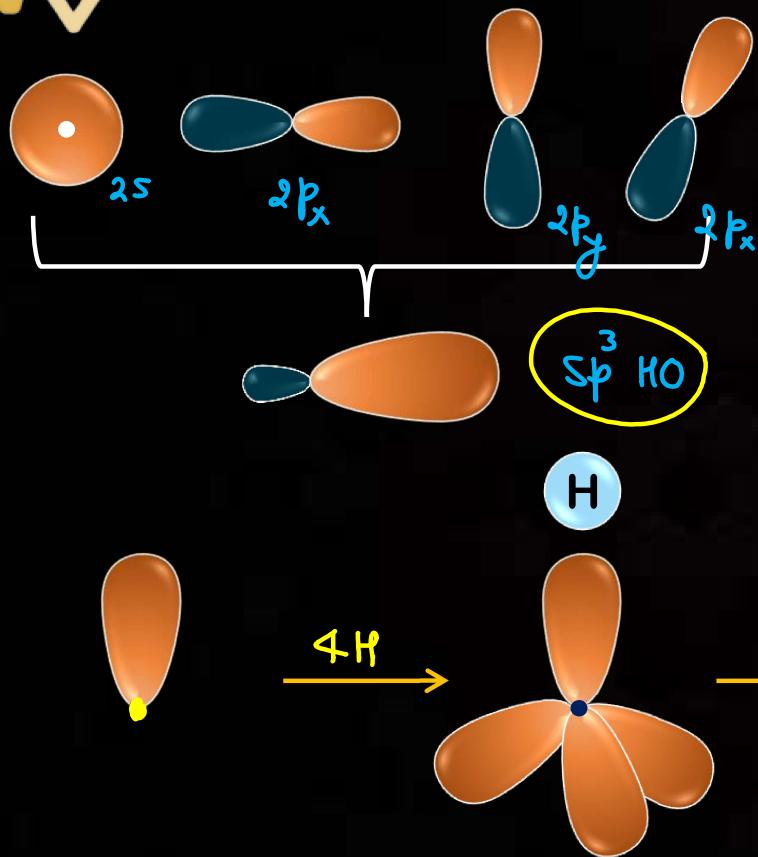


The lone pair are localized on the central atom, each bonded pair is shared between two atoms. As a result, the **lone pair electrons in a molecule occupy more space** as compared to the bonding pairs of electrons.

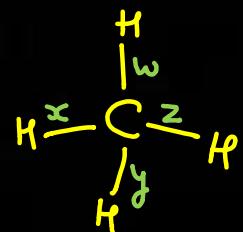


Hybridisation

CH_4



Inter Mixing of pure atomic orbitals before bonding to produce new hybrid orbitals, specially for bonding purpose.



All C — H bonds are same in CH_4



Calculation of state of Hybridisation

$$SN. = SA + LP$$



SN

2



3



4



5



6



7



Geometry

Linear

Trigonal planar

Tetrahedral

Trigonal bi-pyramidal

Octahedral

Pentagonal bi-pyramidal

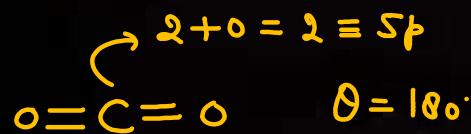


sp Hybridisation

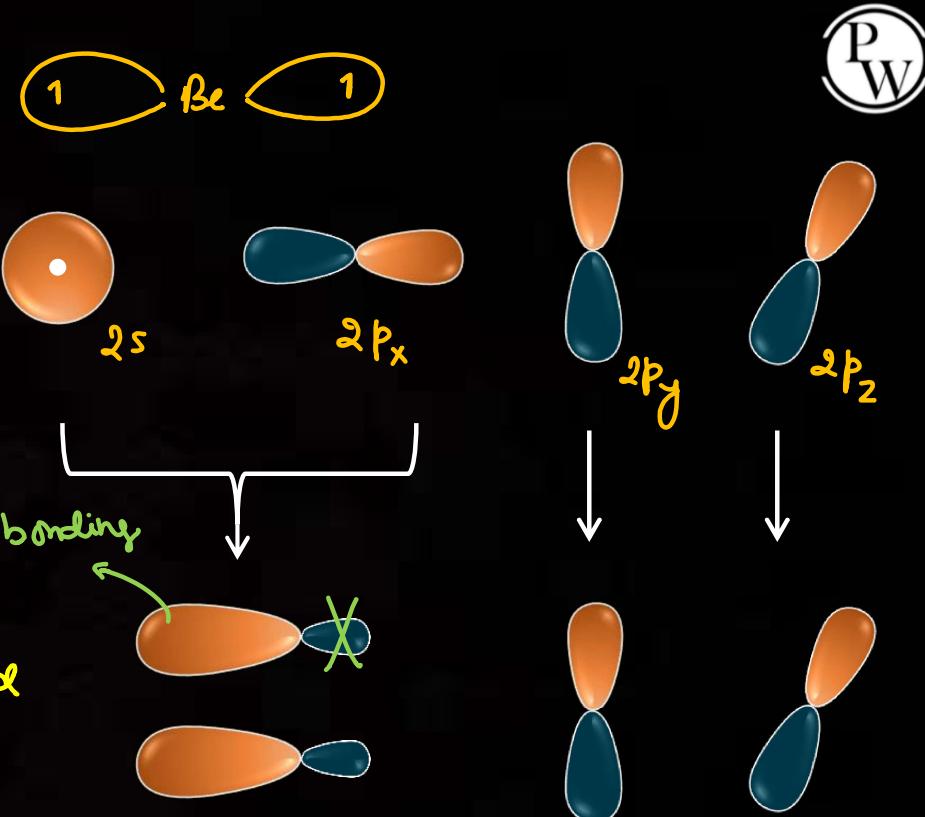
$\theta = 180^\circ$



$$SN = 2 + 0 = 2$$



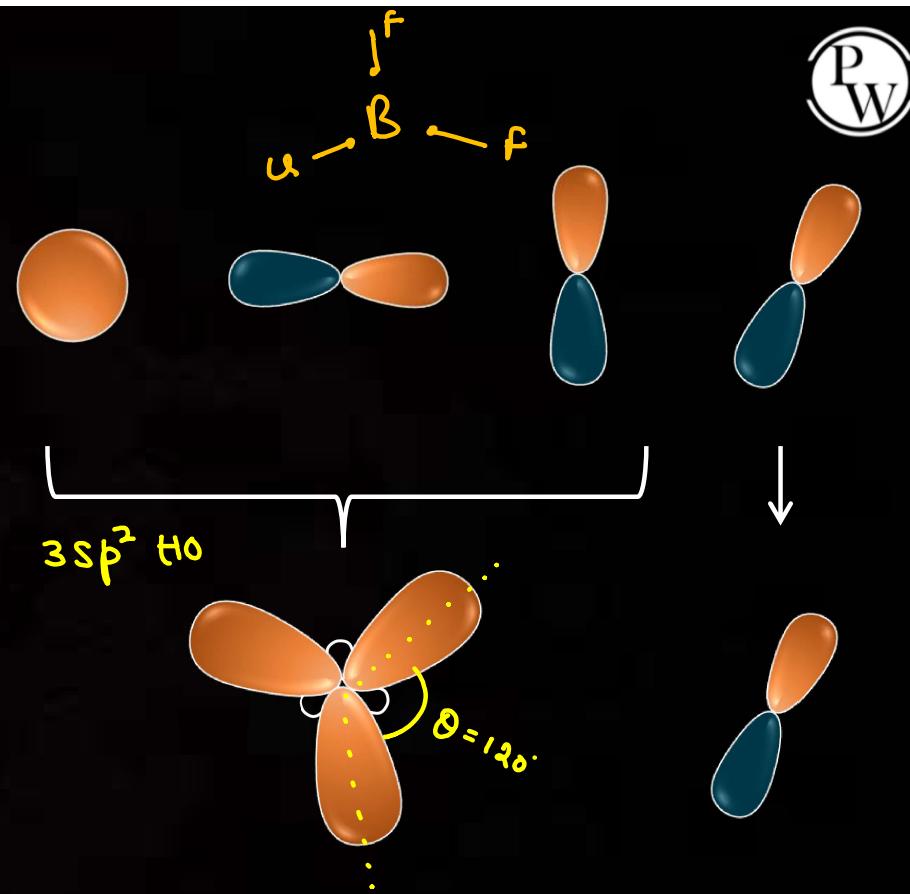
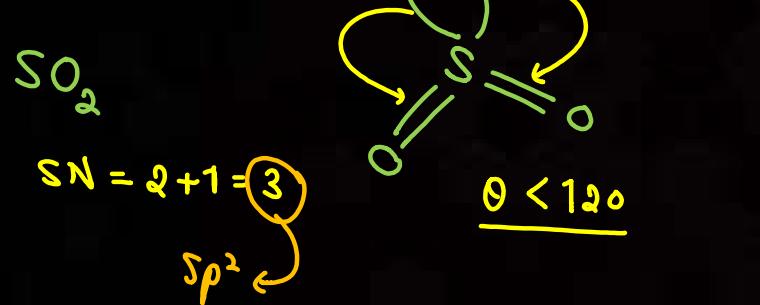
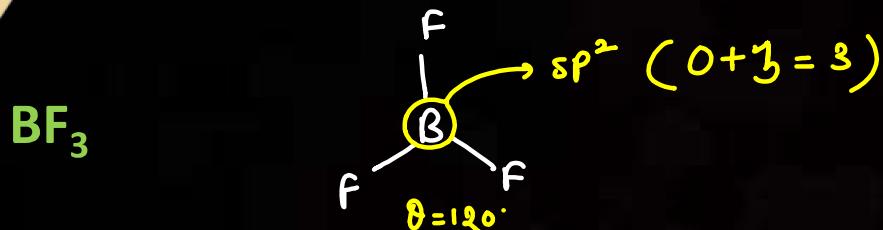
$$\curvearrowleft 1+1=2 \ (\sigma p)$$





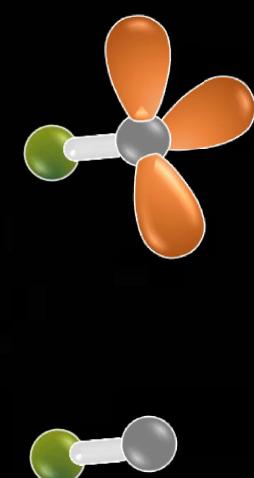
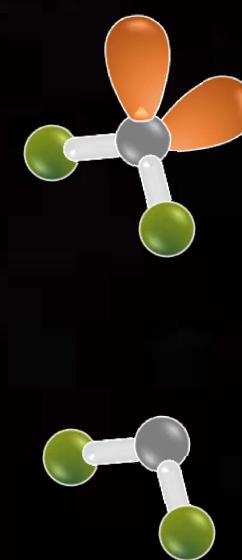
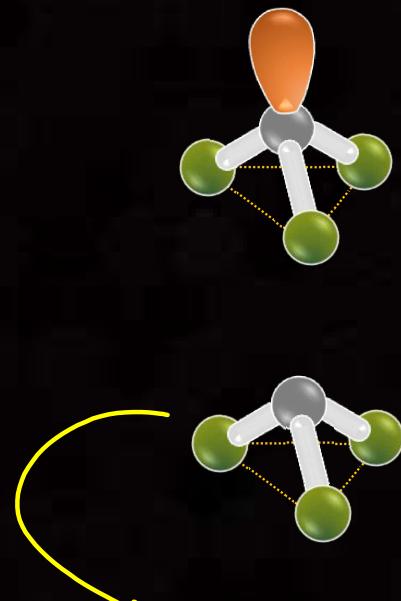
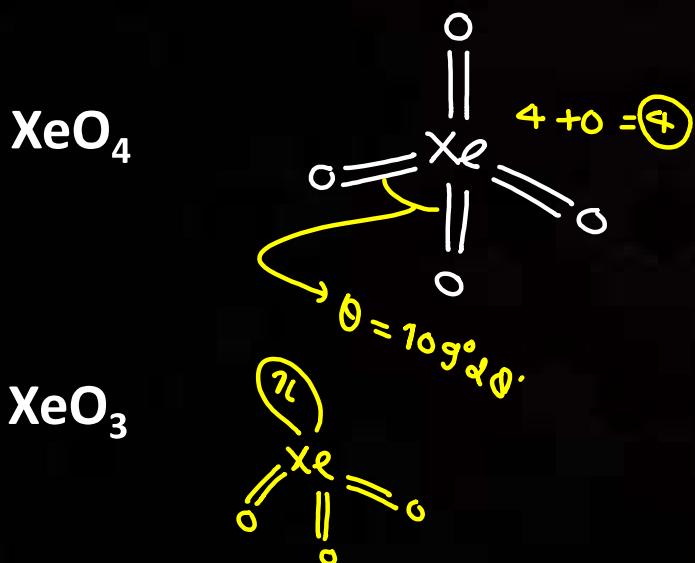
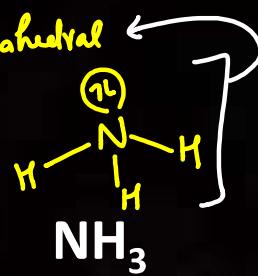
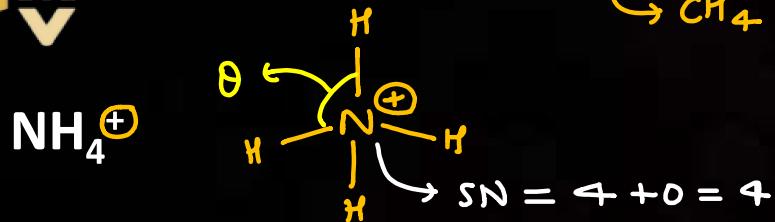
sp² Hybridisation

$\Sigma N = 3$





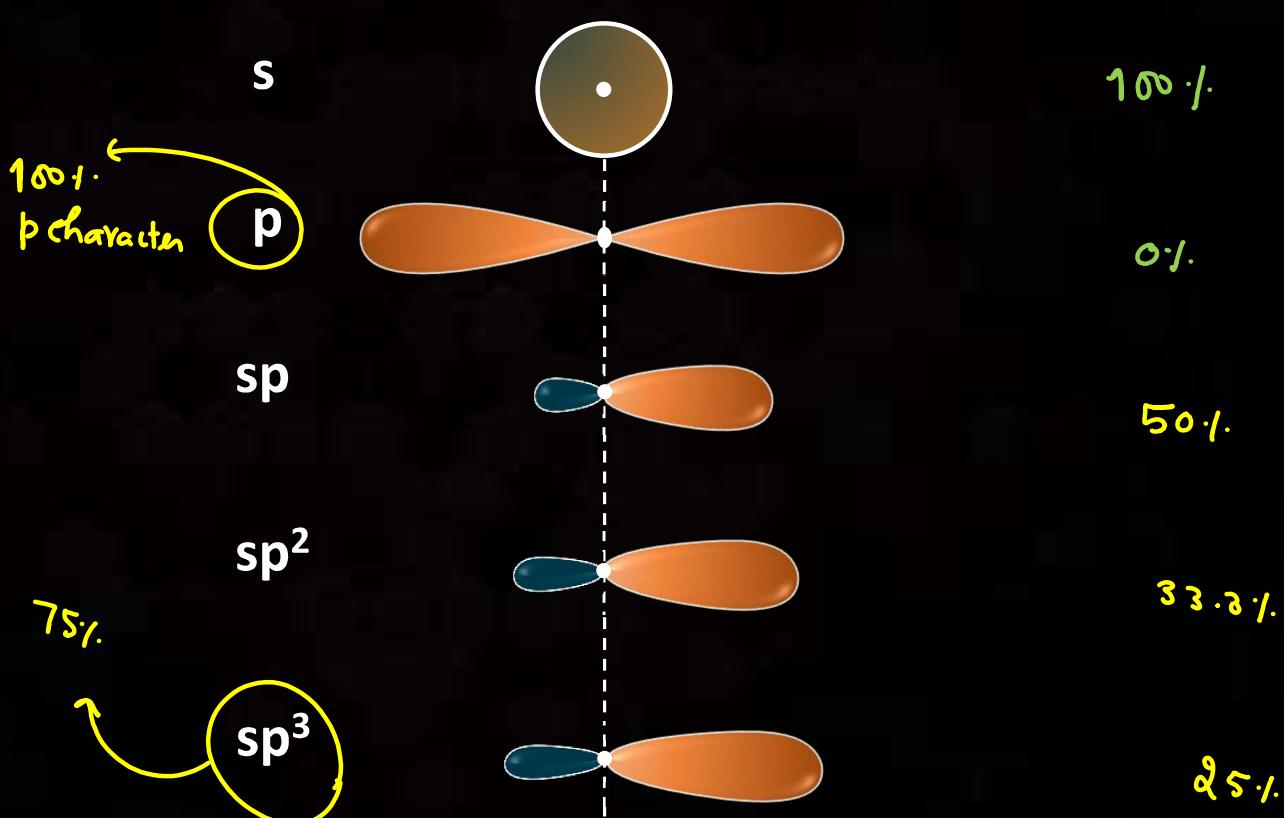
sp³ Hybridisation





% s character

Orbital



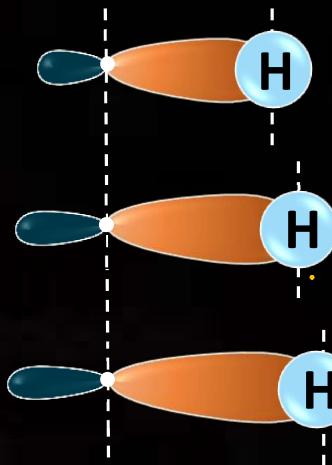


Bond Length & % character

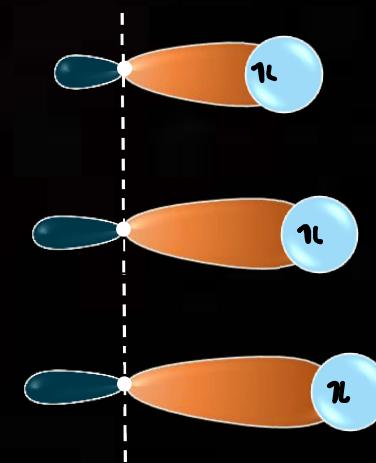
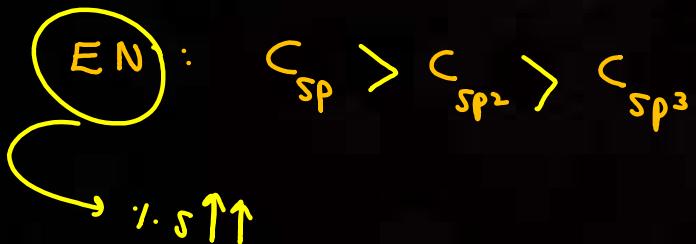
P
W

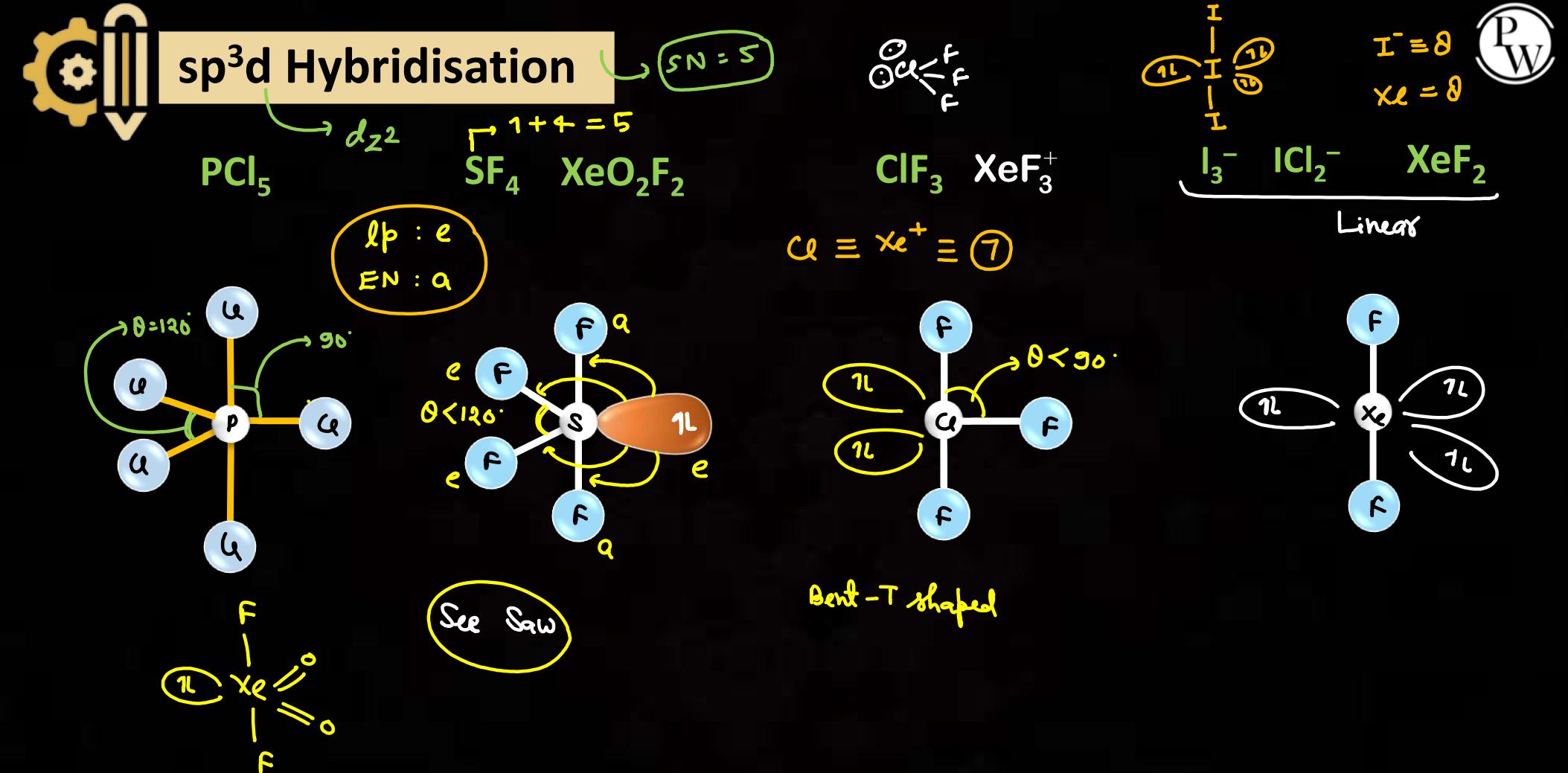
$$\alpha < \gamma < \beta$$

∴ s character ↑ : B.L. ↓



Electronegativity & % s character







sp³d² Hybridisation

$$6+0=6$$



$$S \equiv 6$$

$$P \equiv 5 + 1$$

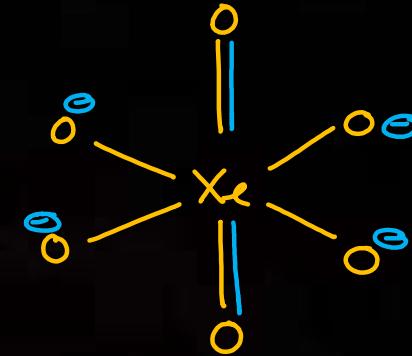
$$SN = 6$$



$$Si \equiv 4 + 2 = 6$$

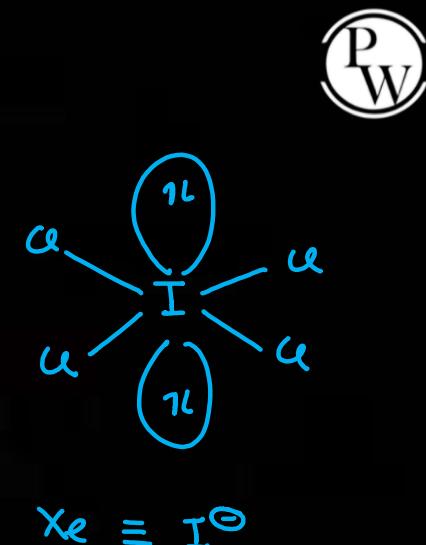
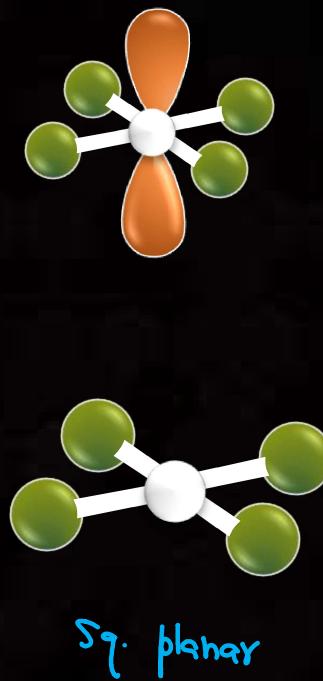
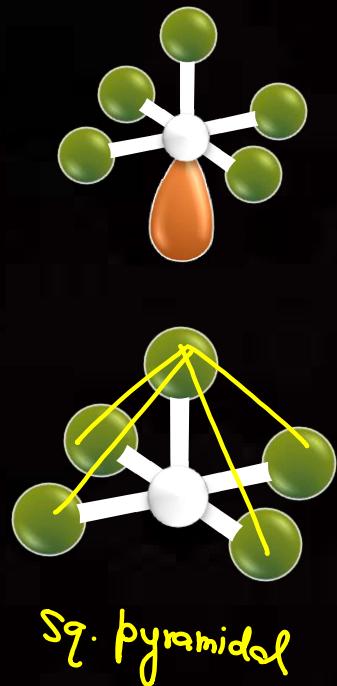
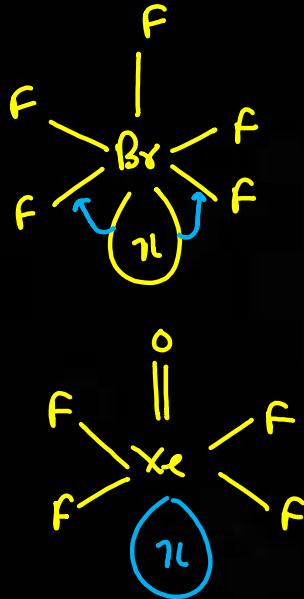


$$Al \equiv 3 + 3$$



$$SN = 6 + 0 = 6$$





$$\text{Xe} \equiv \text{I}^\ominus$$

Q.

Based on VSEPR theory, the number of 90° F–Br–F angles in BrF_5 is (zero)

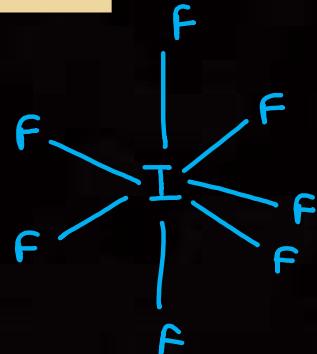
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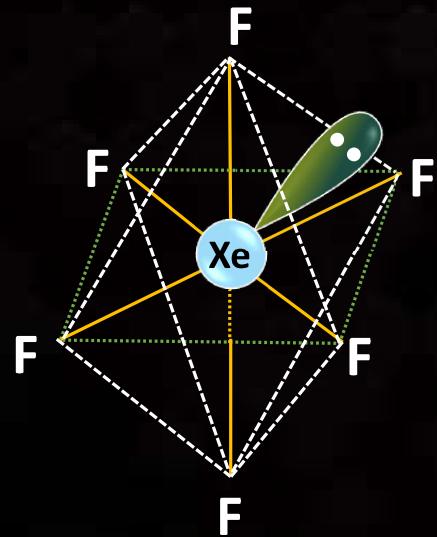
sp³d³ Hybridisation

IF₇, (7+0=7)

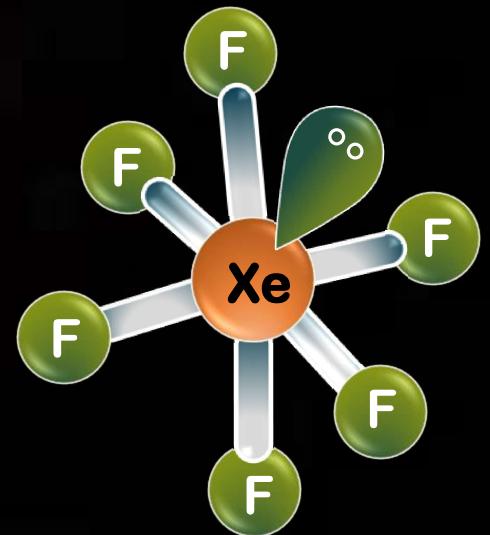


$$\delta \equiv d_{z^2} / d_{x^2-y^2} / d_{xy}$$

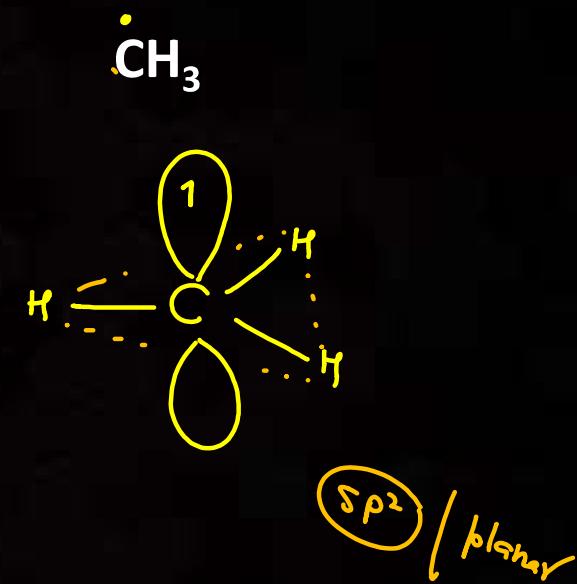
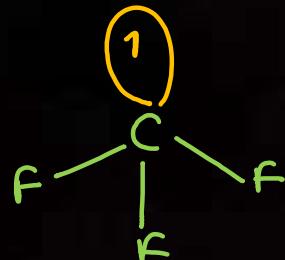
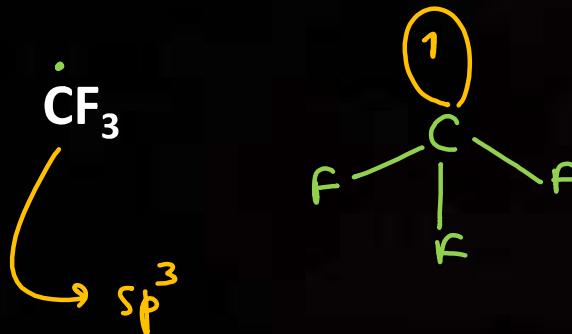
(6+1=7)
XeF₆(g)



Capped octah.



Hybridisation in Odd Electron Species



2.5
 C

2.1
 H

Q.

P
W

Molecular shapes of SF_4 , CF_4 and XeF_4 are respectively :

A

the same with 2, 0 and 1 lone pair of electrons respectively

B

the same with 1, 1 and 1 lone pair of electrons respectively

C

different with 0, 1 and 2 lone pair of electrons respectively.

D

different with 1, 0 and 2 lone pair of electrons respectively.

Q.

The number of lone pair(s) of electrons in XeOF_4 is :

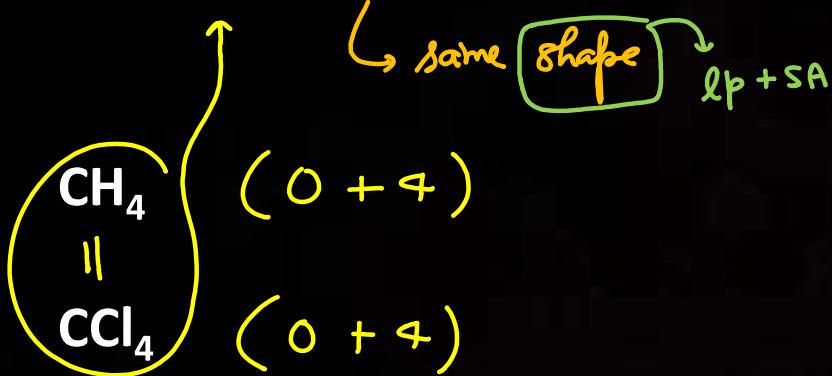
A 3

B 2

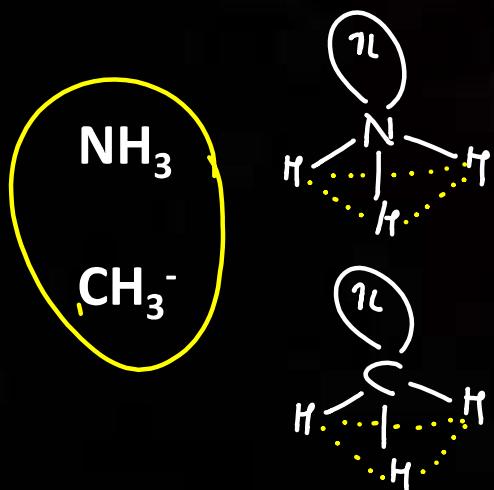
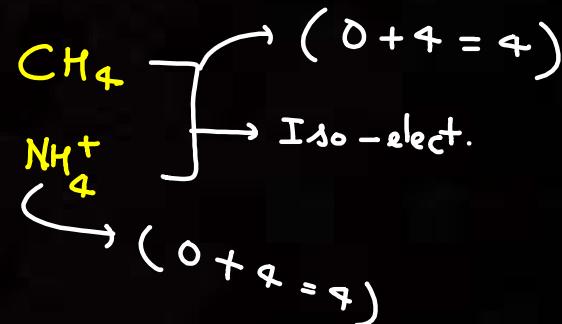
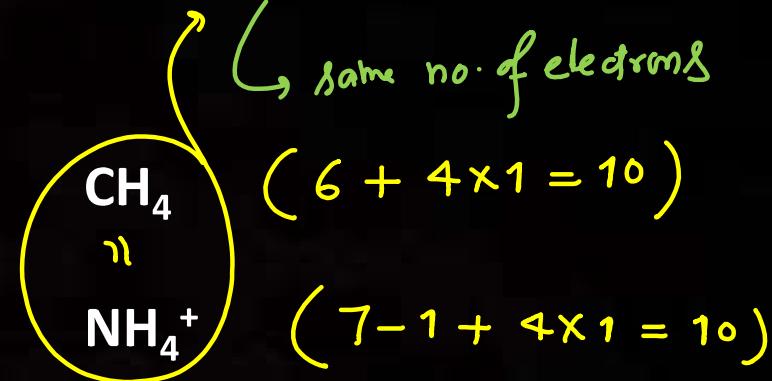
C 1

D 4

Iso-structural Species



Iso-electronic Species



Q.

Which of the following are isoelectronic and isostructural?

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$$6 + 3 \times 8 + 2$$



$$7 + 3 \times 8 + 1$$

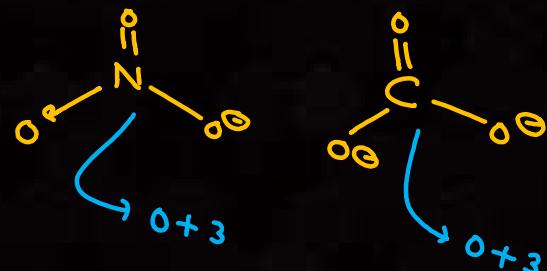
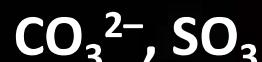
A



B



C



No. of $p\pi - p\pi$ bonds / No of $p\pi - d\pi$ bonds

	π Bond	$B C N O$ Period no = 2	π Bond	$S P Cl$ Period no > 2	π Bond
s	x		s → x		s x
p	✓		p → ✓		p ✓
d	✓		x		d ✓

If CA / SA is from period no 2 , then only p orbital can make π Bond.

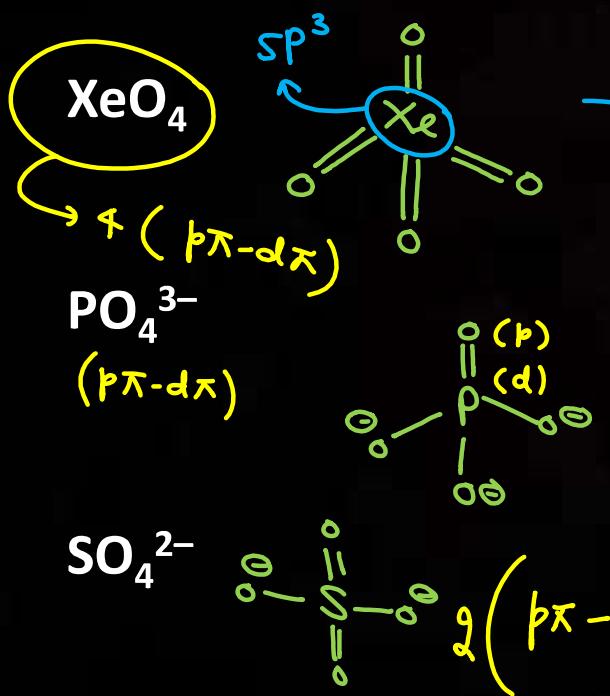
If CA / SA is from period no > 2 , then p and d both can make π Bond.



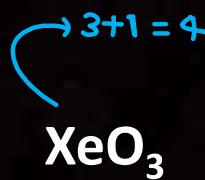
No. of $p\pi - p\pi$ bonds / No of $p\pi - d\pi$ bonds



$$S \equiv [s + p + p] + \frac{p + d + d + d + d}{\pi \text{ bond}}$$

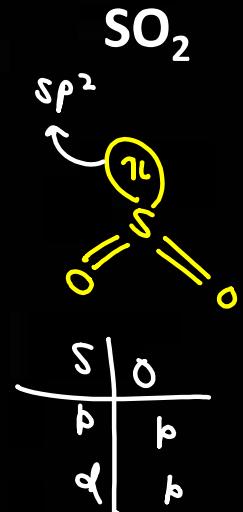
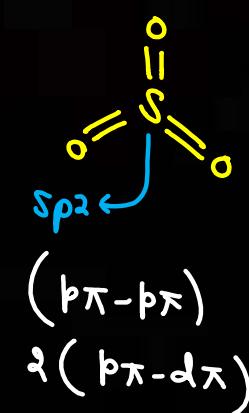


Xe	O
d	p
d	p
d	p
d	p



Xe	O
d	p
d	p
d	p
d	p

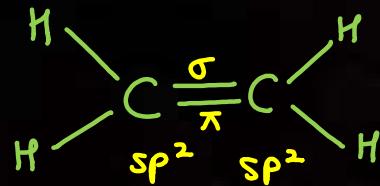
S	O
p	p
d	p
d	p
d	p



Q.

The **nodal plane** in the π -bond of ethene is located in

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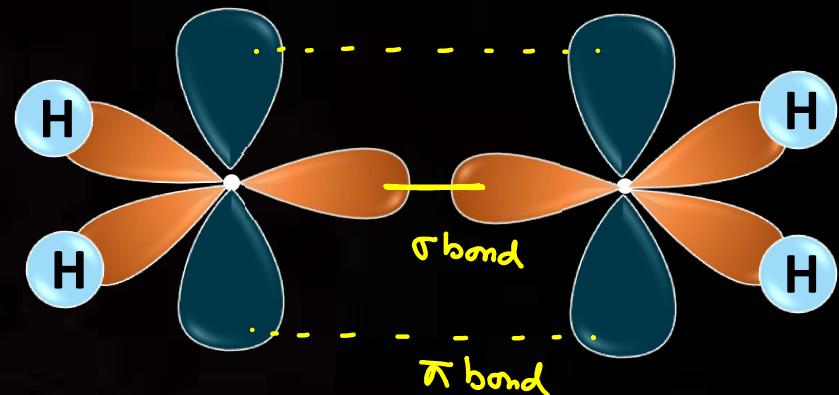


A the molecular plane

B a plane parallel to the molecular plane

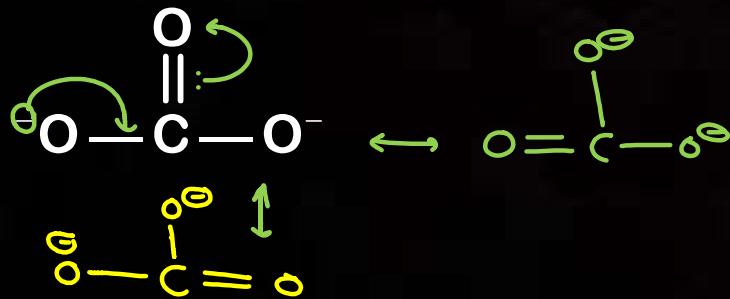
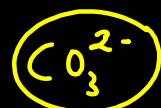
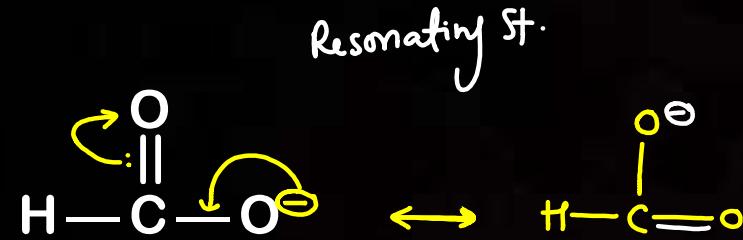
C a plane perpendicular to the molecular plane which bisects the carbon-carbon σ -bond at right angle

D a plane perpendicular to the molecular plane which contains the carbon-carbon σ -bond

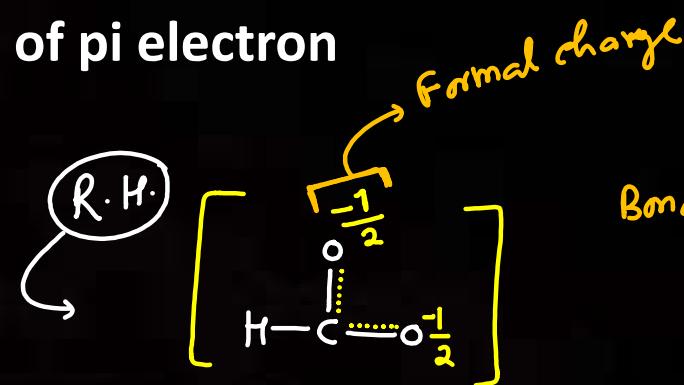




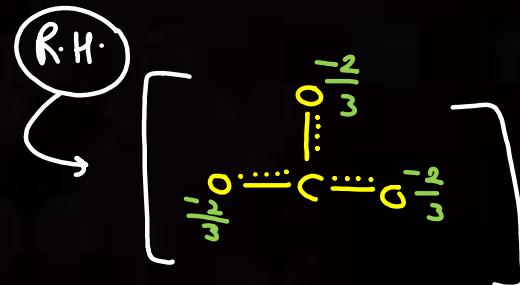
Resonance



Delocalisation of pi electron



$$\begin{aligned} \text{Bond order} &= \frac{\sigma + \pi}{\sigma} \\ &= \frac{2 + 1}{2} \\ &= 1.5 \\ \sigma &\quad \pi_{\text{bond}} \end{aligned}$$



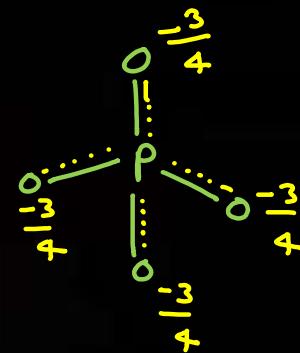
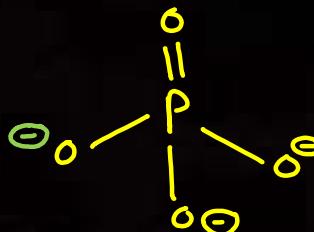
$$\begin{aligned} \text{B.O.} &= \frac{3+1}{3} = \frac{4}{3} \\ &= 1.33 \end{aligned}$$

Q.

In PO_4^{3-} ion, the formal charge on each oxygen atom and P – O bond order respectively are

A -0.75, 0.6

$$\begin{aligned} \text{P} \cdot \text{O} \cdot &= \frac{4+1}{4} \\ &= \frac{5}{4} \\ &= 1.25 \end{aligned}$$

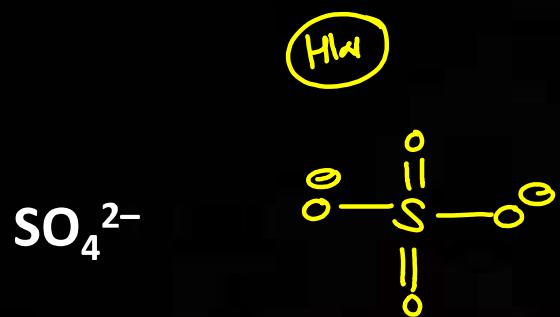


B -0.75, 1.0

C -0.75, 1.25 ✓

D -3, 1.25

P
W

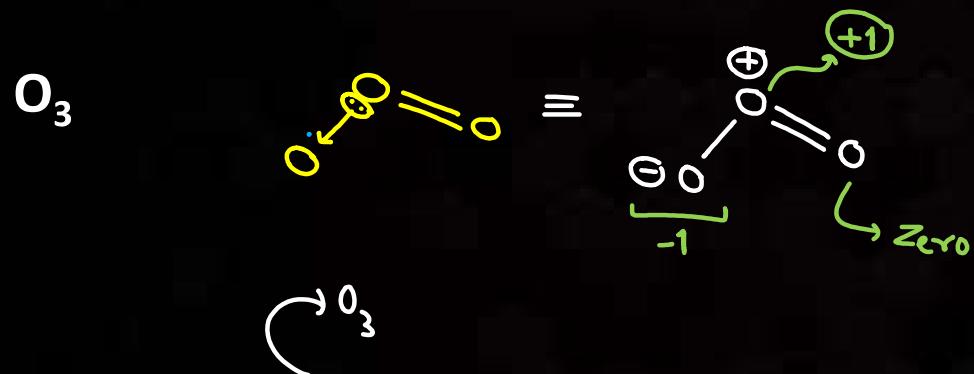


Resonating Hybrid

Bond Order

P
W

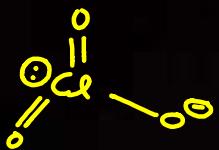
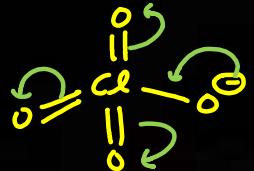
$$\text{B.O.} = \frac{4+2}{4} = \frac{6}{4} = 1.5$$



Formal Charge :

$$(\text{B.O.})_{\text{O}_3} = 1.5$$

Structure



Bond order

$$\text{B.O.} = \frac{4+3}{4}$$

$$\text{B.O.} = \frac{3+2}{3}$$

$$\text{B.O.} = \frac{2+1}{2}$$

$$\text{B.O.} = 1$$

Acid Strength



↙



↙



↙



↙



Conj. Base

Stable

Stability





Bond Parameters

Bond Angle

Bond length

Bond Energy

Dipole Moment





Bond Angle

Angle between two bonds.

$$sp \rightarrow \theta = 105^\circ$$

$$sp^2 \rightarrow \theta = 120^\circ$$

$$sp^3 \rightarrow \theta = 109^\circ 28'$$



Molecules without lone pair



Molecules with lone pair



Hybridisation

No of lone pair $\uparrow : \theta \downarrow$

Size of CA $\uparrow : \theta \downarrow$

Size of SA $\uparrow : \theta \uparrow$

EN of SA $\uparrow : \theta \downarrow$

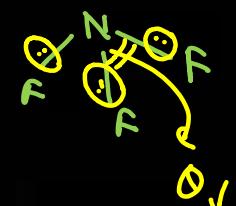
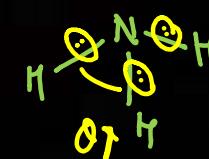


Diagram illustrating the effect of lone pairs on bond angle. A central atom (N) is bonded to four other atoms (H or F). As the number of lone pairs increases from one to three, the bond angle decreases from approximately 105° to 100°.

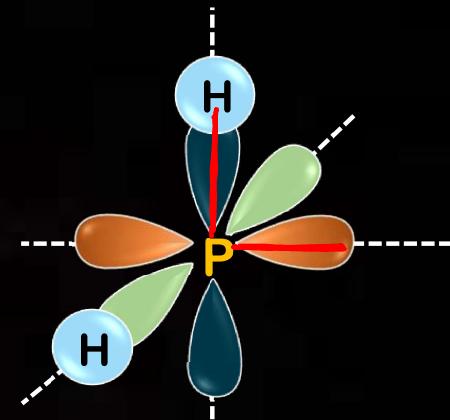


Drago Compounds

NO Hybridisation

NH_3	107°	H_2O	104.5°
PH_3	93.6°	H_2S	92°
AsH_3	91.8°	H_2Se	91°
SbH_3	91.3°	H_2Te	90°

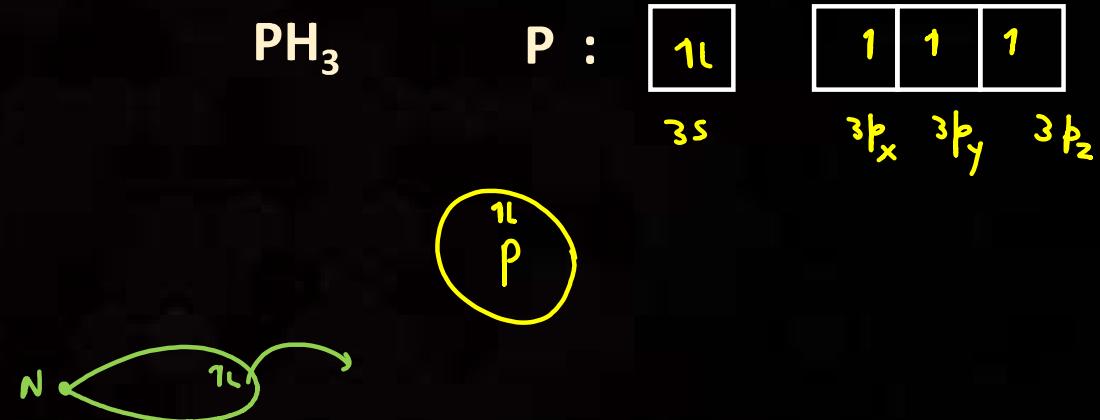
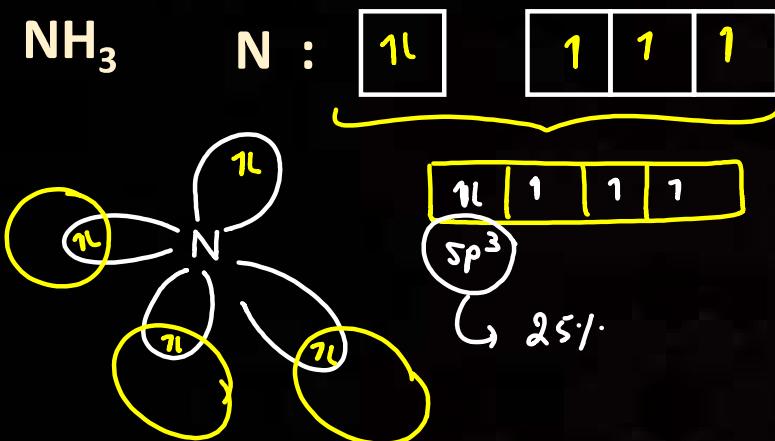
Nitrogen
Oxygen





Lewis Basicity

$\text{NH}_3 > \text{PH}_3$: Lewis basicity ✓



Due to fact that lone pair on N is in **sp^3 hybrid orbital** which is more diffused and directional. But lone pair on P is present in a '**s**' orbital which is contracted and non-directional.



Bond Length

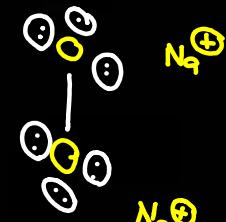
P
W

Bond length ↗ No of shell

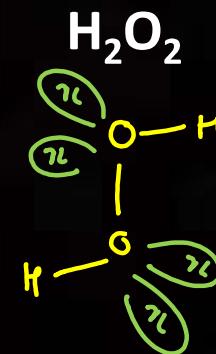


Bond length ↓ ← Bond order ↑ $\text{C}\equiv\text{C} < \text{C}=\text{C} < \text{C}-\text{C} : \beta \downarrow$

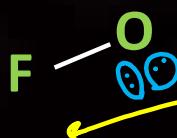
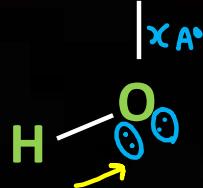
Bond length :



$\chi > \gamma$

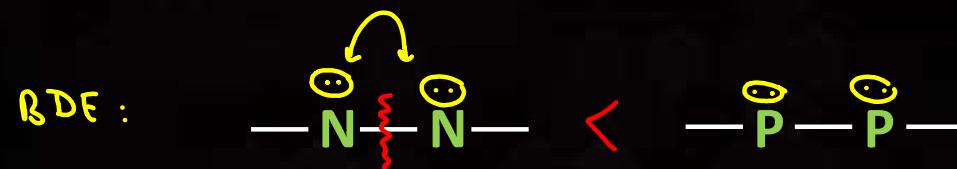
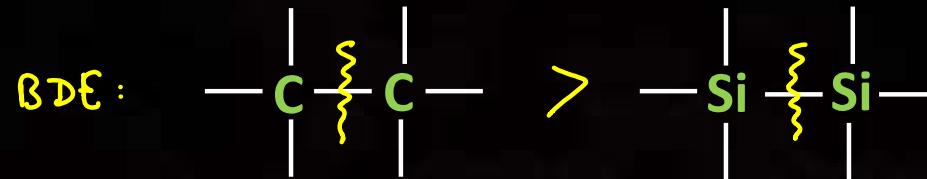


Bond length :





Bond Dissociation Energy



Q.

The correct order of increasing bond angles in the following triatomic species is :

A



B



C

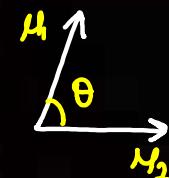
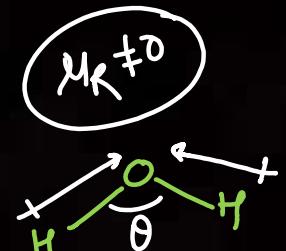
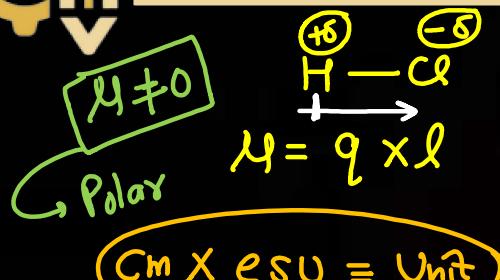


D





Dipole Moment



Unit : Debye (D)

$$1 \text{ D} = 10^{-18} \text{ esu cm}$$

$$\mu_R = \sqrt{\mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 \cos\theta}$$

$$\cos\theta \propto \frac{1}{\theta}$$

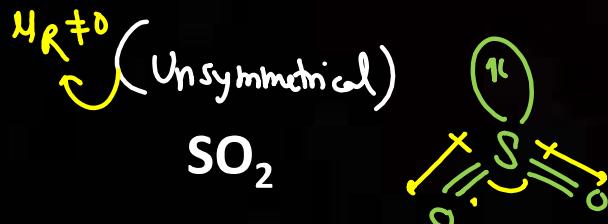
$$q_e = 1.6 \times 10^{-19} \text{ C}$$

$$= 4.8 \times 10^{-10} \text{ esu}$$



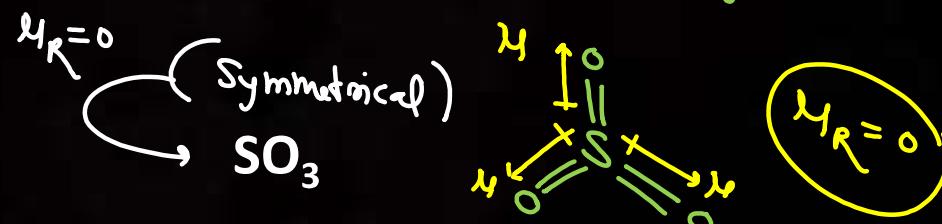
Polar Molecule

Hetero-nuclear diatomic



Non-polar Molecule ($\mu_R = 0$)

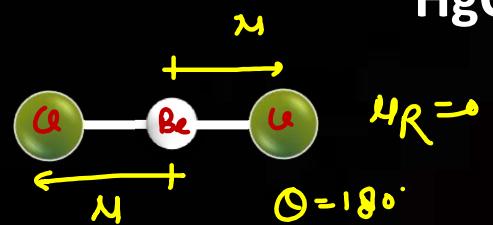
Homonuclear diatomic $\xrightarrow{\circ}$ 0% ionic character



A polyatomic molecule having polar covalent bonds but zero dipole moment indicates the symmetrical structure of the molecule.

Linear

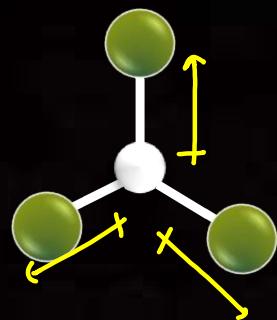
AB_2 : BeCl_2
 HgCl_2



Trigonal planar

AB_3 : BF_3
 BCl_3
 BH_3
 SO_3

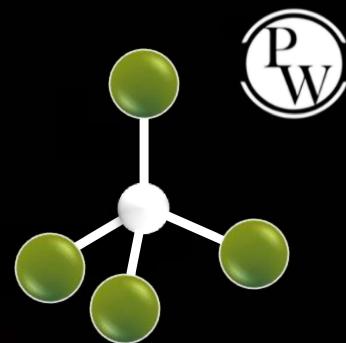
$$\mu_R = 0$$



Tetrahedral

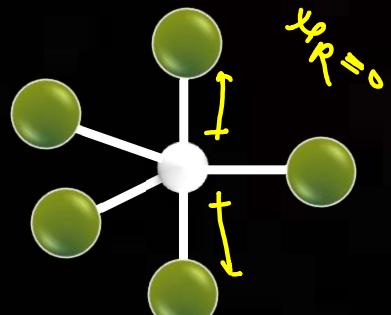
AB_4 : CH_4
 NH_4^+

$$\mu_R = 0$$



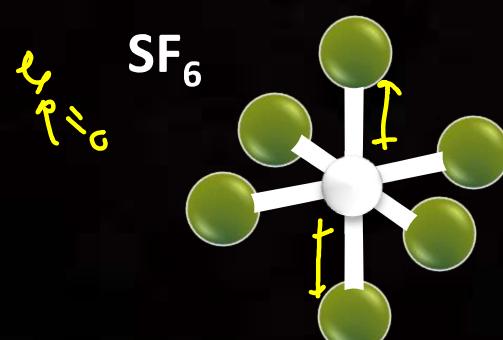
Trigonal Bi-Pyramidal

PF_5
 PCl_5



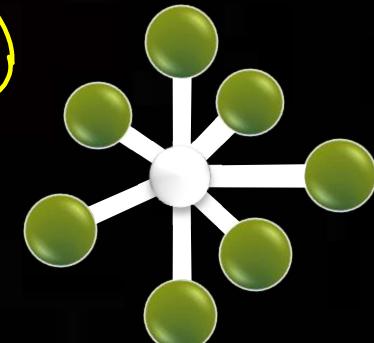
Octahedral

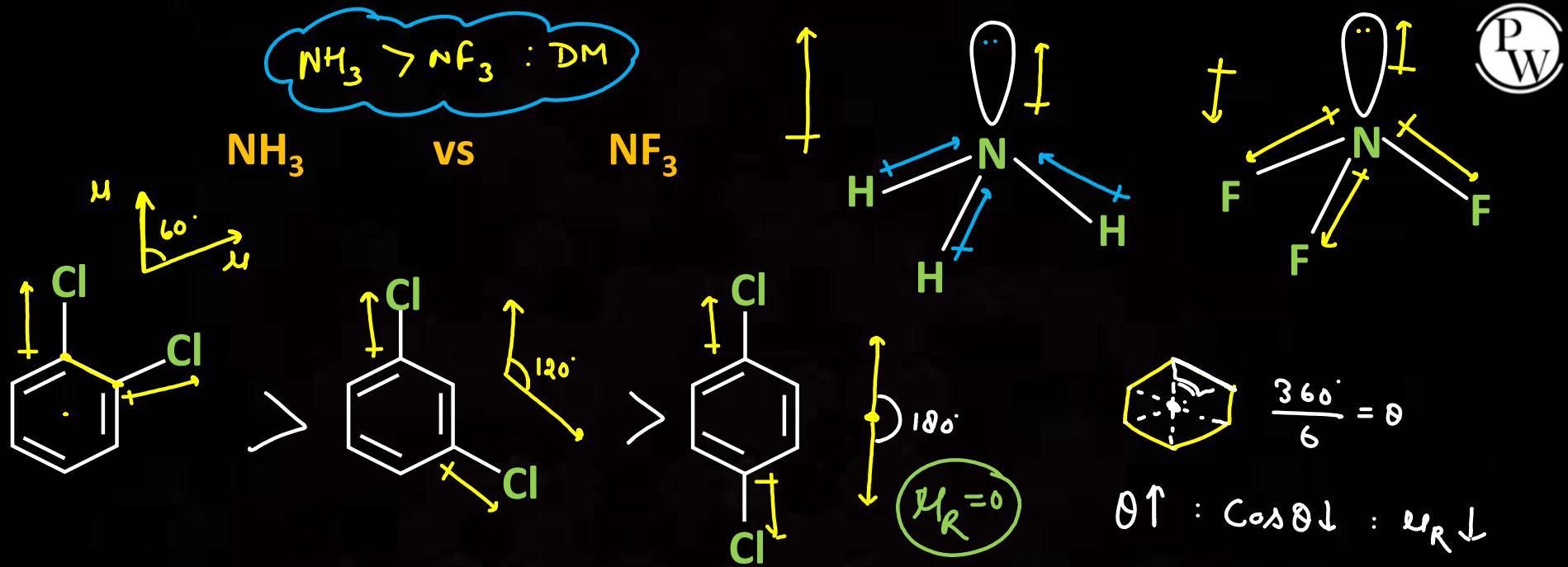
SF_6



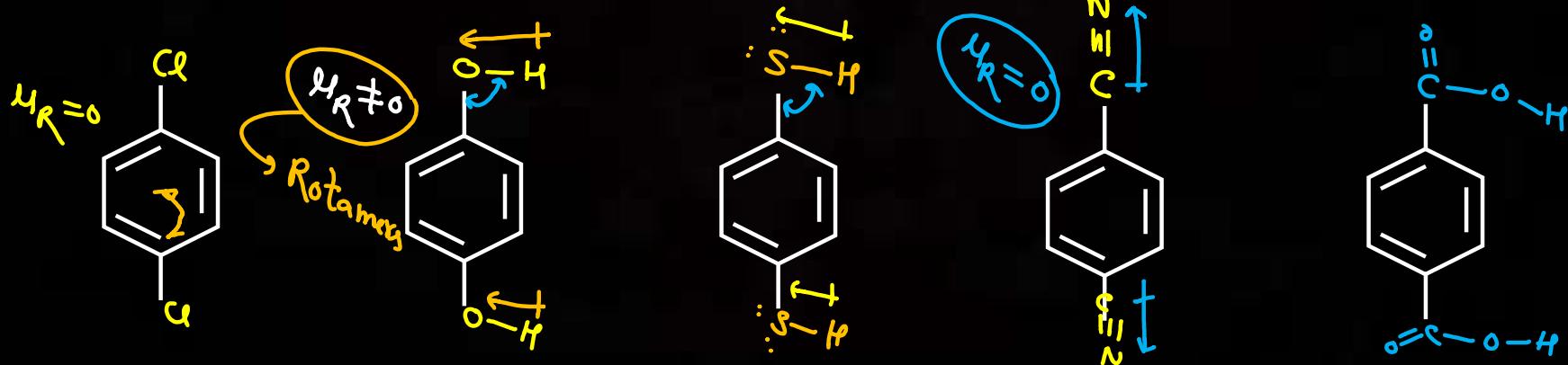
Pentagonal Bipyramidal

IF_7





If $X = \text{Cl}, \text{OH}, \text{SH}, \text{CN}, \text{COOH}$

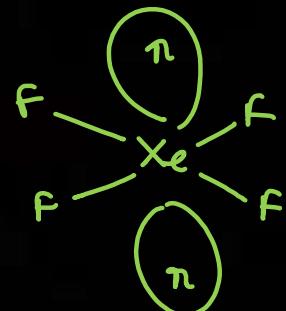


If molecule have $\mu = 0$.

Then it should be linear or having symmetrical geometry.

Linear — CO_2 , CS_2 , $\text{BeCl}_2(\text{g})$

Symmetrical geometry — BF_3 , CH_4 , PCl_5 , SF_6 , IF_7 , XeF_4



If molecules has $\mu \neq 0$



Then it should be angular or having unsymmetrical geometry.

Angular — SnCl_2 , PbCl_2 , SO_2 ,

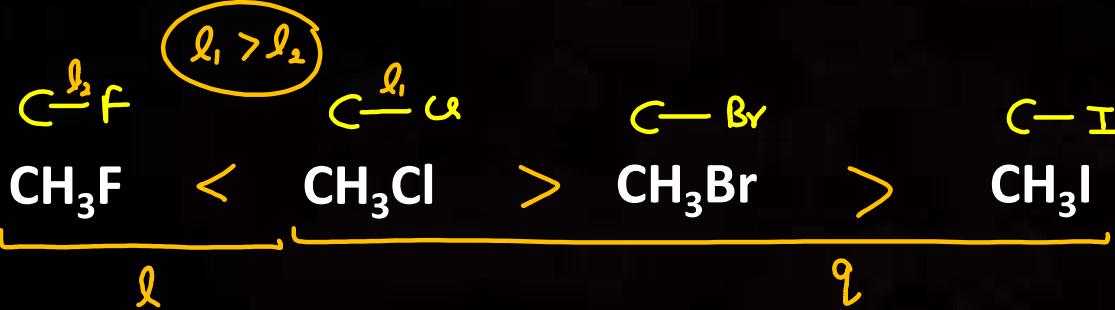
Unsymmetrical geometry — NH_3 , H_2O , NF_3 , SF_4 , SF_4 , H_2S



$$\mu = q \times l$$

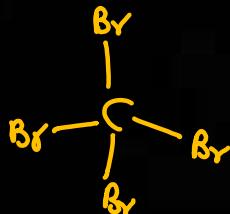
P
W

$$q \uparrow : \mu \uparrow$$



ℓ

q



Q.

Which of the following molecules has the maximum dipole moment?

A



B



C



D



Q.

Which of the following is a polar molecule?

A



B



C



D



Q.

Which of the following would have a permanent dipole moment?

A



B



C



D



Q.

Which of the following set of molecules will have zero dipole moment?

A

Boron trifluoride, hydrogen fluoride, carbon dioxide, 1, 3-dichlorobenzene

B

Nitrogen trifluoride, beryllium difluoride, water, 1, 3-dichlorobenzene

C

Boron trifluoride, beryllium difluoride, carbon dioxide, 1, 4-dechlorobenzene

D

Ammonia, beryllium difluoride, water, 1, 4-dichlorobenzene



% Ionic Character in Covalent Bond



($l = 1.275 \text{ \AA}$)



$$\mu_{(\text{exp/obs})} = 1.03 \text{ D}$$

$$\% \text{ IC} = \frac{\mu_{\text{obs/exp}}}{\mu_{\text{Theo}}} \times 100$$

$$= \frac{1.03 \times 10^{-10} \text{ esu-cm}}{(4.8 \times 10^{-10})(1.275 \times 10^{-8})} \times 100$$

$$\mu_{(\text{cal/theo})}$$



$$q = 4.8 \times 10^{-10} \text{ esu}$$

$$\mu_{\text{Theor}} = (4.8 \times 10^{-10})(1.275 \times 10^{-8})$$

For 100% ionic character

It is assumed that 1 electron is completely transferred from one atom to another

$$\mu_{(\text{cal/theo})} = q \cdot l$$

For HCl gas molecule $\mu = 1.03 \text{ D}$ and bond distance = 1.275 \AA

Calculate the % ionic character.

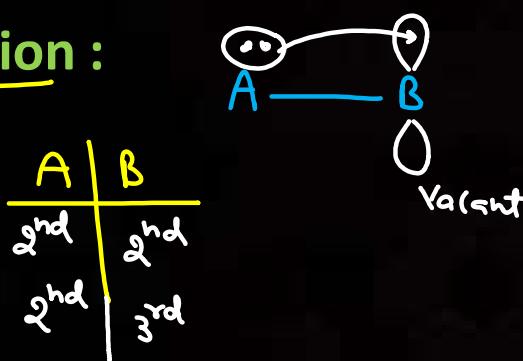


Bond Bonding

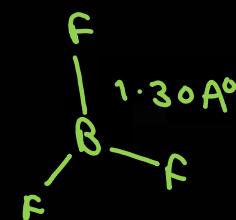
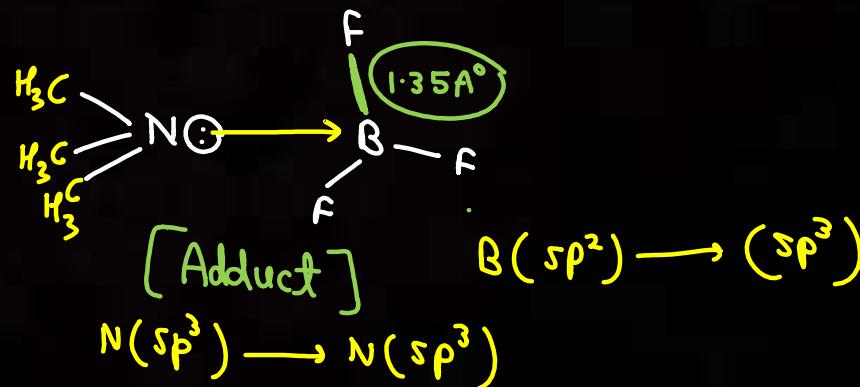
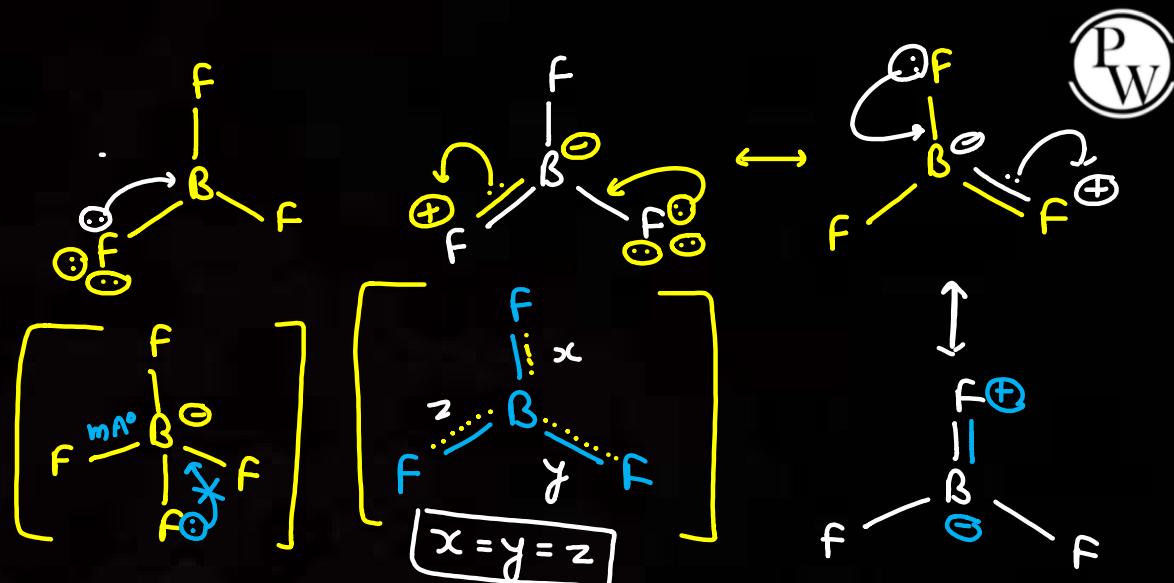
Coordinate pi bond

Bond length : $\text{BF}_3 < \text{BF}_4^-$

Condition :



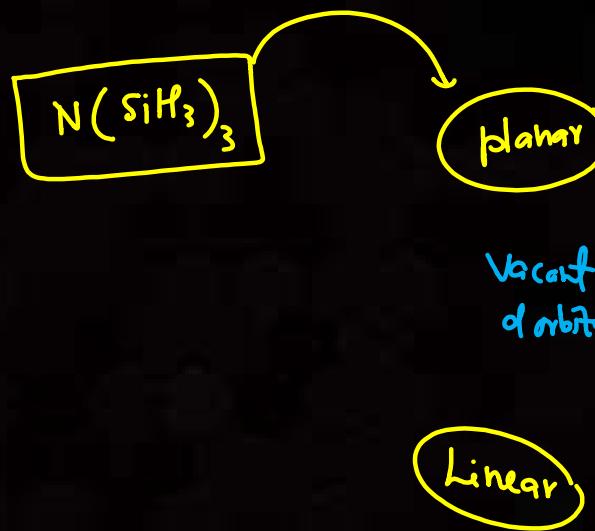
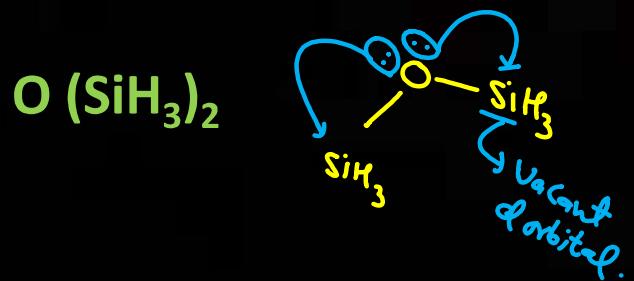
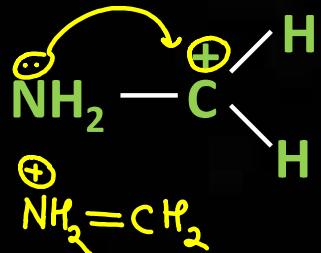
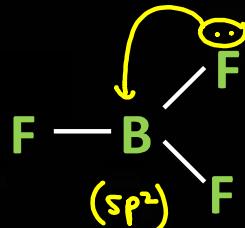
The $\text{B} - \text{F}$ bond length in $\text{Me}_3\text{N} \cdot \text{BF}_3$ is 1.35 \AA , much longer than 1.30 \AA in BF_3 . Explain?



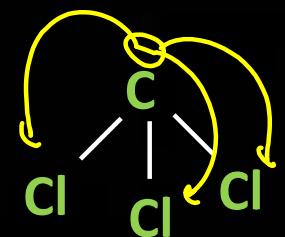
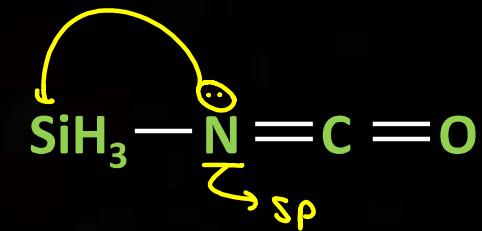
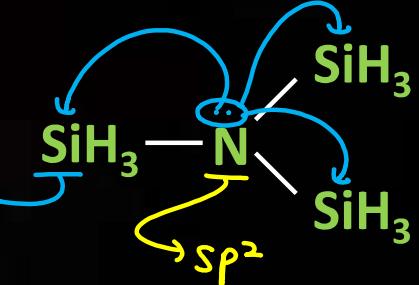


Direction of back bonding

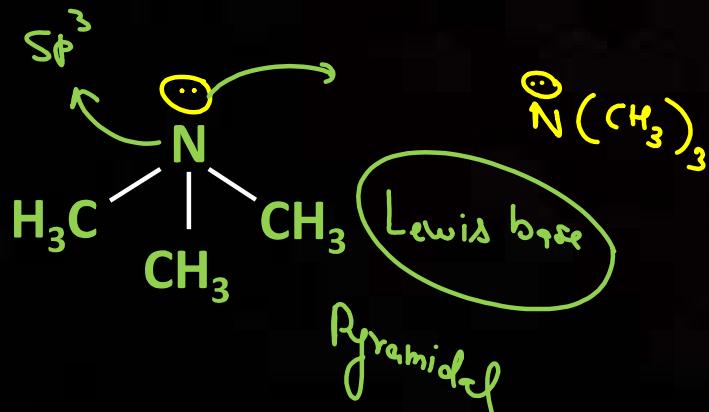
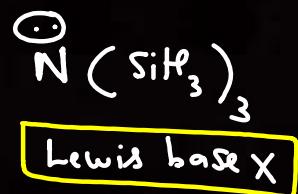
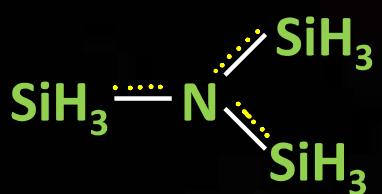
(1) SA to CA (No change in hy.)



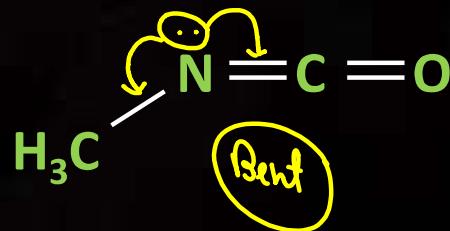
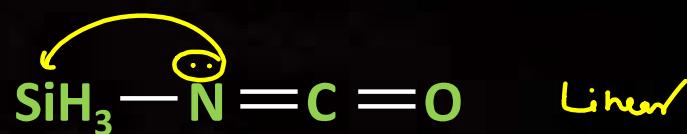
(2) CA to SA



Trisilylamine is a planar molecule and does not act as a lewis base while **trimethylamine** is pyramidal and act as lewis base !

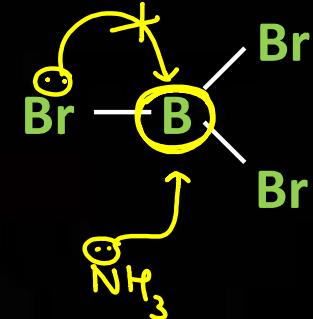
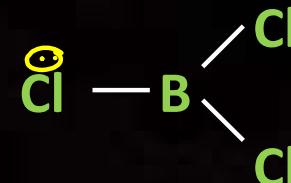
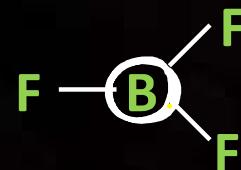


Silyl isocyanate (SiH_3NCO) is linear but methyl isocyanate (CH_3NCO) is bent explain !





Lewis acidic character



Extent of overlapping :

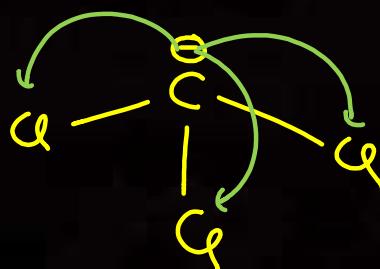
$$(2p - 2p) > (3p - 2p) > (4p - 2p)$$

Lewis acidity :

<

<

Which is more acidic?

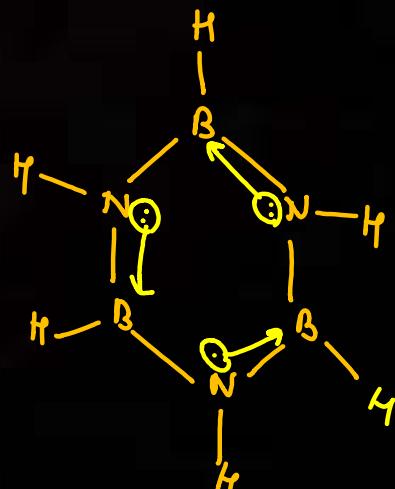


Amin → Stable ↑



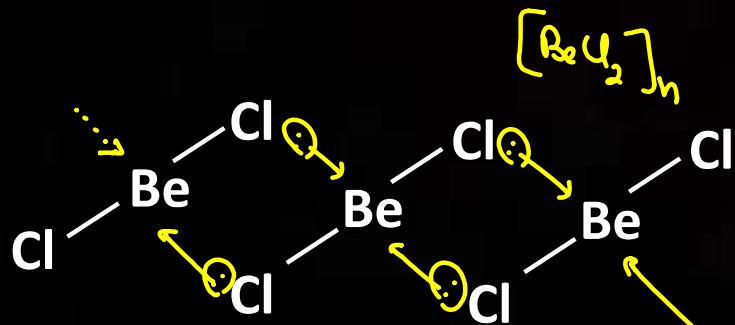
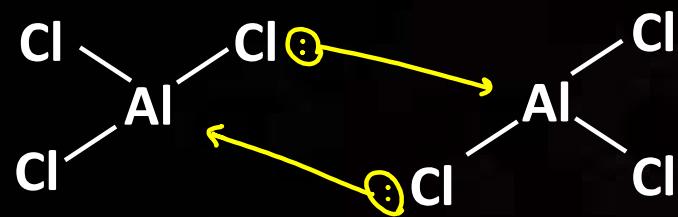
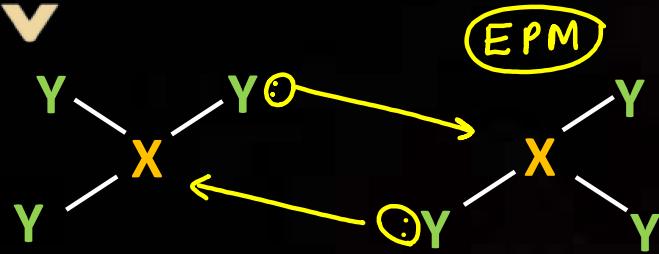
Inorganic Benzene

Borazine / Borazole

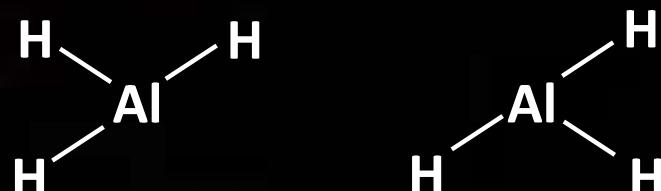
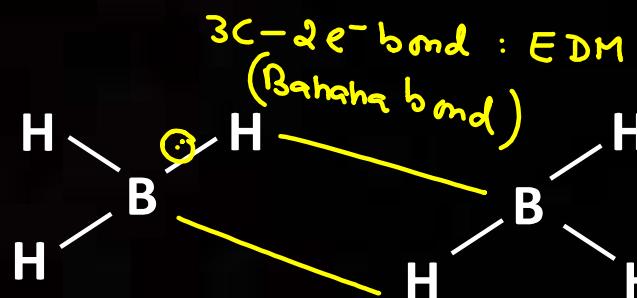
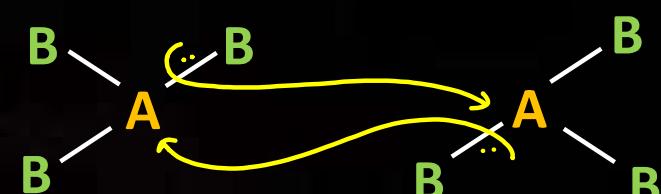




Bridge Bonding



EDM [B : has no lp]





Diborane




$\text{B} :$

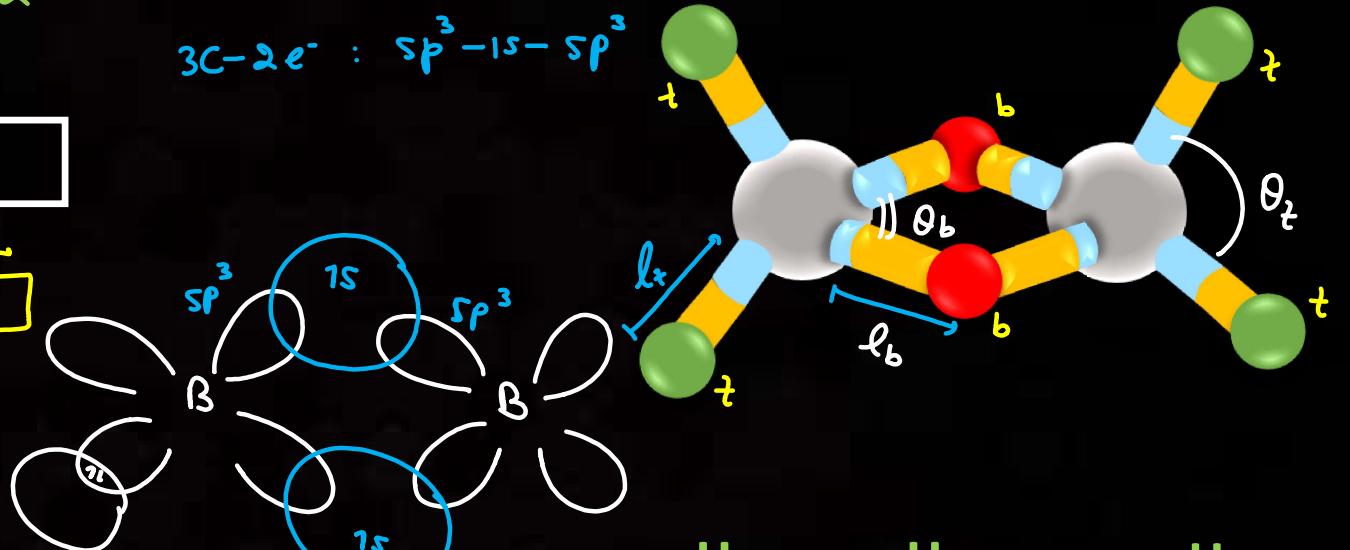
1

1	1	1
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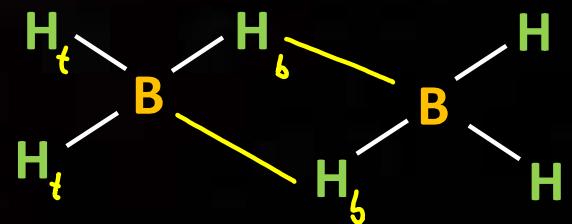


1	1	1	1
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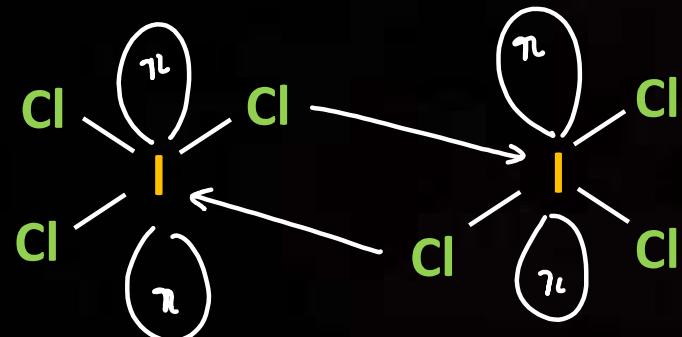
$3\text{C}-2e^- : \text{sp}^3-\text{1s}-\text{sp}^3$



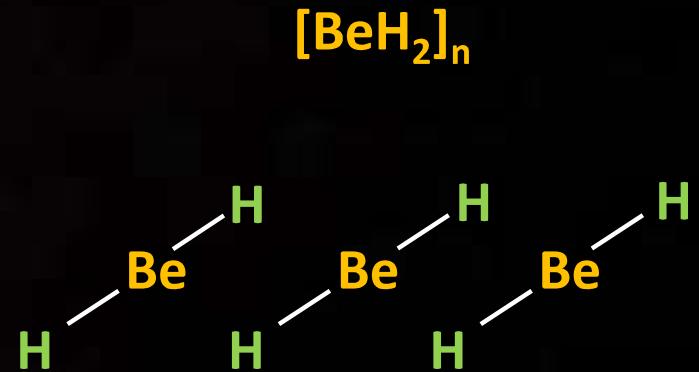
Bond Length : $l_t < l_b$



Bond Angle : $\theta_t > \theta_b (\approx 90^\circ)$
 (120°)



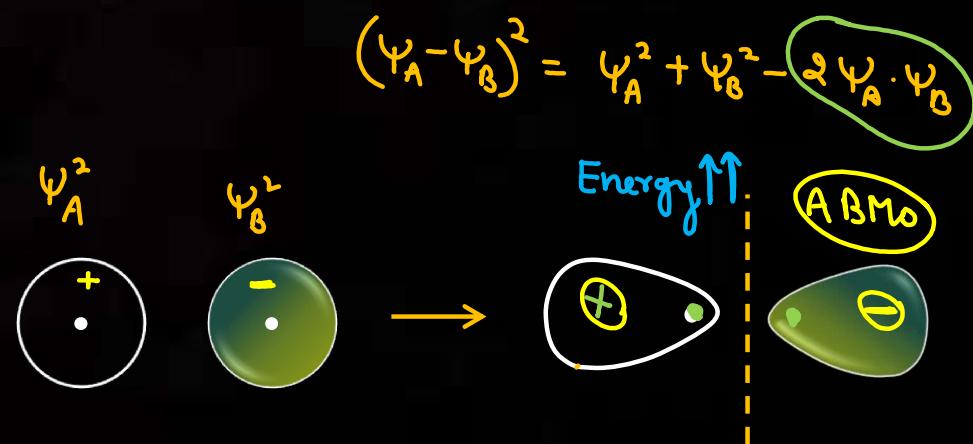
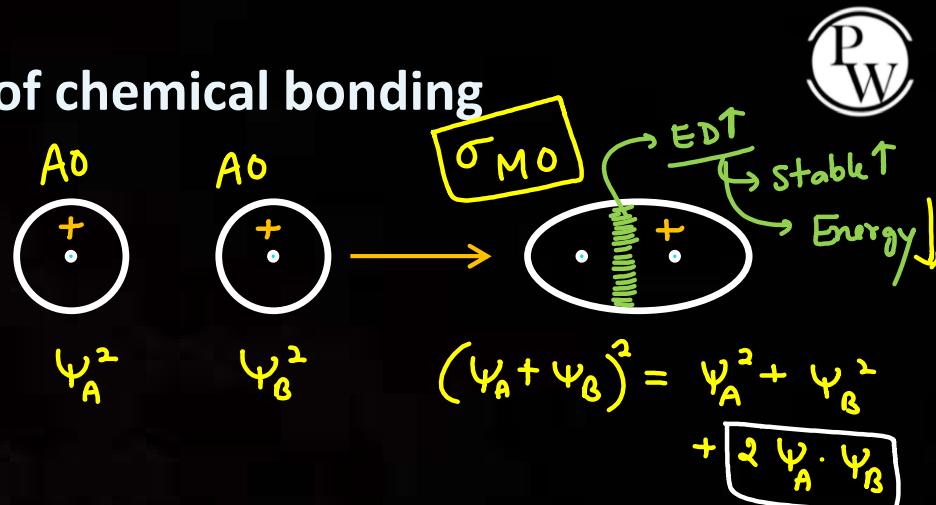
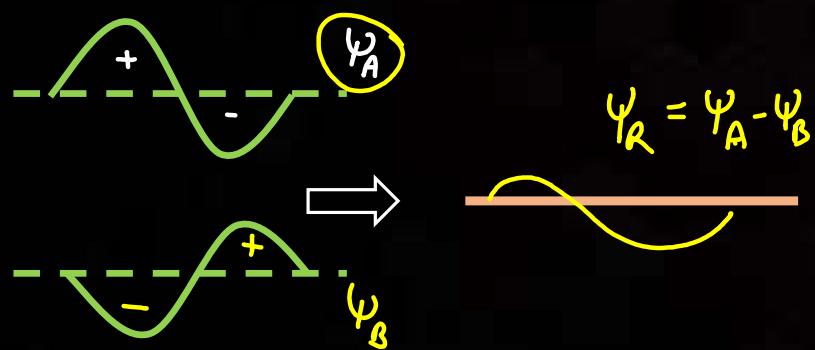
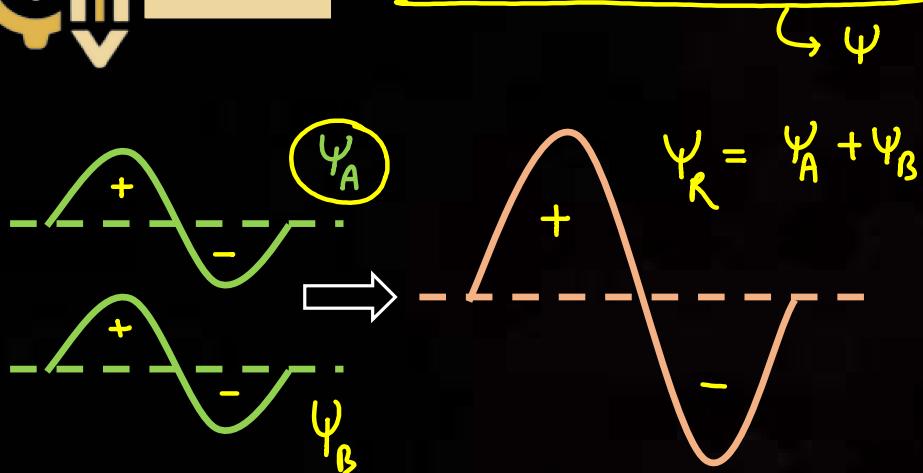
No. of atoms in same plane : 8



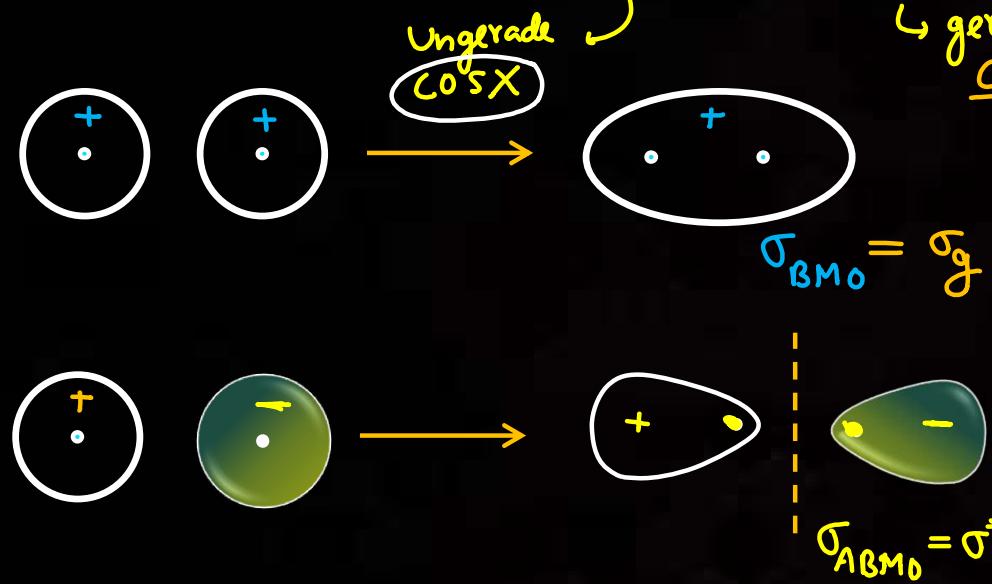


MOT

Quantum mechanical theory of chemical bonding

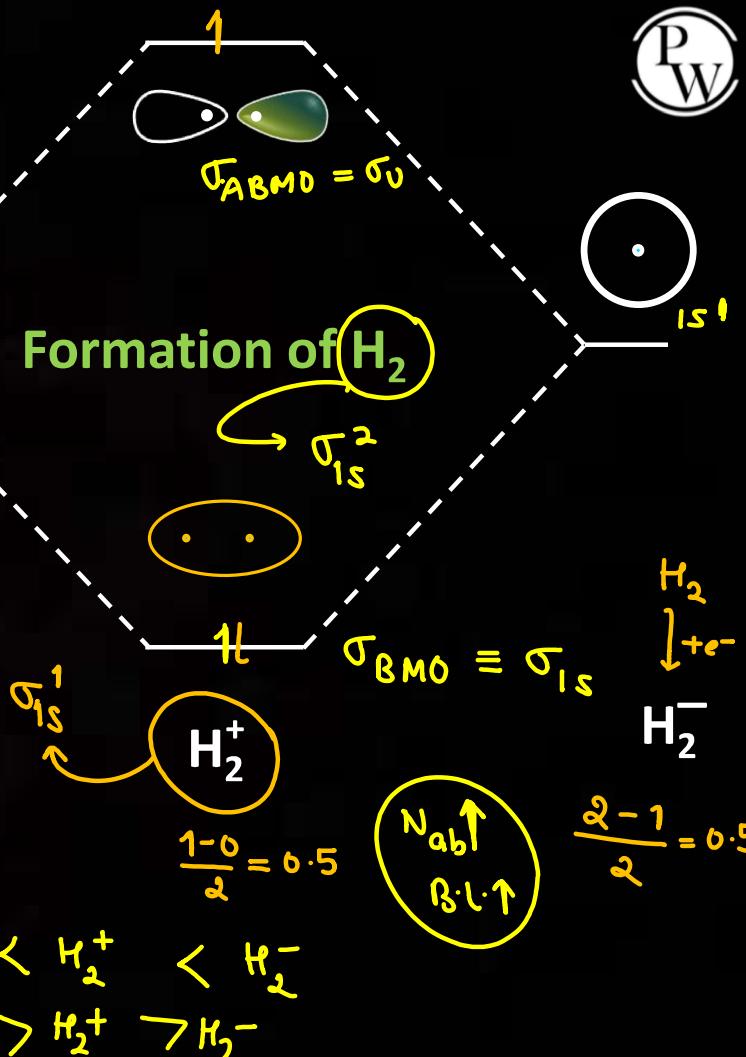


S-S overlapping & Symmetry Term

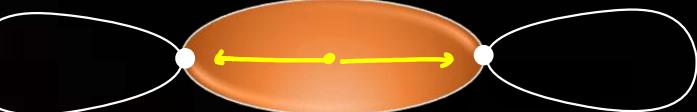
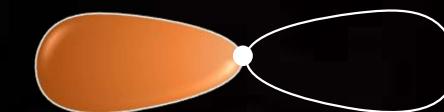
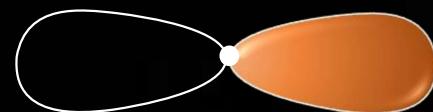


Bond Order : $\frac{N_b - N_{ab}}{2}$

MOT
 $\sigma \cdot 0 \neq 0$
 BO
 BL
 BDE
 Existence

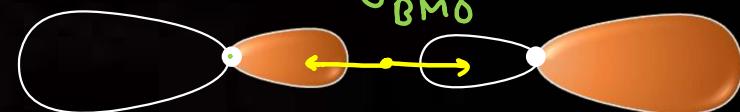
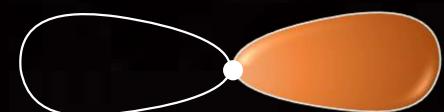
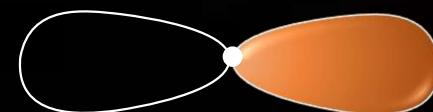


➤ P-P overlapping



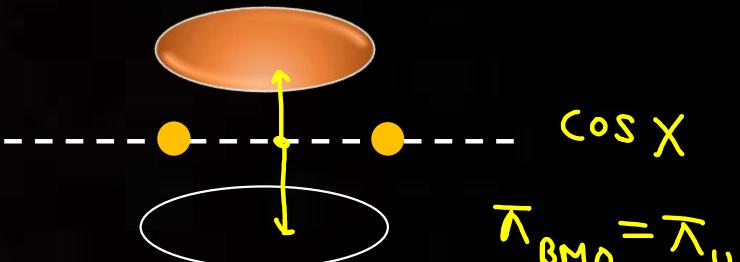
$$\cos \checkmark \sigma_{BMO} = \sigma_g$$

P
W



$$\sigma_{BMO}$$

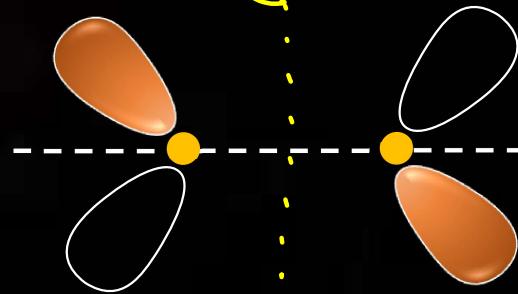
$$\cos X \quad \sigma_{ABMO} = \sigma_u$$



$$\cos X$$

$$\pi_{BMO} = \pi_u$$

Nodal plane ✓

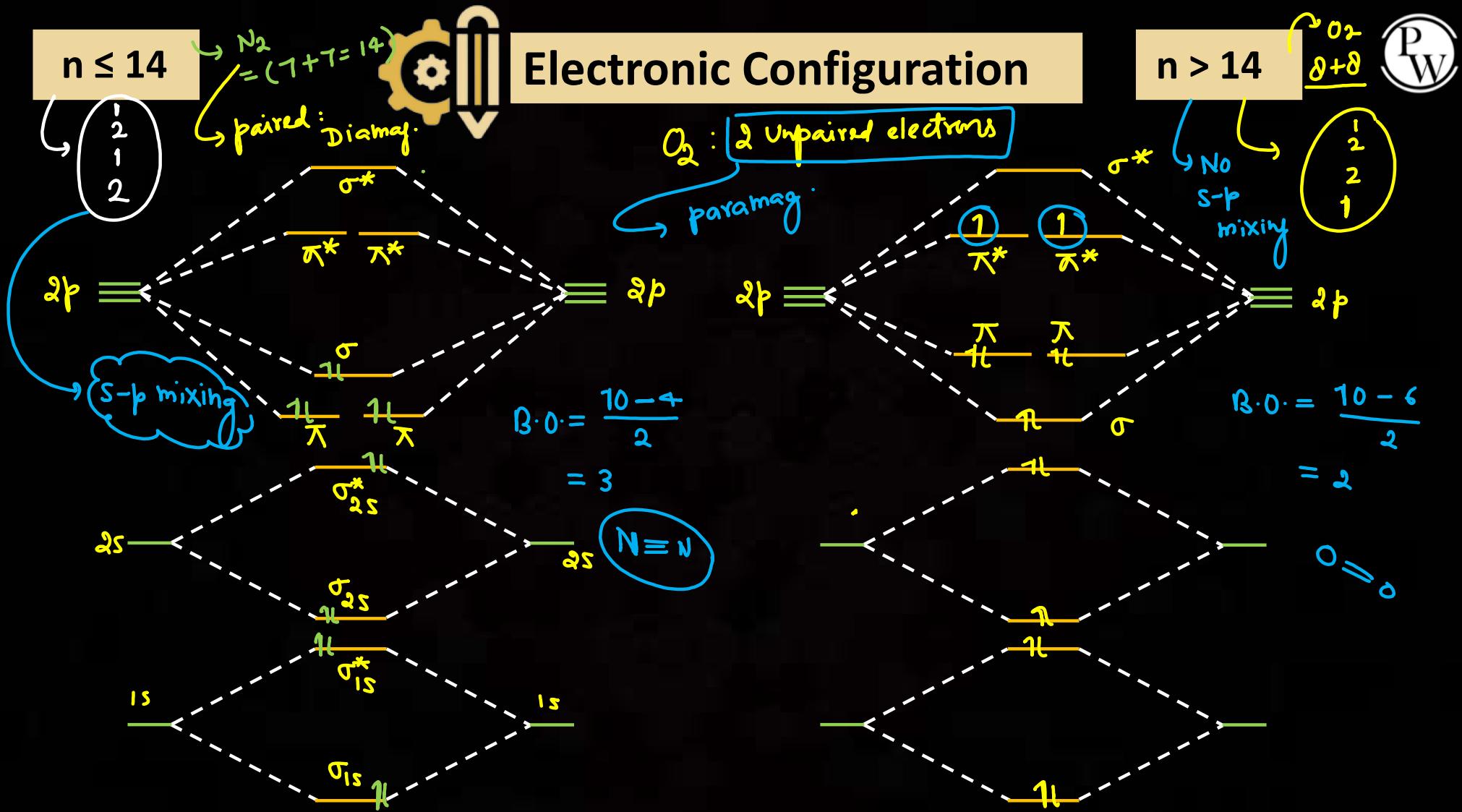


$$\cos$$

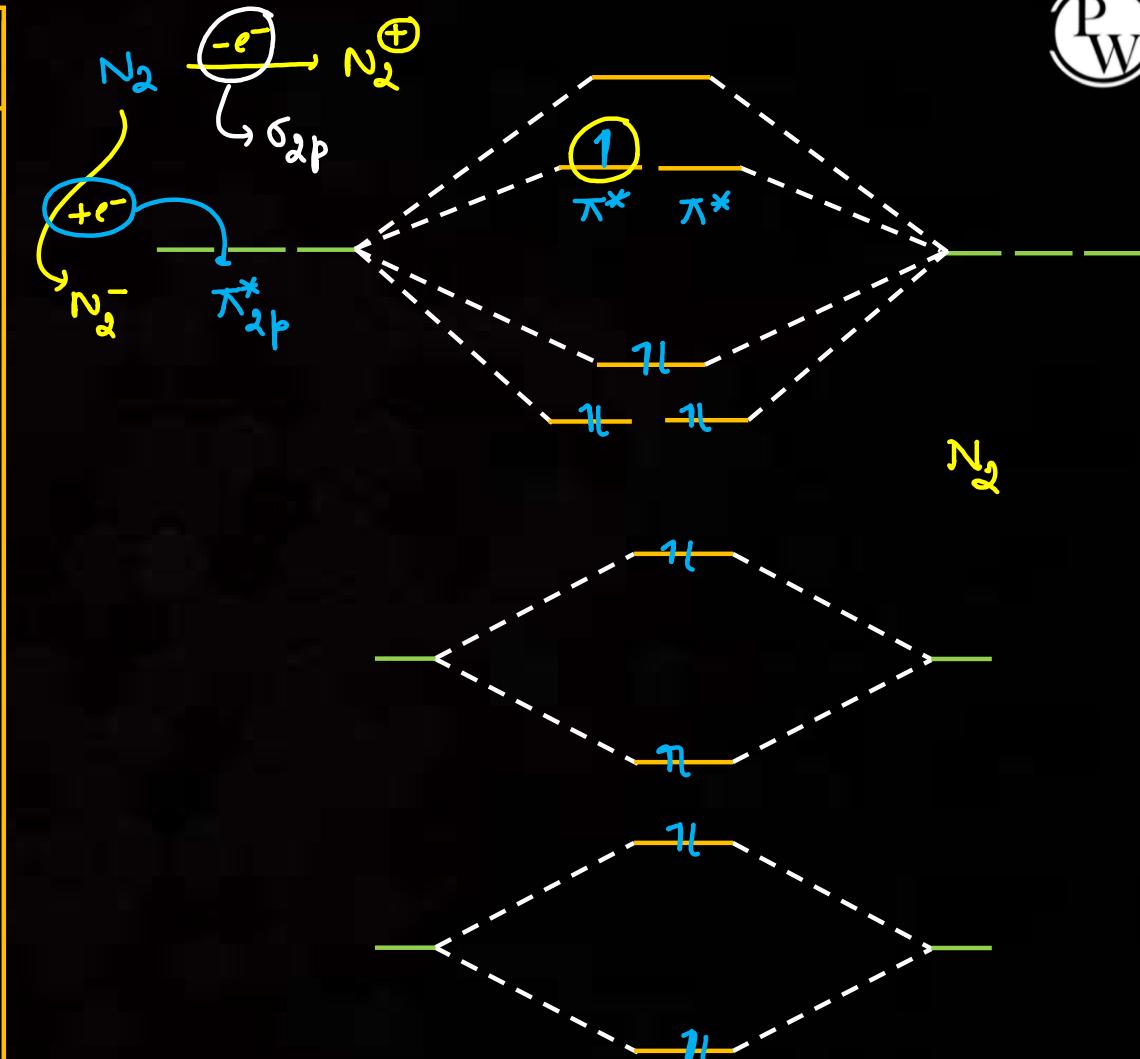
$$\pi_{ABMO}$$

$$\pi_g^*$$

Electronic Configuration



	N_2	N_2^+	N_2^-
N_b	10	9	10
N_{ab}	4	4	5
BO	3	2.5	2.5
BL	$N_2 <$	$N_2^+ < N_2^-$	
BS	$N_2 > N_2^+ > N_2^-$		
BDE	$N_2 > N_2^+ > N_2^-$		
Magnetic Behaviour	Dia	para	para
Existance	✓	✓	✓



Electronic configuration $n > 14$

HW



N_b

N_{ab}

BO

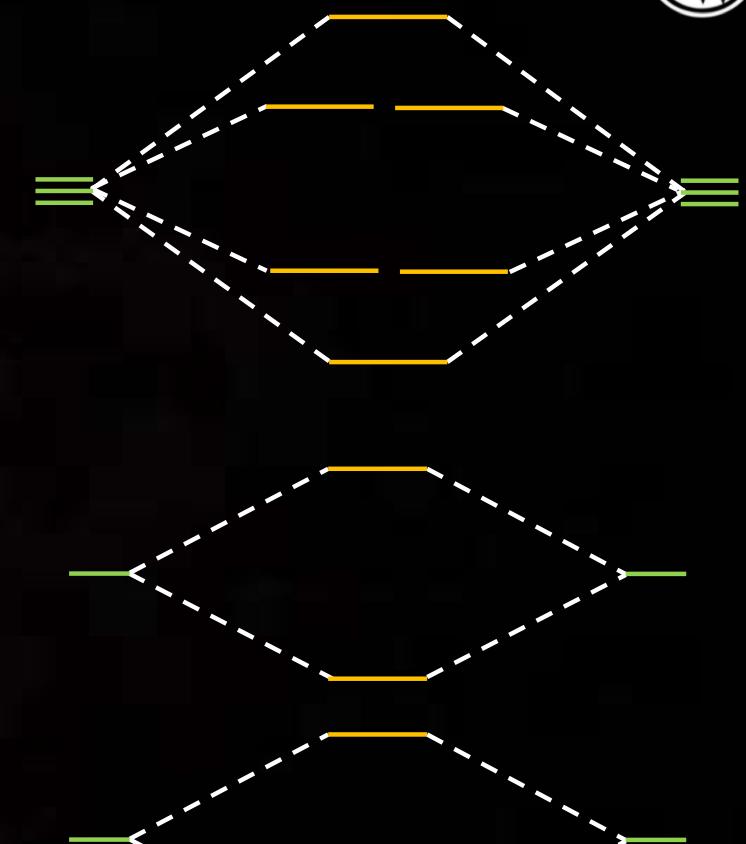
BL

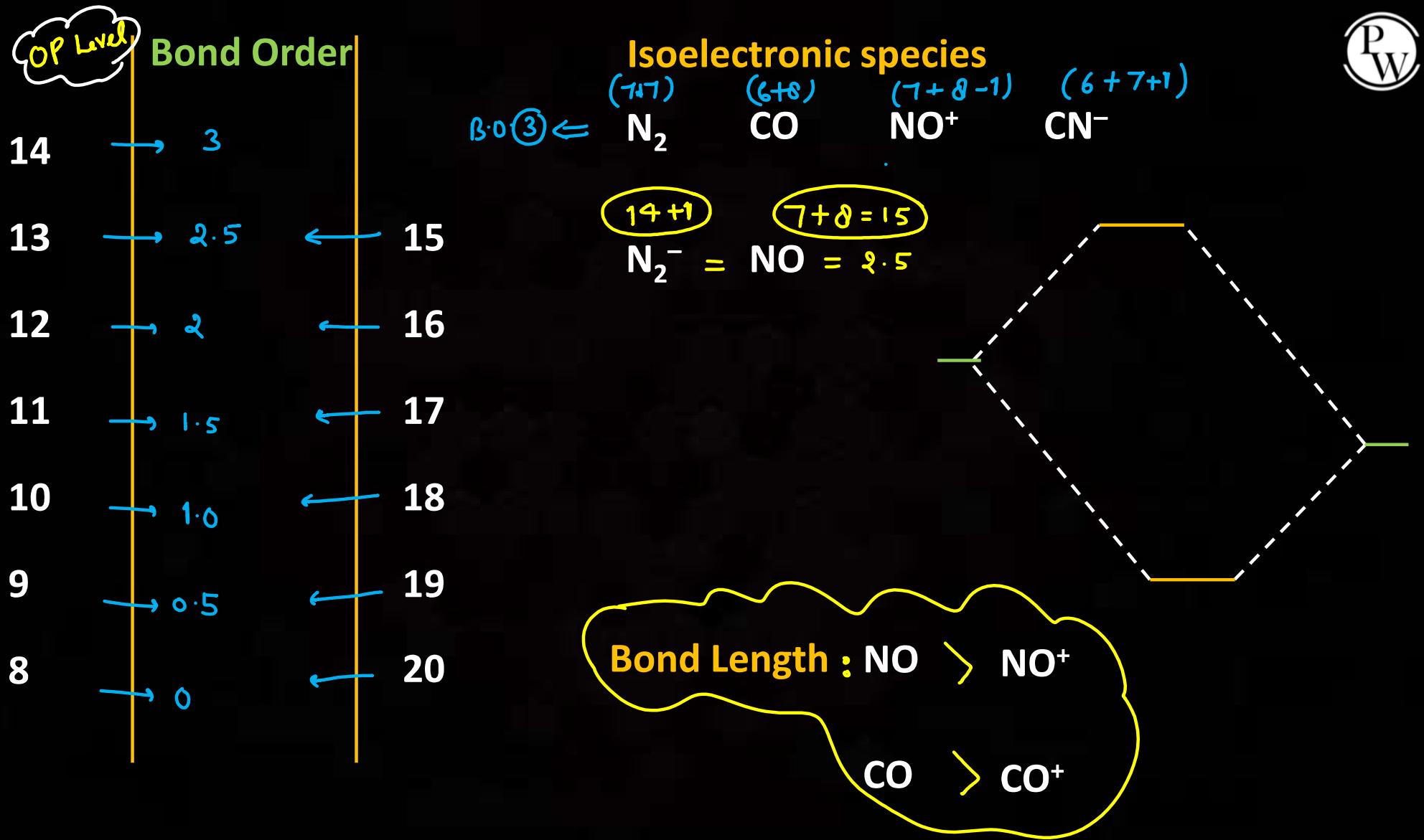
BS

BDE

Magnetic
Behaviour

P
W





Q.

Which of the following diatomic molecular species has only π -bonds according to Molecular orbital Theory?

A O_2 B N_2 C C_2 D Be_2

Q.

Which of the following diatomic molecular species has only π -bonds according to Molecular orbital Theory?

A

Dissociation energy of N_2^+ > dissociation energy of N_2

B

Dissociation energy of N_2 = dissociation energy of N_2^+

C

Dissociation energy of N_2 > dissociation energy of N_2^+

D

Dissociation energy of N_2 can either be lower or higher than the dissociation energy of N_2^+

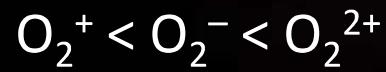
Q.

The correct bond order in the followings species is :

A



B



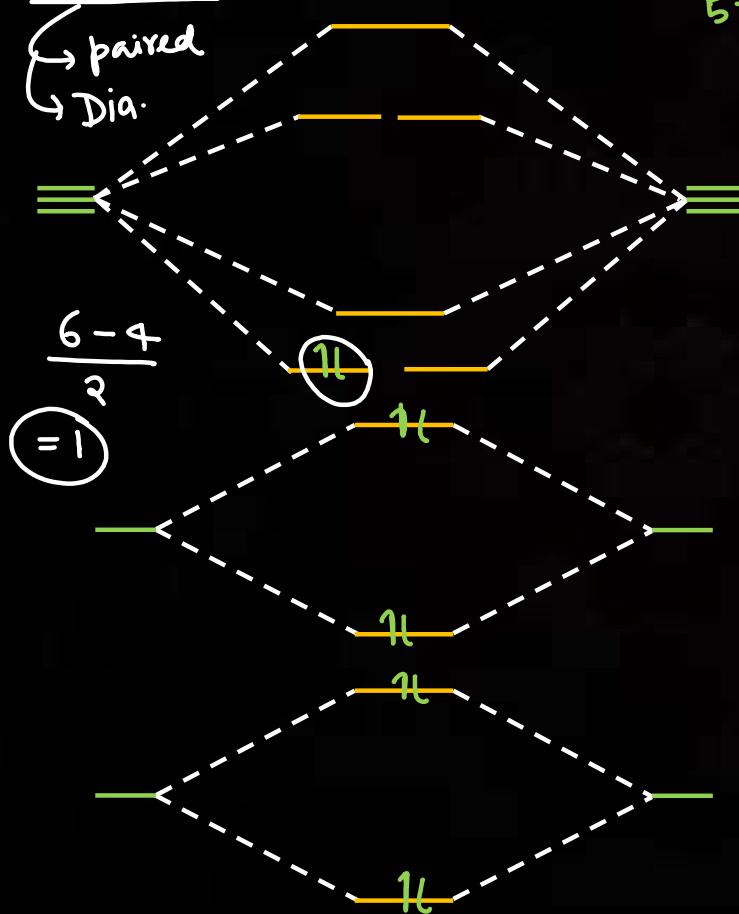
C



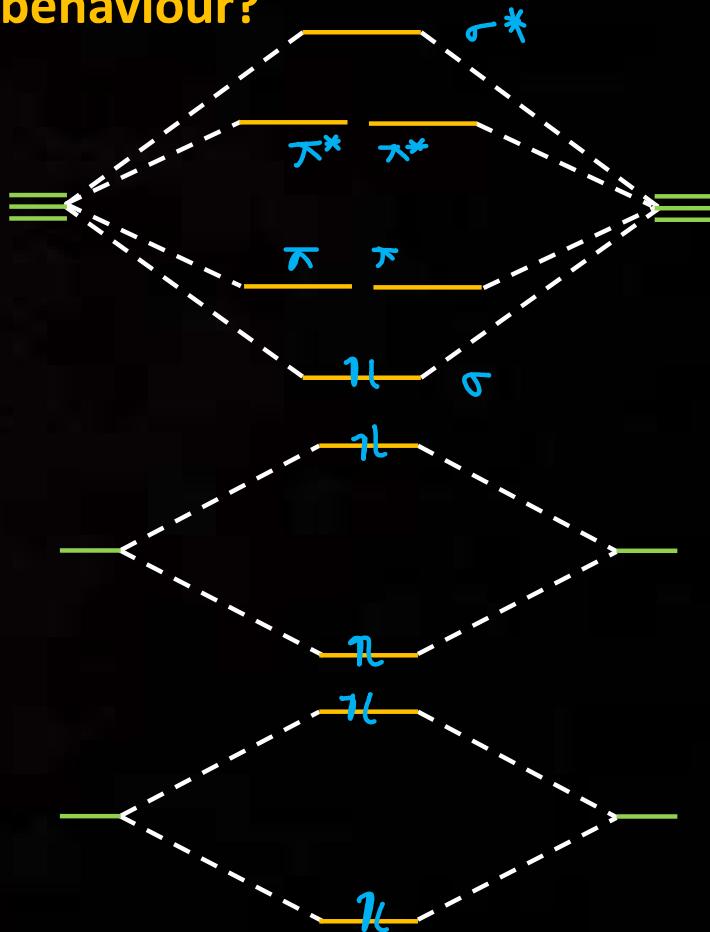
D



Assume violation of Hund's rule in B_2 molecule, then calculate bond order & magnetic behaviour?

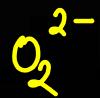


Assume no 2s–2p mixing in B_2 molecule, then calculate bond order & magnetic behaviour?





BO :



(1.5)



(2)



BO :



(2)



BO :



Magnetic Behaviour : O_2



Q.

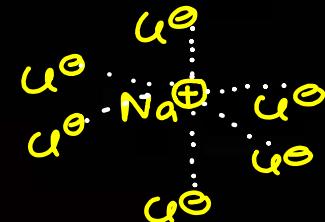
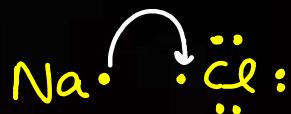
Which of the following diatomic molecular species has only π -bonds according to Molecular orbital Theory?

A O_2 B N_2 C C_2 D Be_2



Ionic Bonding

P
W



a) Metal

b) Group of atoms
having (+)ve charge



a) Non-metal

b) Group of atoms having
(-)ve charge



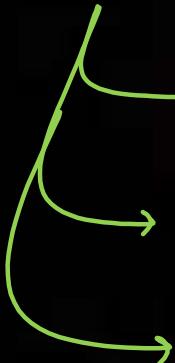
The chemical bond formed between two or more atoms as a result of transfer of one or more electrons between them.



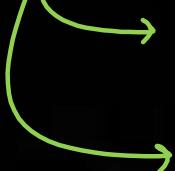
Electrovalent bonds

P
W

Favourable Condition :

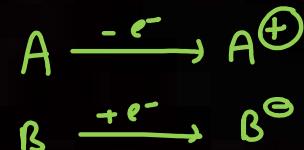


Less I.E.



More E.A.

Energy released because of the combination of cation and anion should be high.



Non-directional in nature



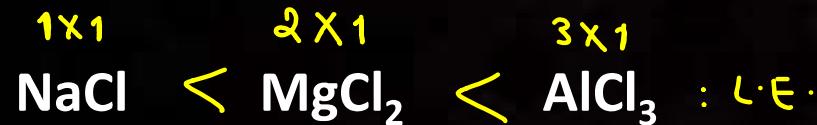
Lattice Energy



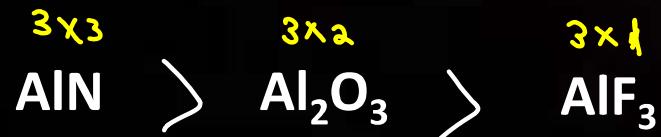
Energy which is released when the component ions (in gas phase) were brought together from infinity to make the lattice of the crystal.



Factors affecting LE



$$\text{L.E.} \propto q_1 q_2 \propto \frac{1}{r}$$



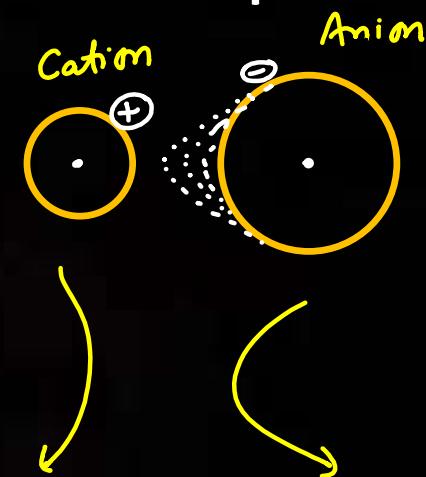


Fajan's Rule

Polarisation
Distortion of electron cloud



Covalent character in ionic compound



Polarising power ↑

Polarizability ↑

Covalent character ↑
↓

Size ↓

Size ↑

Covalent character ↑ : Charge ↑

Charge ↑

Ionic Character : LiCl < NaCl < KCl < RbCl < CsCl

Covalent Character : NaF < NaCl < NaBr < NaI



Covalent Character : SnCl₄ > SnCl₂

Polarising Power : D block cation > S block cation



Q.

Least melting point is shown by the compound :

A



B



C



D



Q.

Amongst LiCl , RbCl , BeCl_2 and MgCl_2 the compounds with the greatest and the least ionic character respectively are :

A

LiCl and RbCl

B

RbCl and BeCl_2

C

MgCl_2 and BeCl_2

D

RbCl and MgCl_2



Inter Molecular Force of Attraction



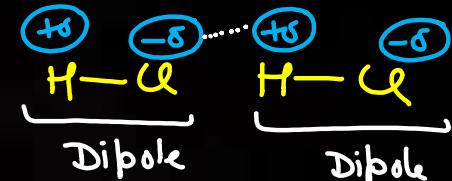
H-Cl Polar

Molecules

Non-Polar Cl-Cl

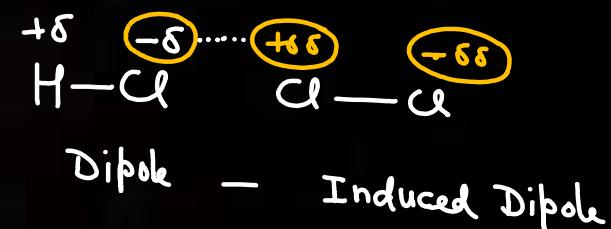
(1) Interaction between Polar molecules

Dipole - dipole attraction



(2) Interaction between Polar & non polar molecules

Dipole - induced dipole attraction



(3) Interaction between non-polar molecules

Instantaneous induced dipole - induced dipole

(Dispersion force/London force)





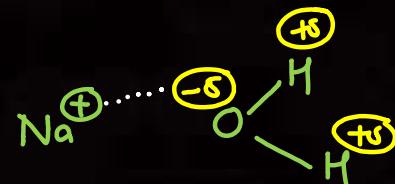
Order of Inter-molecular forces



Ion – ion attraction



Ion – dipole attraction



Dipole – dipole attraction

▽

Ion-induced dipole attraction



Dipole - induced dipole attraction

▽

Ins. Induced dipole - induced dipole

Ion \nrightarrow VWF OA



Energy & Distance Relationship

Ion-ion attraction $E \propto \frac{1}{r}$

Ion-dipole attraction $E \propto \frac{1}{r^2}$

Dipole-dipole attraction $E \propto \frac{1}{r^3}$

Ion-induced dipole attraction $E \propto \frac{1}{r^4}$

→ Dipole - induced dipole attraction

→ Ins. Induced dipole - induced dipole

$$E \propto \frac{1}{r^6}$$

These force are always attractive and interaction energy is inversely proportional to the sixth power of the distance between two interacting particles ($1/r^6$ where **r** is the distance between two particles).



Vander Waal Force of Attraction



Vander Waal force ↑ Molecular mass ↑

PH ₃	H ₂ S	HCl
AsH ₃	H ₂ Se	H Br
SbH ₃	H ₂ Te	H I
..
BP	BP	BP

Boiling Point ↑ ← Vander Waal force ↑

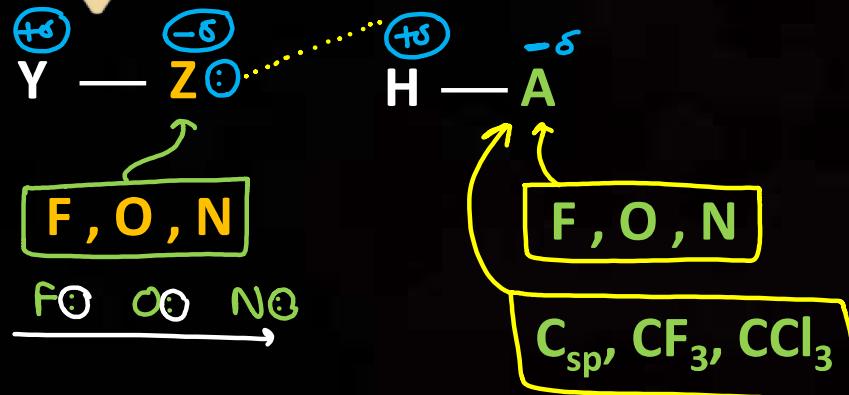
Size of the atom ↑

ρ·ρ· He < Ne < Ar < Kr < Xe



Hydrogen Bonding

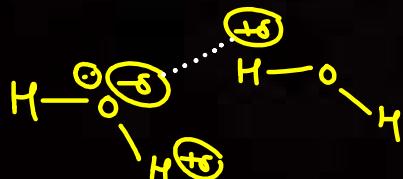
P
W



Extent of H-bonding

- ↓
- (i) Partial (+)ve charge on H
 - (ii) Electron density on Z

Water



Acetone & Chloroform

Acetone and Acetylene

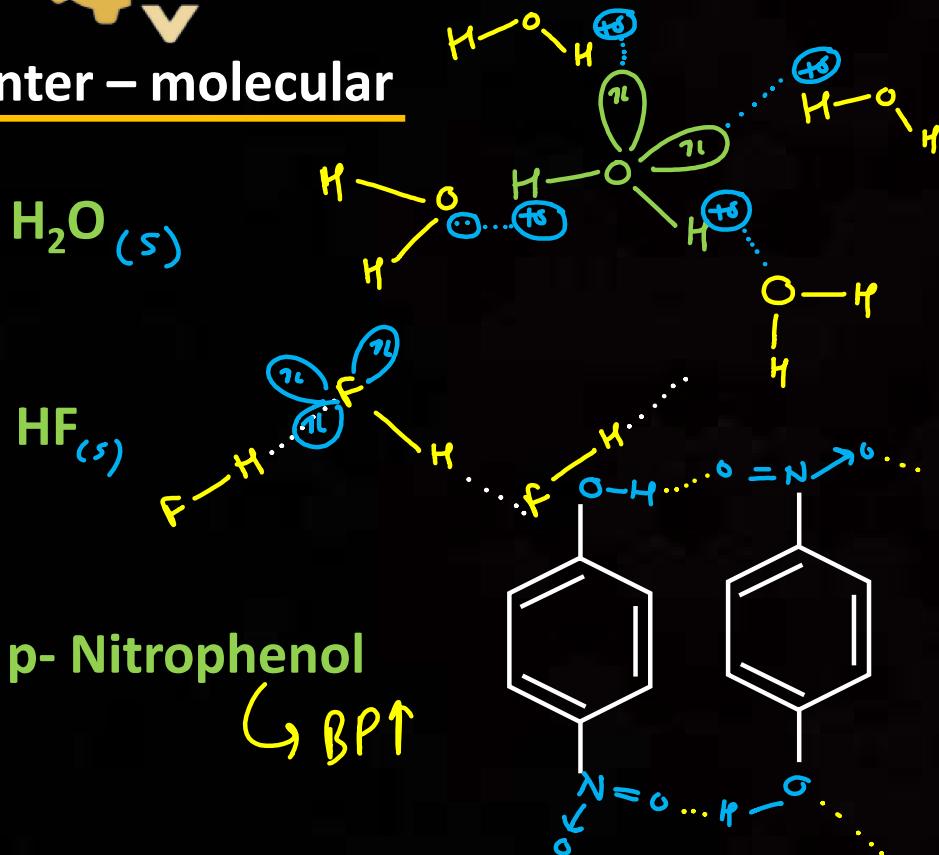
D_a



Types of Hydrogen Bonding



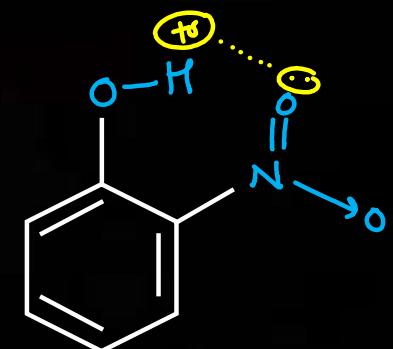
Inter – molecular



Intra – molecular

O-Nitrophenol

$\xrightarrow{\text{BP} \downarrow}$



Only HF and H_2O form polymeric structure due to H-bonding . HF froms linear polymeric , whereas H_2O froms tetrahedral polymeric structure .



Water

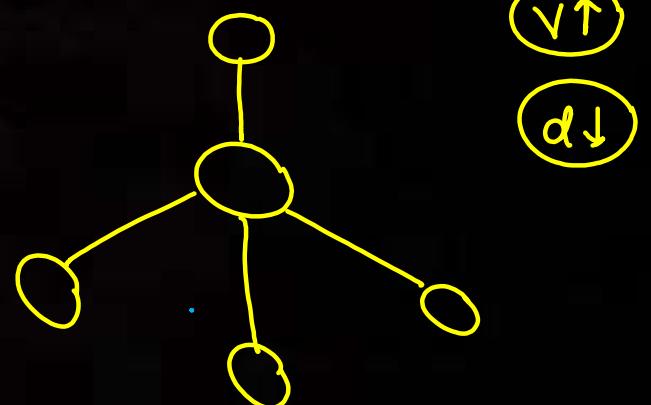


No. of water molecular attached
to 1 H_2O molecule = 4

Tetrahedrally bonded to a water
molecule in solid state.

Density : $\text{H}_2\text{O}_{(s)} < \text{H}_2\text{O}_{(l)}$

Volume :



Q.

Which one of the following molecules will form a linear polymeric structure due to hydrogen bonding?

A



B



C



D





Order of Boiling Point

B.P. \propto M.M

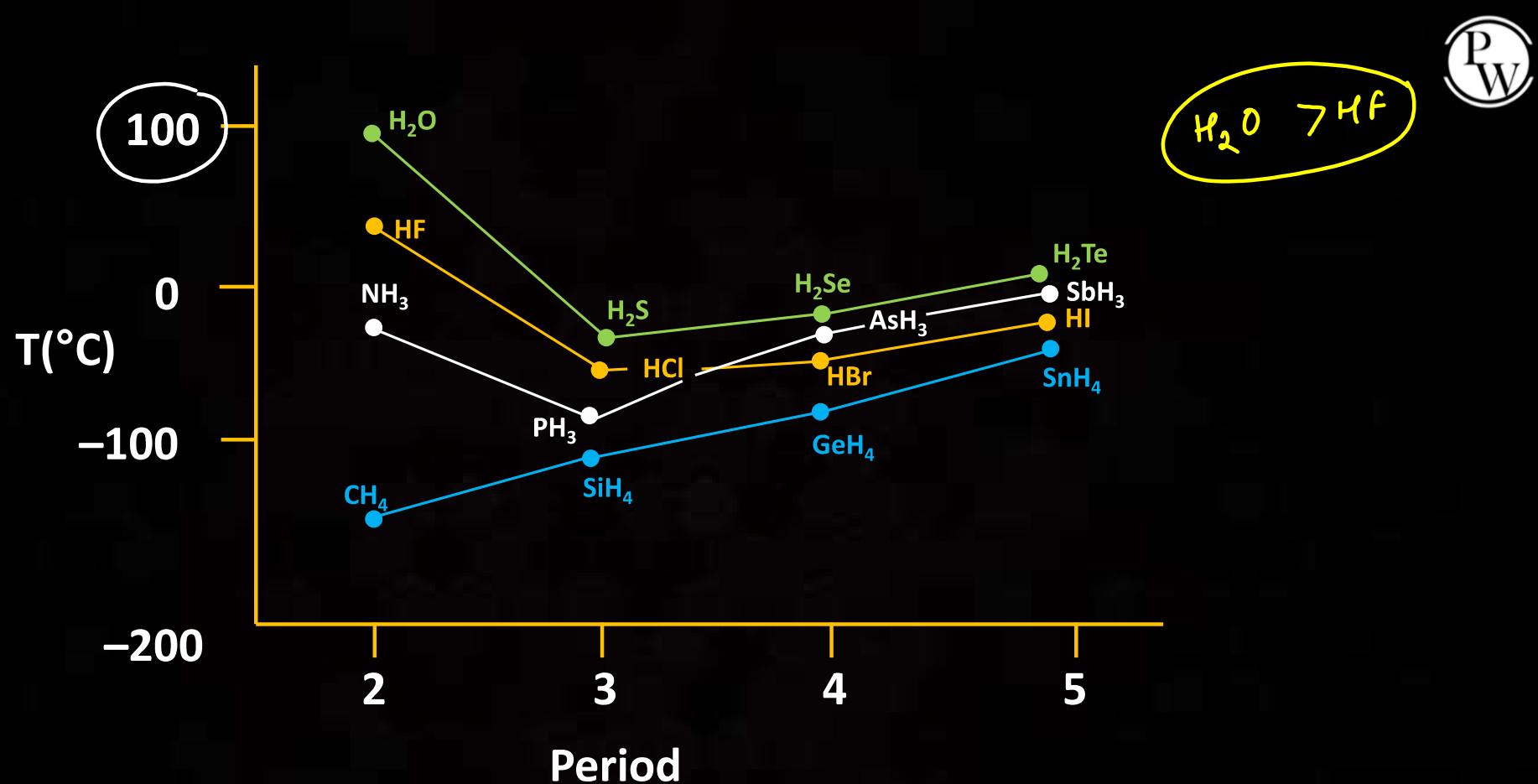


B.P.



(i) H_2O is liquid but H_2S is gas ?

(ii) HF is liquid but HCl is gas ?



Q.

Which intermolecular force is most responsible in allowing xenon gas to liquefy?

A

Instantaneous dipole-induced dipole

B

Ionic

C

Ion-dipole

D

Dipole-dipole