ONE SHOT

CHEMICAL BONDING

#BOUNCEBACK

Sakshi Vora

IIT Roorkee

- 7+ years Teaching experience
- 10th, 12th CBSE State Topper
- KVPY fellow ✓

BounceBack

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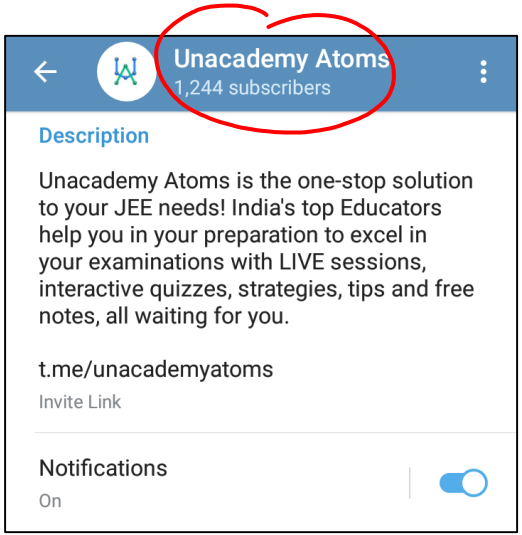
TELEGRAM CHANNEL

- T.ME/UNACADEMYATOMS



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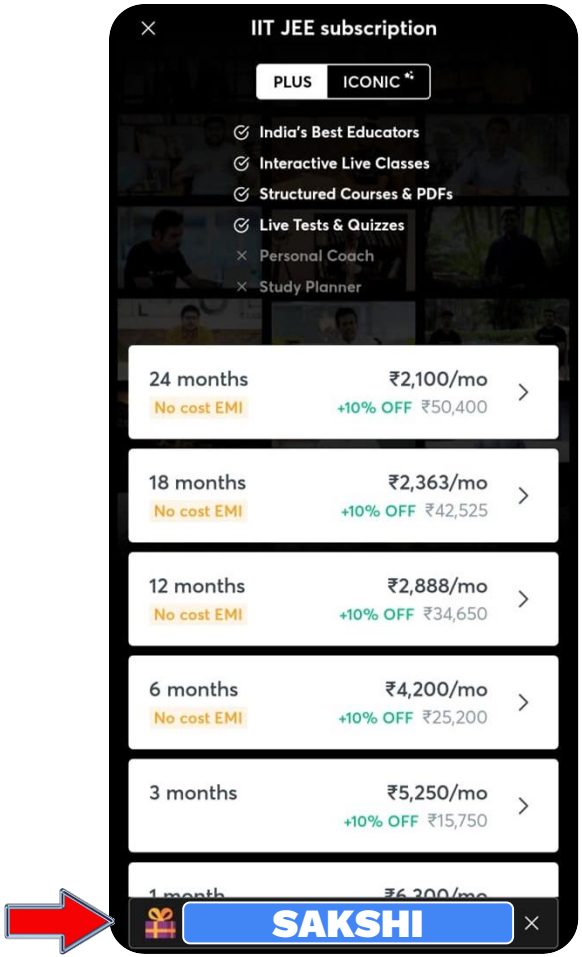
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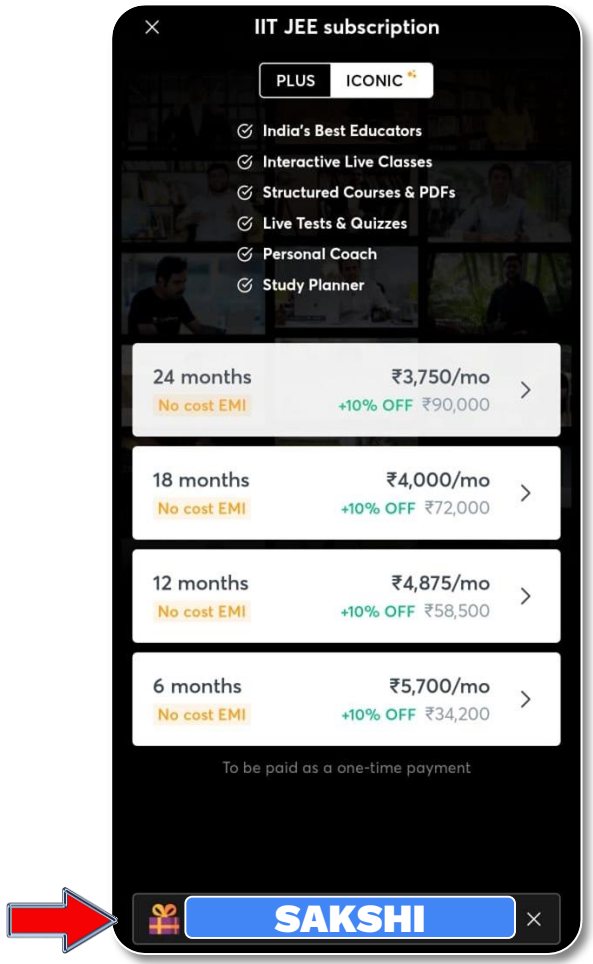
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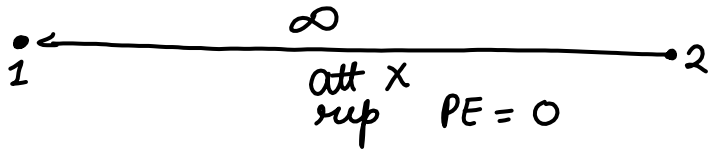
Chemical Bonding

Cause of Bond formation

Reason for bond formation



jee main → 2-3

$F_{att} \uparrow$ $F_{rep} \uparrow$

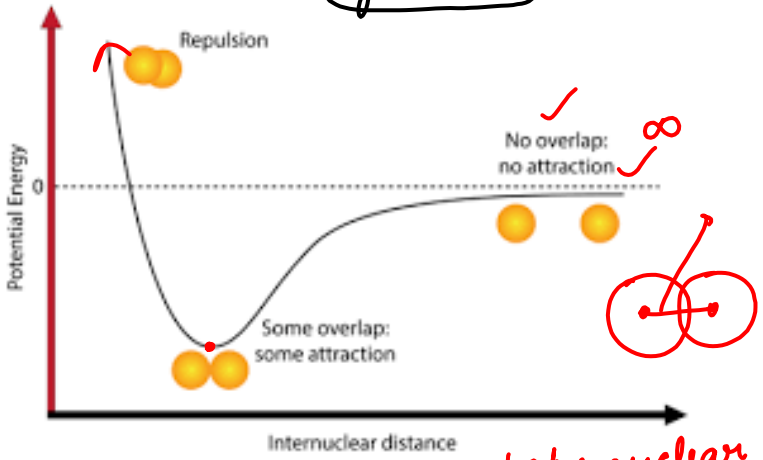
dominating

PE ↓

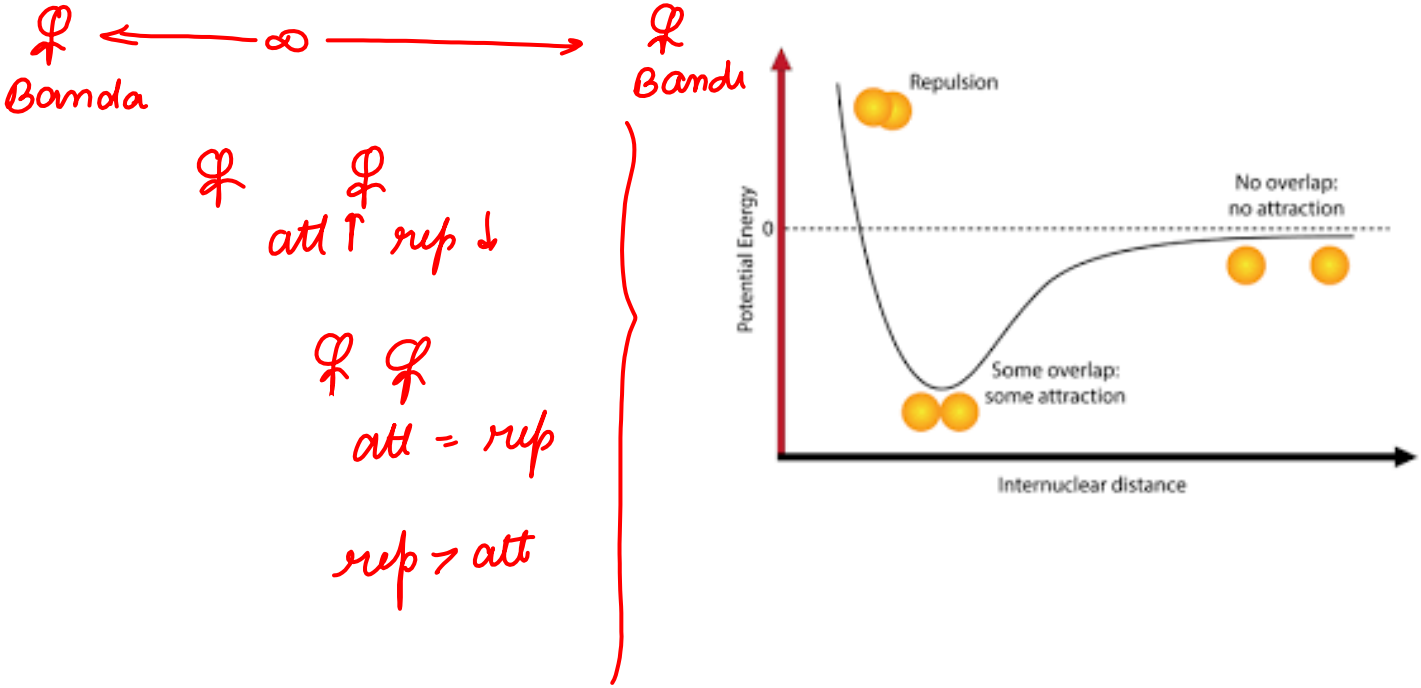
(Bond length)

$F_{att} = F_{rep}$

F_{rep}  PE ↑



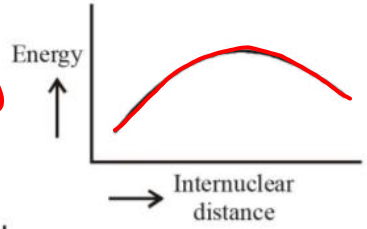
Reason for bond formation



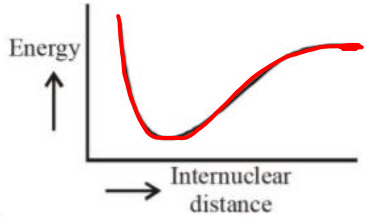
PYQs

The potential energy curve for the H_2 molecule as a function of internuclear distance is :

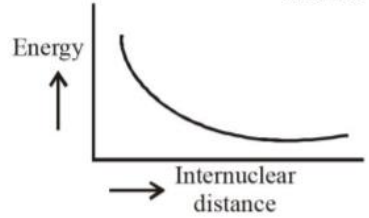
(a)



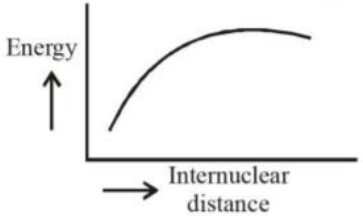
(b)



(c)



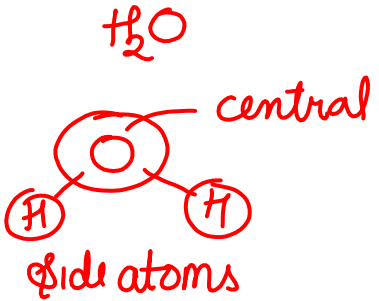
(d)



2013
2016

JEE Main 2020

Structure of compounds with single central atom



Structure of Single Central Atom

AB_x type molecules

1. Identify the central atom
   - →the one which is less in no. ex. SO^{-2}_4
   - →the one which is large in size NOF_3 SNF_3
   - →the one which has maximum covalency ∴ F&H can never be Central atoms

SO_4^{2-}

NOF_3

SNF_3

→ less e neg

H_2O

NF_3

Structure of Single Central Atom

1. F,Cl,Br,I,H,O^- as a surrounding atom will form a single bond
2. If -ve is present & O is also there, always give - to O atom
3. If no oxygen, always give + or - to the central atom

SO_4^{2-}

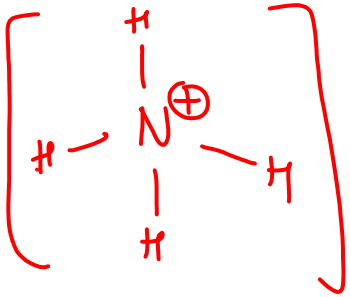
NH_4^+

F—
Cl—
Br—
I—
H—
O=
$\bar{O}$—

Structure of Single Central Atom

NH_4^+

5 − 1 = 4



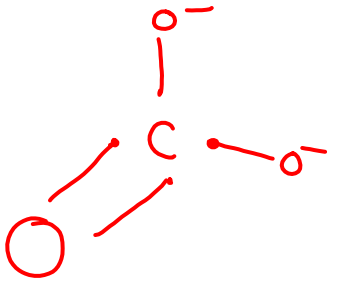
NO_2^+

central atom

5 − 1 = 4

CO_3^{2-}

central atom

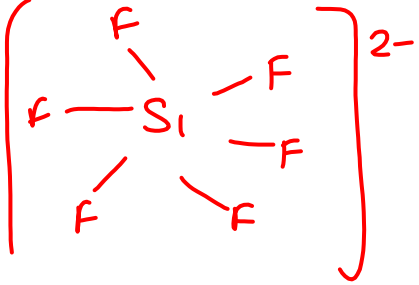


Structure of Single Central Atom

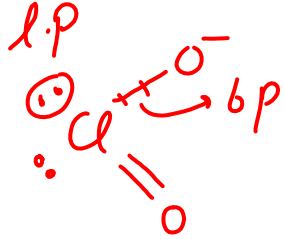
SiF_6^{2-}

central → Si

4+2 = 6



ClO_2^- —ve→ 0

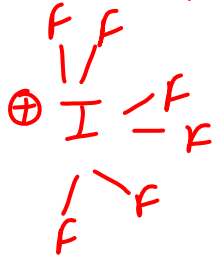


=O

$-O^-$

IF_6^+

7-1 = 6



PYQs

Which of the following compounds contain(s) no covalent bond(s)?

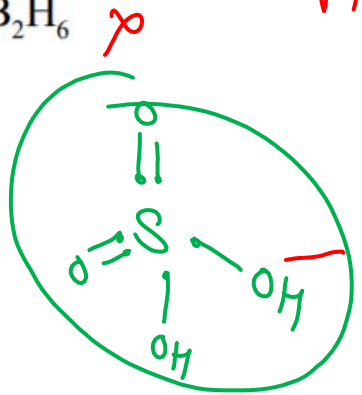
$KCl, PH_3, O_2, B_2H_6, H_2SO_4$

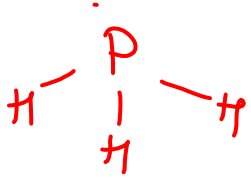
(a) KCl, B_2H_6, PH_3

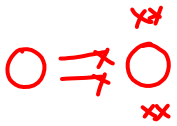
(b) KCl, H_2SO_4

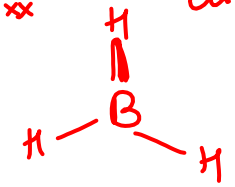
(c) KCl

(d) KCl, B_2H_6



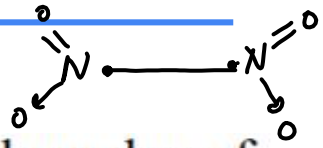




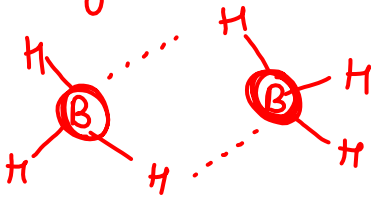


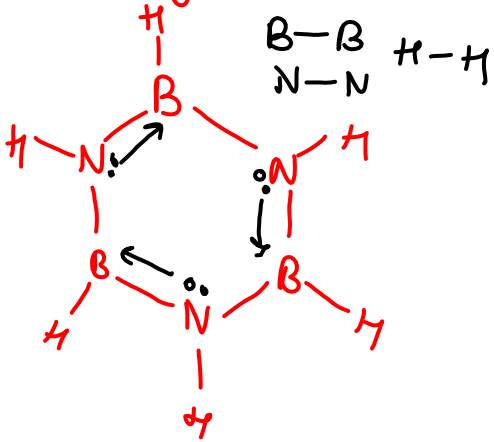
JEE Main 2018

PYQs

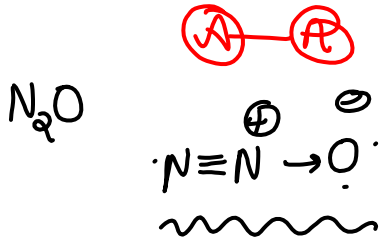


Among B_2H_6, $B_3N_3H_6$, N_2O, N_2O_4, $H_2S_2O_3$, $H_2S_2O_8$, the total number of molecules containing covalent bond between two atoms of the same kind is _____





JEE Adv 2019



PYQs

The sum of the number of lone pairs of electrons on each central atom in the following species is

$[TeBr_6]^{2-}$, $[BrF_2]^+$, SNF_3 and $[XeF_3]^-$

(Atomic numbers: N = 7, F = 9, S = 16, Br = 35, Te = 52, Xe = 54)

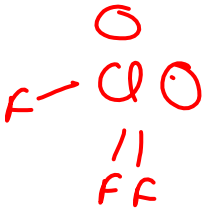
JEE Adv 2017

PYQs

The compound(s) with TWO lone pairs of electrons on the central atom is(are

(a) BrF_5 (b) ClF_3 (c) XeF_4 (d) SF_4

JEE Adv 2016



Lewis Octet Rule

Lewis Octet Rule

Every atom tries to complete its Outermost shell with $8e^-$ (except H=$2e^-$) to gain stability, either by complete transfer or sharing of e⁻s

NaCl

$Na \longrightarrow e^- + Na^+$

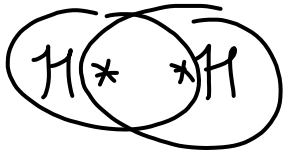
2,8,1 → 2,8

$Cl + e^- \longrightarrow Cl^-$

2,8,7 → 2,8,8

Na^+Cl^-

ionic bond



H — H

Covalent bond

Exceptions

Hypovalent compounds ie, electron deficient compounds with less than $8e^-$

BeX_2 ($4e^-$) X=F, Cl, Br, I, OH, NH_2, CH_3, H

BX_3 ($6e^-$) X=F, Cl, Br, I, OH, NH_3, CH_3, H

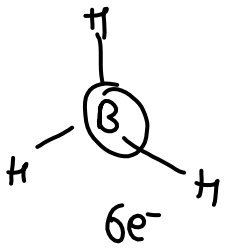
$BeCl_2$

$4e^-$

Cl — Be — Cl

BH_3

borane



$6e^-$

Exceptions

Hypervalent compounds (compounds with>8e$^-$)

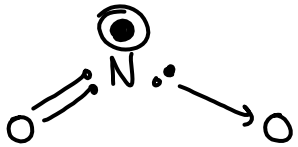
PCl_5 SF_6 ClF_3 BrF_5 XeF_6

$8+6 \rightarrow 14$

Exceptions

Odd e^- species

NO_2 ClO_2 ClO_3 NO $.CH_3$



Coordinate bonds

Coordinate Bond

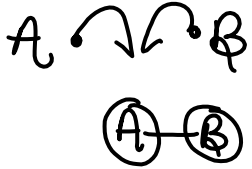
A:→B

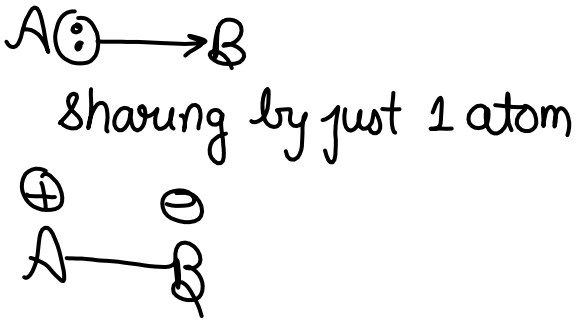
After formation, coordinate bond behave as a covalent bond with charges

+ -

A-B

Covalent



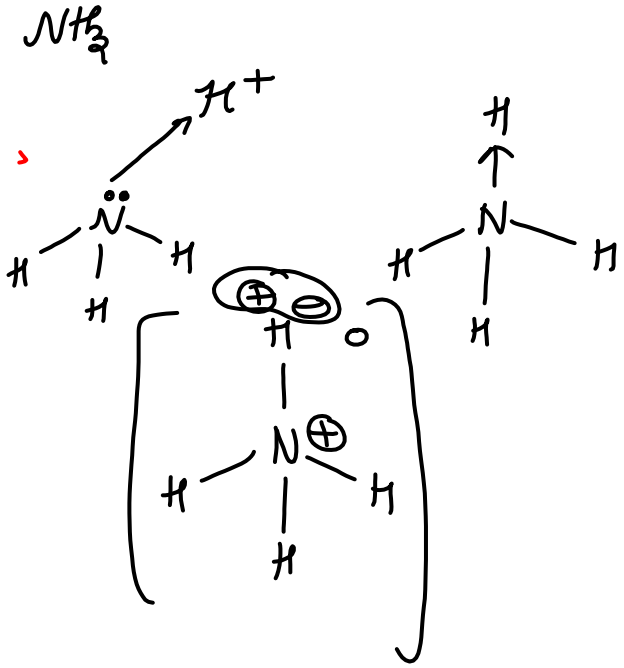


Coordinate Bond

Structure of sulphur dooxide

$H_3N \odot \longrightarrow BF_3$

Coordinate Bond



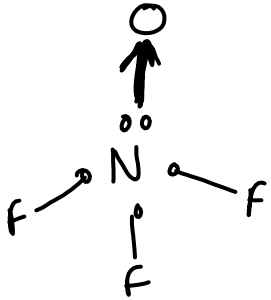
Coordinate Bond

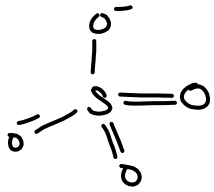
Draw the normal structure always But if the ques is around Octet Rule & if 2^{nd} period element is having>$8e^-$ replace the = by → or + -

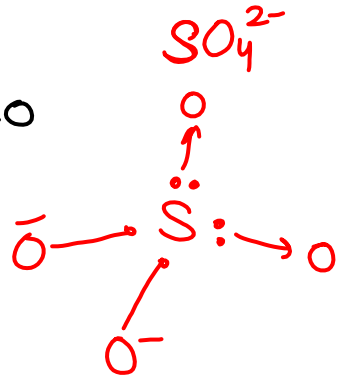
Practise question

Structure of NOF_3

Lewis dot st







N O F₂

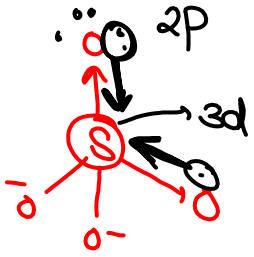
covalency > 0

S → $1s^2 2s^2 2p^6$

$3s^2 3p^4$

3d

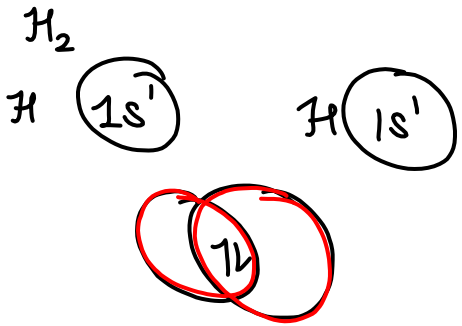
empty

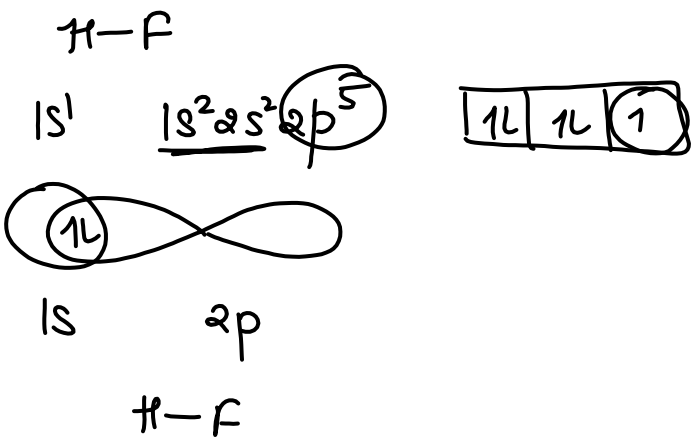


Valence Bond Theory

VBT

- Valence shell e⁻s participate in bond formation
- VBT has further 2 parts
  a) Overlapping theory ✓
  b) Hybridization theory





Valence bond theory

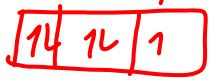
Overlapping Theory

- During covalent bond formation,
  half filled orbitals having opp. spin e^- overlap to form covalent bond.

F_2

F

$1s^2 2s^2 2p^5$



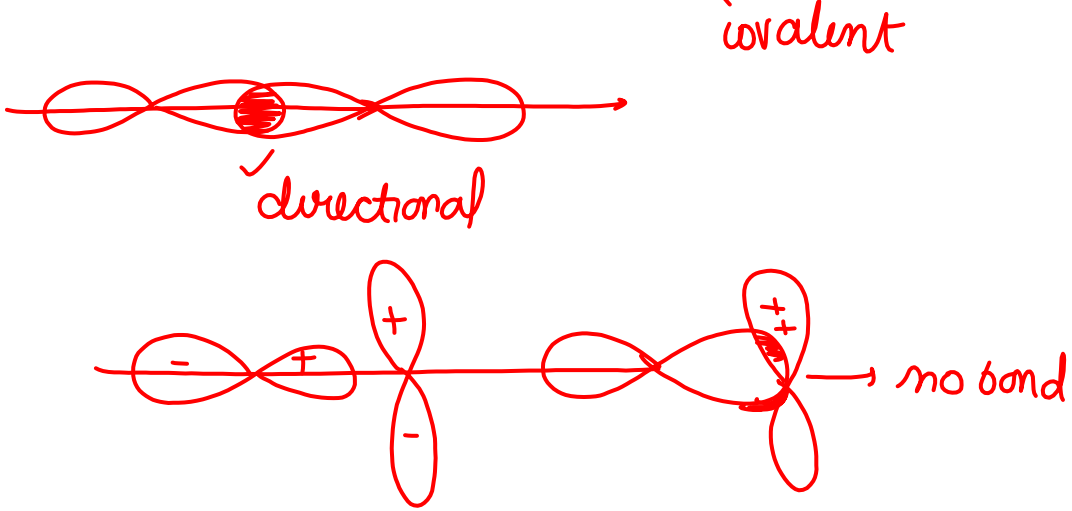
F

$1s^2 2s^2 2p^5$

F – F

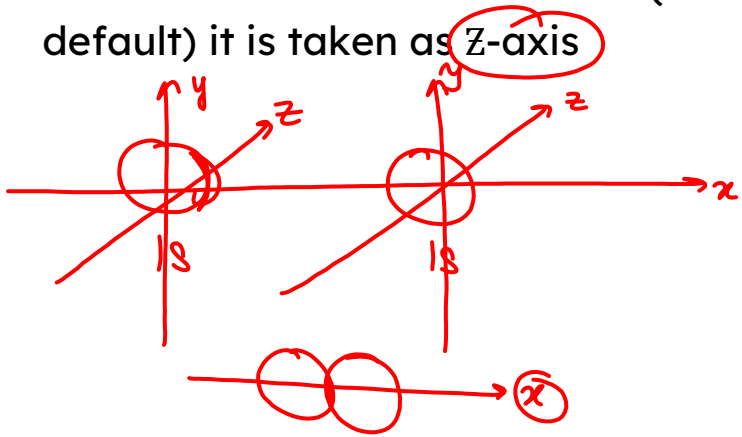
Overlapping Theory

- Covalent bonds are directional in nature i.e., they are formed in a particular direction only.



Internuclear Axis

- Axis on which Nucleus of atom (forming the bonds) is present (By default) it is taken as Z-axis



Structure of N_2 : VBT

N
$1s^2 2s^2 2p^3$

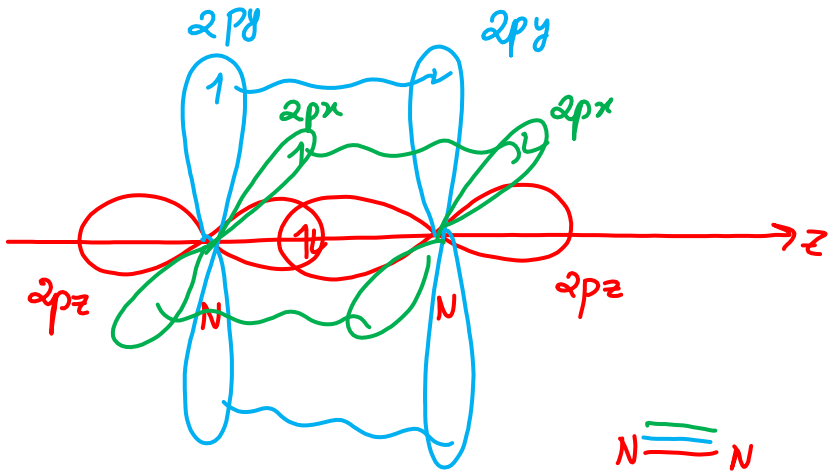
N
$1s^2 2s^2 2p^3$

$N \equiv N$

1	1	1
$2p_x$	$2p_y$	$2p_z$

1	1	1
$2p_x$	$2p_y$	$2p_z$

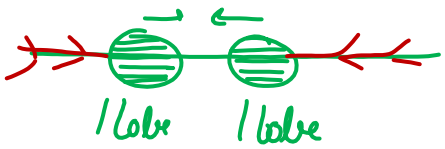
(z) — ina



Types of overlapping

Overlapping

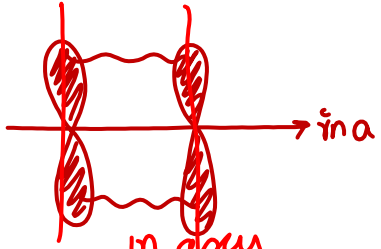
- Coaxial — Head on overlapping



one–one lobe overlap

σ bond

- Colateral / Sideways — in the plane ⊥ to the ina

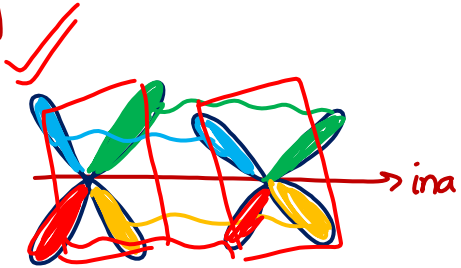


in axis

overlapping ⊥ to the ina

two–two lobe overlap

π bond



4–4 lobes overlap

δ bond

Strength of Overlapping

type – size/shell – directional

tsd

Consider the factors in order

I. Type of bond.
II. If bond is of same type, check size / shell
III. If bond is of same type & shell is also same, check directional nature.

Strength of Overlapping

I. Type of bond / overlap

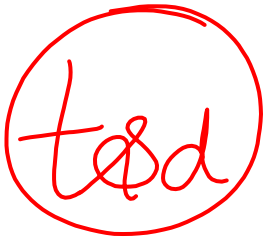
Coaxial overlap >> Collateral
Therefore **Coaxial bonds > Collateral Stronger**

$\sigma >> \pi, \delta$

Strength of Overlapping

II. **If type of bond is same,**
check no. of shell / size

1s - 1s 2s - 2s 3s - 3s 4s - 4s



All are co axial bonds
Therefore compare shell

as no. of shell increases strength decreases

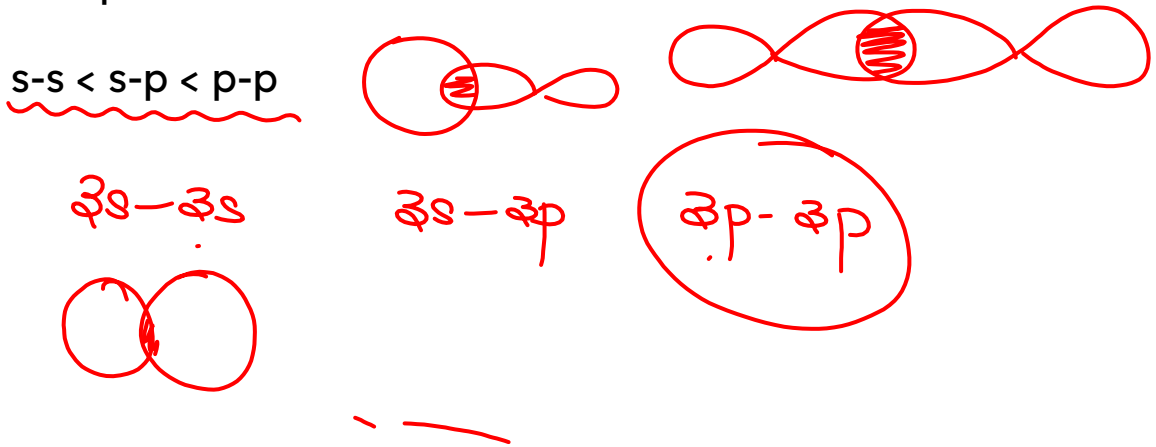
1s - 1s > 2s - 2s > 3s - 3s > 4s - 4s

Strength of Overlapping

III. **If type of bond - same,**
shell - same

Compare directional nature

s-s < s-p < p-p



Practise Question

Compare the bond energy of N-N and P-P bond

a

b

a

b

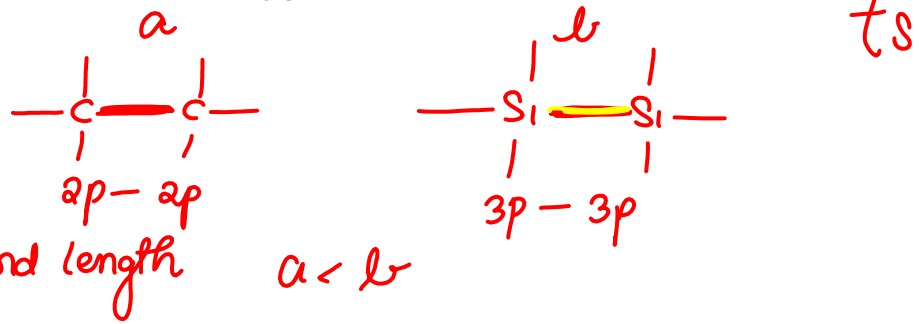
Bond length ✓ N−N ≪ P−P

Bond strength −N̈−N̈− > P−P

N−N− < −P−P−

Practise Question

Compare the bond energy of C-C and Si-Si bonds



Practise Question

Compare Bond length, Bond energy & Thermal stability.

NH_3	PH_3	AsH_3	SbH_3
a	b	c	d

Bond length max · d

Bond energy max · a

Thermal stability max a

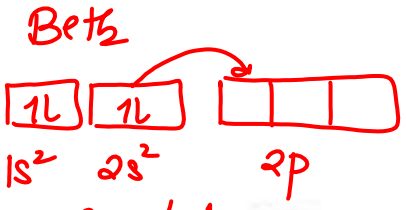
Hybridization

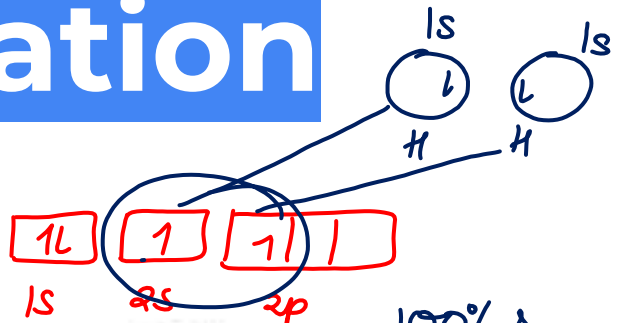
1. Mixing of atomic orbitals of nearly same energy of a particular atom is Hybridization.

1. The energy difference b/w the orbitals should be less.

BeH_2

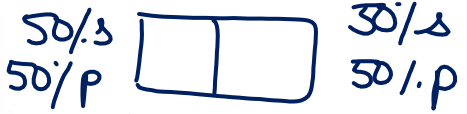
Hybridization



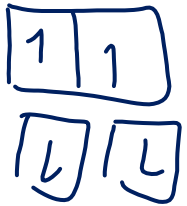


100% s
100% p

Redistribution of energy

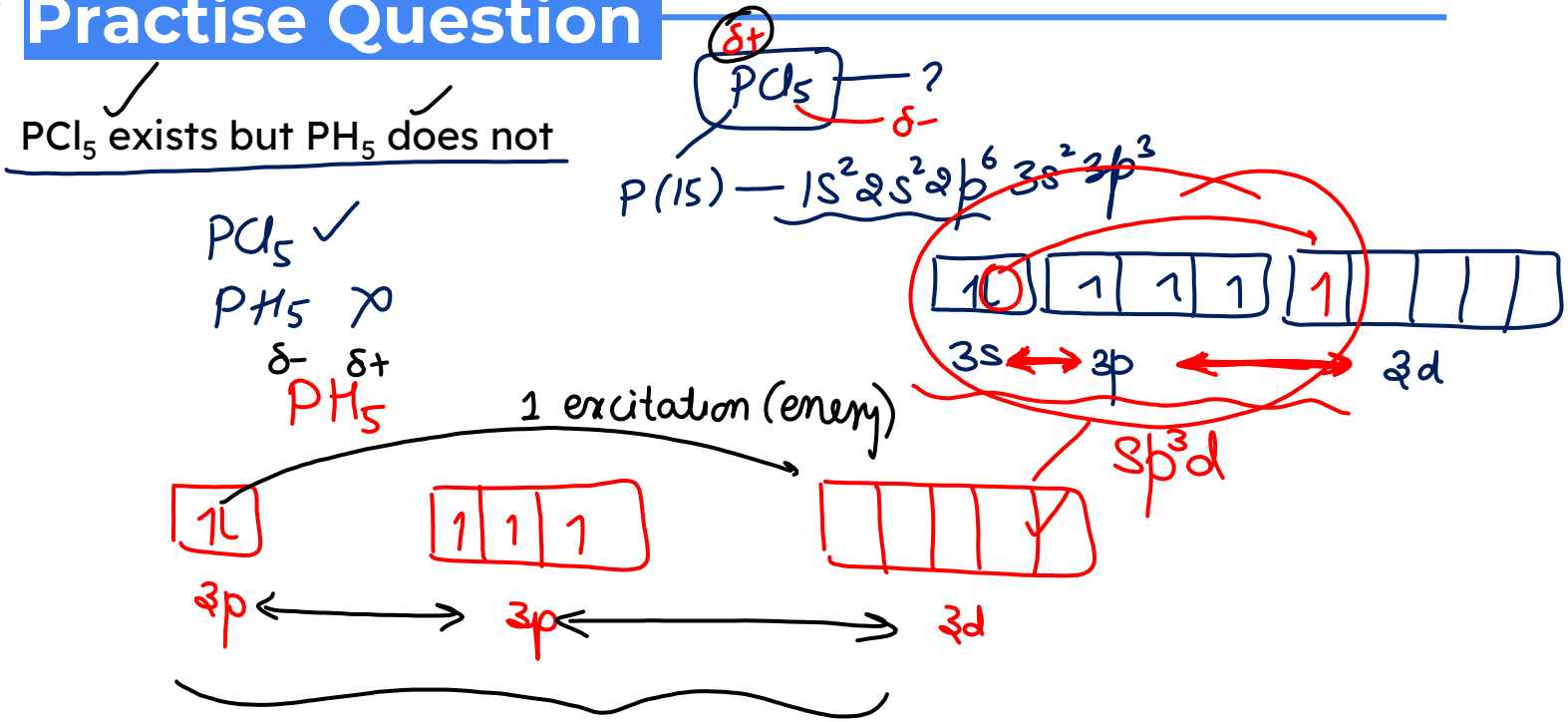


Hybrid orbital
sp



Practise Question

PCl_5 exists but PH_5 does not



d-orbital Contraction

OR Participation of d-orbital in Hybridization

Surrounding atom should be more electronegative for participation of d-orbital in hybridization

$\delta+$
central atom ✓

$\delta-$
central atom ✗

Practise Question

Q- IF_7 exists but IH_7 doesn't

Q- ClF_5 exists but ClH_5 doesn't

Q- BrF_3 exists but BrH_3 doesn't

Q- FI exists also HI exist.

Q- SF_6 exists but SH_6 doesn't

Q- SF_4 exists but SH_4 doesn't

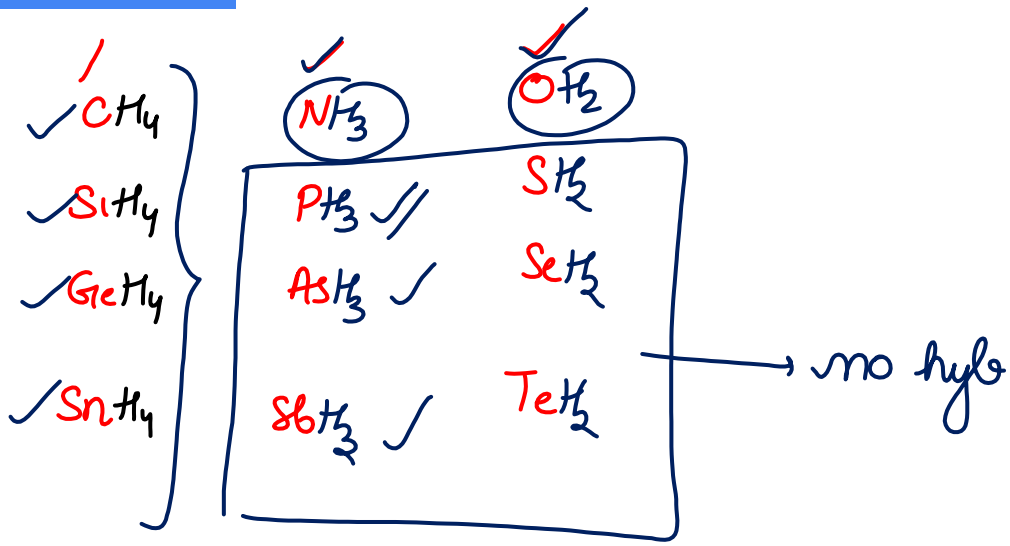
Q- SF_2 exists but SH_2 doesn't exists

Drago's Rule

NO Hybridization

Drago’s Rule

Drago's Rule

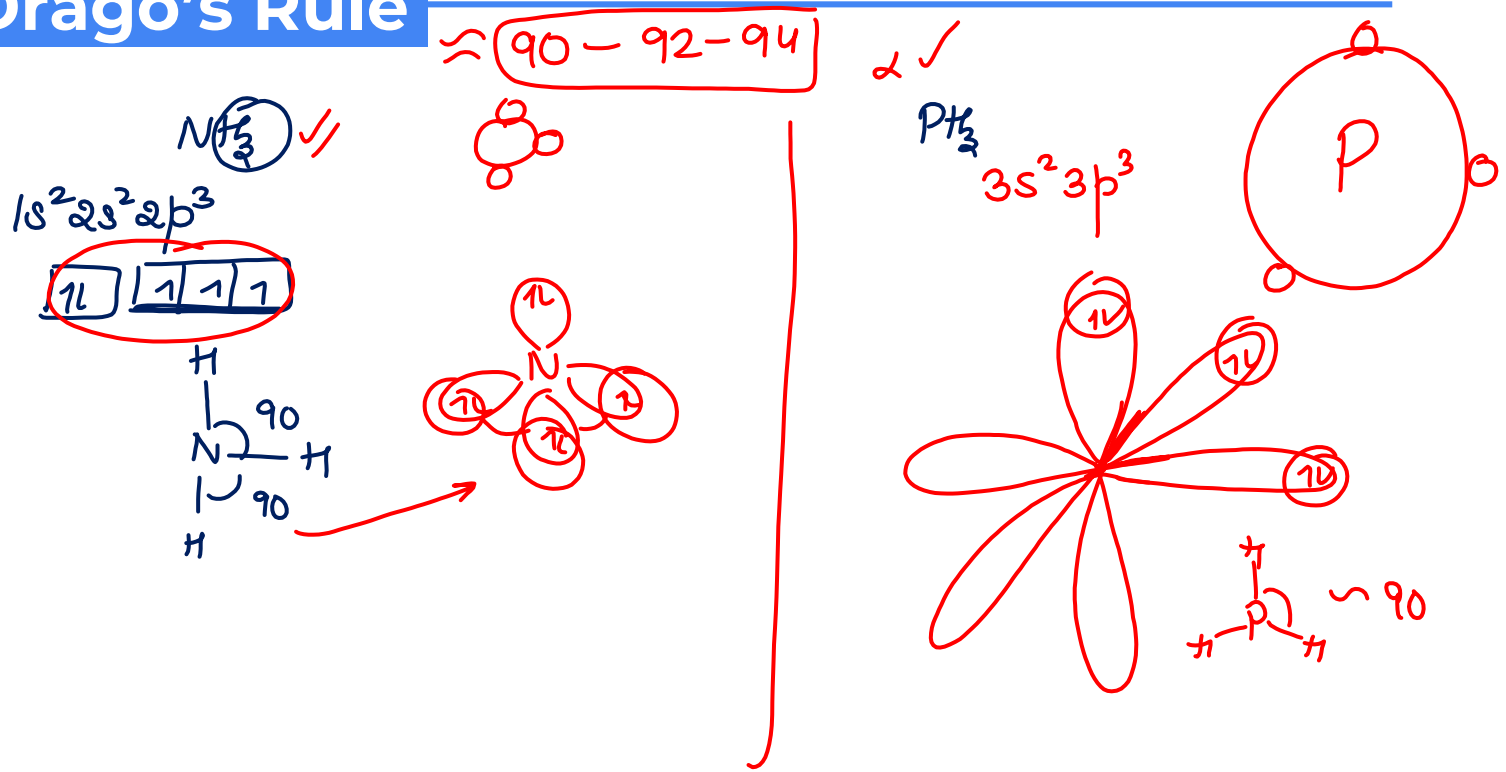


Conditions for NO Hybridization

DRAGO.

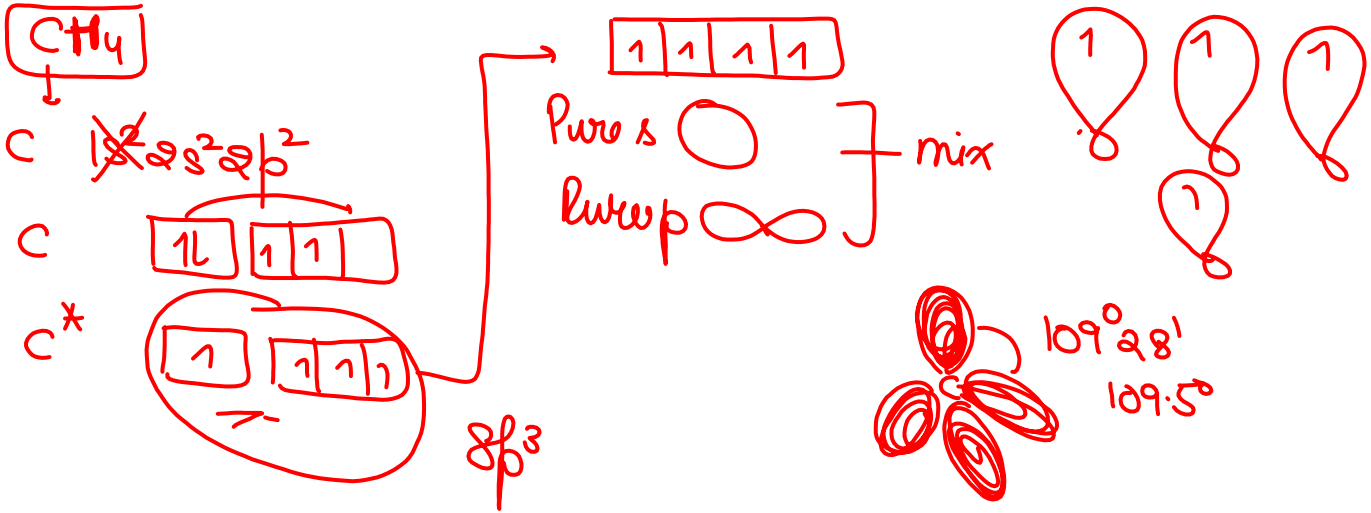
1. Central atom should be 3rd / 4th / 5th / 6th period
1. Central atom should have l.p.
1. Surrounding atom's eneg ≤ 2.5 (Side atom H)

Drago's Rule



Geometry of Hybrid Orbitals

Hybrid Orbitals are arranged in 3D at minimum repulsion.
Therefore the geometry formed by hybrid orbital around the Nucleus of central atom is called electronic geometry.



Geometry of molecules

Electron pair = BP + LP = σ + LP = No. of hybrid orbitals

Types of hybridization

BeH_2

$1s^2 2s^2$

Be: 1 | | | (2s, 2p)

Be*: 1 | 1 | | (2s, 2p)

100% 100%

$2s + 2p \rightarrow$ | |

sp sp

↓

% s = 50

% p = 50

180° linear

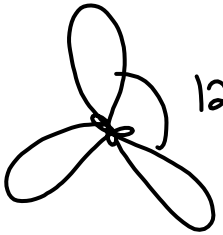
BH_3

3σ + 0lp

↓

3

$S + p + p = sp^2$

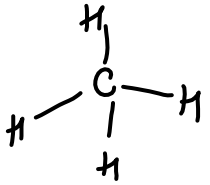


120°, Trigonal planar

Types of Hybridization

Types of hybridization

CH_4

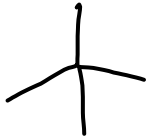


$\sigma = 4$

$lp = 0$

4

sp^3



Tetrahedral

$109°28'$

NH_3

$< 109°$

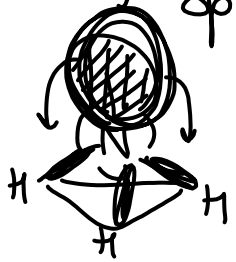
$\approx 107°$

$\sigma = 3$

$lp = 1$

4

sp^3



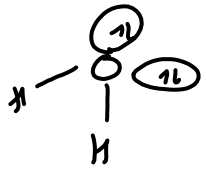
elec geo = tetrahedral

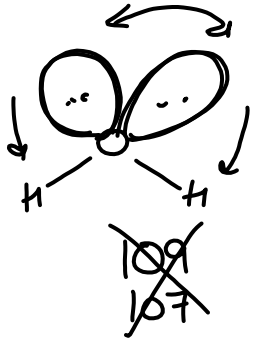
shape · molecular geo

trigonal pyramidal

Types of hybridization

$H_2\ddot{O}:$





$bp = 2$

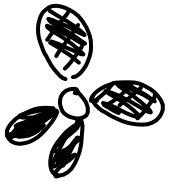
$lp = 2$

Total = 4 → sp^3

104.5°

e geo.

tetrahedral



Shape / mole. geo bent V

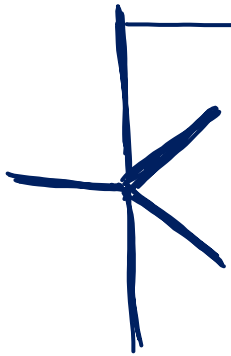
PCl_5

sp^2

$S + p_x + p_y$

$\frac{S}{\text{total}} \times 100$

$\frac{1}{3} \times 100$

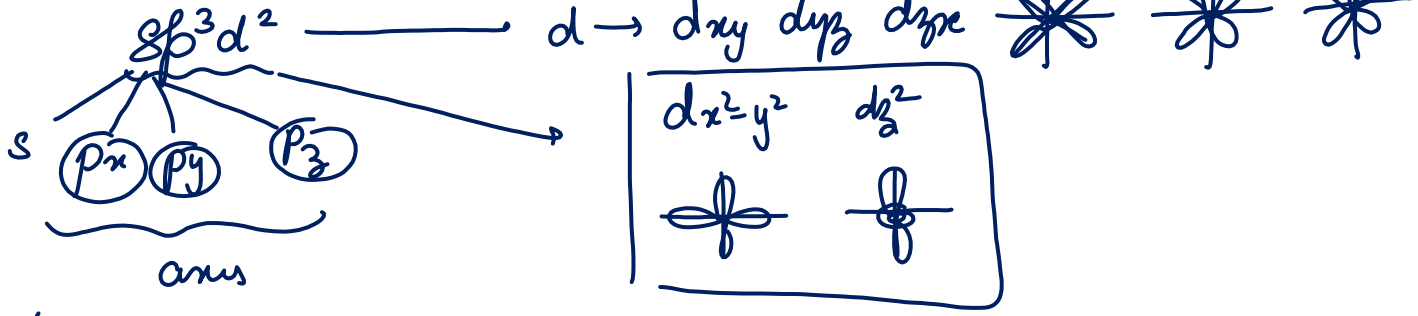


%s = 0% s-less axial

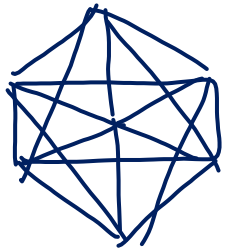
%s = 33% (equatorial)

p_d d_{z^2} p_z

Types of hybridization



$$\frac{\%s\ 100 + 300/p + 200/d}{6}$$



Octahedral

Square bipyramidal

Shortcut for Hybridization

$\sigma + lp =$

(2) ⟶ sp

(3) ⟶ sp^2

(4) ⟶ sp^3

(5) ⟶ sp^3d

(6) ⟶ sp^3d^2

(7) ⟶ sp^3d^3

VSEPR theory

VSEPR Theory

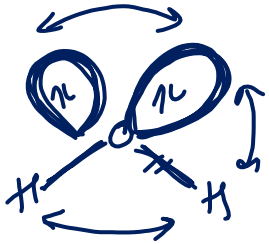
1. l.p-l.p>l.p-bp>b.p-bp repulsion
2. Multiple bond-multiple bond

V

Multiple bond-single bond

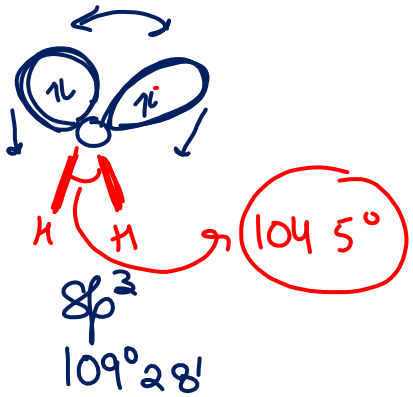
V

Single bond- single bond



Valence shell - electron - pair repulsion theory

Shape/geometry of molecule



Electronic geometry v/s molecular geometry

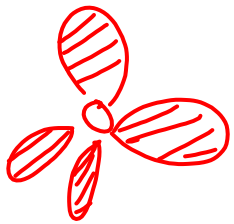
E-geometry→geometry of e-pair

Bp+lp

⇒geometry of hyb orbitals

H_2O.

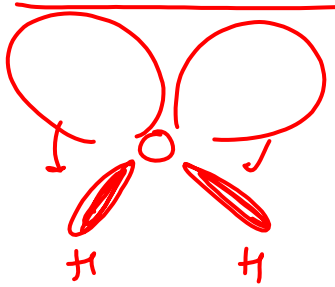
tetrahedral



Molecular geometry Shape

Only Bp are considered

bonds are considered.



Bent V / V

VSEPR Theory

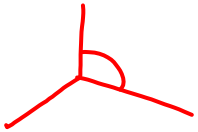
sp → σ = 2

lp = 0

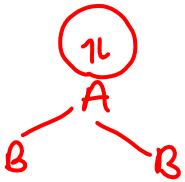
180° linear

sp^2 → σ = 3

lp = 0

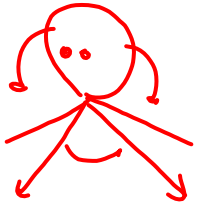


120°, Trigonal planar



σ = 2

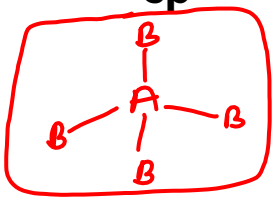
lp = 1

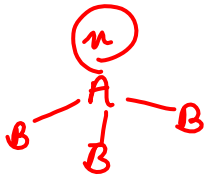


<120°, bent/V/angular

VSEPR Theory

sp^3





$\sigma = 4$ ✓

$lp = 0$ ✓

sp^3

tetrahedral, 109°28'

$\sigma = 3$

$lp = 1$

sp^3

trigonal pyramidal, <109

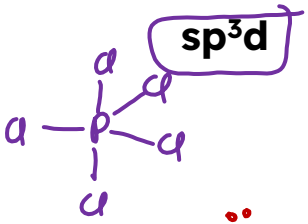
$\sigma = 2$

$lp = 2$

H_2O

Bent/V/angular, <109

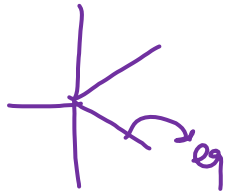
VSEPR Theory



σ = 5
lp = 0

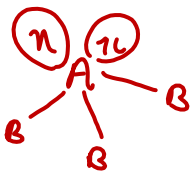
TBP, 120°, 90°, 180°

Trigonal bipyramidal



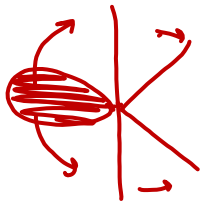
σ = 4
lp = 1
} 5 sp^3d

seesaw <180°, <120°, <90°

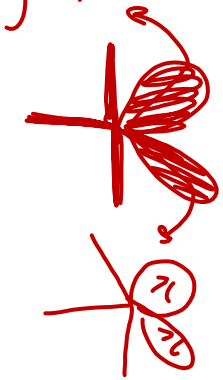


σ = 3
lp = 2
} sp^3d

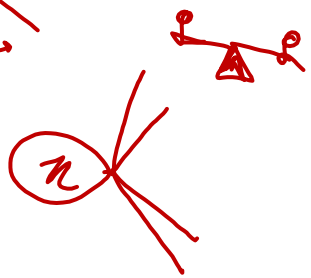
Bent T<109°



σ = 2
lp = 3



linear 180°



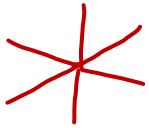
VSEPR Theory

sp^3d^2

all 6 bonds are identical

σ = 6
lp = 0

octahedral

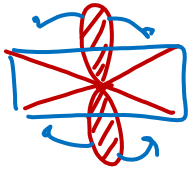


σ = 5
lp = 1

square pyramidal <90°

σ = 4
lp = 2

square planar, 90°, 180°



180°

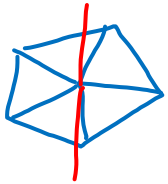
90°

VSEPR Theory

sp^3d^3

jee adv

$\sigma = 7$
$lp = 0$

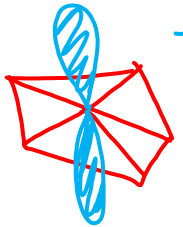


Pentagonal Bipyramidal

$\sigma = 6$
$lp = 1$

hold

$\sigma = 5$
$lp = 2$



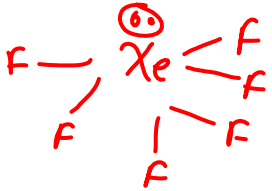
pentagonal planar

Special case of VSEPR

sp^3d^3 → σ = 6
lp = 1
is a special case → normal VSEPR → ✗

XeF_6

sp^3d^3



Special case of VSEPR

$\sigma = 6$
$lp = 1$

जिंदा lp

Active lp

Participate in geo & fluxonial movable

XeF_6, IF_6^-

मरा हुआ

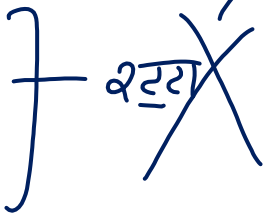
Inactive lp

Doesn't Participate in geo

ClF_6^-, BrF_6^-

$SbCl^{3-}_6$, $SbBr^{3-}_6$,

$TeCl^{2-}_6$, $TeBr^{2-}_6$

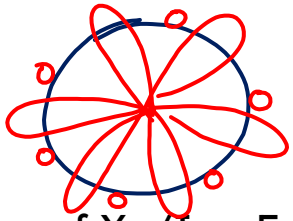


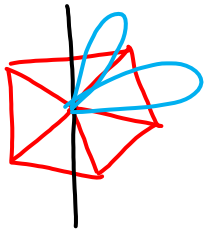
$\sigma = 6$
$lp = 1$

VSEPR Theory

XeF_6, IF_6^-

sp^3d^3



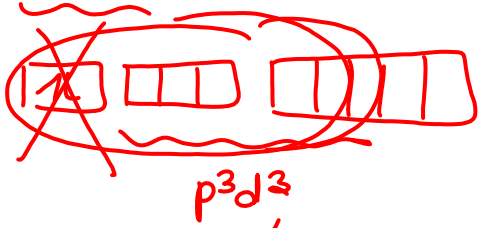


Size of Xe/I>>>F

∴lp-gets active participates in geo

fluxonial

$ClF_6^-, BrF_6^-, TeCl^{2-}_6, TeBr^{2-}_6$

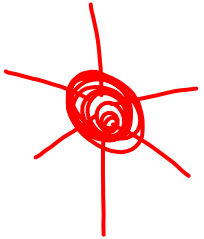


p^3d^3 ✓

Size of Cl>F ✓

But 6 F make steric crowding

∴lp-inactive-doesn't participate in geo

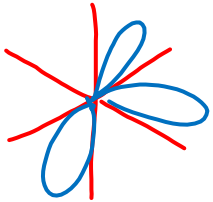


VSEPR Theory

XeF_6, IF_6^-

Here lp is active
& participate in hyb
hyb=sp^3d^3 ✓
s,px,py,dx^2-y^2,dxy
pz,d_{z^2}

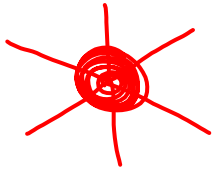
distorted oct



$\sigma = 6$
$lp = 1$

As lp gets inactive
Goes to s-orbital
→lp in pure s orbital &
6 orbitals(for 6 bonds)
↓

Px,py,dx^2-y^2,dxy
Pz,d_{z^2}-pyramidal
P^3d^3 hyb
Octahedral perfect



Important point

When more eneg atom is there,% s character in hybrid orbital of central atom dec

PYQs

The compound that has the largest H – M – H bond angle (M = N, S, C), is :

(a) H_2O → 104.5°

(b) NH_3 → 107°

(c) H_2S → drago ≈ 90°

(d) CH_4 → 109°28'

JEE Main 2020

PYQs

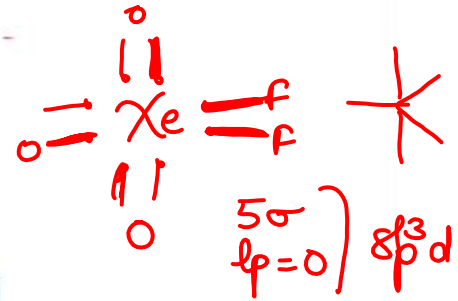
The shape/ structure of $[XeF_5]^-$ and XeO_3F_2, respectively, are :

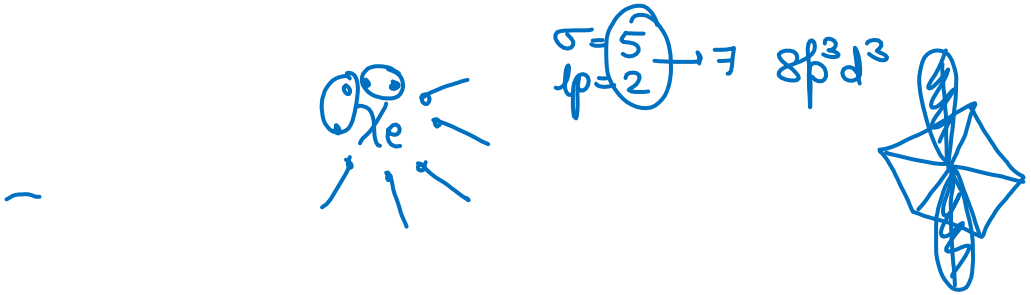
(a) pentagonal planar and trigonal bipyramidal

(b) octahedral and square pyramidal

(c) trigonal bipyramidal and pentagonal planar

(d) trigonal bipyramidal and trigonal bipyramidal





JEE Main 2020

PYQs

Coord comp

The molecule in which hybrid MOs involve only one *d*-orbital of the central atom is :

(a) $[Ni(CN)_4]^{2-}$

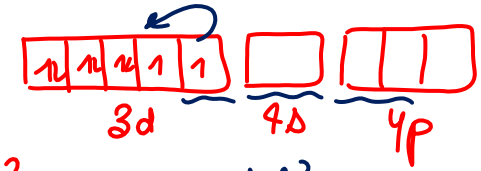
(b) BrF_5

(c) XeF_4

(d) $[CrF_6]^{3-}$

sq

$Ni^{+2} \longrightarrow 3d^8$



dsp²

Br = 5+1 = 6 — sp^3d^2

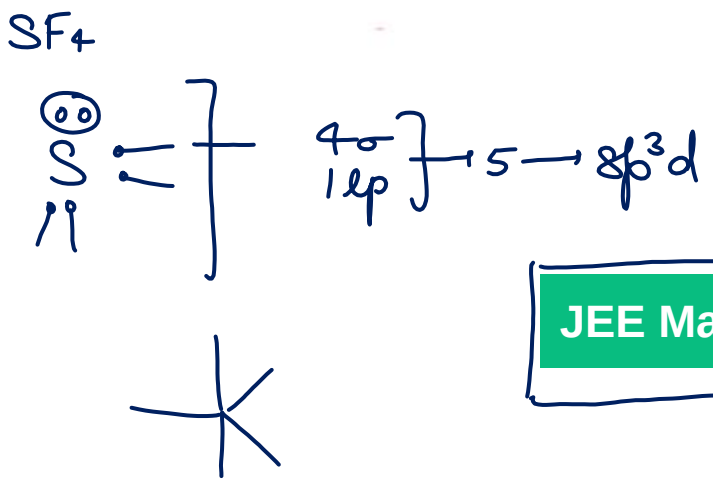
Xe = 4+2 = 6 — sp^3d^2

JEE Main 2020

PYQs

The molecular geometry of SF_6 is octahedral. What is the geometry of SF_4 (including lone pair(s) of electrons, if any)?

(a) Tetrahedral
(b) Trigonal bipyramidal
(c) Pyramidal
(d) Square planar



JEE Main 2020

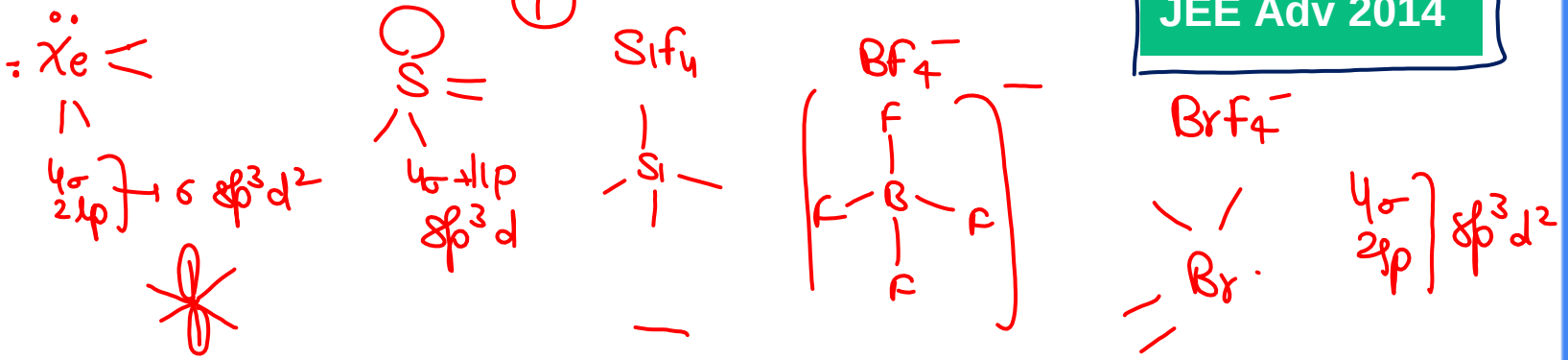
PYQs

JEE Adv 2014

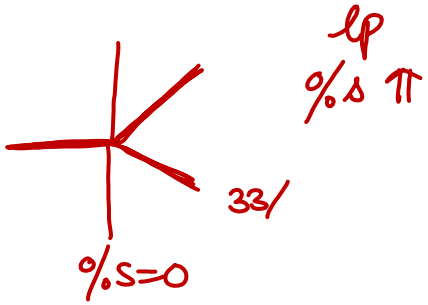
A list of species having the formula XZ_4 is given below.

XeF_4, SF_4, SiF_4, BF_4^-, BrF_4^-, $[Cu(NH_3)_4]^{2+}$, $[FeCl_4]^{2-}$, $[CoCl_4]^{2-}$ and $[PtCl_4]^{2-}$.

Defining shape on the basis of the location of X and Z atoms, the total number of species having a square planar shape is



Bent's Rule



Bent's rule

Effect of LP.

L.P can acquire any position in Sp^2, Sp^3, sp^3d^2

∵all position are equivalent

→ due to l.p.

%S↑ in the hybrid orbital

& %S↓ in other hybrid orbital.

Bent's rule

Sp^3d Sp^3d^3

l.p goes to that orbital which has more % s

Polarity of Bonds

Polar v/s non polar bonds

Polar

charge sep

A—B

δ+ A — B δ-

△eng≠0

(acts as dipoles)

Bond

Non-polar

△eng=0

A—A

A—B

Dipole moment:

Equal & opposite charge q separated by dis d

$\mu = q \times d$

Vector quantity

$\mu = q \times d$

←d→

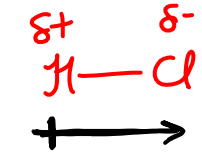
+Q —Q

Dipole pos to -ve

Dipole moment

$\mu = q \times d$

1D = 1 Debye = 3.3×10^{-30} c.m



Dipole – vector

Polar

Bond

A — A

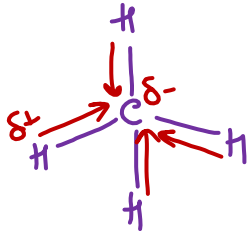
H — H

non-polar

H — Cl

polar

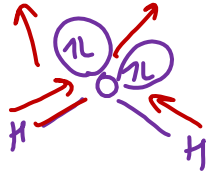
molecule



Bond – polar

$\mu = 0$

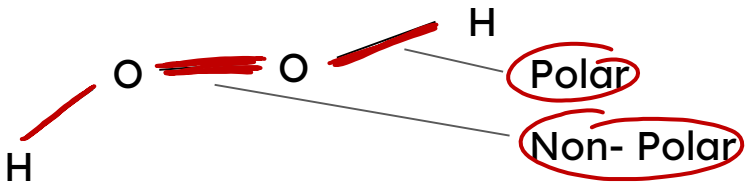
molecule – non-polar

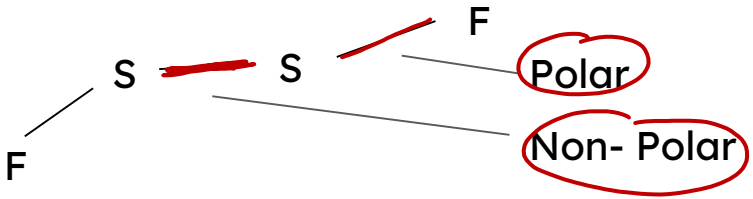


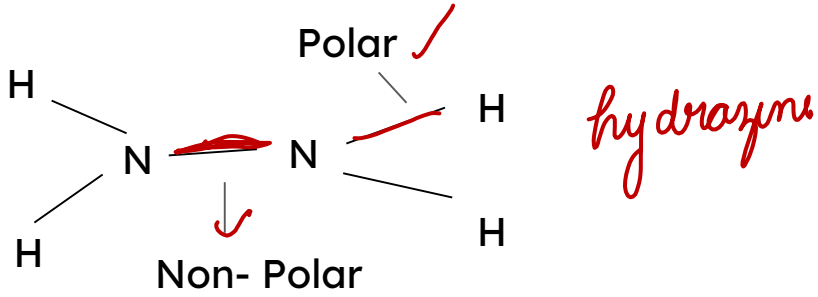
Polar bonds

Polar molecule

Polar and non polar bonds





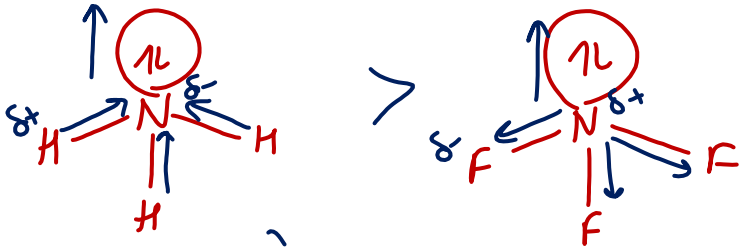


Practise Question

a b

Compare the dipole moment of NH_3 and $\ddot{N}F_3$ a

Ans— a or b



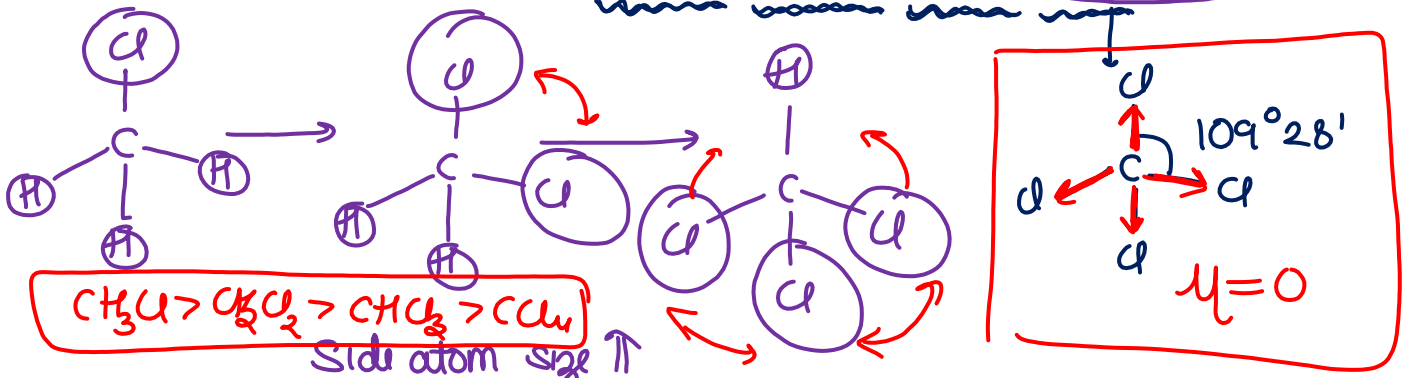
μ = net ≠ "cancellation"

μ = net = add

(↑)

Practise Question

Compare the dipole moment of CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 = CH_4



$CH_3Cl > CH_2Cl_2 > CHCl_3 > CCl_4$

Std atom size ⇑

Bond angle ↑

θ ↑

cosθ ↓

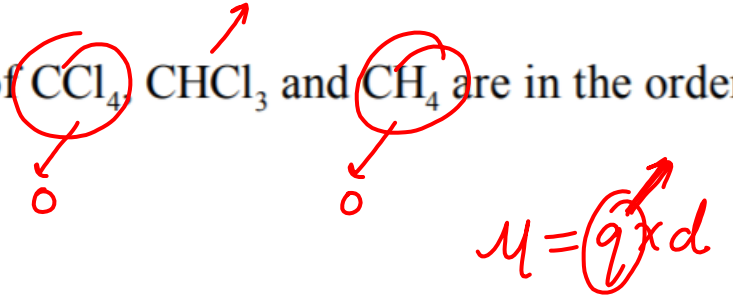
μ ↓

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

PYQs

The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order:

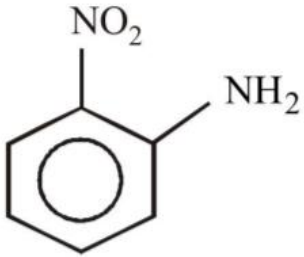
(a) $CHCl_3 < CH_4 = CCl_4$
(b) $CCl_4 < CH_4 < CHCl_3$
(c) $CH_4 < CCl_4 < CHCl_3$
(d) $CH_4 = CCl_4 < CHCl_3$

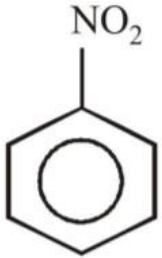


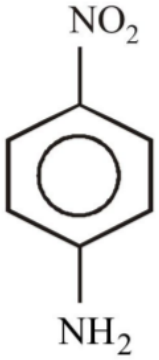
JEE Main 2020

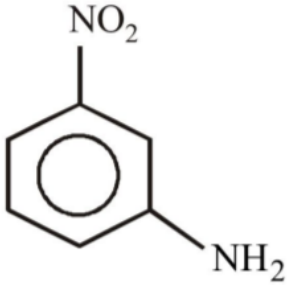
PYQs

Which compound exhibits maximum dipole moment among the following?

(a) 

(b) 

(c) 

(d) 

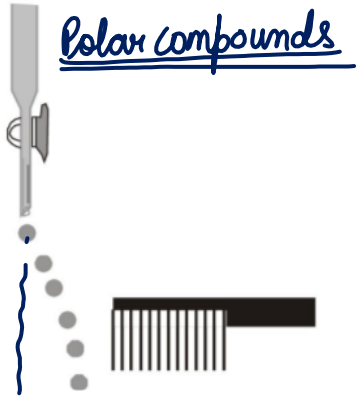
JEE Main 2015

PYQs

Consider the following compounds in the liquid form:

O_2, HF, H_2O, NH_3, H_2O_2, CCl_4, $CHCl_3$, C_6H_6, C_6H_5Cl. ✓

When a charged comb is brought near their flowing stream, how many of them show deflection as per the following figure?



Polar compounds

6

JEE Adv 2020

PYQs

Each of the following options contains a set of four molecules. Identify the option(s) were all four molecules posses permanent dipole moment at room temperature.

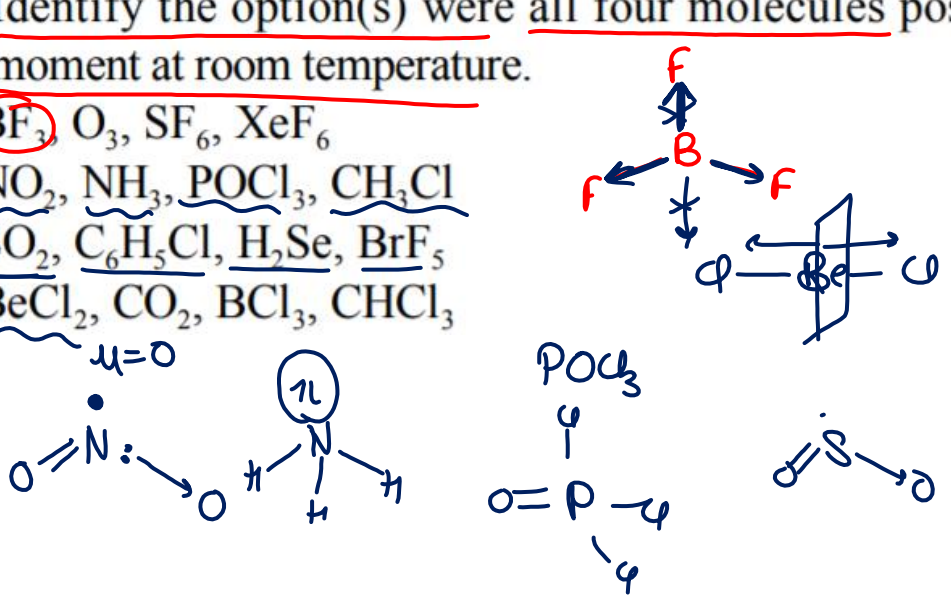
multi correct

(a) BF_3, O_3, SF_6, XeF_6

(b) NO_2, NH_3, $POCl_3$, CH_3Cl

(c) SO_2, C_6H_5Cl, H_2Se, BrF_5

(d) $BeCl_2$, CO_2, BCl_3, $CHCl_3$



JEE Adv 2019

PYQs

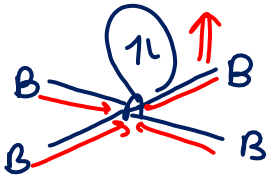
If AB_4 molecule is a polar molecule, a possible geometry of AB_4 is :

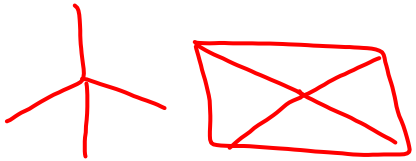
(a) Square pyramidal

(b) Tetrahedral

(c) Rectangular planar

(d) Square planar



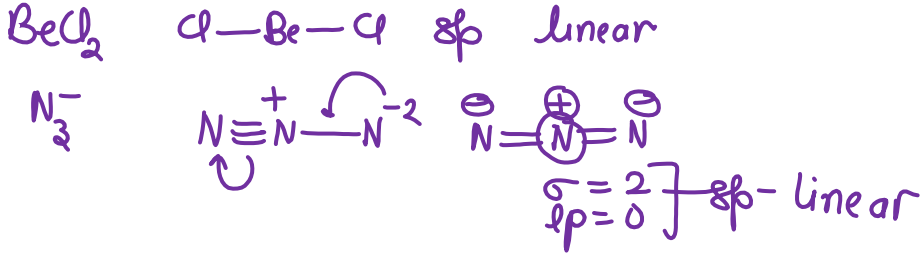


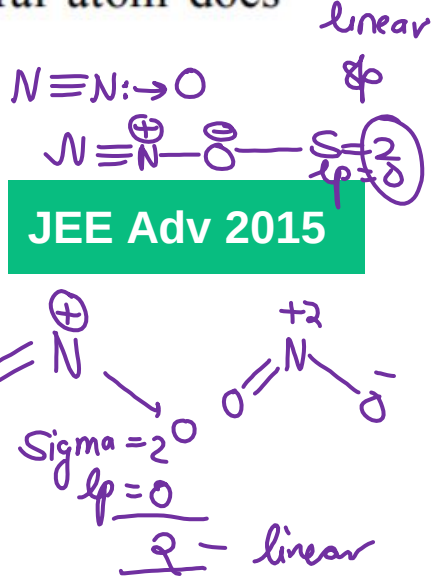
JEE Main 2020

PYQs

Among the triatomic molecules/ions, $BeCl_2$, N_3^-, N_2O, NO_2^+, O_3, SCl_2, ICl_2^-, I_3^- and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the *d*-orbital(s) is

[Atomic number : S = 16, Cl = 17, I = 53 and Xe = 54]





Molecular Orbital Theory

Molecular Orbital Theory

According to MOT, as the e^-s are present in atomic orbitals in an atom

1. The e-s are present in molecular orbital in a molecule

2. All atomic orbitals participate in formation of molecule

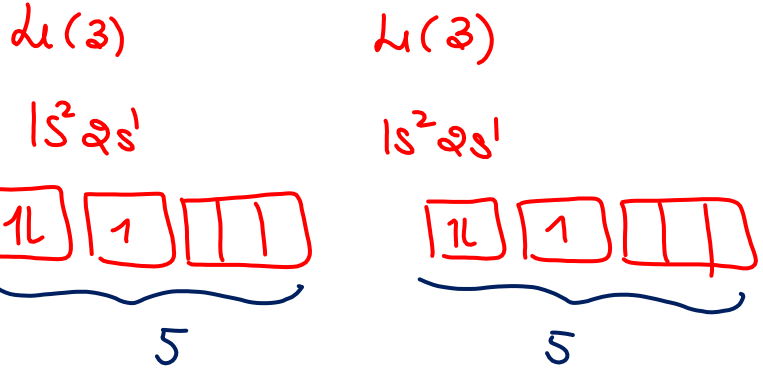
   All atomic orbitals - change to MO

Molecular Orbital Theory

3. No of AO = No. of MO

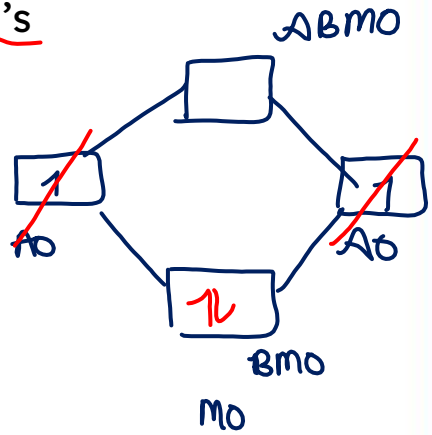
No. of molecular orbitals in H_2 = 2

No of molecular orbitals in Li_2 = 10

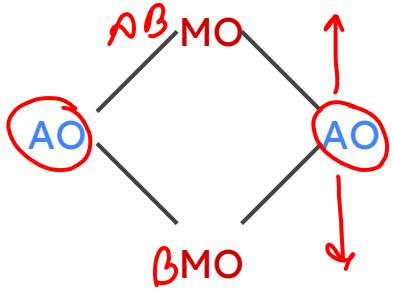


Molecular Orbital Theory

4. Electrons in MO are filled by (n + l), Hund's rule & Pauli's exclusion principle.
5. Sum of energy of MO = Sum of energy of AO



Anti bonding MO



Energy inc = rep

Energy dec = att = Bond

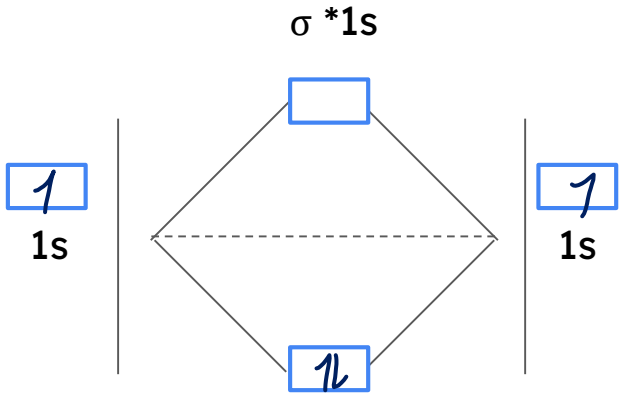
MOT for hydrogen

Energy diagram

Hydrogen (H_2)

$\sigma_{1s}^2 \sigma_{1s}^{*0}$

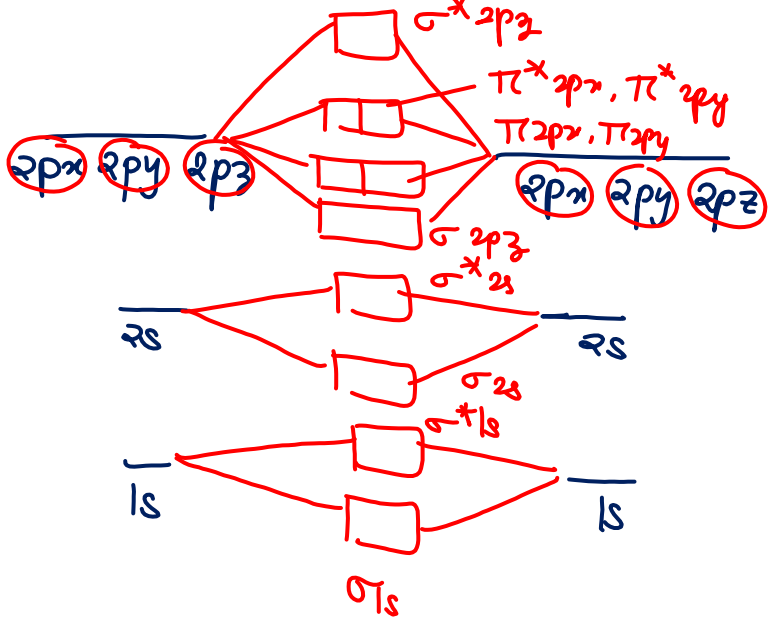
H_2 σ_{1s}^2



MOT for O2, Ne2, F2 & their charged species

Only for
O_2, Ne_2, F_2 and their charged species.

O_2^+ O_2^- Ne_2^+ Ne_2^- F_2 F_2^+ F_2^{2-} . .



MOT special case

sp mixing

B C N O F Ne

$2s^2 2p^1$ $2s^2 2p^2$ $2s^2 2p^3$ $2s^2 2p^4$ $2s^2 2p^5$ $2s^2 2p^6$

$2s^2 2p^x$

x = 1 to 6

Left to right, 2s has $2e^-$, but pe^- ↑

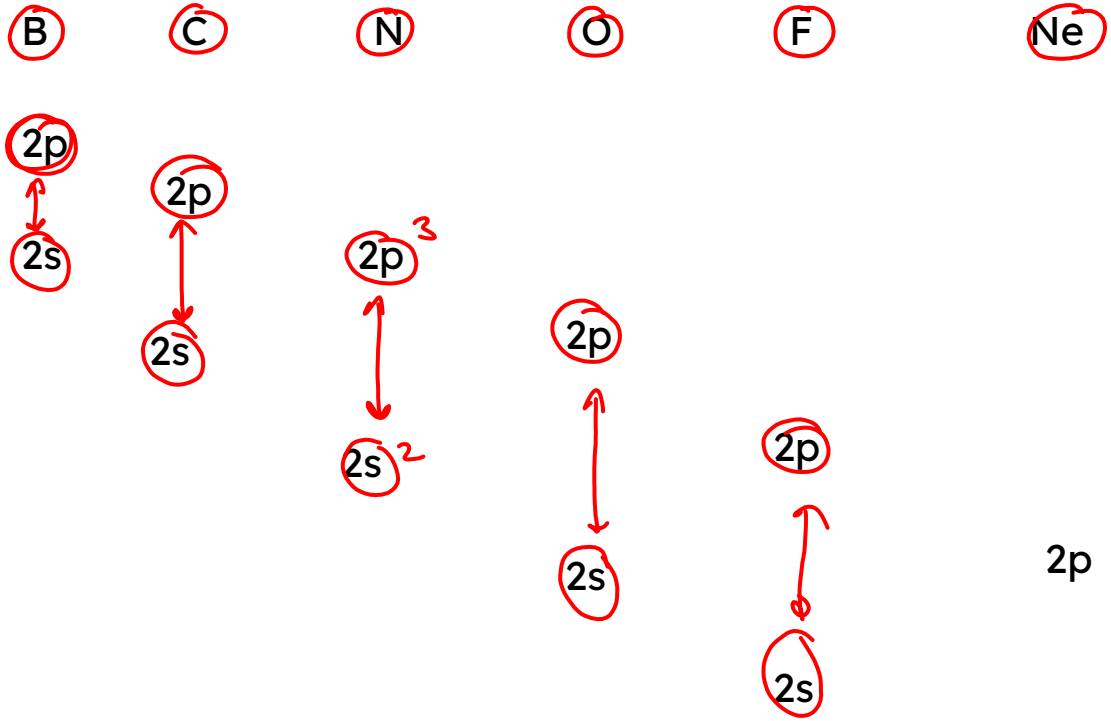
e- e- represion ↑

as 2 pe- ↑

Repulsion between 2s & 2p e-↑

Energy gap between 2s & 2p inc.

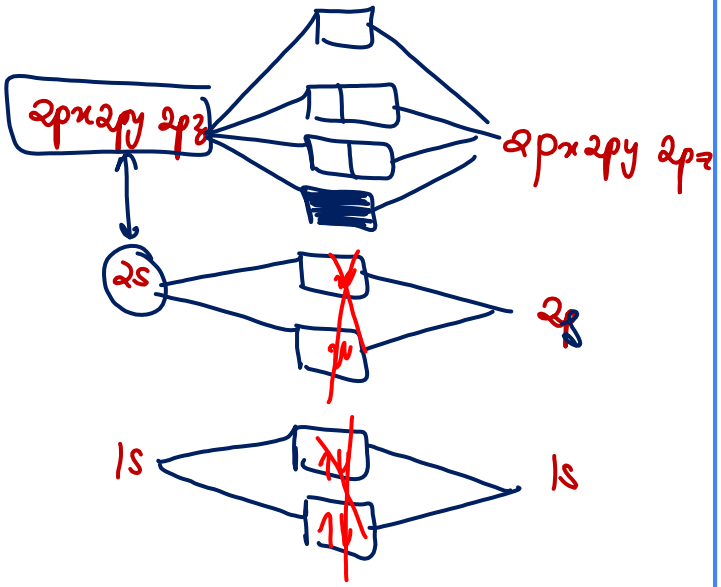
Molecular Orbital Theory



Molecular Orbital Theory

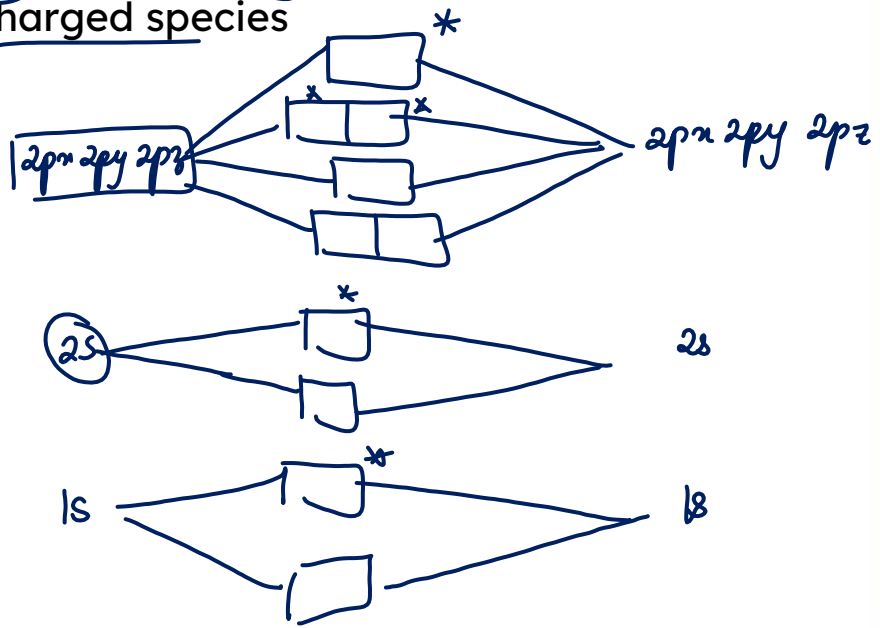
Without sp mixing

O_2, F_2, Ne_2 & their charged species



With s-p mixing

Li_2, Be_2, B_2, C_2, N_2 & their charged species



Molecular Orbital Theory

Without sp mixing	With s-p mixing
O_2, F_2, Ne_2 & their charged species	Li_2, Be_2, B_2, C_2, N_2 & their charged species

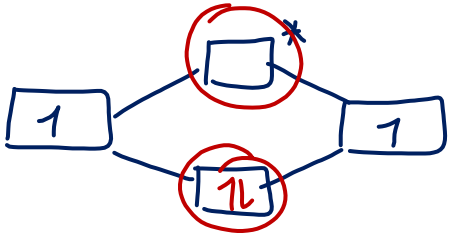
Bond order calculation

Calculation of Bond order

$BO = N_B - N_A/2$

H—H

H_2



$\frac{BMO - ABMO}{2}$

$\frac{2-0}{2} = 1$

Inte

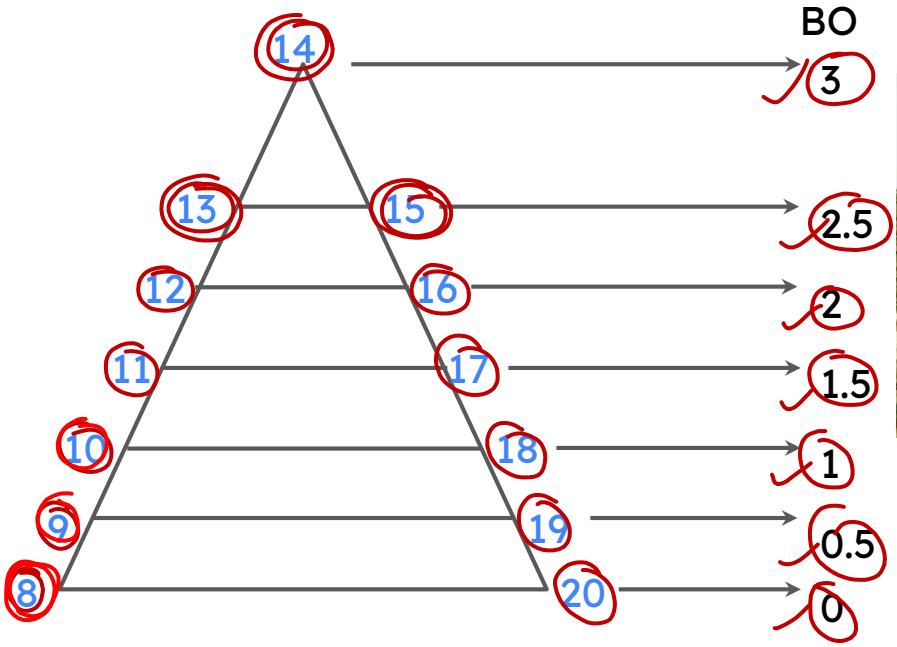
fraction

25, 05, 25

A = B

e^-

Chotila method



O_2, F_2, No_2

Paramagnetic Diamagnetic

odd e^-
10 e^-
16 e^-

even e^-

Bond st ↑
BO ↑

BL ↑ ← BO ↓

BL ↓ ← BO ↑

BO ↑ Bond enyy ↑

Paramagnetism and Diamagnetism

unpaired e⁻ — all e⁻ paired

species with → odd e⁻, 10, 16 e⁻ → paramagnetic → fractional BO

except 10 & 16e⁻

species with → even e⁻ except 10, 16 e⁻ → diamagnetic → integer BO

Bond order ↑

Bond strength ↑

Bond length ↓

Bond enrgy ↑

PYQs

The structure of PCl_5 in the solid state is:

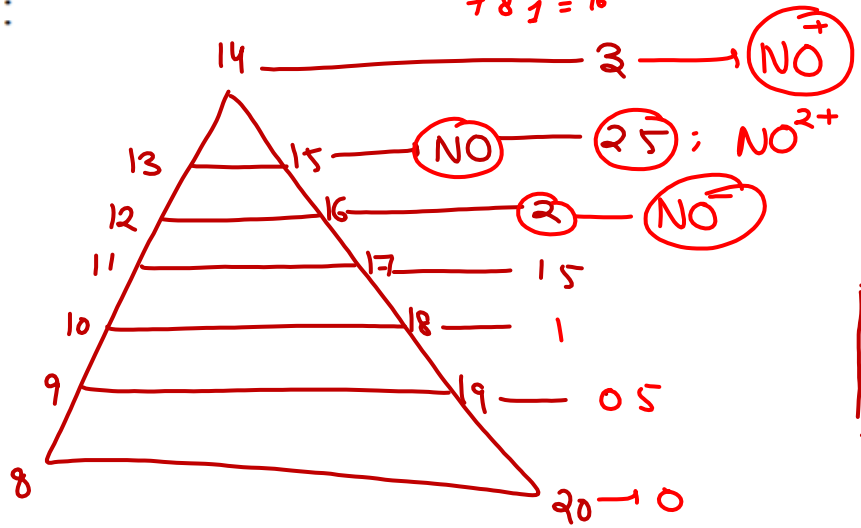
(a) tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$
(b) square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$
(c) square pyramidal
(d) trigonal bipyramidal

JEE Main 2020

PYQs

Of the species, NO, NO^+, NO^{2+} and NO^-, the one with minimum bond strength is :

(a) NO^+
(b) NO
(c) NO^{2+}
(d) NO^-



JEE Main 2020

PYQs

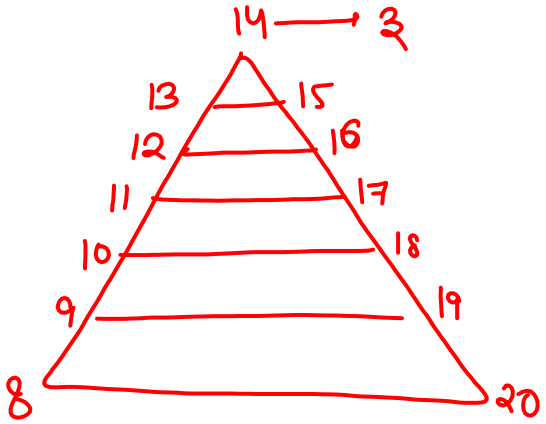
The bond order and the magnetic characteristics of CN^- are:

(a) $2\frac{1}{2}$, diamagnetic

(b) 3, diamagnetic

(c) 3, paramagnetic

(d) $2\frac{1}{2}$, paramagnetic



6+7+1 = 14

even → dia

JEE Main 2020

PYQs

Among the following, the molecule expected to be stabilised by anion formation is:

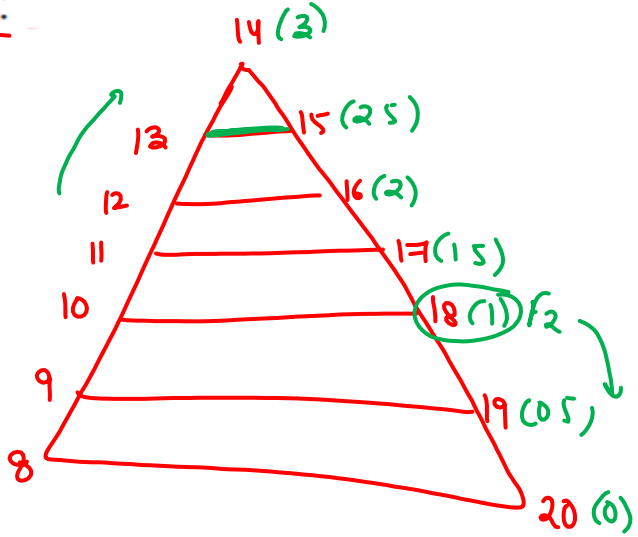
(a) C_2, O_2, NO, F_2

(b) C_2

(c) F_2

(d) NO

(e) O_2



JEE Main 2019

PYQs

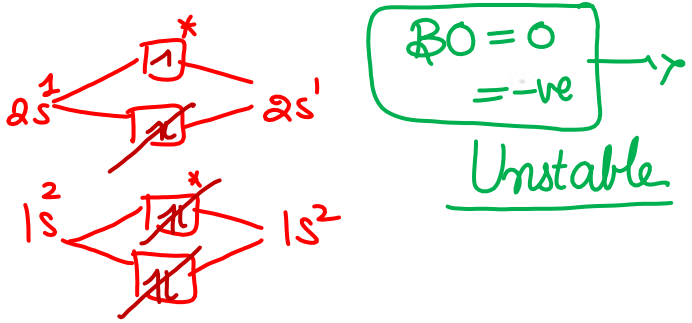
According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^-?

(a) Li_2^+ is unstable and Li_2^- is stable

(b) Li_2^+ is stable and Li_2^- is unstable

(c) Both are stable

(d) Both are unstable



Li_2^+ Li_2^-

3+3-1= 5 2+3+1=7 $\frac{2-1}{2}$ = 0.5

0.5

JEE Main 2019

PYQs

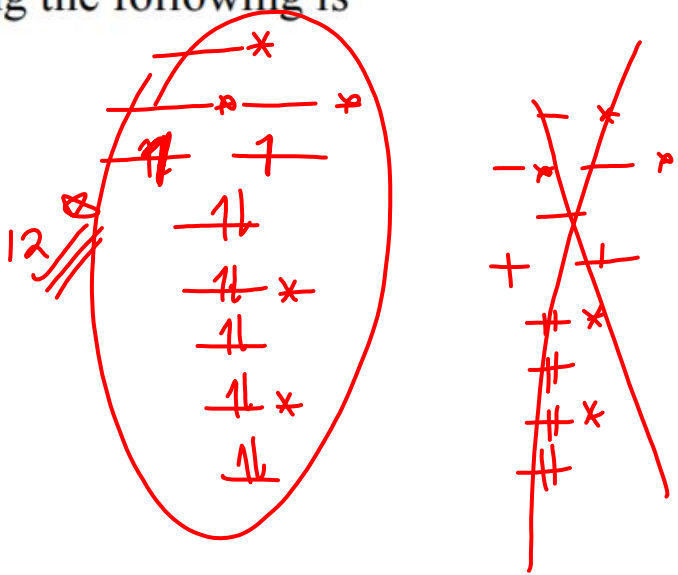
Assuming $2s$-$2p$ mixing is **NOT** operative, the paramagnetic species among the following is

(a) Be_2

(b) B_2

(c) C_2

(d) N_2



JEE Adv 2014

PYQs

Among H_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2 and F_2, the number of diamagnetic species is

(Atomic numbers: H = 1, He = 2, Li = 3, Be = 4, B = 5, C = 6, N = 7, O = 8, F = 9)

JEE Adv 2017

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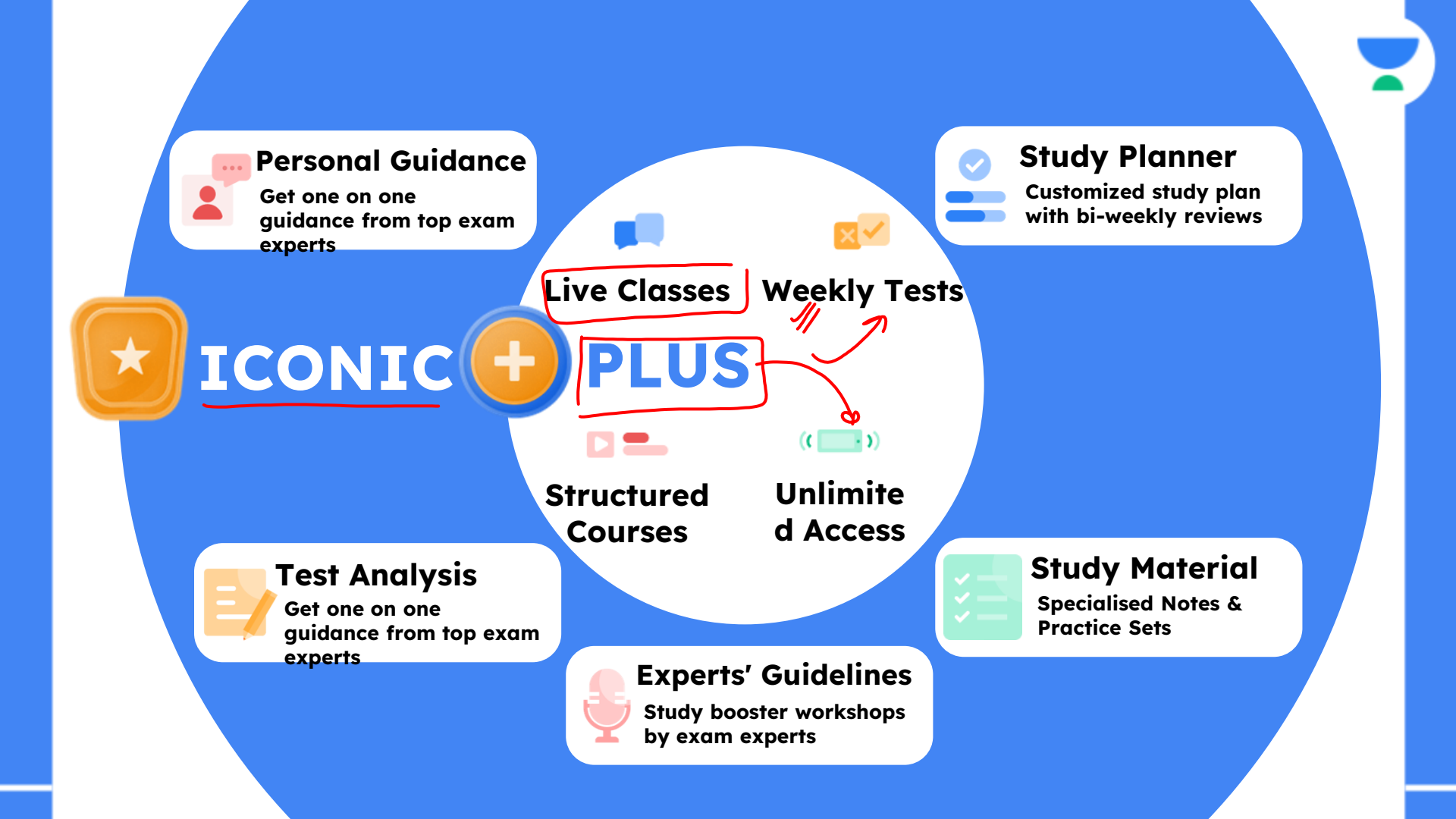
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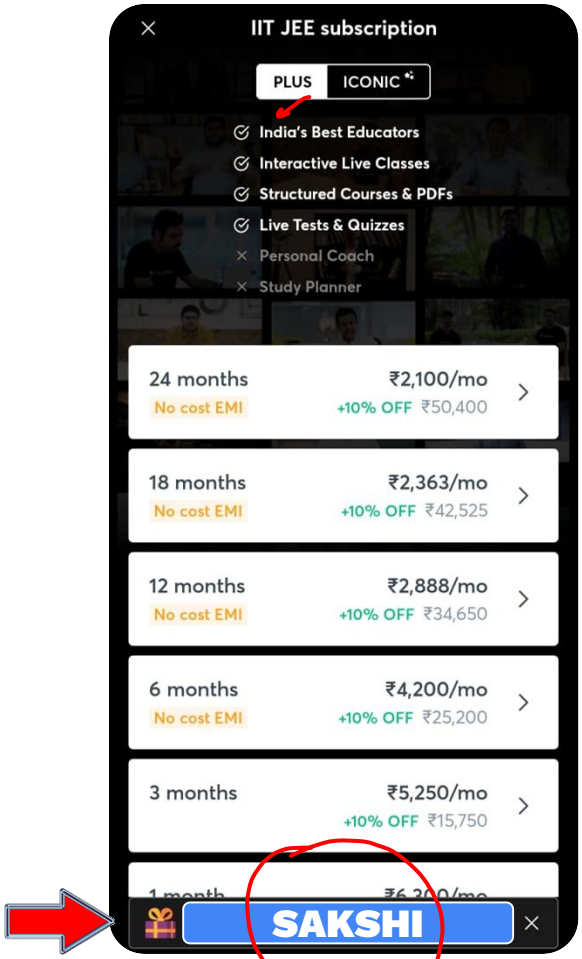
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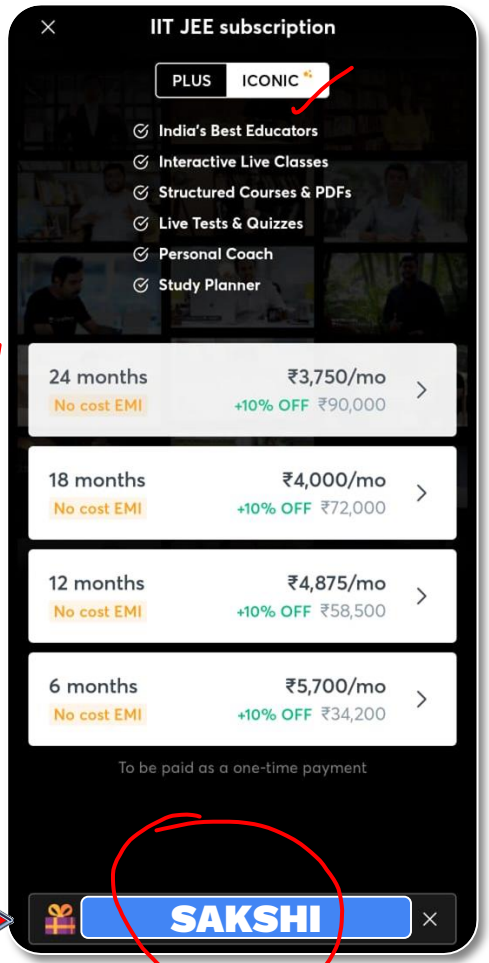
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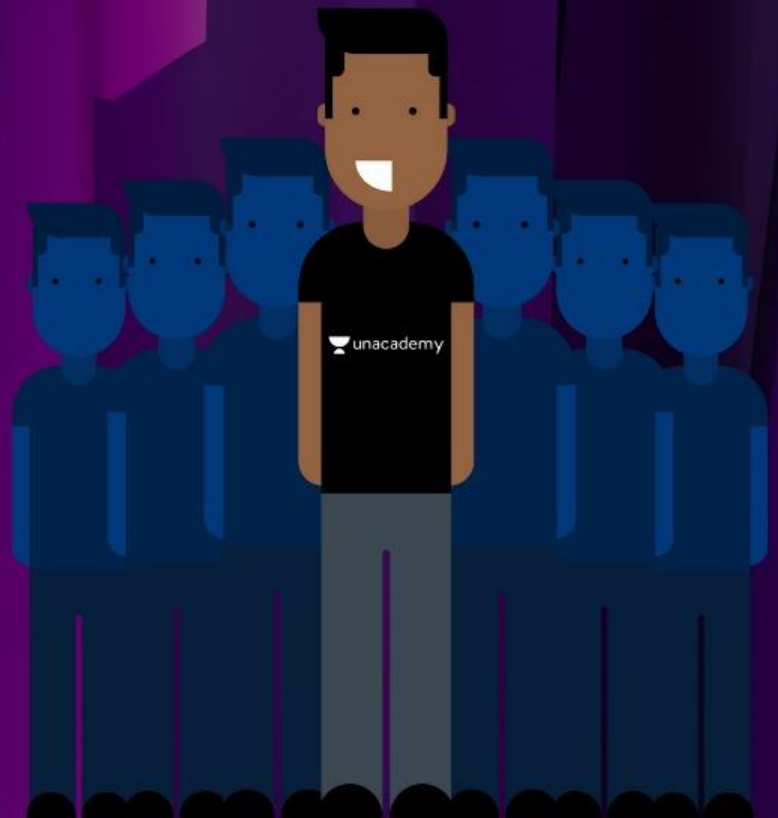

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