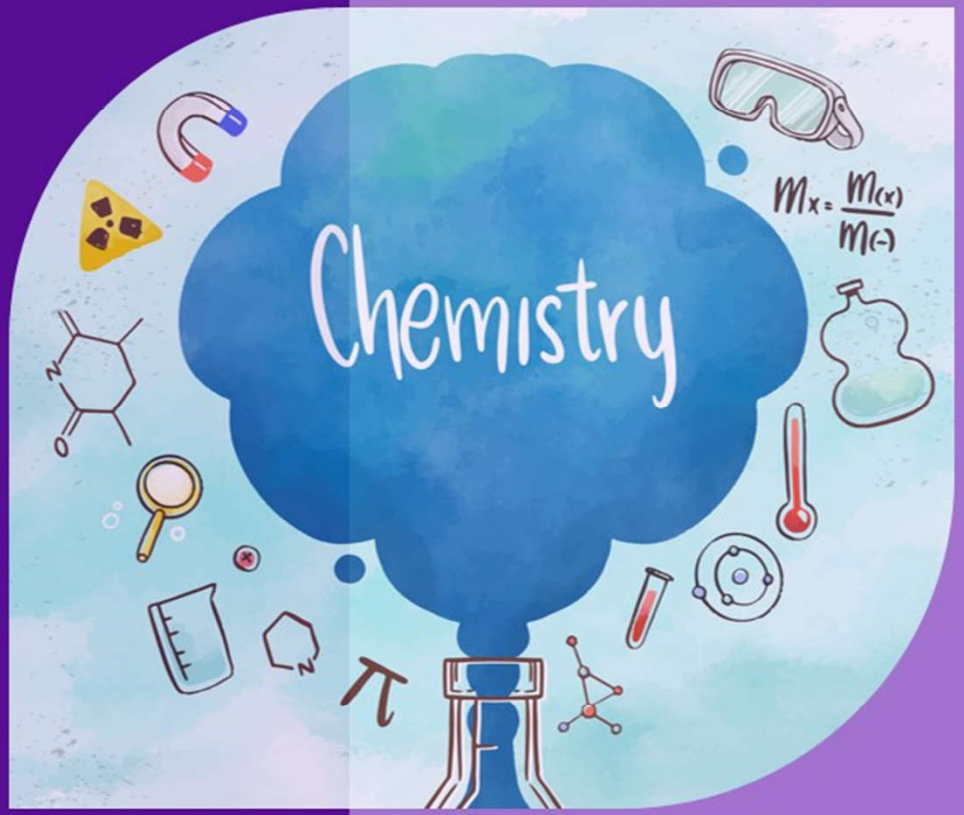
VARSITY 'Ka' ADMISSION PROGRAM 2020

CHEMISTRY

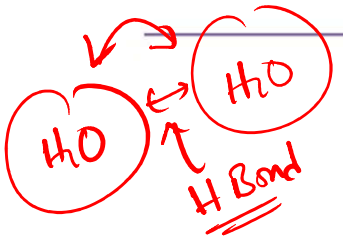
LECTURE : C-02

CHAPTER 3 : PERIODIC PROPERTIES OF ELEMENTS

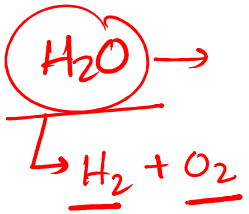
Is Chemical Bonds

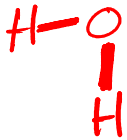


Chemical Bonding



molecule to molecule interaction → state (phase)
- gas
- liquid
- solid





chemical Reaction

- Bond
  - Chemical Bond (breakdown via chemical Reaction)
    - Ionic Bond
    - Covalent Bond
    - Metallic Bond
  - Physical Bond (breakdown via stress, temp.)
    - Van Der Waals Bond / force
    - Hydrogen Bond

Why?

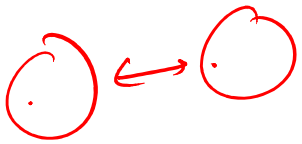
Chemical Bond

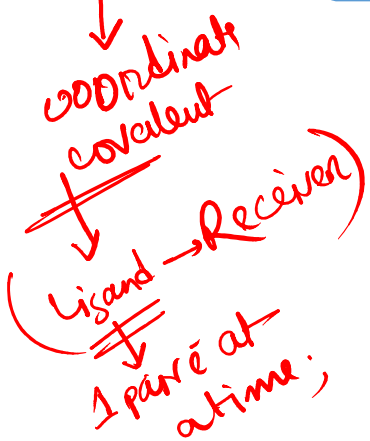
- The tendency of achieving stable electronic configuration of inert gases.
- The tendency of elements having minimum static energy to achieve maximum stability.

octate fill up's

static

Chemical Bonding

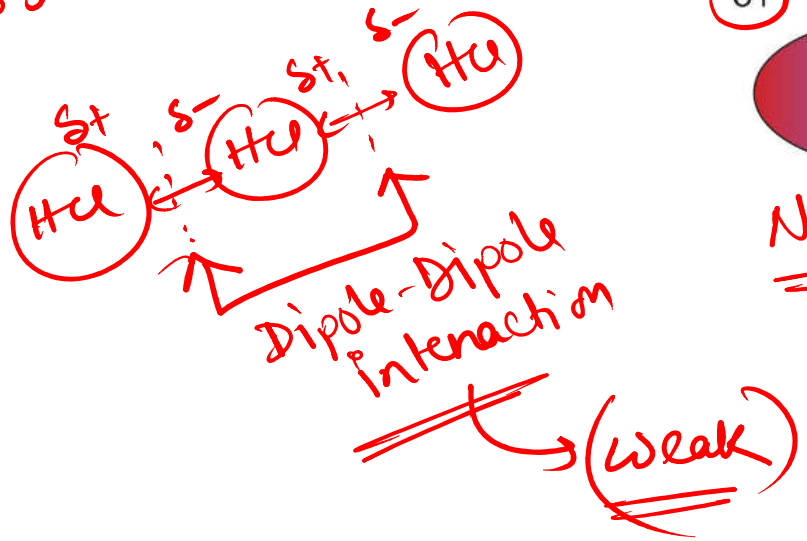


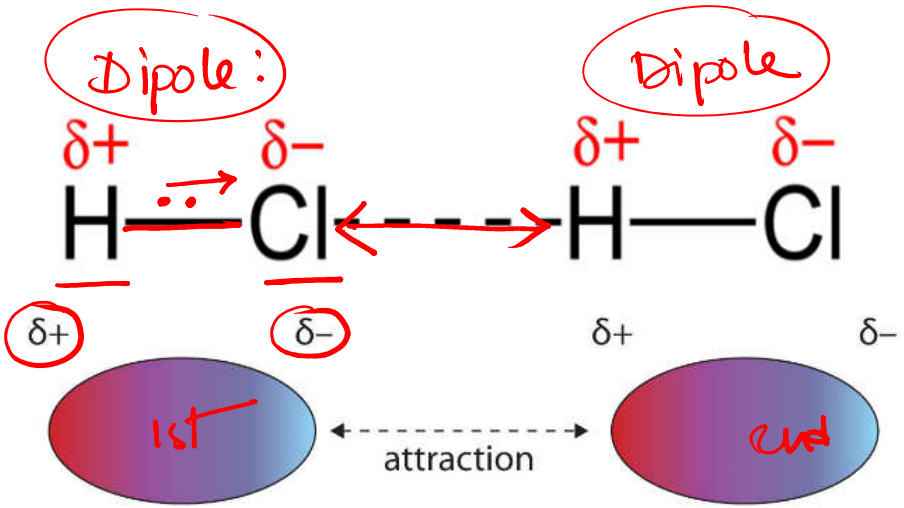


Dipole-Dipole

Inter molecular chemical Bonding

HCl → gaseous?

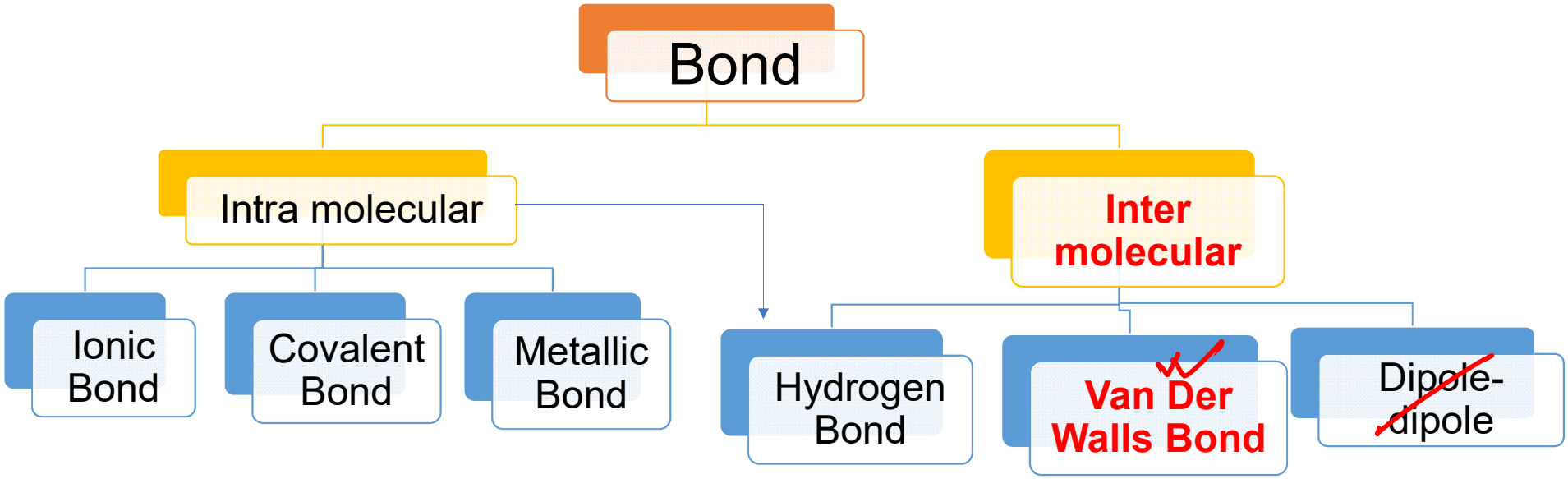




1g → 10J

100 × 1J = 100J

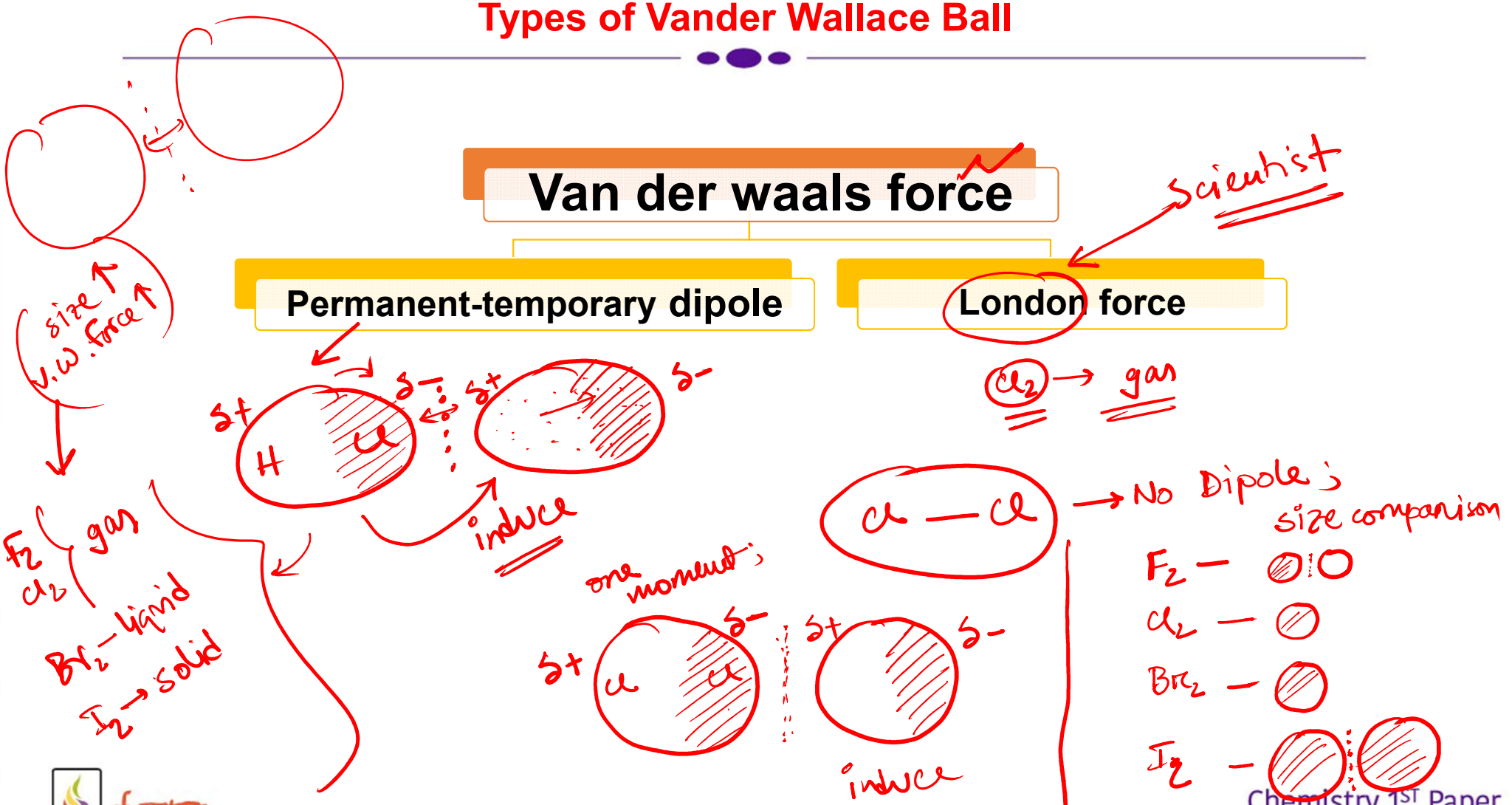
Chemical Bonding



Types of Vander Wallace Ball

Van der waals force

- Permanent-temporary dipole
- London force



Poll Question-01

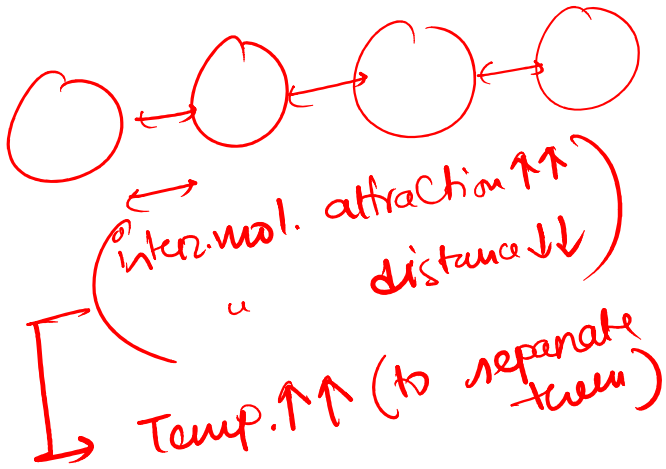
Which one has the higher boiling point?

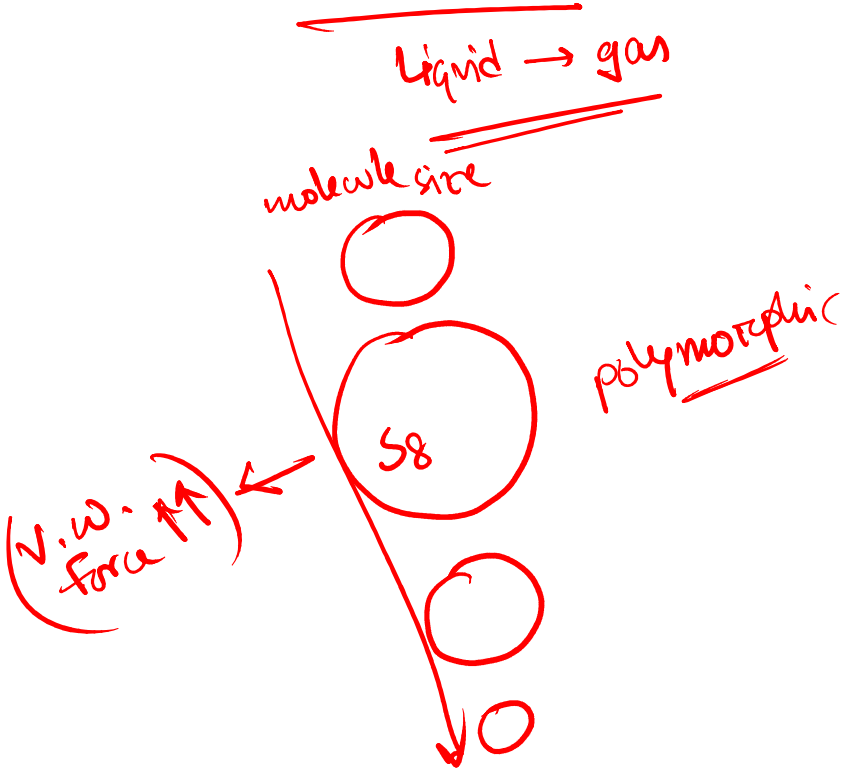
(a) Cl_2

(b) S_8

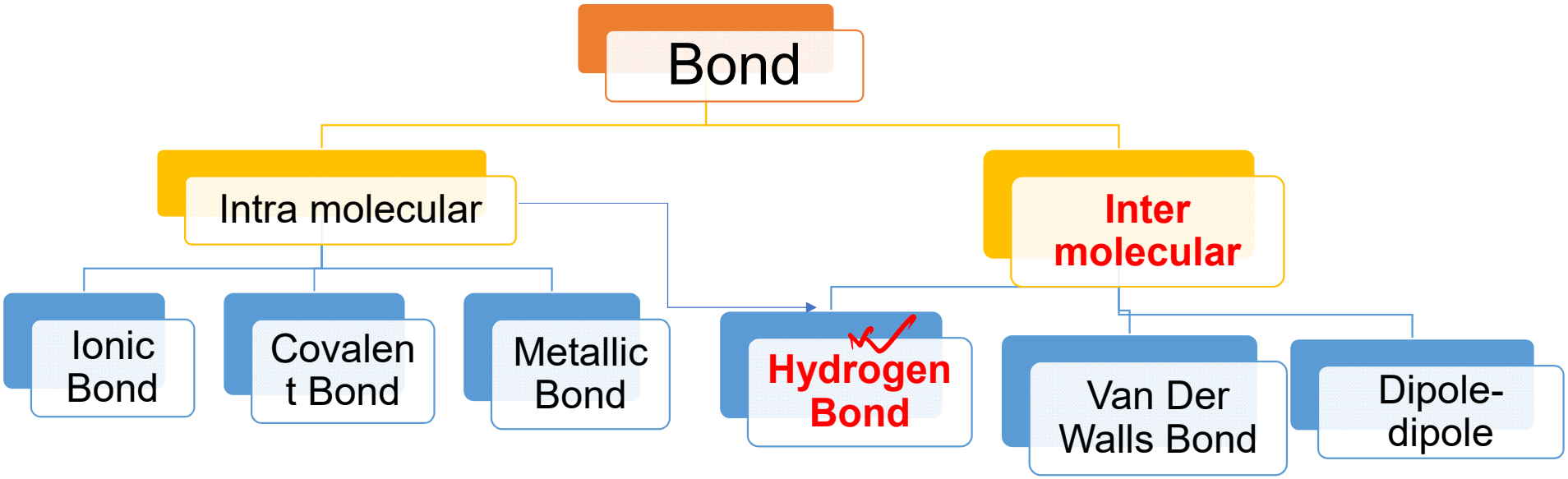
(c) P_4

(d) Ar



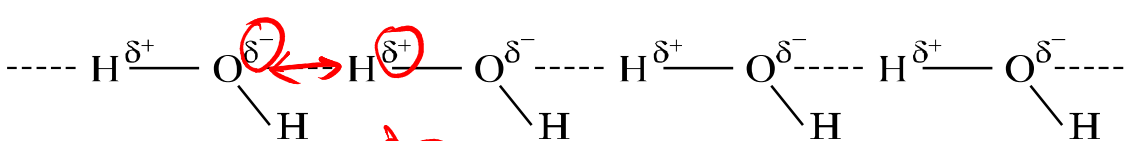


Chemical Bonding



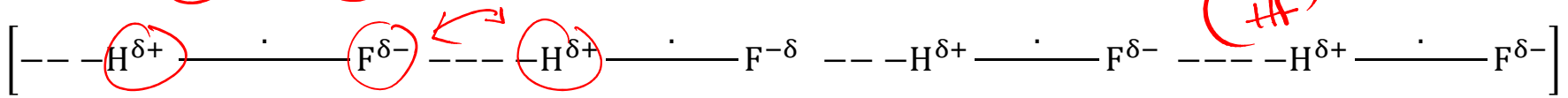
H-bond

- H atom has to be bonded with high electronegative atom (F, O, N)
- That atom must be small in size



(H2O)

H.Bond



(HF)

(NH3)

δ+ δ+

H----O

H----F

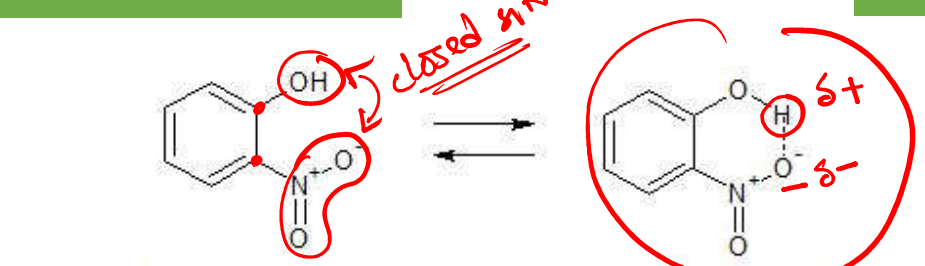
H----N

H-bond

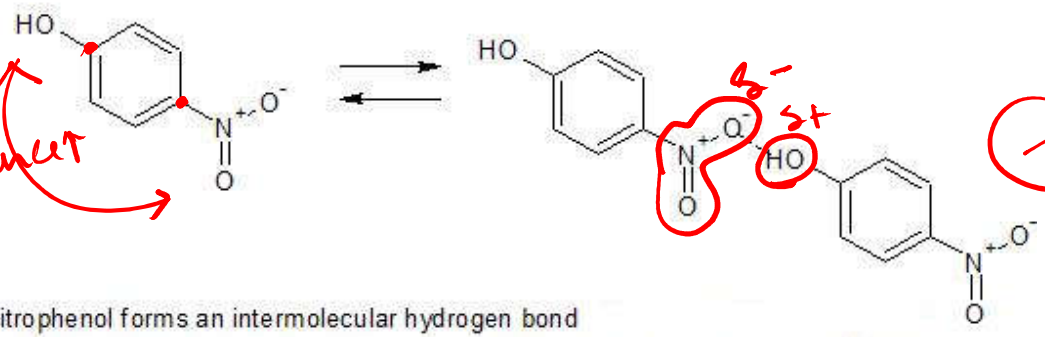
H-bond

Inter molecular

Intra molecular



o-nitrophenol forms an intramolecular hydrogen bond



p-nitrophenol forms an intermolecular hydrogen bond

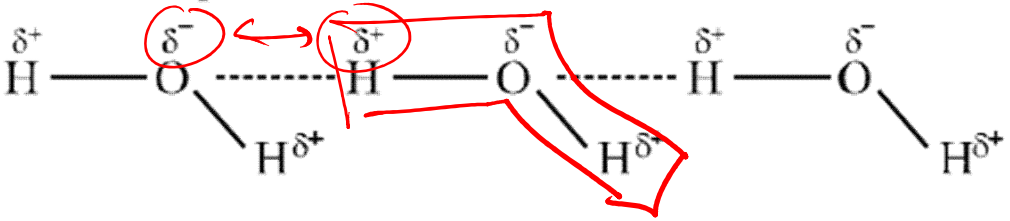
Liquid & Gaseous Condition

- Why water is liquid in normal condition, but H_2S is gaseous ? → (because of H-bond)

→ Room Temp.

High electronegative atom

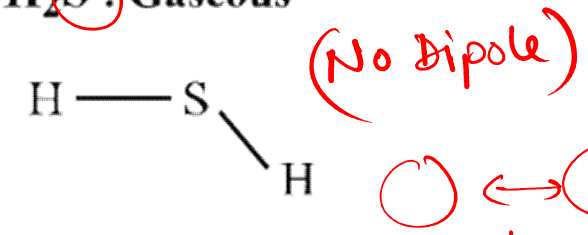
H_2O : Liquid



H-bond: Bunch of molecules

(Electronegativi: H = 2.1, O = 3.5 ∴ Dipole Creation)

H_2S : Gaseous



(No Dipole)

Discrete H_2S molecule
No H-bond

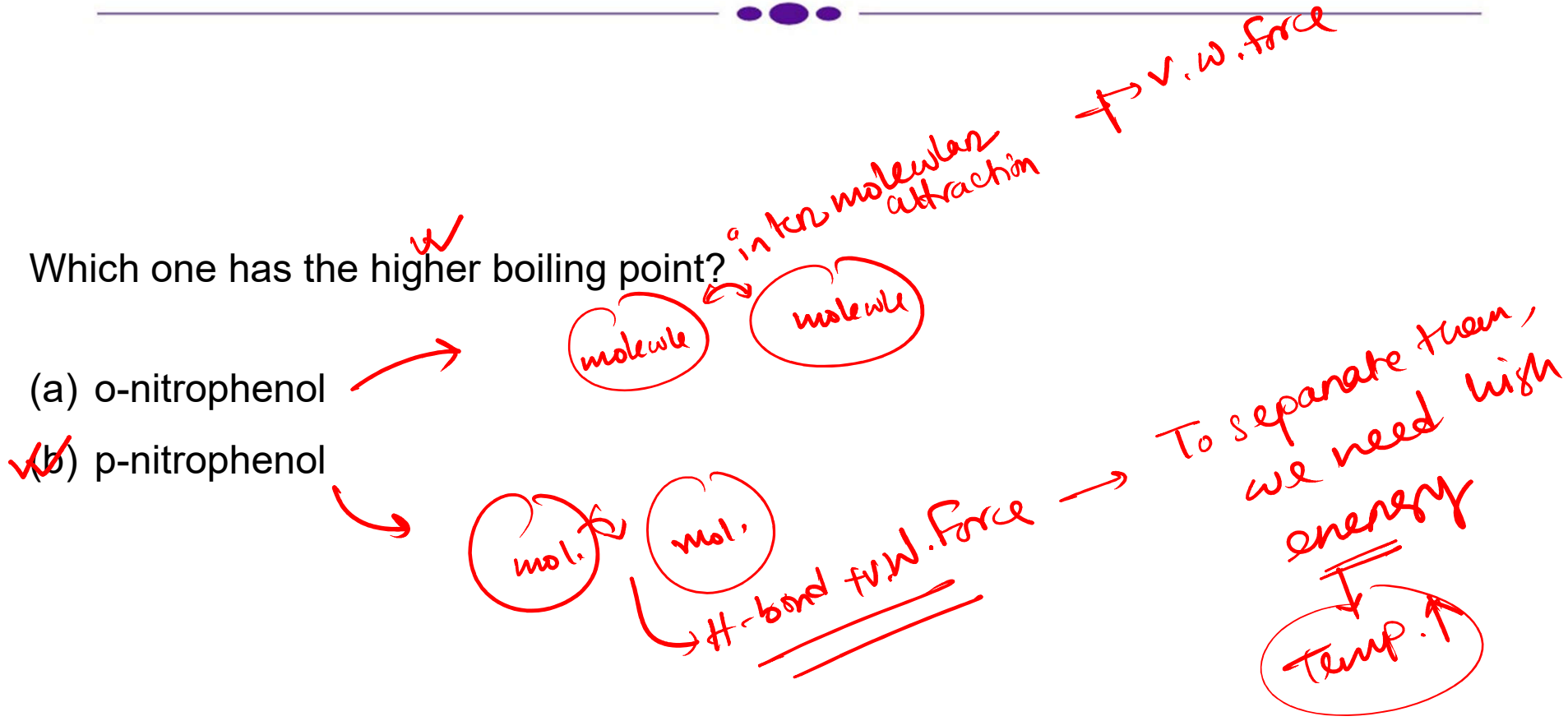
gaseous

Poll Question-02

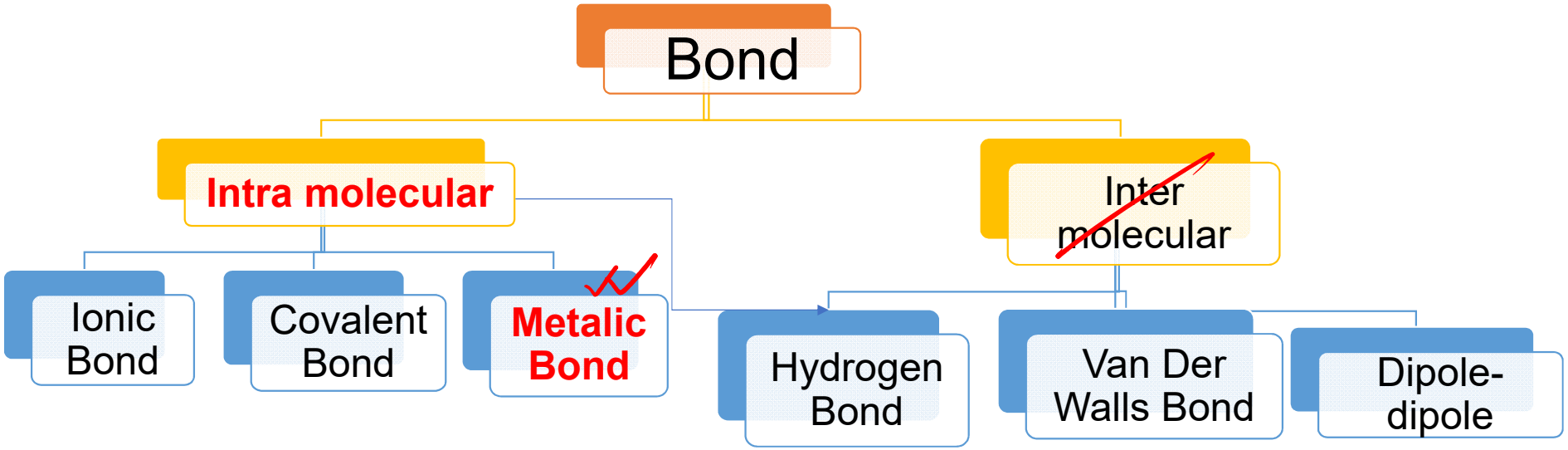
Which one has the higher boiling point?

(a) o-nitrophenol

(b) p-nitrophenol



Chemical Bonding

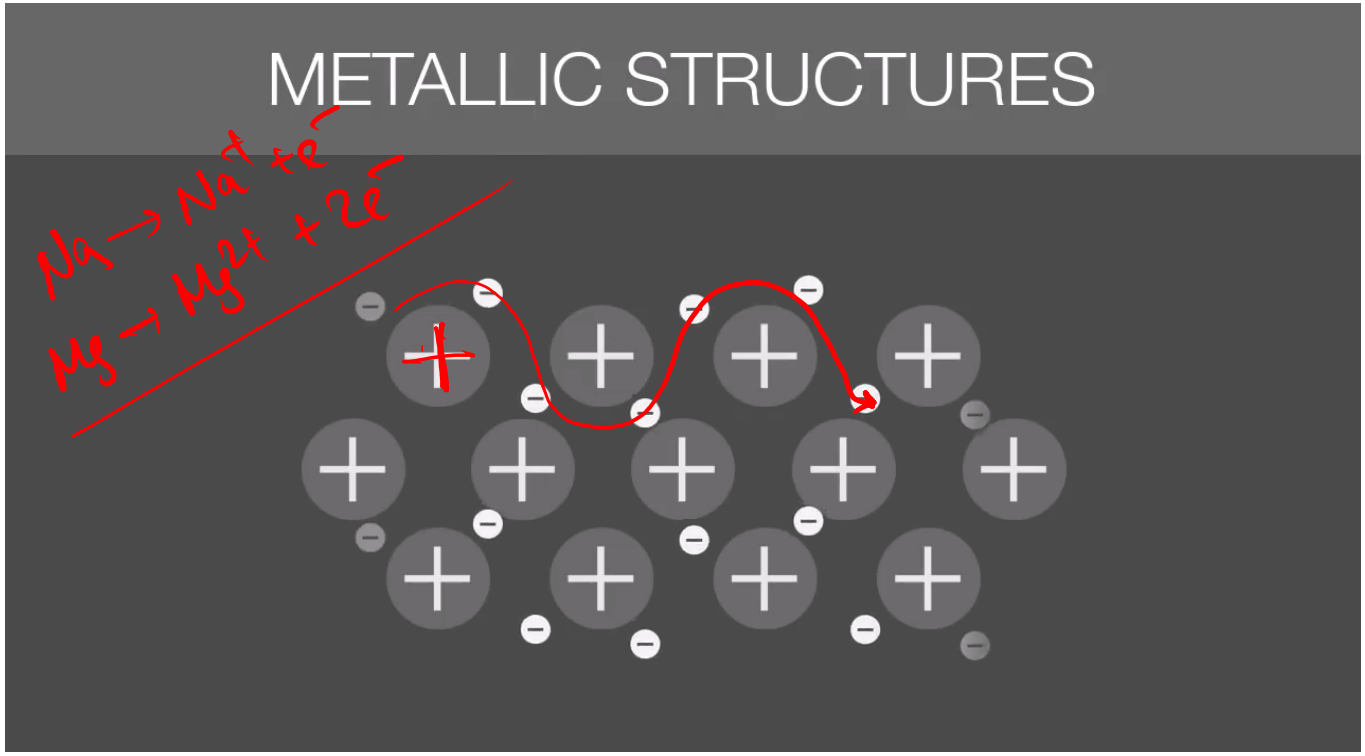


Metalic Bond

- Available electrons come out from every atom.

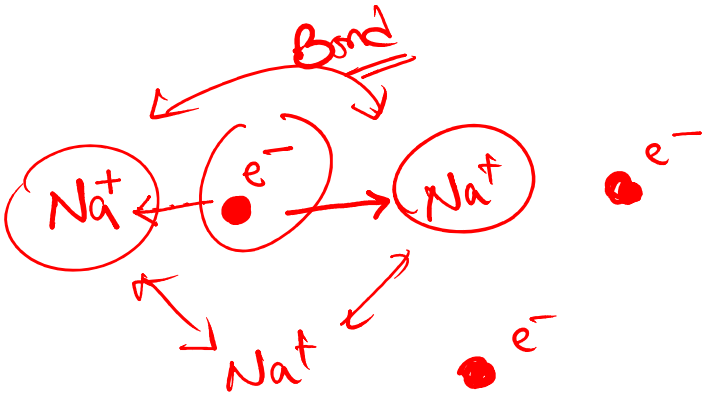
Valence electron

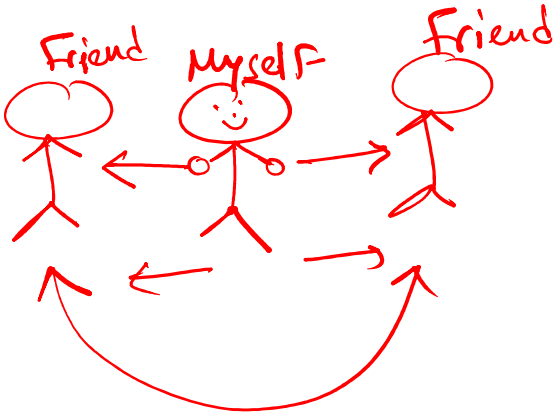
Last shell e⁻



Metalic Bond

- The higher the number of participant electron, the stronger metallic bond will form





Poll Question-03

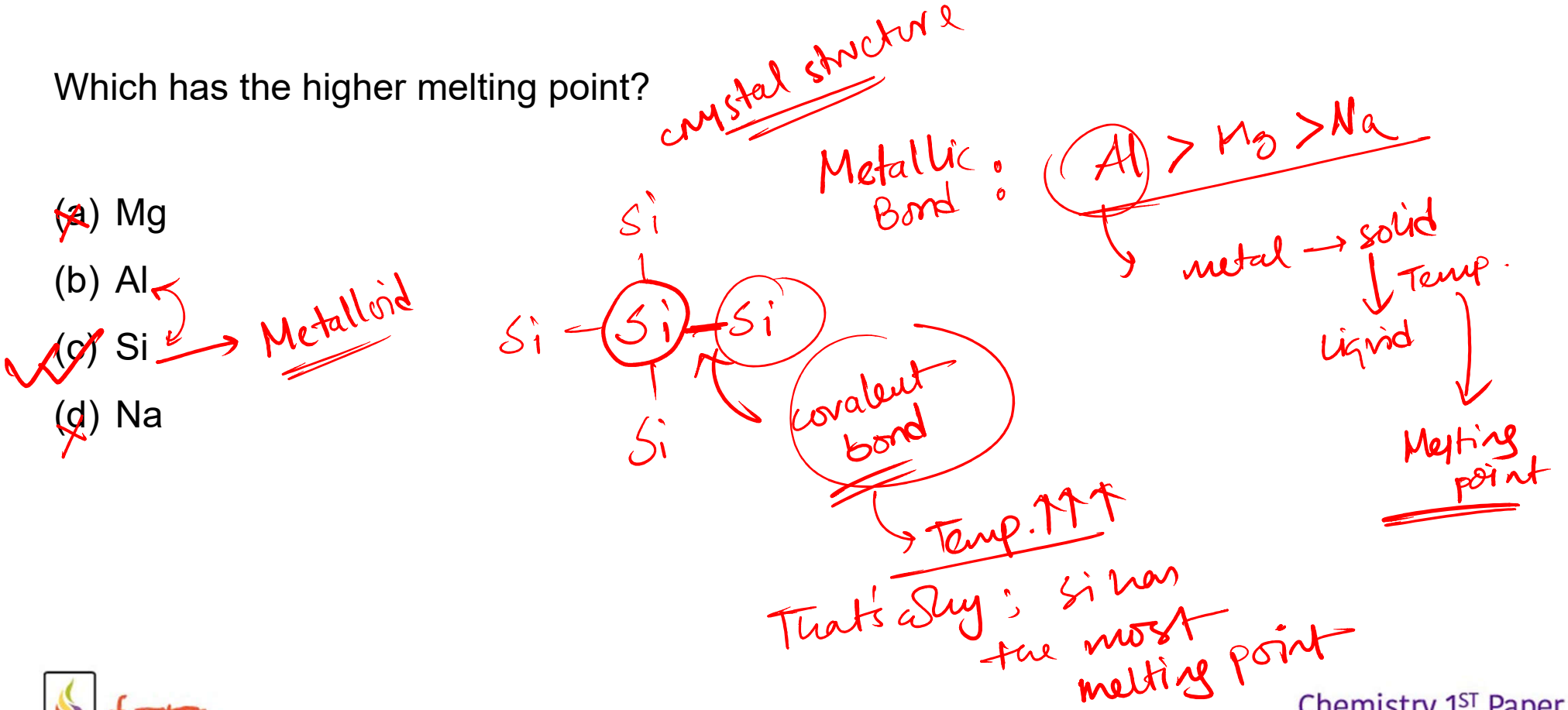
Which has the higher melting point?

(a) Mg

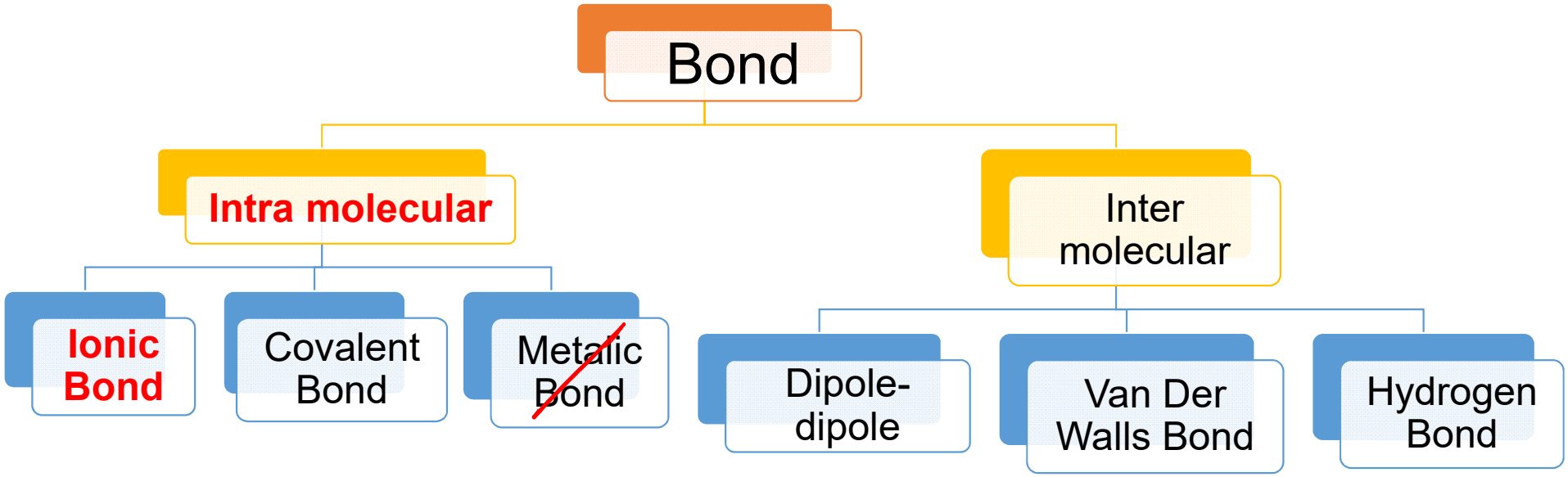
(b) Al

(c) Si

(d) Na



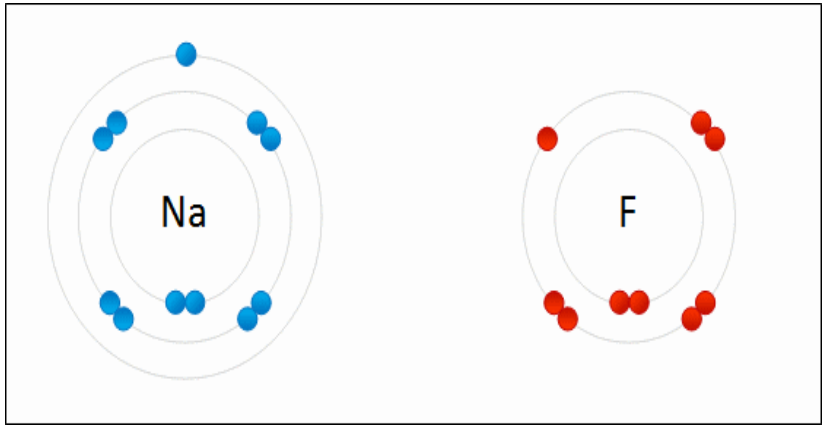
Chemical Bonding



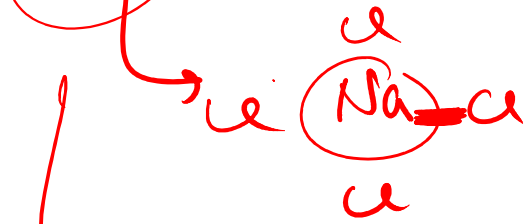
Ionic Bond

(metal – nonmetal)
↓ e⁻ receive
e⁻ donate

- Low ionization potential of metal
  - ↳ easily e⁻ donate
- High electron affinity of non-metal
  - ↳ quickly e⁻ receive
- High lattice energy of the newly formed molecule



$Na^+ \longleftrightarrow F^-$



→ solid ionic compound → reaction rate much less ↓↓,

Ionic Bond

❑ Ionic Bond:

➢ General properties of ionic compounds :

(i) Melting and boiling points are very high. (high lattice energy)

(ii) They are non-volatile. (can't be easily evaporated)

(iii) They are good conductor of electricity in molten state or in solution, but in solid state, they cannot conduct electricity.

No avaible electron

(iv) The rate of reaction is very high. (aq.)

(v) In chemical reaction, the ions of that ionic compound retain their properties.

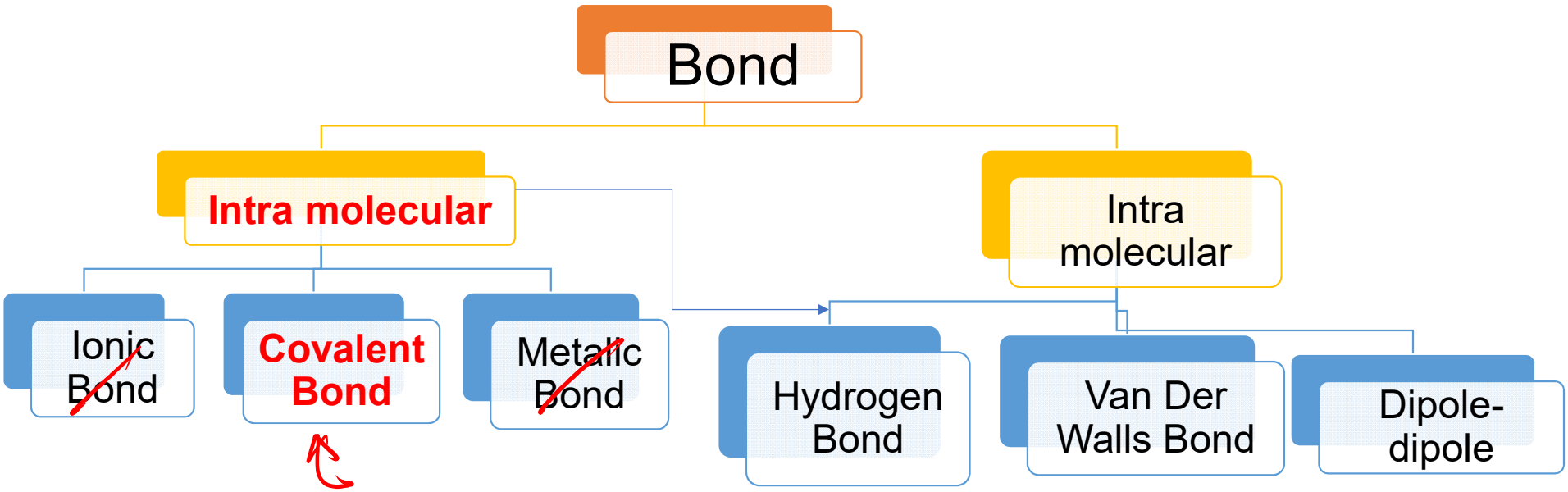
↳ $NaNO_3 \rightarrow Na^+ + NO_3^-$ ✓

$NaCl \rightarrow Na^+ + Cl^-$ ✓

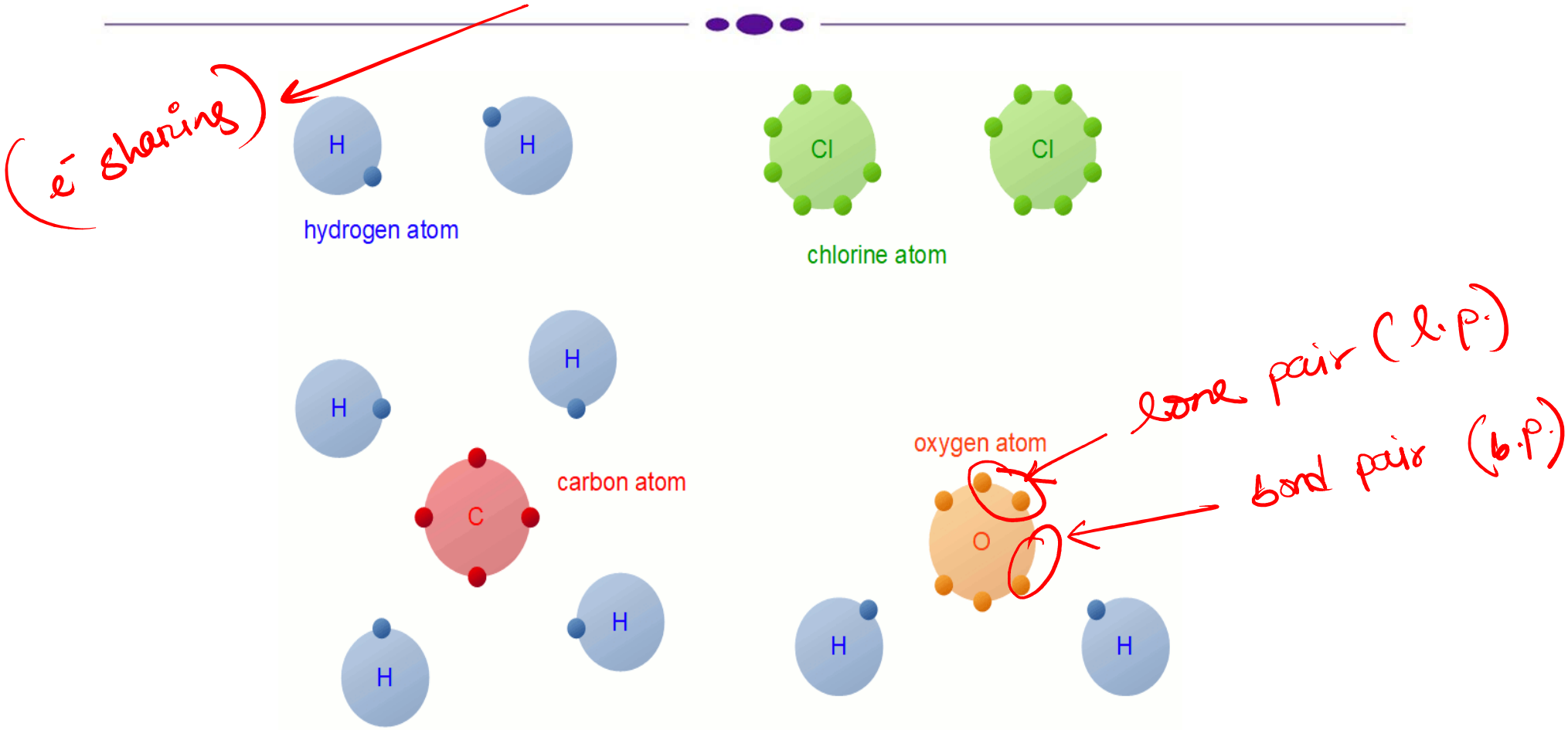
Reaction → condition → breakdown of bond

$NaCl_{(aq.)} \rightarrow Na^+ + Cl^-$

Chemical Bonding



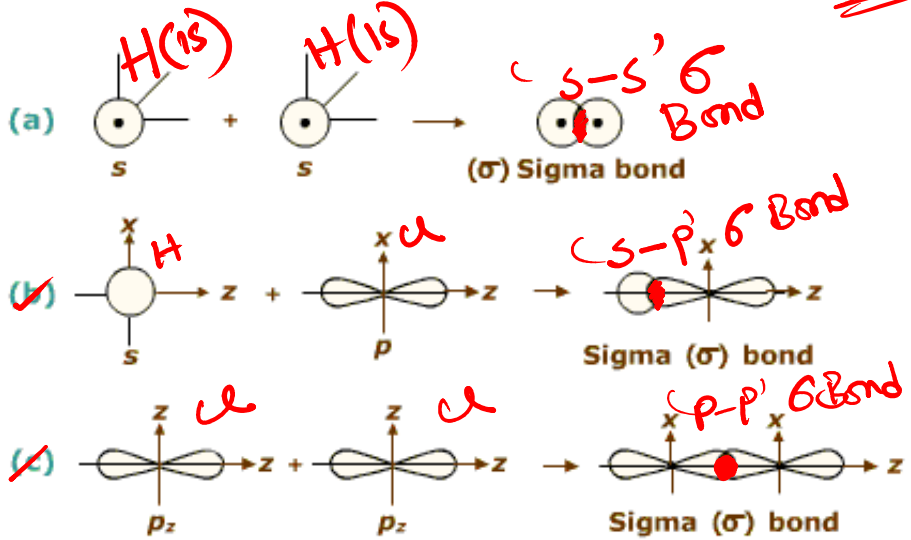
Covalent Bond



Covalent Bond

Covalent Bond

sigma (σ)



Formation of a sigma bond due to (a) The *s* - *s* overlap (b) The *s* - *p* overlap (c) The p_z - p_z overlap

pi (π)

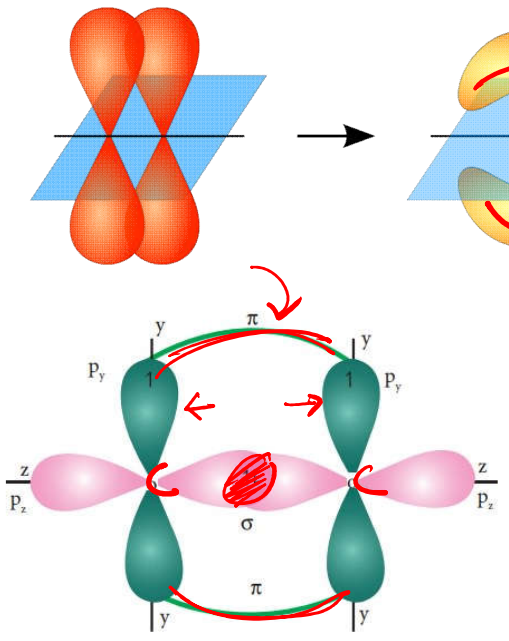
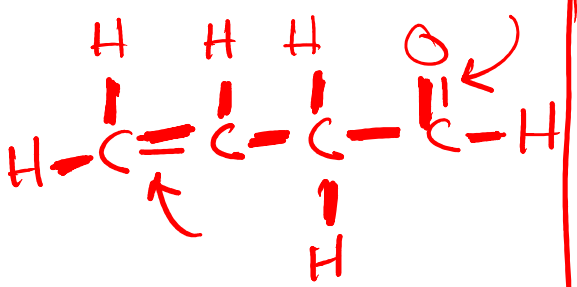


Fig Formation of π bond in O_2 Molecule

Sigma (σ) and Pi (π) Bond Countdown

1. $CH_2 = CH - CH_2CHO$

✓[DU'15-16]

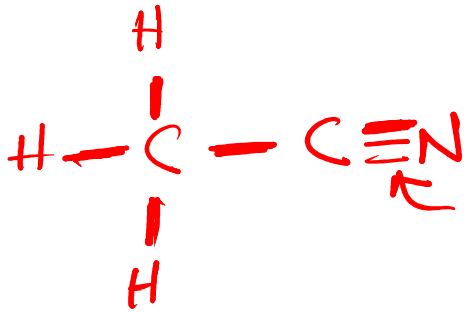


$\sigma = 10$

$\pi = 2$

2. CH_3CN

[DU'12-13]



$\sigma = 5$

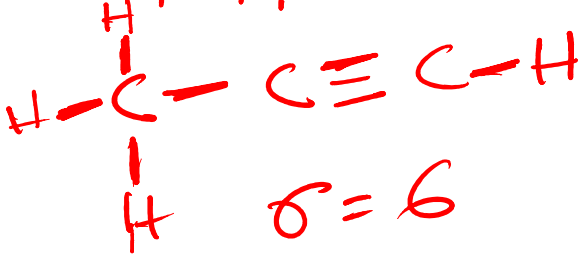
$\pi = 2$

3. C_3H_4

[DU'13-14]

$\sigma = ?$; $\pi = ?$

'propyne'



$\sigma = 6$

$\pi = 2$

organic compound

	σ	π
single bond (—)	1	0
double bond (=)	1	1
triple bond (≡)	1	2

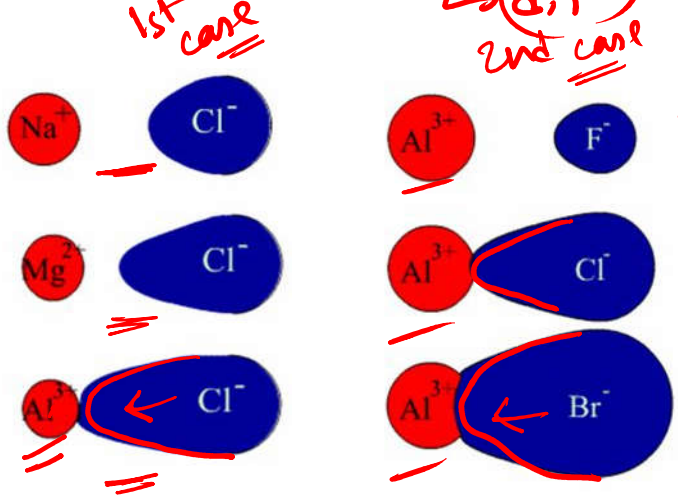
Covalent Character of Ionic Compound (Polarization)

The conditions are-

(i) Higher charge in cation or in anion.

(ii) Smaller size of cation and larger size of anion

(iii) If the cations having ns2 np6(n−1) d10 electronic configuration



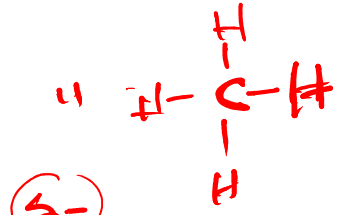
Ionic Character of Covalent Compound (Polarity)

Difference of Electronegativity → ΔEN ↑ ; polarity ↑

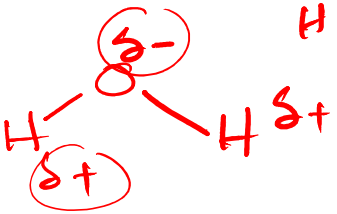
(+/−)

1. ❑ ΔE.N = 0 (Purely covalent) ; Cl_2 ; ΔEN = 3.0 − 3.0 = 0 ; No Dipole

2. ❑ ΔE.N <0.5 (non-polar co-valent) ; CH_4 ; $\Delta EN = {}^{(C)}2.5 - {}^{(H)}2.1 = 0.4$;



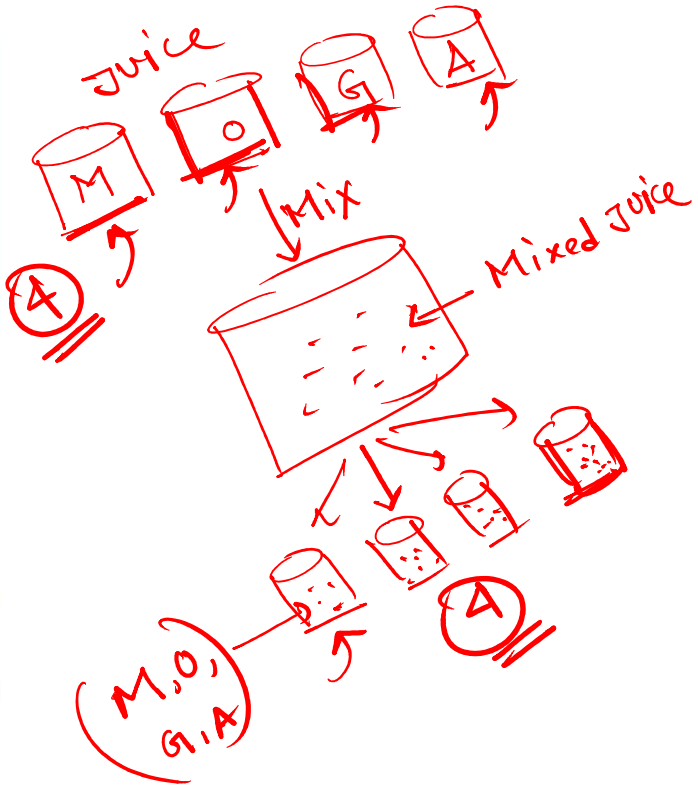
3. ❑ 0.5< ΔE.N <1.7(polar co-valent) ; H_2O ; $\Delta EN = {}^{(O)}3.5 - 2.1 = 1.4$;

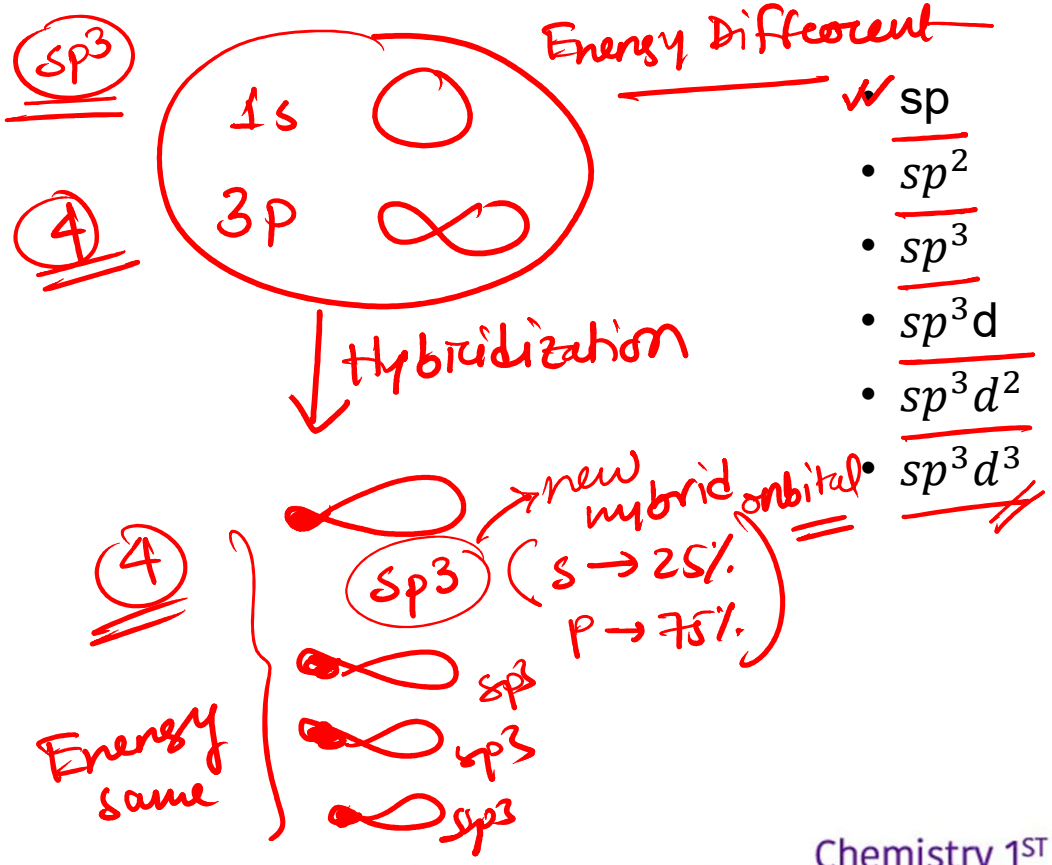


4. ❑ ΔE.N>1.7 (Almost Ionic) ; NaCl ; ΔEN = 3.0 − 0.9 = 2.1 ; Na^+ ; Cl^-

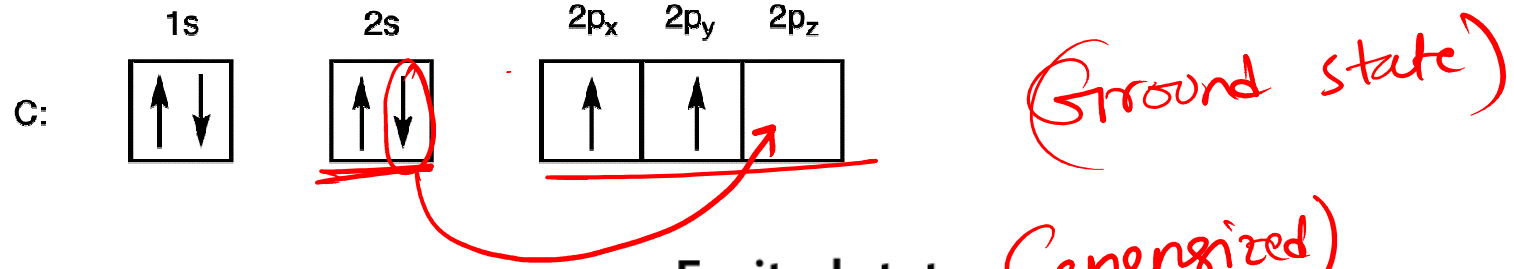
Hybridization

- With equal energy, equal number of new orbitals are formed



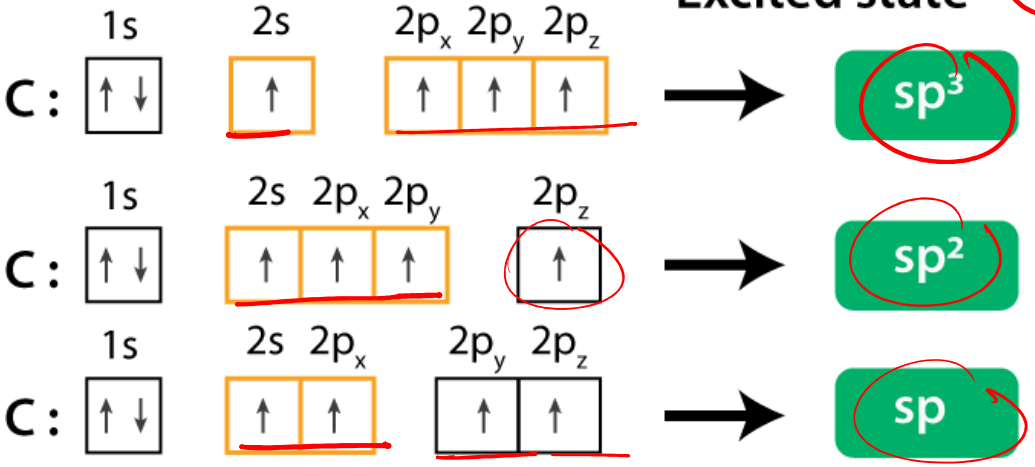


(Hybridization of Carbon)



(Ground state)

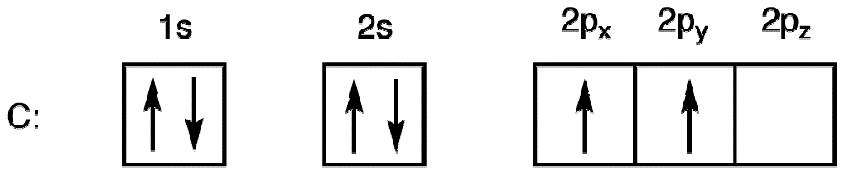
Excited state (energized)

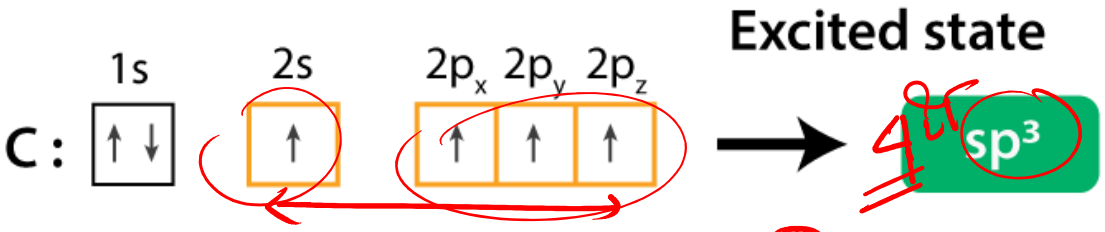


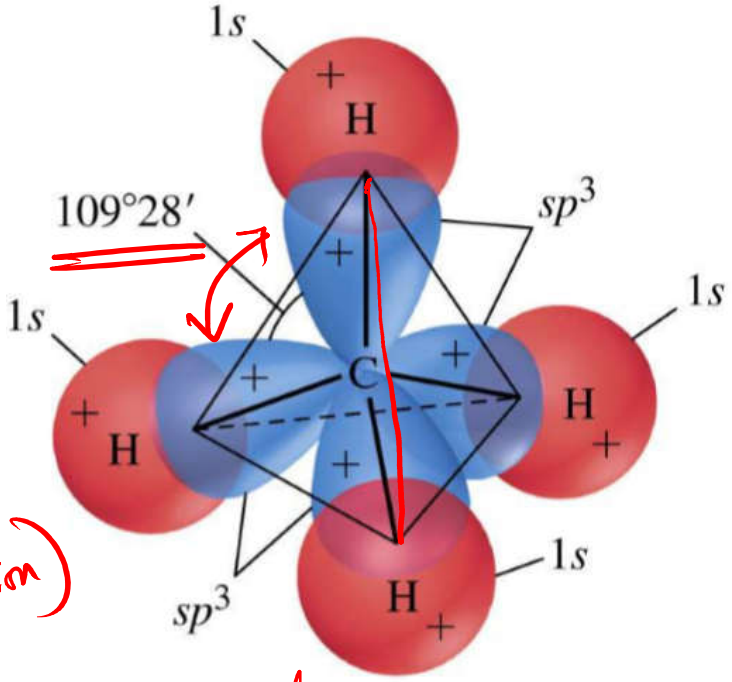
Yellow box → participated in hybridization

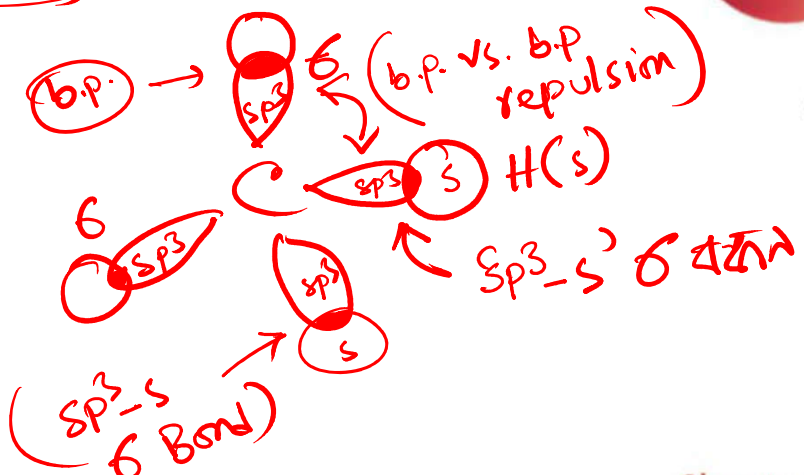
Black box → unhybridized orbital ;

sp^3 Hybridization : Methane



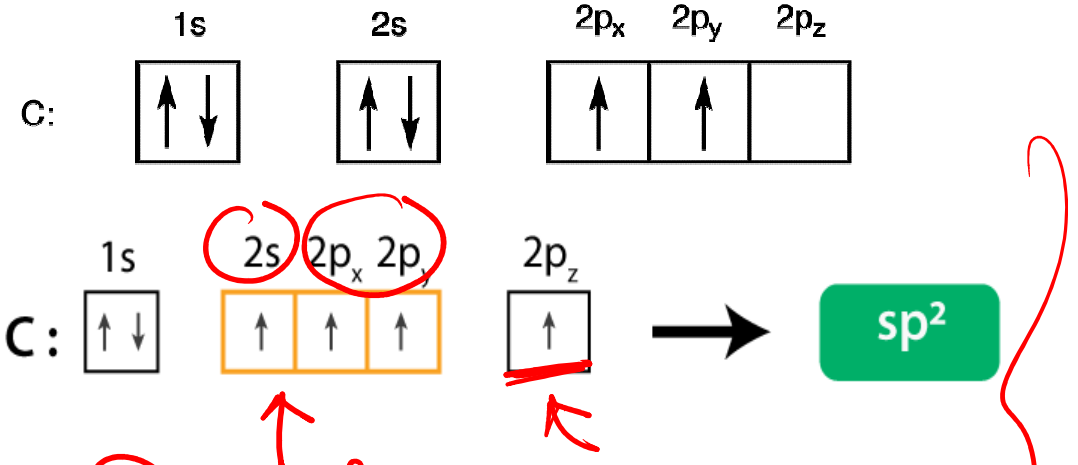


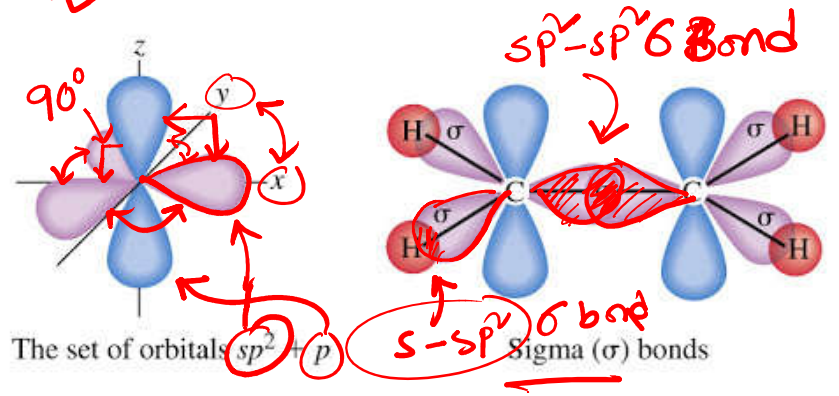


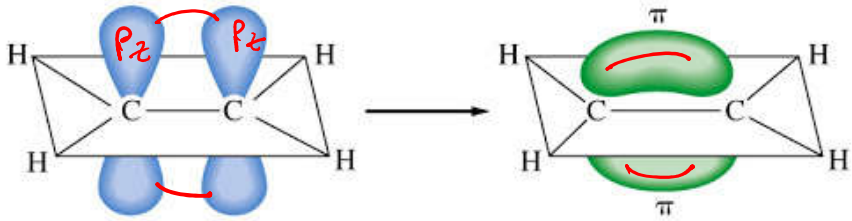


Tetrahedral

sp^2 Hybridization : Ethene

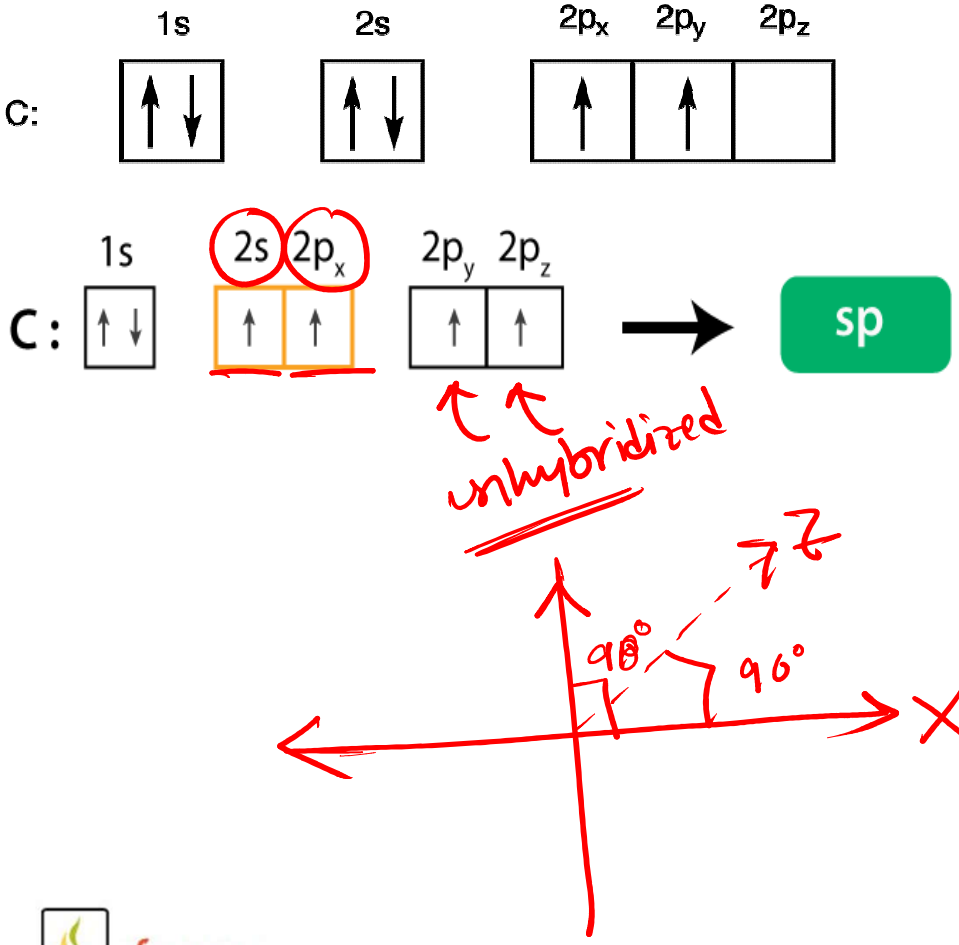


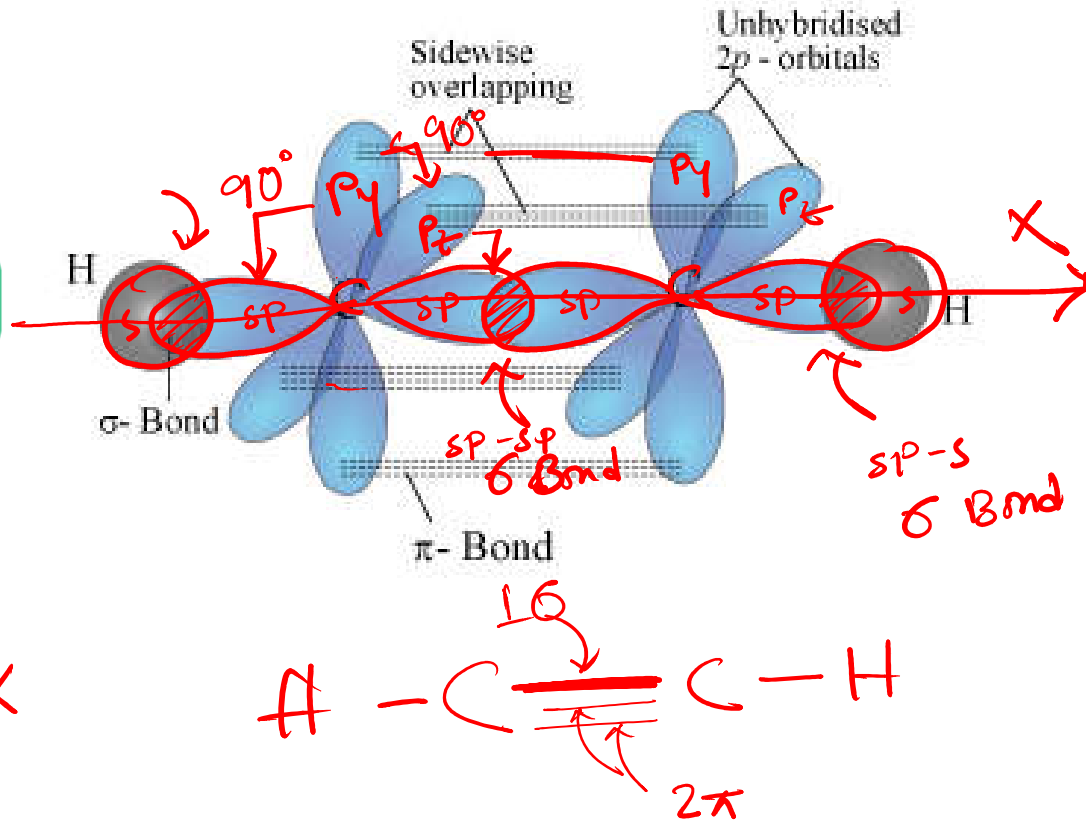




360°/3 = 120°

sp Hybridization : Ethyne





Poll Question-04

In the following compound which carbons show sp^3 hybridization

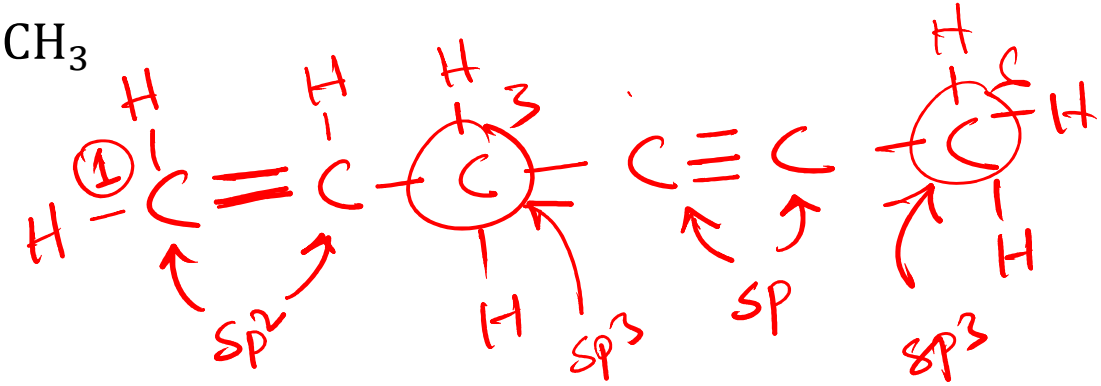
$H_2\overset{1}{C} = CH - CH_2 - C \equiv C - CH_3$

(a) 1 & 5

(b) 1 & 3

(c) 3 & 6

(d) 1 & 4



(Ene-yne)

Molecule With One Central Atom

steric number

$X = 1/2\ [V + M - C]$ = (6 Bond + lp. e^-)

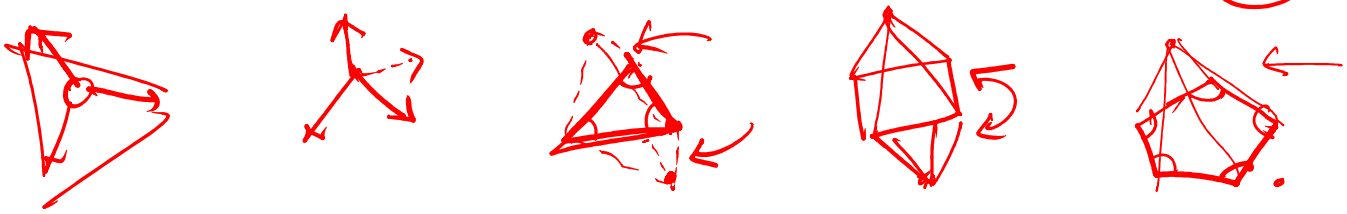
V = Number of e in the valence shell of central atom

M = Number of monovalent atom/group

C = charge

CH_4 : $x = \frac{1}{2}(4+4-0) = 4 \rightarrow sp^3$

CO_3^{2-} : $x = \frac{1}{2}(4+0+2) = 3 \rightarrow sp^2$

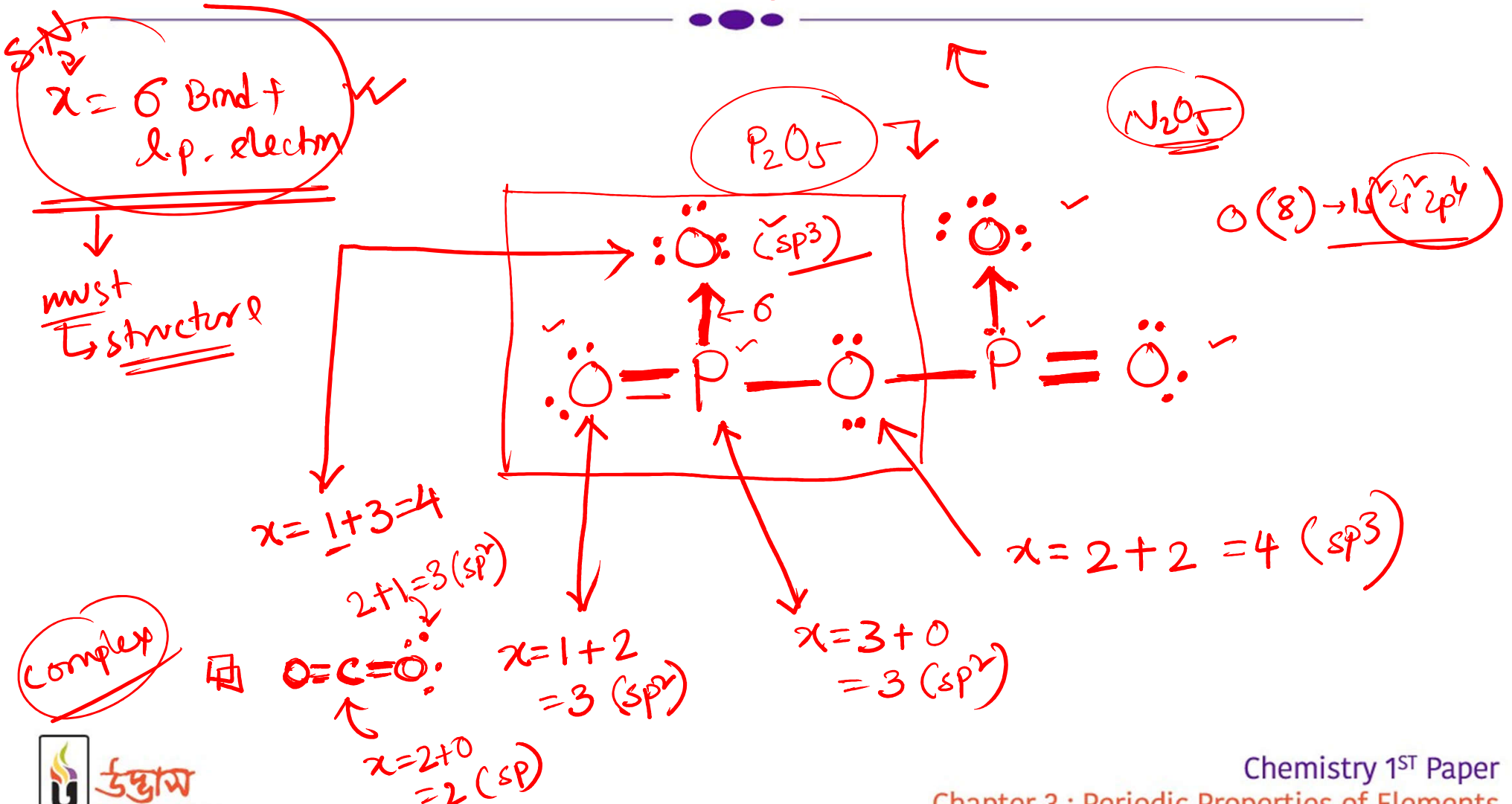


x	2	3	4	5	6	7
Hybridization	sp	sp^2	sp^3	sp^3d	sp^3d^2	sp^3d^3
Geometric Shape of Molecule/ion	Linear	Trigonal Planar	Tetrahedral	Trigonal Bypyramidal	Octahedral	Pentagonal Bypyramidal

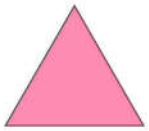
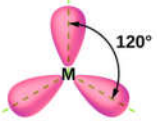
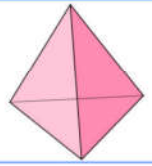
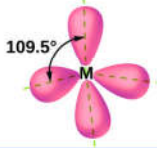
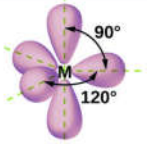
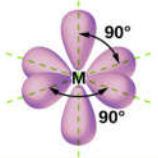
Compound Formula for Hybridization

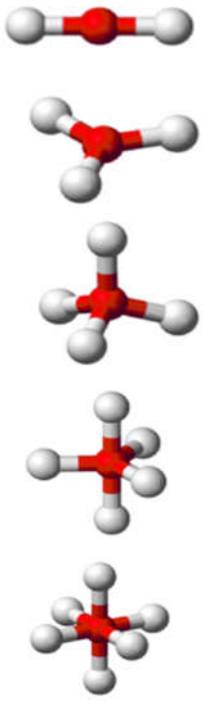
Compound/Ion	Formula	Hybridization
PCl_5	$H=\frac{1}{2}(x+y)=\frac{1}{2}(5+5)=5$	sp^3d
XeF_4	$H=\frac{1}{2}(x+y)=\frac{1}{2}(8+4)=6$	sp^3d^2
XeF_6	$H=\frac{1}{2}(x+y)=\frac{1}{2}(8+6)=7$	sp^3d^3
SF_6	$H=\frac{1}{2}(x+y)=\frac{1}{2}(6+6)=6$	sp^3d^2
NH_2^- (Azanide)	$H=\frac{1}{2}(x+y-c)=\frac{1}{2}(5+2+1)=4$	sp^3
NH_4^+	$H=\frac{1}{2}(x+y-c)=\frac{1}{2}(5+4-1)=4$	sp^3

Molecule with many central atoms



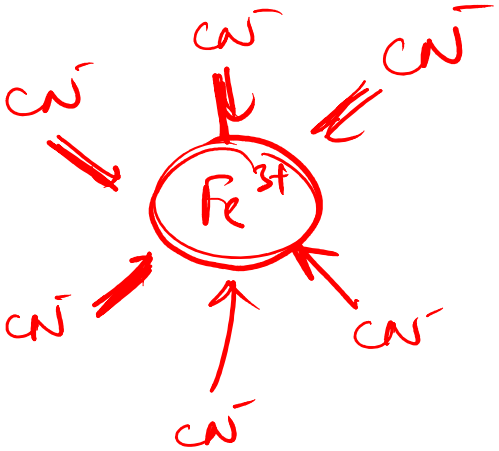
Hybridization

Regions of Electron Density	Arrangement		Hybridization	
2	———	Linear	*sp*	
3		Trigonal planar	sp^2	
4		Tetrahedral	sp^3	
5		Trigonal bipyramidal	sp^3d	
6		Octahedral	sp^3d^2	



complex

$K_3[Fe(CN)_6]$



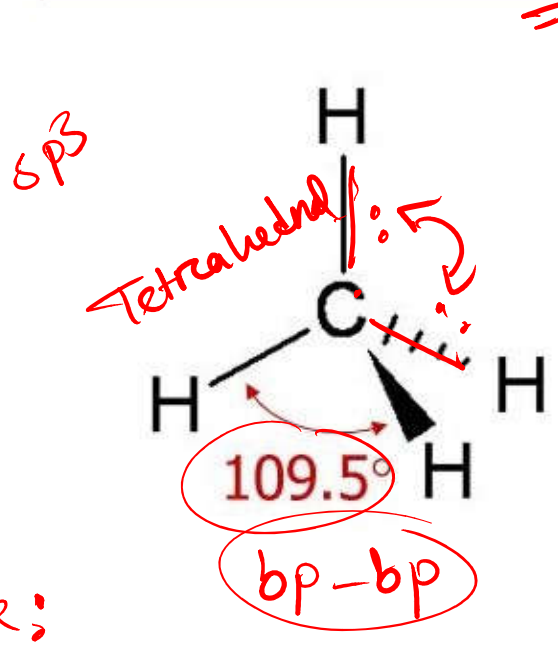
co-ordinate = x

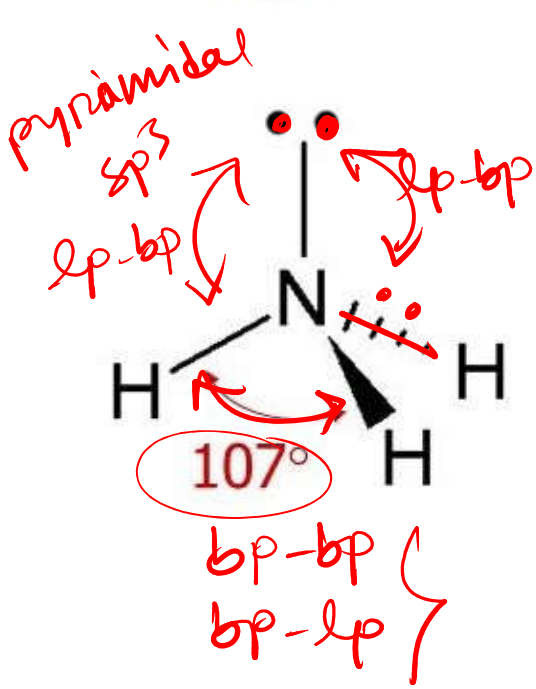
x = 6 + l.p.

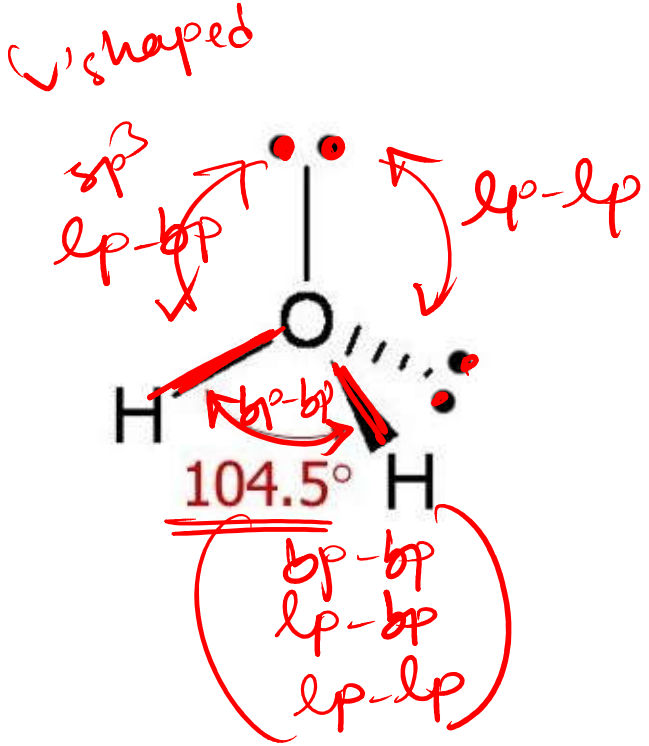
= 6 + 0 = 6 (sp^3d^2)

Not 3D structure

Bond angle deviation VSEPR (Valence Shell Electron Pair Repulsion) Theory







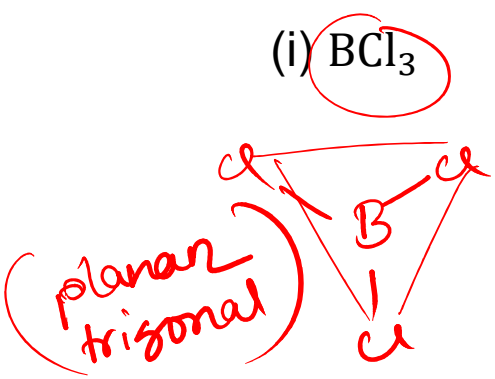
Type:

VSEPR Theory: lp–lp > lp–bp > bp–bp

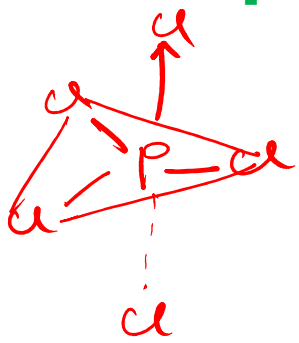
Important MCQ

❑ Write down the name of shape of the following compounds: [BUET'16-17]

(i) BCl_3 (ii) NH_3 (iii) PCl_5



pyramidal



$x = \frac{1}{2}(5+5)$

$= 5$

$(sp3d)$

Trisonal Bipyramidal

❑ Mention the hybridization state of central atom of the following compounds:

SF_6

$x = \frac{1}{2}(6+6) = 6 \longrightarrow sp^3d^2$

Poll Question-05

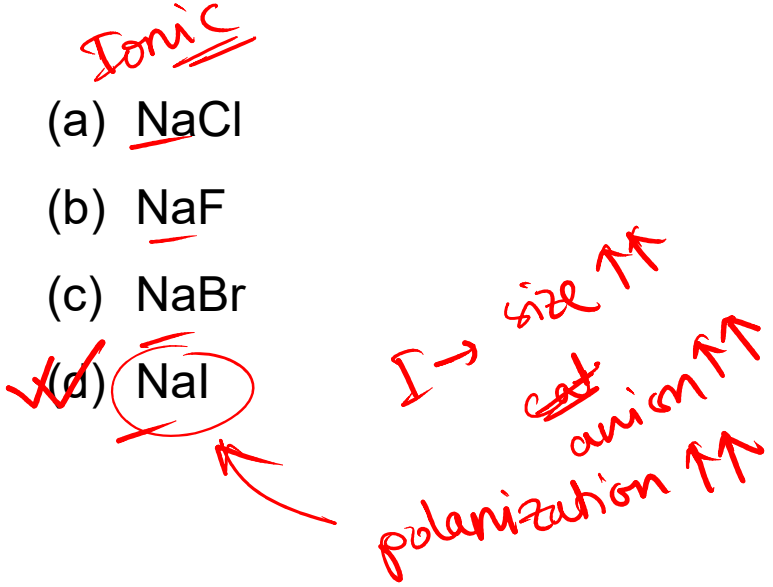
Which one is more covalent?

(a) NaCl

(b) NaF

(c) NaBr

(d) NaI



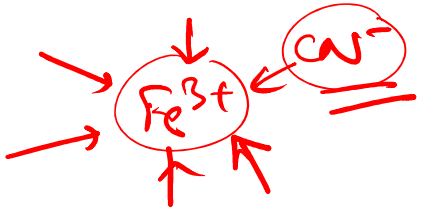
Finding different types of Chemical Bonds in a Compound

Ammonium chloride and Potassium Ferricyanide is formed by which types of bond? Mention their number. [BUET'00-01]

H.W.

$K_3[Fe(CN)_6]$

$3K^+ \leftrightarrow [Fe(CN)_6]^{3-}$: Ionic (3)



: Coordinate covalent (6)

$6 \times CN^- \rightarrow C \equiv N$: covalent (3×6=18)

লেগে থাকো সৎ ভাবে,
স্বপ্ন জয় তোমারই হবে।