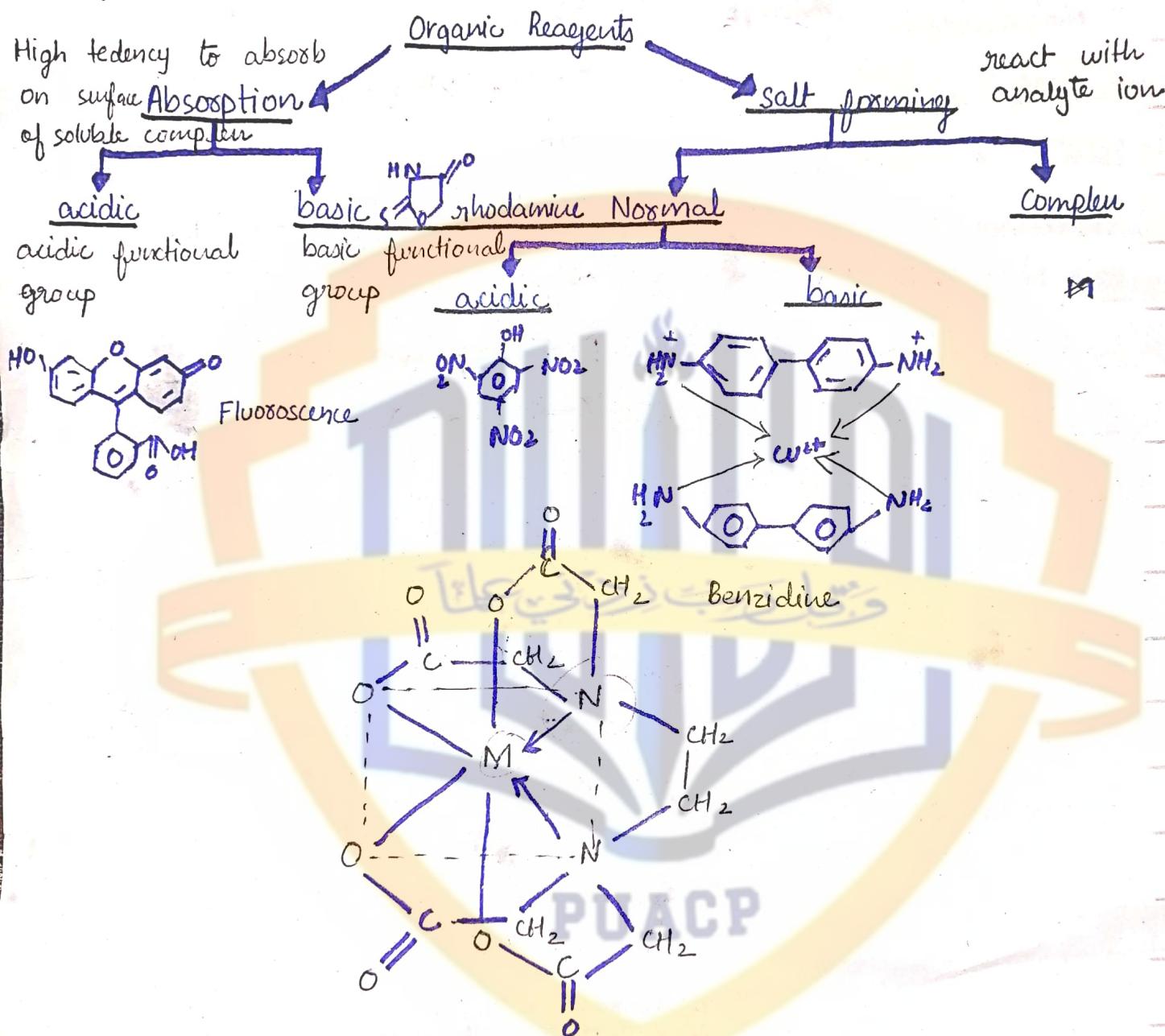


(2017)

(i)

Describe classification of organic reagents used in inorganic analysis?



What is diagonal relationship? Give two similarities between Li and Mg.

A diagonal relationship is when elements in adjacent groups and periods show similar properties due to similar charge densities and e<sup>-</sup> negativity.

Both the ions have high polarizing power  
enthalpies of both the elements are comparable

What is s-inert pair effect?

A chemical phenomenon

that describe the tendency of the 2 e<sup>-</sup> in the outermost s-orbital of an atom to remain unshared in a compound.

Inert pair effect occur when s-e<sup>-</sup> in the outermost electron shell of an atom are less likely to participate in chemical bonding.

This is because the inner orbital electrons do not shield the s-e<sup>-</sup> well, making them more tightly bound to the nucleus and more difficult to ionize or share.

example

It is most commonly observed in the heavier elements of groups 13-16 of periodic table such as

Thallium form +1 oxidation expected +3

Tin (Sn) 5s e<sup>-</sup> does not participate in C.B

Lead (Pb) //

Q3(IV) Ans

Describe application of organic reagents in chromatographic analysis as locating agents.

Organic reagent used in chromatographic analysis as:

### Locating reagent

Group I  $\text{Ag}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Hg}^{2+}$  sodium Rhodizonate

Group II A  $\text{Hg}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Cu}^{2+}$  Thiourea, Diphenyl carbazole

Group II B  $\text{Sn}^{4+}$ ,  $\text{As}^{3+}$ ,  $\text{Sb}^{3+}$  Diphenyl carbazole

Group III  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$  Alizarine, Aluminone

### Elution

Q4(V) Ans

Why does Fluorine show peculiar behavior in group VIIA?

Fluorine differs from the other members of

its own subgroup due to

- (a) its small size
- (b) its high electronegativity
- (c) non-availability of d-orbitals in its valence shell

Oct	Tet
eg	t <sub>2g</sub>
t <sub>2g</sub>	eg

Draw correlation diagram of  $d_2$  and  $d_8$  octahedral and tetrahedral complexes.

spectroscopic term

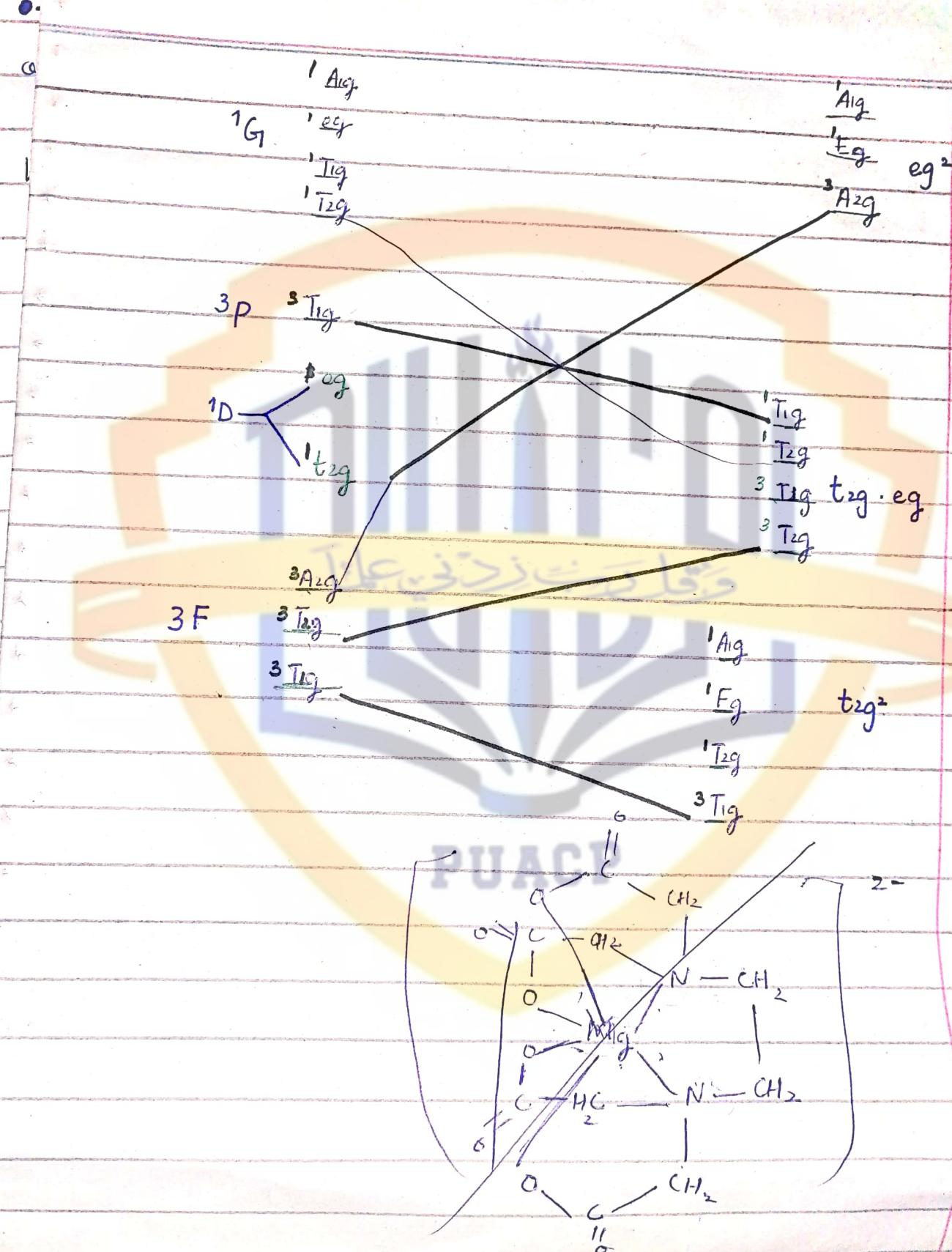
correlation of the relative energy of orbitals with the help of diagram is known as correlation diagram

electronic configuration  $\longrightarrow$  spectroscopic term  $\longrightarrow$  Hückel term

$\downarrow$   
molecular term

Starting point describing molecular bonding.

in instance of electron pairing



### (viii) gaw

Write two points of differences between VBT and MOT?

MOT

An e- moves under the influence of only two or more nuclei of a molecule.

In VBT, only half-filled orbitals of the valence shell take part in bonding and completely filled orbitals remain non-bonding orbitals.

VBT

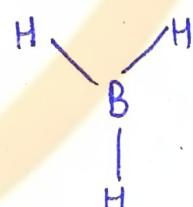
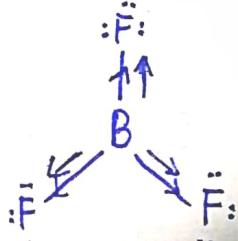
An e- moves under the influence of only one nucleus of an atom.

In MOT, all the atomic orbitals, whether completely filled, partially filled or vacant overlap to form molecular orbital.

### (viii)

Why  $\text{BF}_3$  is more stable than  $\text{BH}_3$ ?

$\text{BF}_3$  is more stable than  $\text{BH}_3$  primarily due to the difference in electronegativity of the atoms involved and the overall molecular structure.



- (i) Trigonal planar geometry
- (ii) Fluorine is highly electronegative, which means it pulls e-density toward it self.
- (i) similar geometry
- (ii) Hydrogen less e-negative

### (ix)

Why  $\text{PF}_3$  exists whereas  $\text{NF}_3$  does not?

exists whereas  $\text{NF}_3$  does not, due to differences in atomic size, electronegativity and bonding capacity between phosphorus and nitrogen.

## atomic size

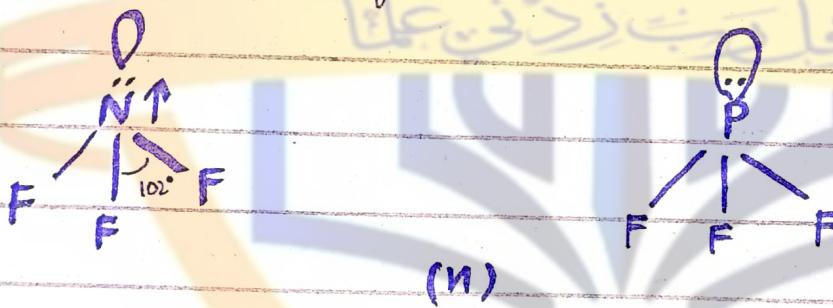
large, which allow it to accommodate three F atoms more easily.

## electronegativity

Phosphorus has lower electronegativity than Nitrogen, making it more willing to share  $e^-$  with F atom.

## Bonding Capacity

Phosphorus can form three covalent bonds with F due to its ability to expand its octet, while Nitrogen tends to form three covalent bonds <sup>only</sup> with H



What is 3c-4e bond? Give example?

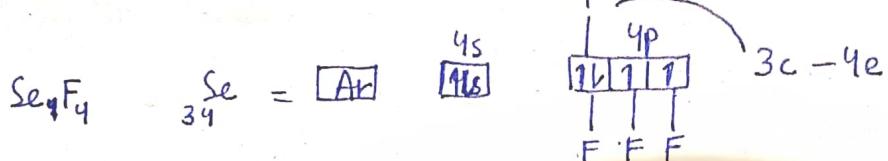
3c-4e electron bond formed from a p-orbital of the central atom and the s-orbital of two outer atoms.

3c-4e model approach based on the two main ideas:

Use of outer d-orbitals of the central atom of non-transition metal ion is so slight that these

may be neglected altogether

Presence of bond angles close to  $90^\circ$  and  $180^\circ$  in  $\text{AB}_4$  molecule suggests that orbitals perpendicular to one another are being used.

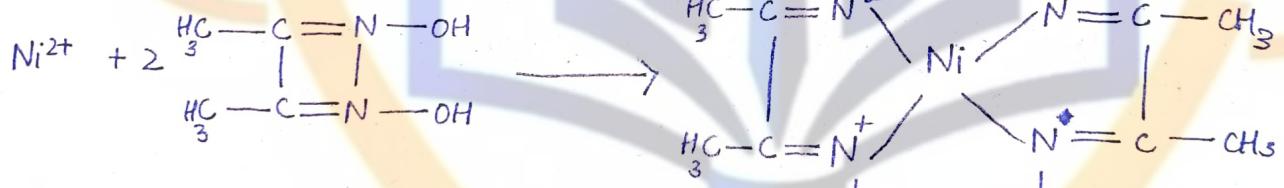


(2018)

(i) What are chelates?

These are special type of coordination compounds containing one or more rings in their structures. The rings structure are formed by linking metal ion with polydentate ligand. Such ring structure compounds are called chelates.

example



(ii)

Mention 4 points of similarities between VBT and MOT?

- Both explain the formation of chemical bond between atoms in a molecule.
- Both theories use atomic orbitals as the

starting point describing molecular bonding.

• Both emphasize importance of electron pairing in forming covalent bonds.

• Both predict the geometry and shapes of a molecule.

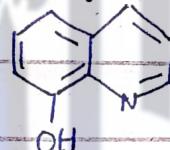
(iii)

What is s-inert pair effect?

repeat (2017)

(iv)

Give two uses of 8-hydroxyguanine in inorganic analysis.

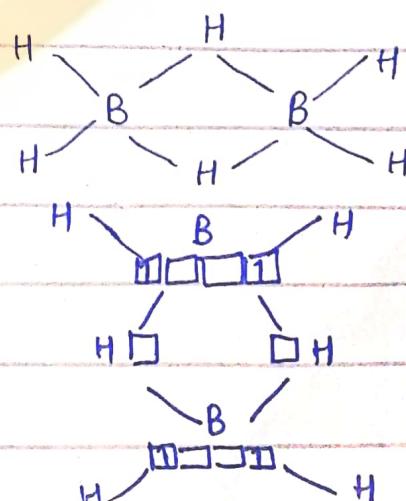
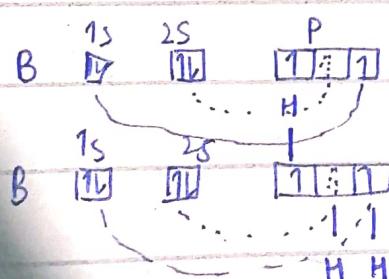
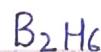


- Used for gravimetric analysis  $\text{Al}^{3+}$ ,  $\text{W}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{U}^{6+}$ ,  $\text{W}^{6+}$
- Used for solvent extraction and gravimetric determination of  $\text{Cu}^{2+}$  and  $\text{V}^{3+}$  in  $\text{CHCl}_3\text{Cl}$  (chloroform) soln.

(v)

What is 3c-2e bond? Give example.

3c-2e bond is electron deficient bond where 3 atoms share two electrons.



Why does F show peculiar behavior with group VIA?  
Repeat (2017)

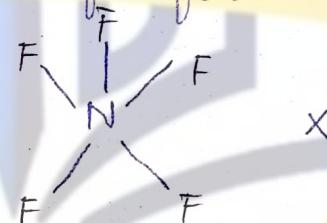
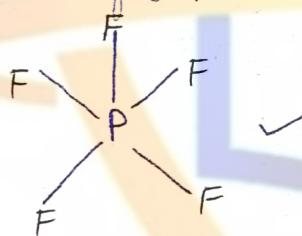
explain why PF<sub>5</sub> exists but NF<sub>5</sub> does not?

PF<sub>5</sub> exists, whereas NF<sub>5</sub> does not, due to differences in the atomic size, electronegativity and bonding capacity between P and N.

(i) Phosphorus has large atomic size, allowing it to accommodate five fluorine atom easily.

(ii) Phosphorus has lower electronegativity than nitrogen making it more willing to share e<sup>-</sup> with F atom.

Phosphorus can expand its octet and form five covalent bond with F atoms, while nitrogen tends to form a maximum of four covalent bond.



$$P_{15} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^1, 3p^7 \quad N_7 = 1s^2, 2s^2, 2p^1, 2p^7, 2p^3$$



VSEPR

### Advantages

predict molecular shape (three dimensional structures)

explains bond angles and lengths

292.21986

advantages  
or simplification

It assumes that e- pair repell each other equally, which is not always the case.  
Limited predictive power

It struggles to accurately predict the shape and bonding of molecules with delocalized electrons.

Name factors that can affect sensitivity, selectivity and specificity of an organic reagent?

electronic configuration

charge and size ratio / Polarizability

Geometry of resulting metal complex

(2019)

Give two failure of VBT?

It can not explain the color of coordination compounds. And it can not explain the magnetic properties of coordination compounds.

What are physical states of different halogens at room temperature.

Fluorine, Chlorine gases

Iodine solid

Bromine liquid

How they are differ?

These are different from due to the increasing atomic size, molecular weight and intermolecular forces down the group.

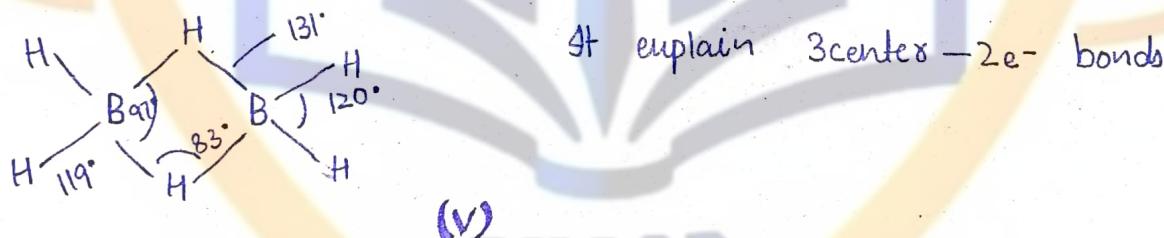
(iii)

Which type of bonding is stronger between  $\text{p}\pi-\text{p}\pi$  and  $\text{d}\pi-\text{d}\pi$  and why?

The  $\text{p}\pi$  and  $\text{d}\pi$  bond is stronger than the  $\text{p}\pi-\text{p}\pi$  bond. Due to a larger level of overlap in the electron clouds in  $\text{p}\pi-\text{d}\pi$  bond, the extent of overlap is greater, resulting in a lower energy bonding.



Give the structure of diborane molecule? Which type of bond explains its structure?



It explain 3center-2e- bonds

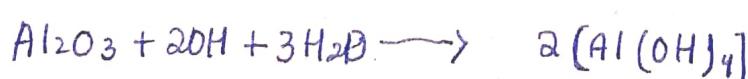
What are amphoteric oxides? Give example.

It is an oxide that can act as either acid or base in a reaction to produce a salt and water. It depends on the oxidation states available to a chemical species.

Acidic



basic



is s-inert pair effect?

Repeat (2017, 2018)

(vii)

Name different organic reagents used as indicators in acid base titration.

phenolphthalein

Methyl orange

Methyl red

(viii)

Name various types of organic reagent (other than organic indicators) used in analysis.

citric acid

oxalic acid

(ix)

How chelates can be classified?

Chelates can be classified into several categories based on their properties, structure, and binding characteristics.

classification by ligand

Aminocarbonylate chelats

Polyphenolic

polyamine

Bidentate

Triidentate

Polydentate

(ii)

What are complexometric titration?

The volumetric titration in which concentration of metal ion is determined by titrating it against complexing agent solution is called as complexometric titration.

(i)

(2020)

Drawbacks of VSEPR Repeat (2018)

(ii)

Dis/ Give one experimental evidence for dπ-pπ and why?

Comparison of stability of phosphine oxide & amine oxide

phosphine oxide

$R_3P=O$  is more stable than  $R_3NO$  because of dπ-pπ bonding

If there is a bond between two atoms with one vacant orbital on one atom and one lone pair of electrons on the other atom, then this electron pair is donated to that corresponding unoccupied orbital,



example



(iii)

ence between

### molecular Orbital

### Hybrid orbital

- (o) When atomic orbitals form  
by combining orbitals of  
different atoms
- (o) Hybrid orbitals are formed  
when atomic orbitals of  
same atom mix
- (o) describe the distribution  
of electrons in a molecule.
- (o) While Hybrid orbitals explain  
localized bonds within an atom.

(iv)

What is 3c-4e bond? Give one example.

Repeat (2017)

(v)

Give two similarities between Li and Mg?

- (o) high polarizing power, enthalpies  
of both elements are comparable.

(vi)

What is s-inert pair effect? Repeat (2017, 2018, 2019)

(vii)

Why  $\text{BH}_3$  is less stable than  $\text{BF}_3$ ? Repeat (2017)

(viii)

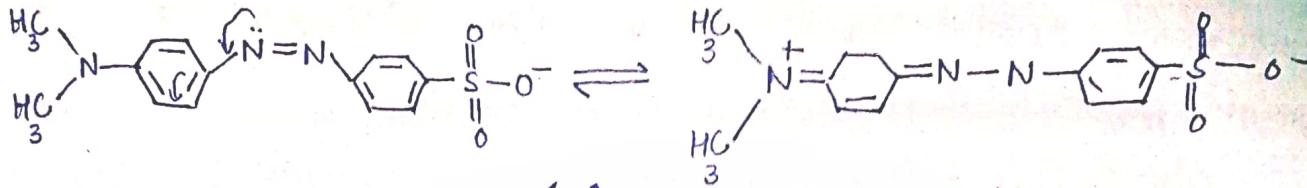
Why is buffer used in EDTA titration?

A buffer is used in EDTA titration to maintain  
the pH of solution. Always remember that a  
buffer is added to solution that undergoes titration  
in specific range.

(iii)

Brief acid-base indicators?

They are weak acids or bases that change colour with concentration of  $\text{H}^+$  or  $\text{OH}^-$  ion in a solution changes.



How can chelates be classified?  
Repeat

Long Questions

## Periodic anomalies

It is generally assumed that the properties of various families of the periodic chart change smoothly from less metallic (more electronegative) at the top of the family to more metallic (less electronegative) at the bottom of family.

Post-Transition metal.

### Atomic radius

Post-transition metals typically exhibit a decrease in atomic radii across a period. However anomalies can occur due to factors such as electron configuration and shielding effect.

### Ionization energy

lower than expected. This anomaly influenced by electronic configuration.

Non-metal

When moving left to right across period, the change in atomic radius is smaller. This is because nonmetals tend to have more electrons in their outermost shell. • increased shielding effect

Non-metals have high ionization energy due to their small

In some cases, e<sup>-</sup> in the s subshells are easier to remove than predicted due to the

size and high E.N. In 2nd group of periodic table Be 1st ionization energy is higher than boron. This

presence of partially filled d orbital, which offers less effective shielding from nucleus.

is because Be valence shell is completely filled.

## Electronegativity

Measures an atom's ability to attract electrons in a chemical bond.

Lower electronegativity, this anomaly can be attributed to the presence of partially filled d-orbital, which reduce effective nuclear charge, thus decreasing their ability to attract electrons.

Higher electronegativity because they have more valence e<sup>-</sup> and more likely to gain e<sup>-</sup> to become anions. Nuclear charge <sup>in</sup> decrease and atomic size decrease.

## Reactivity

Less reactive due to the stability conferred by fully or partially filled d-subshells. This anomaly arises from the reluctance of post-transition metals to lose or gain electrons.

Nonmetals become more reactive as you move up a group on the periodic table. For example chlorine is more reactive than phosphorus. This is because

- (•) no. of valence shell increase
- (•) tendency to lose e<sup>-</sup> increases

## $\text{P}\pi-\text{P}\pi$ bonding in heavier congeners of group 4A.

The  $\text{p}$ -orbitals of one atom overlap sideways with the  $\text{p}$ -orbitals of another atom in this type of bonding, resulting in formation of pi bind, also known as  $\text{p-pi-pi}$  bond.

$\text{P}\pi-\text{P}\pi$  bonding involves the overlap of  $\pi$ -orbitals, which are oriented perpendicular to the  $\sigma$ -bonding axis. This type of bonding is common in molecules containing multiple bonds between second row elements C, N.

Heavier congeners of group 4A are Si, Ge, tin and Pb. These elements exhibit different chemical properties compared to C, due to their larger atomic size and lower

negativity.

In the heavier congeners of Group IVA,  $\text{P}\pi-\text{P}\pi$  bonding is less common due to following reasons.

### Atomic size

The larger atomic size of heavier congeners results in a longer bond length, making it more difficult for  $\pi$  orbitals to overlap effectively.

### Electronegativity

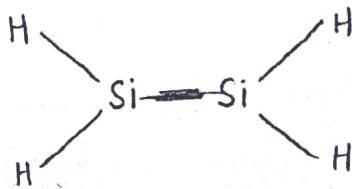
Lower electronegativity of heavier congeners reduces the energy difference between  $\pi$  orbital, making it less favorable to  $\text{P}\pi-\text{P}\pi$  bonding.

### Relativistic effects

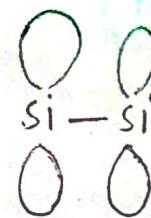
In the heavier heavier elements relativistic effects become more significant, leading to:

- (i) contraction to atomic orbitals
- (ii) reduction in overlap between  $\pi$ -orbitals

Heavier elements of this group do not form  $\text{P}\pi-\text{P}\pi$  bonds as their atomic orbitals are so large and diffuse that they cannot have effective overlapping. Despite these challenges,  $\text{P}\pi-\text{P}\pi$  bonding has been observed in some molecules containing heavier congeners of Group IVA elements.

$^{14}\text{Si}$  $1s^2 2s^2 2p^6 3s^2 3p^2$ 

dimers



## experimental evidence of dπ-pπ bonding

One example of the apparent existence of π-bonding is in phosphine oxide.

Characteristics feature of hybridization

Mixing of atomic orbital form new hybrid orbit  
formation of equivalent orbital  
Change in orbital shape  
Directional properties

structure of oxine



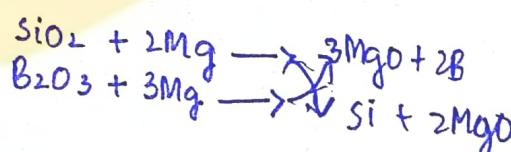
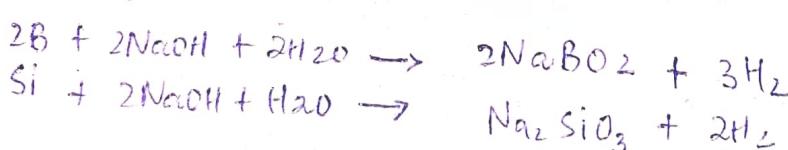
oxine

Diagonal relationship

(Complexes) Hydrofluoboric acid (HFB), fluosilicate acid ( $\text{H}_4\text{SiF}_6$ )  
None of occur free state, attacked by water

Allotropic and amorphous

High M.P  
Prepared by reducing their oxide  
dissolve alkalis

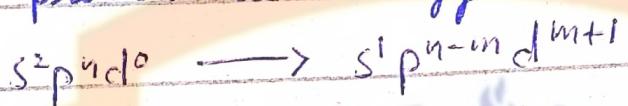


Configuration.

several workers have been objected on the inclusion of d-orbital of bonding in non-metals.

### Factors

#### (i) Large promotional energy.



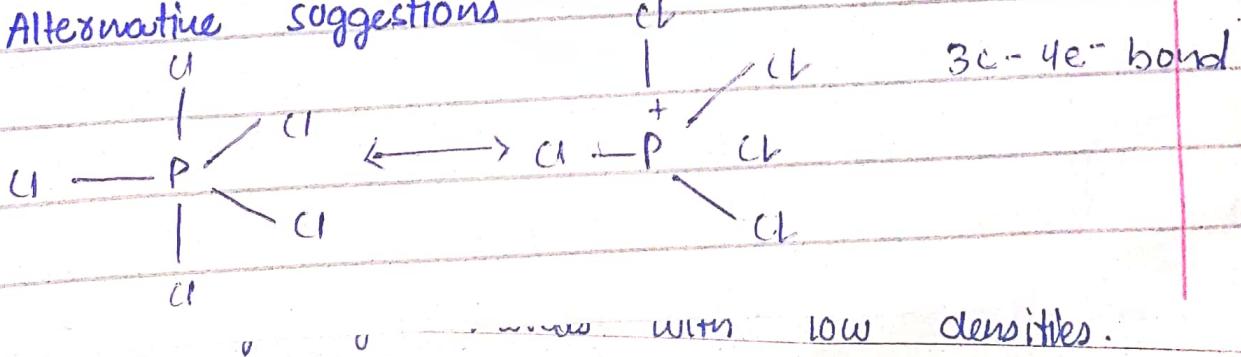
d-orbital has large energy as compared to s and p-orbitals. So large proportional of energy is required for the excitation of  $e^-$  from p to d-orbital.

#### (ii) Poor Overlapping

They make orbital with neighboring atom.

The 3d orbital of S-atom is completely shielded by lower lying  $e^-$  and hence do not feel  $\sigma$ . As a result completely diffuse due to this orbital will be more effective in overlapping neighboring atomic orbitals.

#### Alternative suggestions



(2021)

(i)  
How does MOT differ from MOT?

Repeat 2017 past paper

(ii)  
How does stability of chelates depend upon the nature of ligand?

The stability of chelates depend upon the nature of ligand involves

- (•) Basicity of ligands
- (•) Size and charge of central metal ion
- (•) Chelate ring size

Write two similarities between Be and Al (iii)

- (•) Both elements have low melting points
- (•) Both of elements are form covalent bond.
- (•) The oxide and hydrides of both elements are amphoteric.

Which indicators are used in EDTA titration? (iv)

Eriochrome black T (EBT)

Calmagite

What is inert pair effect give examples? (v)

Repeat (2017, 2018, 2019, 2020)

SiCl<sub>4</sub> react with water while CCl<sub>4</sub> does not, justify it. (vi)

Carbon in  $\text{CCl}_4$  is not having empty d-orbital for water molecule to approach it and form bond ( $\text{H}_2\ddot{\text{O}} \rightarrow$  Oxygen can donate e-pair to the empty orbital) whereas in Si in  $\text{SiCl}_4$  having d-orbital and water can easily get attached to it resulting hydrolysis.



(vii)

Why  $\text{NF}_5$  molecule does not exist?

Repeat (2018)

(viii)

Give classification of organic reagents used in inorganic analysis?

Q (i)-(S) Repeat 2017 pas paper

Give 4 similarities between Li and Mg.

(1) Both are highly reactive due to their low ionization energies and high reactivity with water.

(2) Both react with oxygen to form



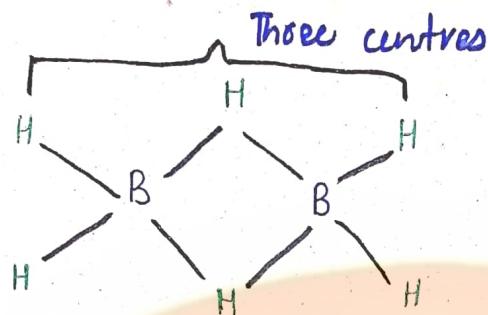
(3) Both react with water to form hydrides



(4) Both relatively light metals with low densities.

(vi) What is 3 center - 2 electron bond?

It is an electron deficient chemical bond where atoms share two electrons



(vii)

Name different organic reagents used as indicators in acid base titrations.

phenolphthalein

Methyl orange

(viii)

Why is  $\text{BF}_3$  more stable than  $\text{BH}_3$ ?

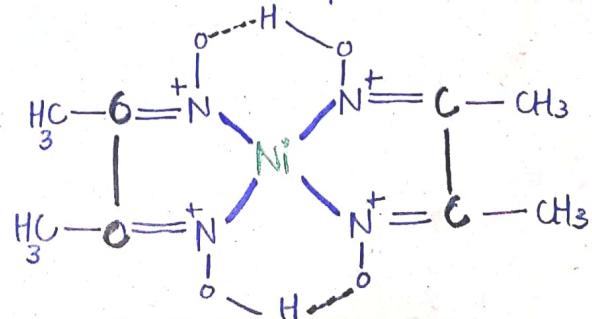
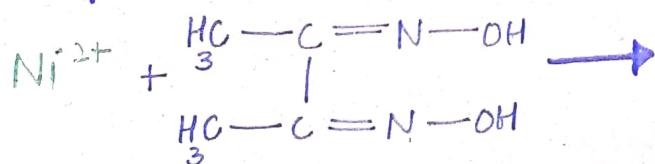
Repeat (2017, 2020)

(ix)

What are chelates?

They are special type of coordination compound containing one or more ring in their structures. The ring structures are formed linking metal ion with polydentate ligand. Such ring structure compounds are called chelates.

example

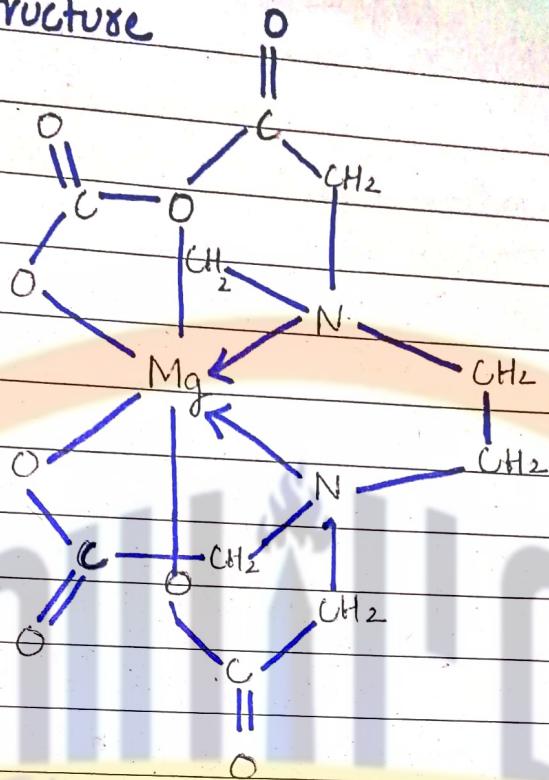


(niv)

(Mg - EDTA)<sup>2-</sup> Draw

structure

2-



(niv)

Write physical state of halogens at room temperature and why they are different?

Fluorine (gas)

Chlorine (gas)

Bromine (liquid)

Iodine (solid)

Why they are different?

As we move down the group from fluorine to iodine:

Atomic size increase, electronegativity decrease.

and increasing molecular weight, this leads increase in dispersion forces between molecules.

2022 fall  
level 1 B

What are major drawbacks of directed VBT?

Fails to explain carbon's tetra valency  
energies of electrons are not discussed

There is no distinction between weak and powerful ligand.

(ii)

Why is a disodium salt of EDTA prepared?

Disodium salt of EDTA is prepared for

- (•) Improve solubility
  - (•) enhanced stability
  - (•) better chelating properties
- It is a complexing agent that dissolves metal ion. It is a heavy metal chelating agent that can remove lead and copper from metal poisoning.

(iii)

How can chelates be classified?

Chelates can be classified on the basis of their coordination sites:

Monodentate

Bidentate

Polydentate

PUACP

(iv)

Why is  $\text{BF}_3$  is more stable than  $\text{BH}_3$  why?

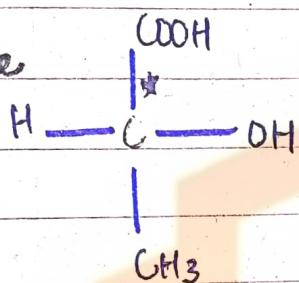
Repeat

(V)

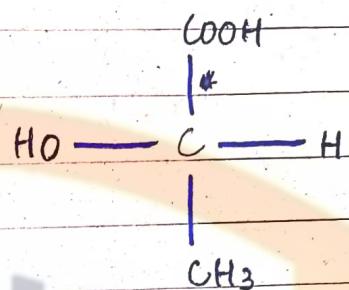
Name: Define stereochemistry with few examples

A branch of chemistry that deal with the spatial arrangement of atom and groups in molecules. It is the three dimensional structure of molecule.

example



(+) d-lactic acid



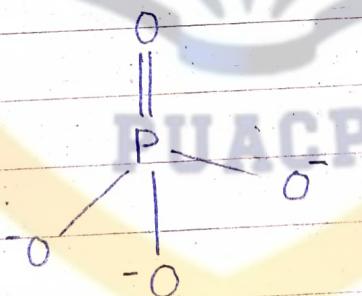
(-) l-lactic acid

(vi)

What is  $d\pi-p\pi$  bond? Give one example.

When the pi-bond is established between the p-orbital of one element and the d-orbital of the other element, it is called the  $d\pi-p\pi$  bond. It can not be formed by elements that do not have a vacant d-orbital.

example



(vii)

What is difference between molecular and hybrid orbital?

Repeat in 2020 past paper

(viii)

What kind of relationship is present between Li and Mg? Brief.

Li and Mg have a diagonal relationship, which means they are diagonally adjacent elements in the periodic table and have similar properties.

(ix)

What different types of organic reagent used?

Grignard reagent

electrophilic reagent

silver nitrate ( $\text{AgNO}_3$ )

(x)

What are the factors that affect sensitivity and selectivity of an organic reagent? repeat (2017)

- (o) electronic configuration
- (o) charge and size ratio
- (o) geometry of resulting metal complex

(xi)

Write few properties of chelates?

- (o) stable due to formation of multiple bond between metal ion and ligand.
- (o) increase solubility of metal in water
- (o) exhibit kinetic inertness
- (o) exhibit para or ferromagnetism

(xii)

What is 3c-2e bond? Give 1 example.

Repet (2021)

(niii)

What kind of stability is observed in chelates?

Chelates can exhibits several types of stability:

- (i) Thermodynamic
- (ii) Kinetics
- (iii) Structural
- (iv) Configuration

(niv)

Write two advantages of VSEPR

- (i) predict molecular shape
- (ii) predict bond length and bond angle

of (n v) 32

Write physical state of halogens at room temperature and why they are differed.

Repeat (2020)

Correlation diagram suggest the shape of triatomic

$AB_3$ , tetra-atomic  $AB_4$ , penta-atomic molecules through correlating their geometry with electronic state.

Walsh diagram were first introduced by Prof. A.D. Walsh

These diagram predicts geometries of small molecule and explain why a given molecule is more stable in certain geometry.

For  $H_2O$

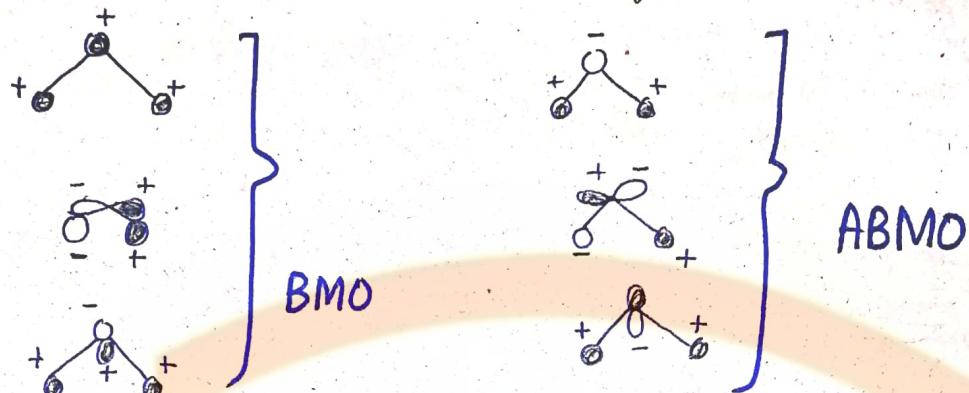
Hydrogen =  $1s^1$

Oxygen =  $1s^2, 2s^2, 2p^6, 2p^1, 2p^2$



- Bent geometry
- 2-H atoms
- contains lone pair

S, p<sub>y</sub>, p<sub>z</sub> correlate in case of bent



linear



Bent



PUACP

