Toppersnotes
Unleash the topper in you

CSIR-NET

Council of Scientific & Industrial Research

CHEMICAL SCIENCE

VOLUME - II

INORGANIC CHEMISTRY

SIERRA INNOVATIONS

Index

HEPTACITY

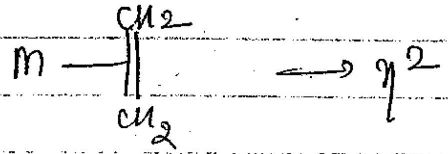
→ It is the property of ligand

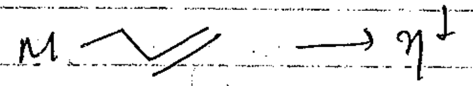
→ It is the total no. of atoms of the ligand through which it is coordinated to central atom.

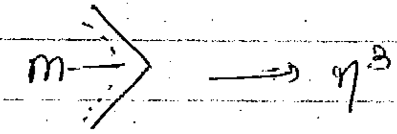
→ It is represented by greek letter η^x

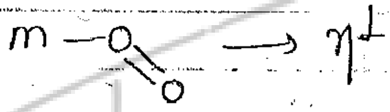
x → Total no. of Donor atoms of ligand, directly attached to Central Metal Atom.

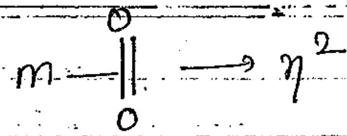
eg: $M-CH_3 \rightarrow \eta^1$

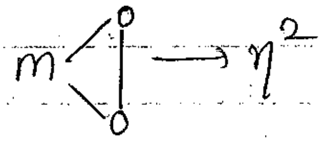
(2) 

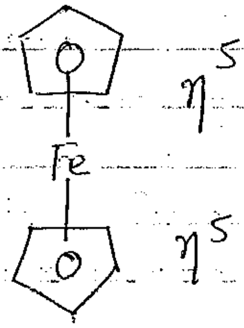
(3) 

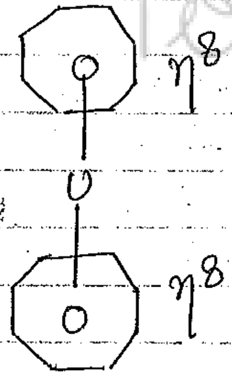
(4) 

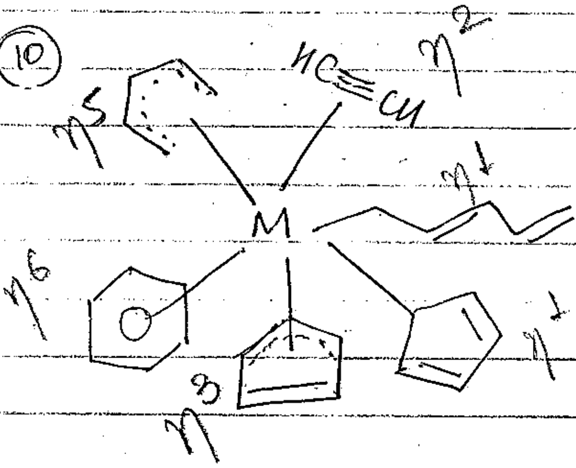
(5) 

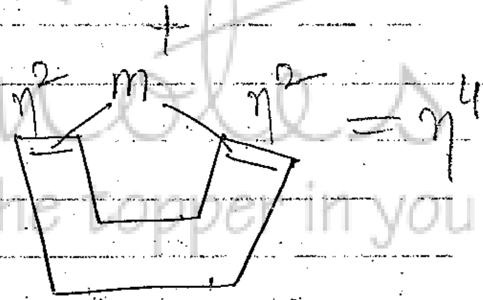
(6) 

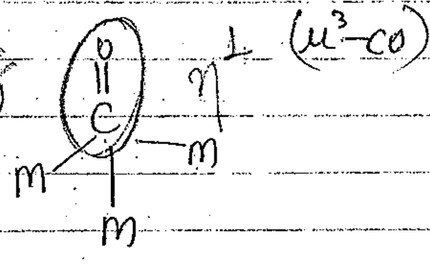
(7) 

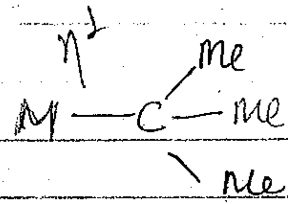
(8) 

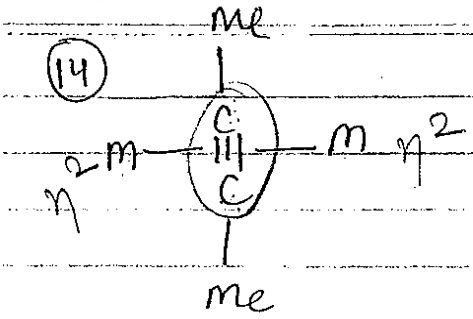
(9) 

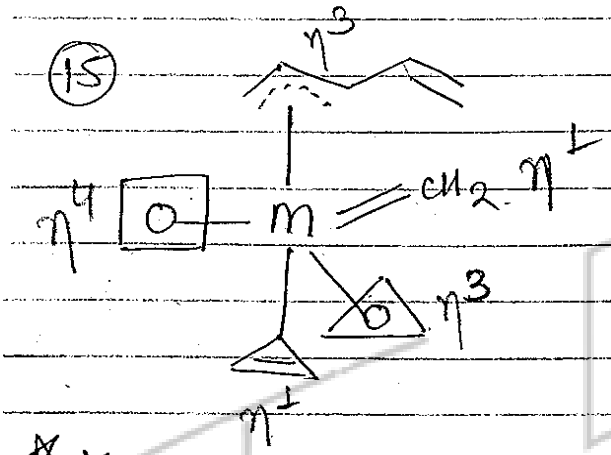
(10) 

(11) 

(12) 

(13) 

(14) 

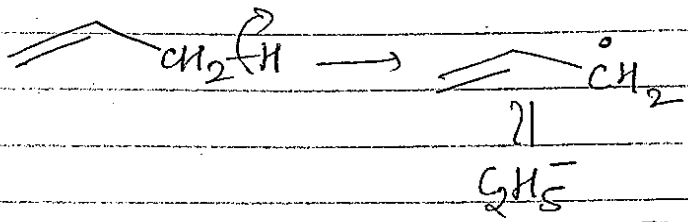
(15) 

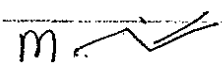
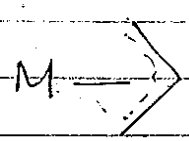
(16) $M \equiv C-R$ η^1

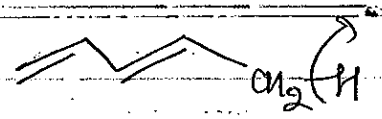
(17) $M-SiR_3$ η^1

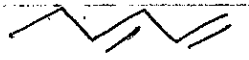
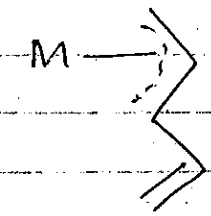
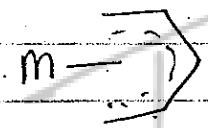
**
\# Determination of no. of e^-s contributed by ligand on the basis of their hepticity acc. to NEUTRAL ATOM METHOD:-

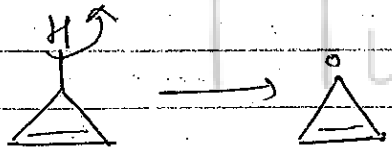
eg:

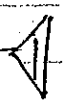
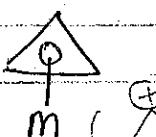


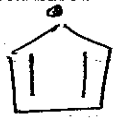
		e^- donor	charge
	$\eta^1-C_3H_5$	1e	−1
	or		
	$\sigma-C_3H_5$		
	$\eta^3-C_3H_5$	3e	−1
	or		
	$\pi-C_3H_5$		

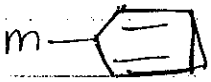
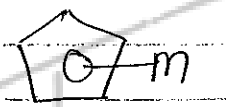
(2)  $\simeq C_5H_7^-$

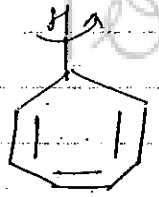
			CHARGE
M 	$\eta^1-C_5H_7$ (or) $\sigma-C_5H_7$	1 e⁻	−1
M 	$\eta^3-C_5H_7$ (or) $\pi-C_5H_7$	3e⁻	−1
M 	$\eta^5-C_5H_7$ or $\pi-C_5H_7$	5e⁻	−1

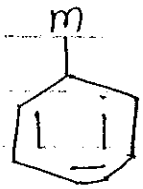
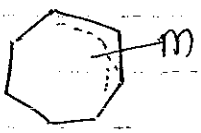
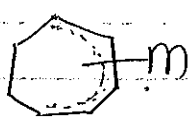
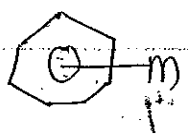
(3)  $\simeq C_3H_3^+$

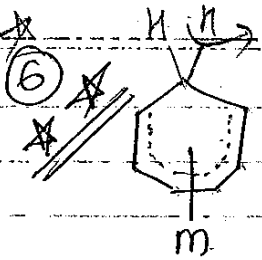
M 	$\eta^1-C_3H_3$ (or) $\sigma-C_3H_3$	1e⁻	(−1)
M  (+1) charge	$\eta^3-C_3H_3$ (or) $\pi-C_3H_3$	3e⁻	(+1) charge कम वाले पॉइंट से देखना है (aromaticity)

(4)  →  (cp⁻) ≃ $C_5H_5^{\circ}$

			CHARGE
	$\eta^1-C_5H_5$ $\alpha-C_5H_5$	1e⁻	−1
	η^3-Cp (2)	3e⁻	−1
	η^5-Cp (2) $\pi-Cp$	5e⁻	−1

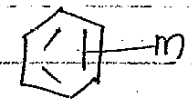
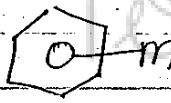
(5)  −H· →  ≃ $C_7H_7^{\circ}$

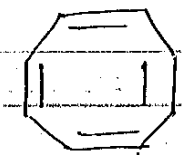
	$\eta^1-C_7H_7$	1e⁻	−1
	$\eta^3-C_7H_7$	3e⁻	−1
	$\eta^5-C_7H_7$	5e⁻	−1
	$\eta^7-C_7H_7$	7e⁻	+1

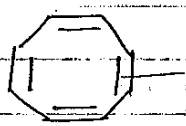
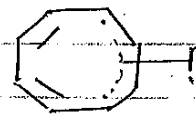
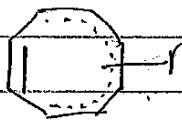
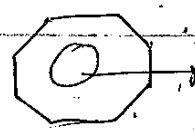
⑥ 

$\eta^6-C_7H_8$ $6e^-$ **Neutral**

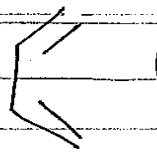
⑦  (C_6H_6)

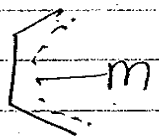
			CHARGE
	$\eta^2-C_6H_6$ $\nwarrow-C_6H_6$	$2e^-$	0
	$\eta^4-C_6H_6$ $\nwarrow-C_6H_6$	$4e^-$	0
	$\eta^6-C_6H_6$ $\nwarrow-C_6H_6$	$6e^-$	0

⑧ Cyclo-octa-tetraene **COT** **C_8H_8** 

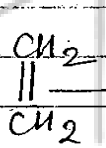
			CHARGE
	$\eta^2-C_8H_8$	$2e^-$	0
	$\eta^4-C_8H_8$	$4e^-$	0
	$\eta^6-C_8H_8$	$6e^-$	0
	$\eta^8-C_8H_8$	$8e^-$	(−2) Preferred for aromaticity.

Neutral hota hai 1,3 Butadiene.

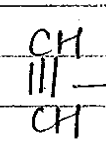
(9) 1,3 Butadiene  (C_4H_6)

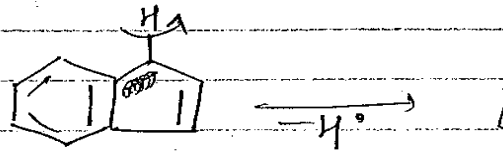
			CHARGE (Neutral)
	$\eta^2-C_4H_6$	2e⁻	0
	$\eta^4-C_4H_6$ $\wedge-C_4H_6$	4e⁻	0

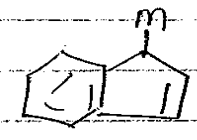
(10) Ethylene

	$\eta^2-C_2H_4$ (2) $\wedge-C_2H_4$	2e⁻	0

(11)

	$\eta^2-C_2H_2$ $\wedge-C_2H_2$	2e⁻	0

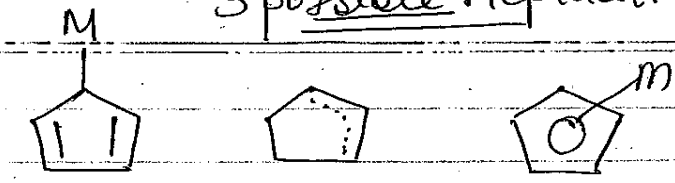
(12)  Indenyl

	η^1-indenyl	1e⁻	−1
	η^3-indenyl	3e⁻	−1
	η^5-indenyl	5e⁻	−1

(Cp⁻¹)

$C_5H_5^-$

3 possible Heptacities:-

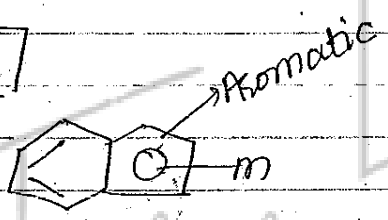


η^1 η^3 η^5 - Cp (Aromatic)

$\eta^1 \longrightarrow \eta^3 \longrightarrow \eta^5$

- favourable process
- spontaneous process

Indenyl



Reso E
(Benzene > Cp)

η^5 (less stable bcz Cp में aro. hai) $\longrightarrow$ η^3 more stable (bcz benzene में aromaticity hai)

Aromaticity ↓

Benzene की reso. Energy (↑) jada hoti h Cp से

∴ η^3 से η^5 जाने पे reso E कम (aromaticity कम होगी ई।)

∴ UNFAVOURABLE PROCESS ($\eta^3 \longrightarrow \eta^5$)

Contribution of e⁻s by diff. ligand to calculate EAN by Neutral Atom Method:-

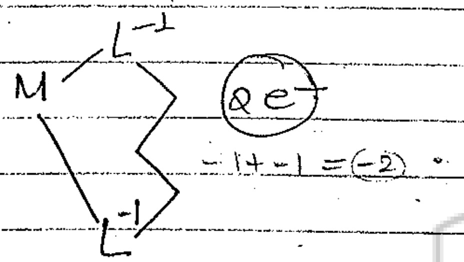
NOTE: Each neutral donor site contibute 2e⁻ during calculation of EAN acc. to neutral atom Method.

Note: Each ~~binding~~ ionic ligand donate e⁻s acc. to its charge. (applicable for terminal ligand).

eg: ① M—L (neutral) → (2e⁻)

② M—$L^{\ominus}$ (−1 charge) → (1e⁻)

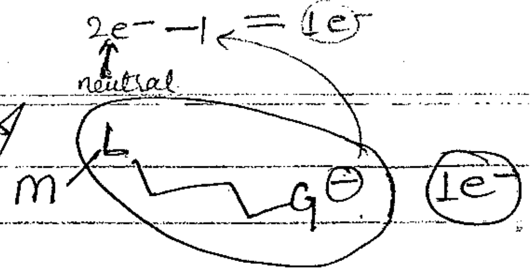
③



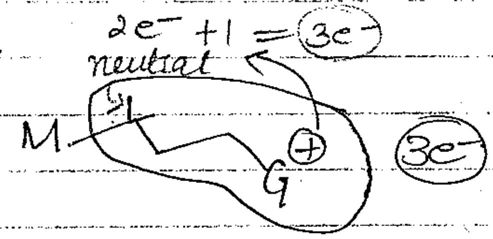
④ M—L^{-2} → (2e⁻)

⑤ M—L^{-3} → (3e⁻)

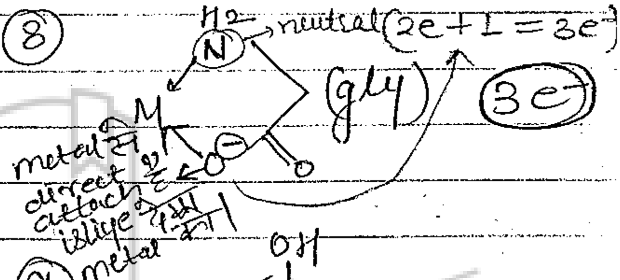
⑥



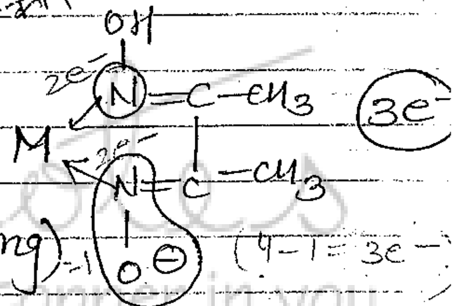
⑦



⑧



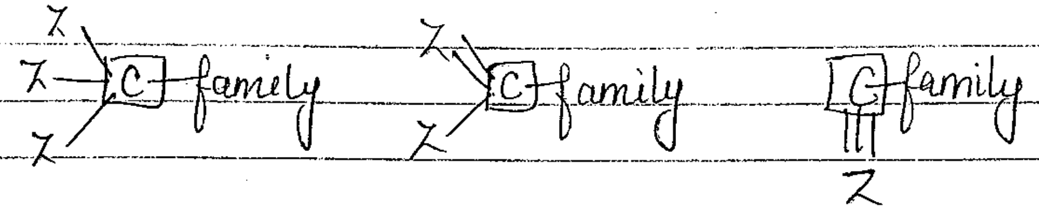
⑨



Eg. of [1e⁻ Donor] [for terminal ligand]

① F	⑧ D	⑭ CCl_3	㉑ $GeMe_3$
② Cl	⑨ T	⑮ C_2H_5	
③ Br	⑩ CH_3CO	⑯ CMe_3	
④ I	⑪ O_2^-	⑰ phenyl	
⑤ OH		⑱ vinyl	
⑥ H	⑫ NO (Bent)	⑲ SiH_3	
⑦ OAc	⑬ CH_3	⑳ GeH_3	

} charge (−1) ⇓ 1e⁻ donor



OH, OR, SH
SeR, TeMe, SPh, O,Ph
SePh, OtBu

(O family, with Z attached to O) ⟹ charge (−1)

NH_2, PH_2, PCl_2, PPh_2
NMe_2, NCl_2, NPh_2, $SbMe_2$,
$AsMe_2$, $AsPh_2$

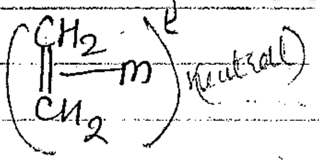
Z, Z > N family ⟹ charge = (−1)

Eg's of 2e⁻ donor :-

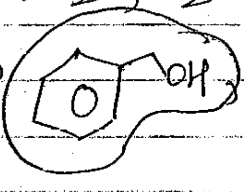
→ Those c have 1 neutral Donor SITE

ya → 10/12th upr (−2) charge ho.

1. CH_3CN (neutral)
2. CO
3. CS
4. Py (neutral)
5. CO_3
6. SO_4
7. SO_3
8. O
9. S
10. O_2^{-2}
11. Ox (ox^{2-})
12. $\eta^2-C_2H_4$
13. CH≡CH ($C_2H_2-\eta^2$)



H_2O, ROH, ROR, H_2S, H_2Se,
Me-SH, MeSeH, (benzyl alcohol ring with OH),
H_2Te, (Φ-OH) C_6H_6-OH (phenol)



⟹ Neutral ; 2e⁻ donor

G, G > O family

NH_3, PH_3, AsH_3, NMe_3, $AsPh_3$
$SbPh_3$, NCl_3, PCl_3 etc ⟹ Neutral ; (2e⁻) donor

G–N G=N G≡N

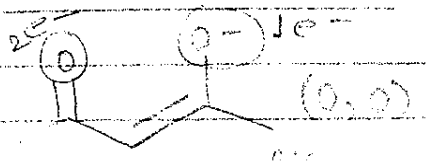
CH_2, CCl_2, $SiCl_2$, $SiPh_2$, $C(NH_2)_2$, CPh_2, CHMe, C^{Ph}_{OH} etc. ⟹ charge −2 ⇓ 2e⁻ donor

G–C family ; G=C family.

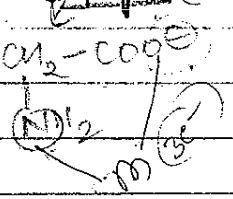
NH, PH, NMe, PPh, SbMe, PEt, AsPh ⟹ charge −2 ⇓ 2e donor.

G–N family

3e⁻ DONOR :— (g a d)



① N (N^{3-})
② NO (Linear)
③ PO_4
④ Gly (N,O donor ligand)
⑤ acac
⑥ dmg
⑦ CH (Carbyne)

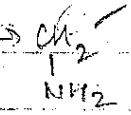


CH, SiH, CMe, CPh, SiMe, GePh, SnMe ⟹ Charge (−3)

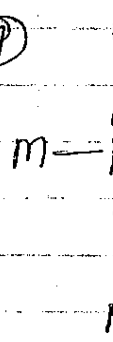
G–C family

Eg. of 4e⁻ donor

① en
② bipy
③ i-Bn
④ o-phen (N, N)
⑤ pn
⑥ tmd → (tm)



⑦



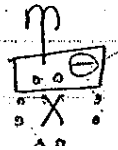
Bridging Alkyne

* halides के पास 3lp होते है।

TERMINAL V/S BRIDGING LIGAND:-

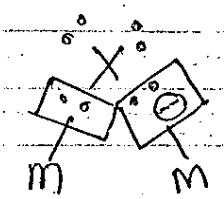
① Halo / Halide / X⁻ → { 1 metal → 1e⁻ ; 2 metal → 3e⁻ ; 3 metal → 5e⁻ donor }

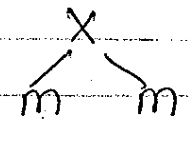
↳ F⁻, Cl⁻, Br⁻, I⁻



(halide के पास 1 ⊖ve charge hota h)

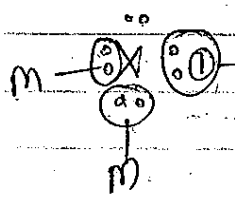
m—X 1e⁻

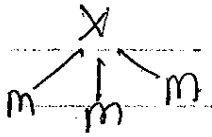




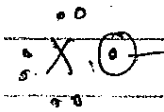
3e⁻

(Halides have 3 lp & 1 ⊖ve charge.)



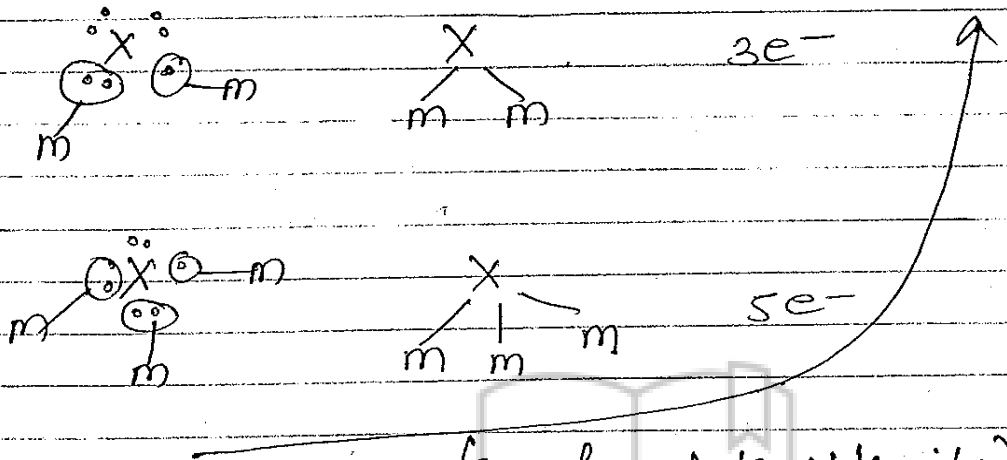


5e⁻



m—X 1e⁻

N के valence shell में 5e⁻ hote h ; (NH_2) 2 bond बना चुका है H, H के sath, अब बचा 1e⁻ & (1 lp), lp कभी भी टूट के Bond नहीं बनाता (एक sath ही donate hota h)

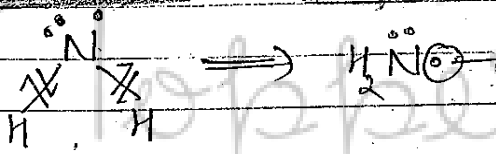


② $NH_2^{\ominus}$ (Amide) (Same for whole N family)

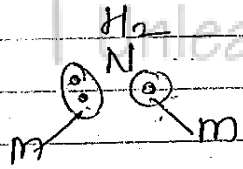
N के पास 1 lp

→ 1e⁻ (Terminal)

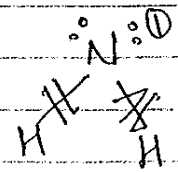
→ 3e⁻ (Bridging) इससे ज्यादा नहीं मिलता



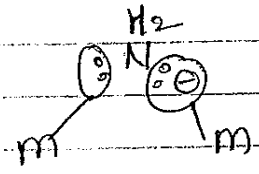
$H_2\ddot{N}-m$ 1e⁻ donor (in terminal)

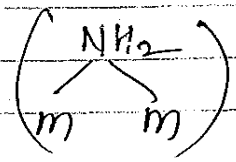


3e⁻ donor (in bridging)



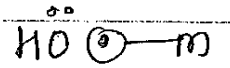
$H_2\ddot{N}-m$ 1e⁻ ($m-NH_2$)



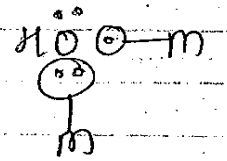
3e⁻ 

OH^-

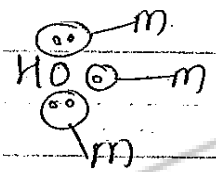
:Ö—H (for whole Oxygen family)




1e⁻ (1 metal)

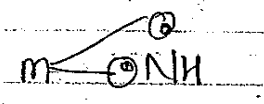
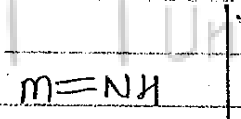


3e⁻ (∈ 2 metal)

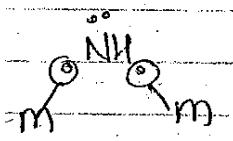
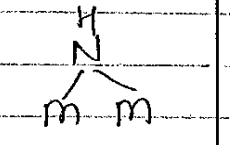



5e⁻ (∈ 3 metal)

(nitrene) :NH ⊖:N—H ≃ NH^{2-} (for whole N family)

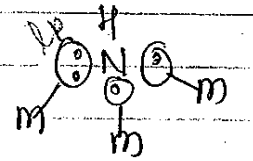
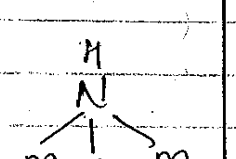



2e⁻ (1 metal के sath शेयर 2e⁻ donor है)

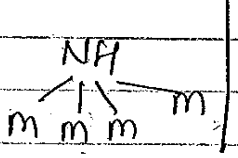



2e⁻

NH^{-2}
1 metal → 2e⁻ donor
2 metal → 2e⁻
3 metal → 4e⁻

4e⁻



4e⁻ (bcz max 4e⁻ ही donate kr skta hai)