Diazotisation → Nitrosation RX.

↓

electrophilic subst^{n} on N.

aq. $NaNO_2 + HCl \xrightarrow{0.5^{\circ}C}$

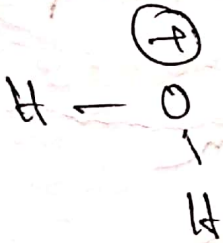
↓

$HO-N=O$.

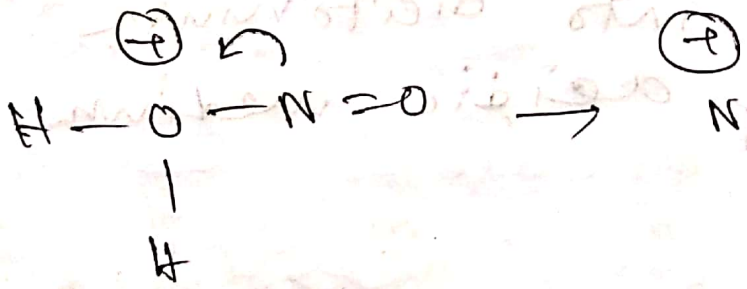
Weakly acidic medium :-

$2HO-N=O \longrightarrow O=N-O-N=O$.

Increase the acidity



on further increase of acidity



$R-NH_2$ | $Ar-NH_2$

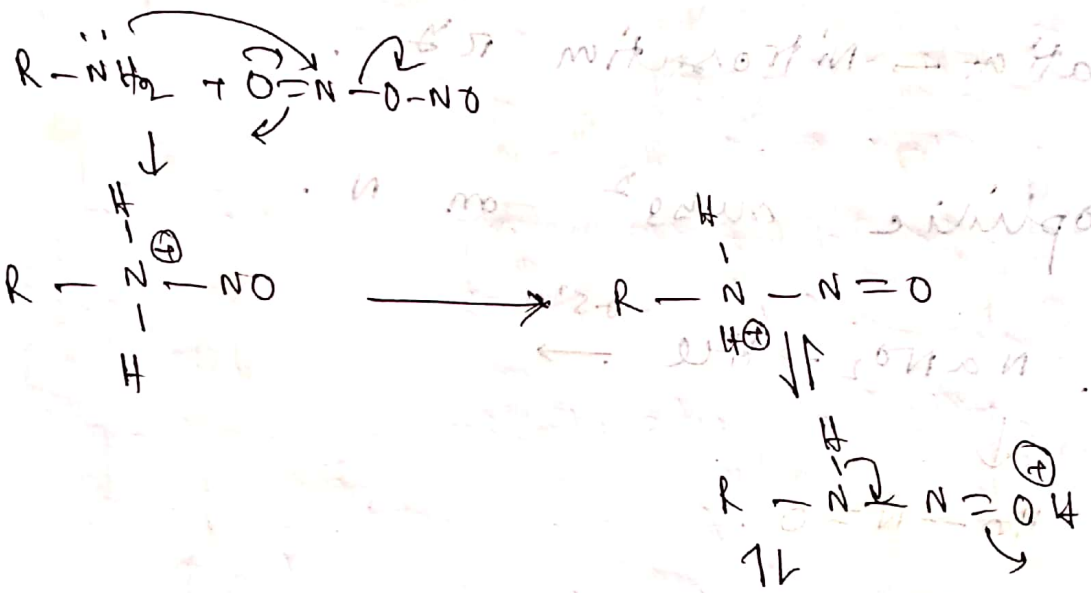
Stronger Base | weaker base

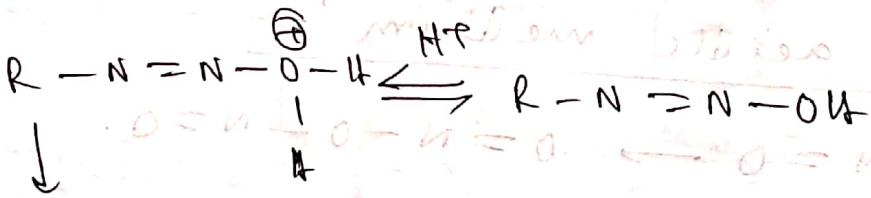
more nucleophilic | less nucleophilic

$R-NH_2$

↓ Strong acidic medium

$R-\overset{\oplus}{N}H_3$





$R-N\equiv N$ (unstable even at low temp.)

If we do the diazotization in strong acidic medium then it fully converts into diazonium salt. So, strong acidic medium is not used.

$R \equiv CH_3CH_2CH_2CH_2-$

$CH_3CH_2CH_2CH_2-\overset{\oplus}{N}\equiv N \xrightarrow{-N_2} CH_3CH_2CH_2\overset{\oplus}{C}H_2$

$CH_3CH_2CH_2\overset{\oplus}{C}H_2 \xrightarrow{-H^+} CH_3CH_2-CH=CH_2$

$CH_3CH_2CH_2\overset{\oplus}{C}H_2 \xrightarrow{H_2O} CH_3CH_2CH_2CH_2OH$

$CH_3CH_2CH_2\overset{\oplus}{C}H_2 \xrightarrow[(HCl\ med.)]{Cl^\ominus} CH_3CH_2CH_2CH_2Cl$

$CH_3CH_2CH_2\overset{\oplus}{C}H_2 \longrightarrow CH_3CH_2\overset{\oplus}{C}H-CH_3$ (1° carbocation (less stable))

$CH_3CH_2\overset{\oplus}{C}H-CH_3 \xrightarrow{H_2O} CH_3CH_2\underset{OH}{CH}-CH_3$

$CH_3CH_2\overset{\oplus}{C}H-CH_3 \xrightarrow{Cl^\ominus} CH_3CH_2\underset{Cl}{CH}-CH_3$

$CH_3CH_2\overset{\oplus}{C}H-CH_3 \xrightarrow{-H^+} CH_3CH=CH-CH_3$

As $Ar-NH_2$ is less nucleophilic so, more electrophilic species is required for diazotization. So, more acidic med. is required.

$Ar-NH_2 \xrightarrow[0-5^\circ C]{NaNO_2+HCl} Ar-\overset{H}{\overset{|}{\overset{\oplus}{N}}}-N=O$

$Ar-\overset{H}{\overset{|}{\overset{\oplus}{N}}}-N=O \rightleftharpoons Ar-\underset{H}{\overset{|}{N}}-N=O \xrightarrow{H^+} Ar-N=N-\overset{\oplus}{O}H_2 \xrightarrow{-H_2O} Ar-N\equiv N$

$Ar-N=N-OH \xrightarrow{H^+}$ (1L)

$Ar-\overset{\oplus}{N}\equiv N$ → weak electrophile

acid med. :
neutral "
weakly basic med.

$Ar-N=N-OH$
Diazo hydroxide.

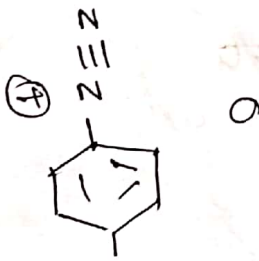
↓ further increase of basicity.

$Ar-N=N-O^{\ominus}$
Diazotate ion.

So, in strong basic med. $Ar-N_2^{\oplus}$ can't be used as E+.

$Ar-N_2^{\oplus}$ is relatively stable at low temp. (because of the resonance stabilisation)

more stable.
~~but~~ but less electrophilic



as the e^- withdrawing capacity of the attached gr, increase, the electrophilic character of the diazonium comp. increase.

$Ar-NH_2$ $\xrightarrow{\text{Diazotization}}$ $[Ar-NH_2]$

in weaken acid med.

$Ar-N\equiv N \rightarrow Ar-NH_2$

↓

coupling

for this reason diazotization is not done in weaken acid med.

$H_2N-CH_2-C(=O)-OEt$ $\xrightarrow[HCl]{aq.\ NaNO_2,}$ $0-5^\circ C$

Methyl glycine

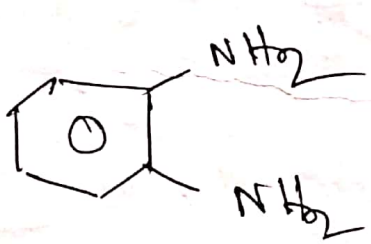
$N\equiv N^{\oplus}-CH(H)-C(=O)-OEt$

H ← acidic.

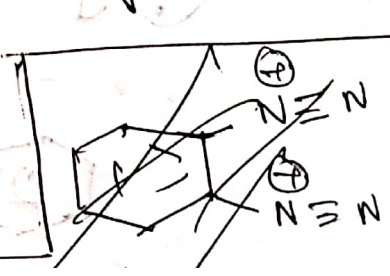
$\xrightarrow{-H^+}$

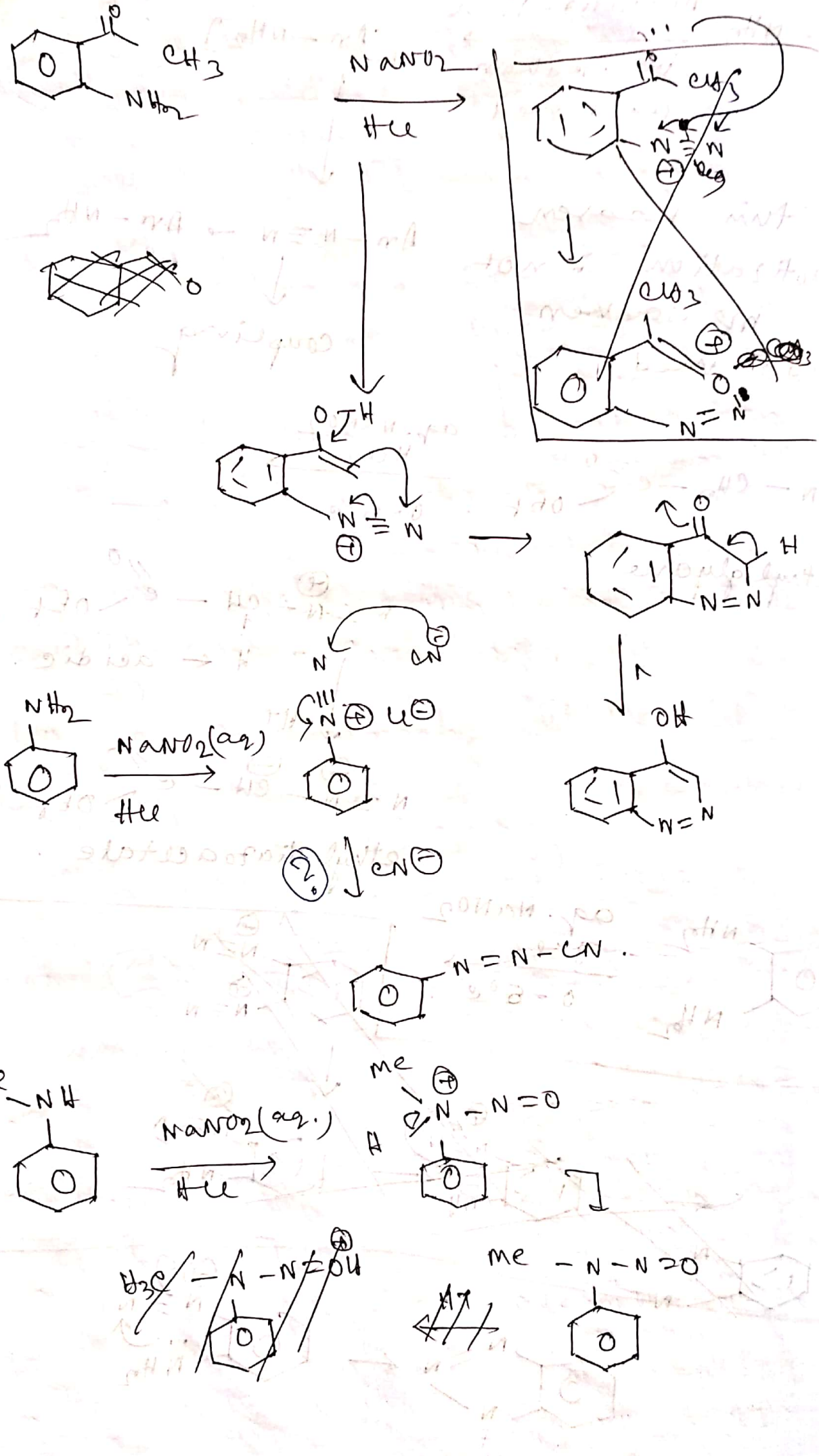
$N\equiv N^{\oplus}-CH^{\ominus}-C(=O)-OEt$

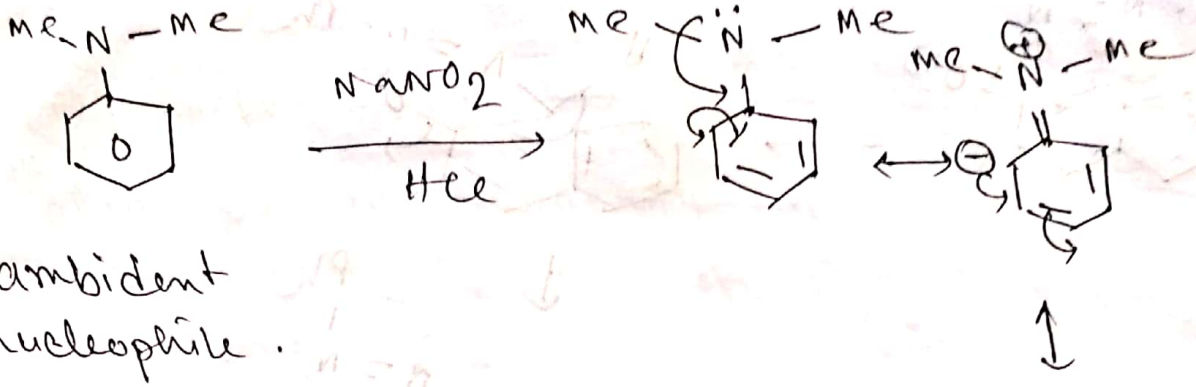
ethyl diazoacetate.



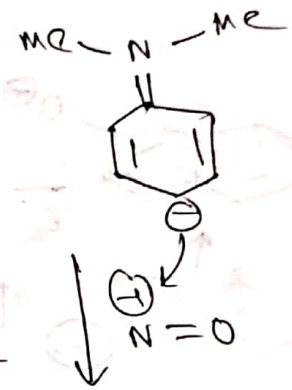
$\xrightarrow[HCl]{aq.\ NaNO_2}$ $0-5^\circ C$



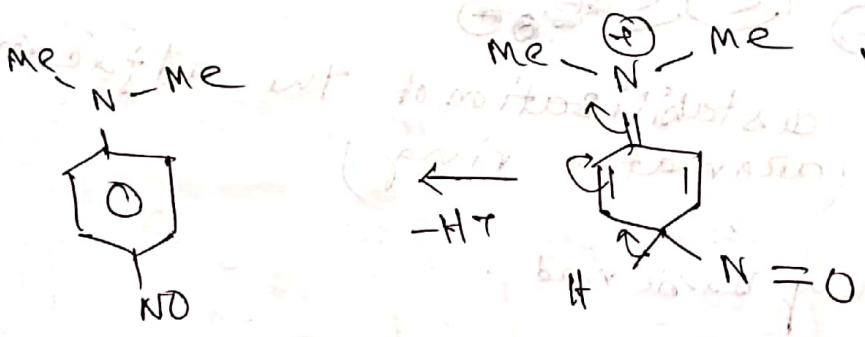


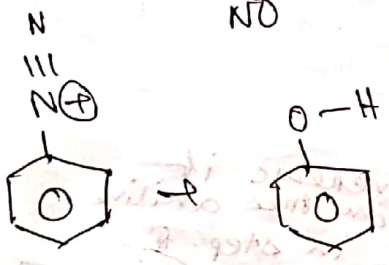


ambident nucleophile.

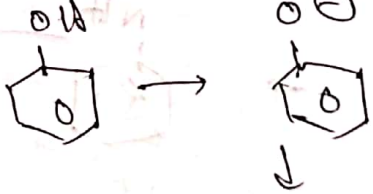


O-position is substantially hindered. So, $NO^{\oplus}$ attack the p-carbon.



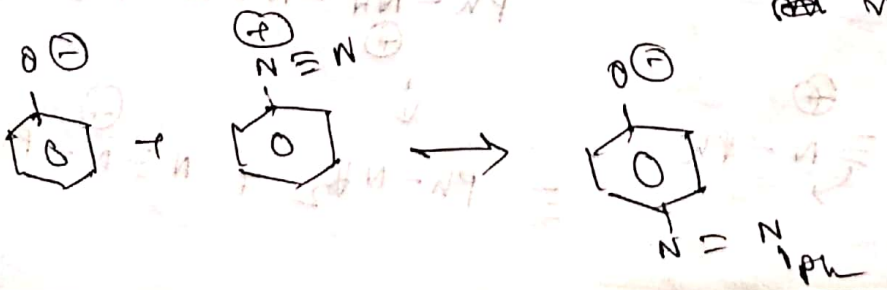


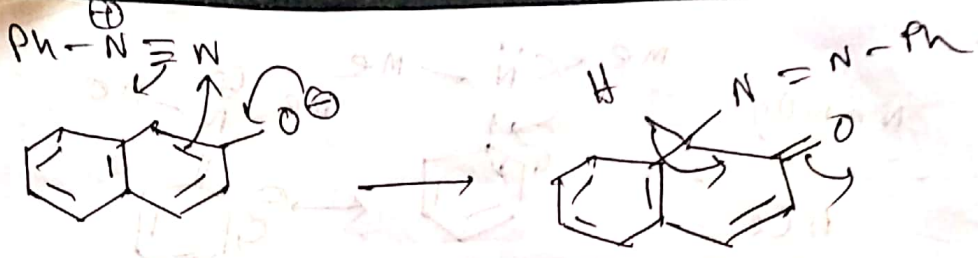
in weakly basic med,

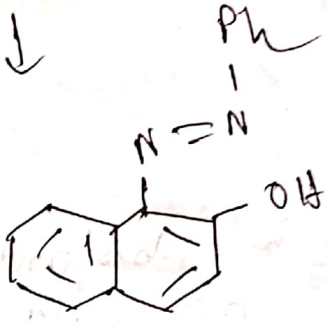


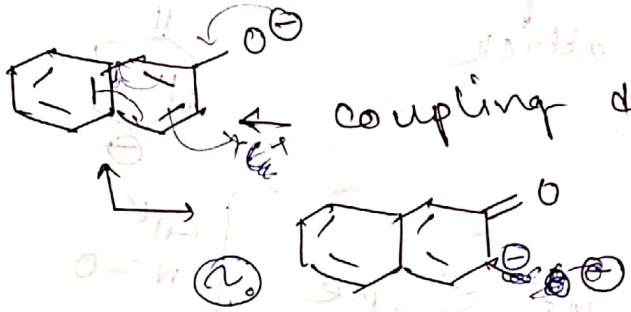
e-density increase. So, it becomes more e⁻ doner & becomes good nucleophile.

So, the rxn is carried out in weakly basic med. In acidic med, this rxn does not occur.



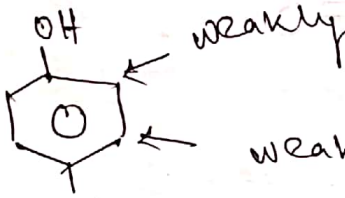






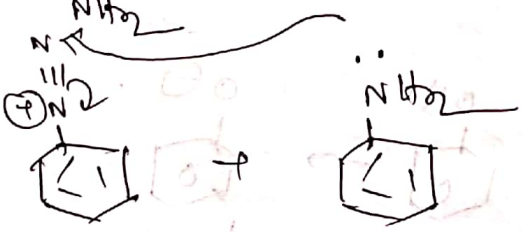
coupling does not occurs at this position

distabilization of the adjacent (aromatic ring)

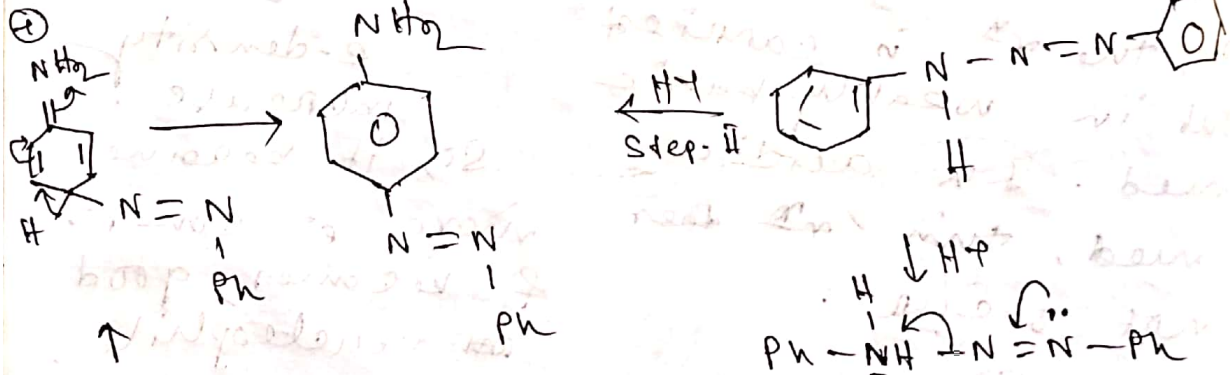


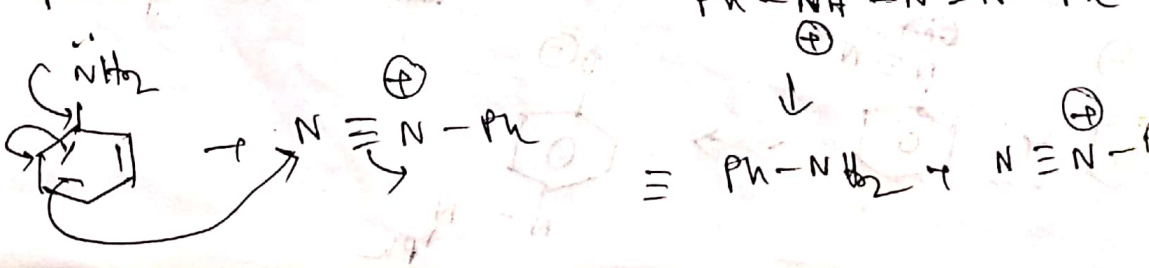
weakly basic med.

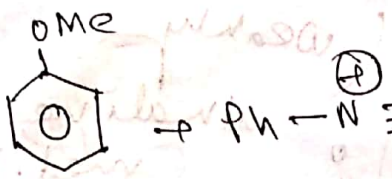
weakly acidic med.



+ rxn rate increase if we add some free aniline in step-II.

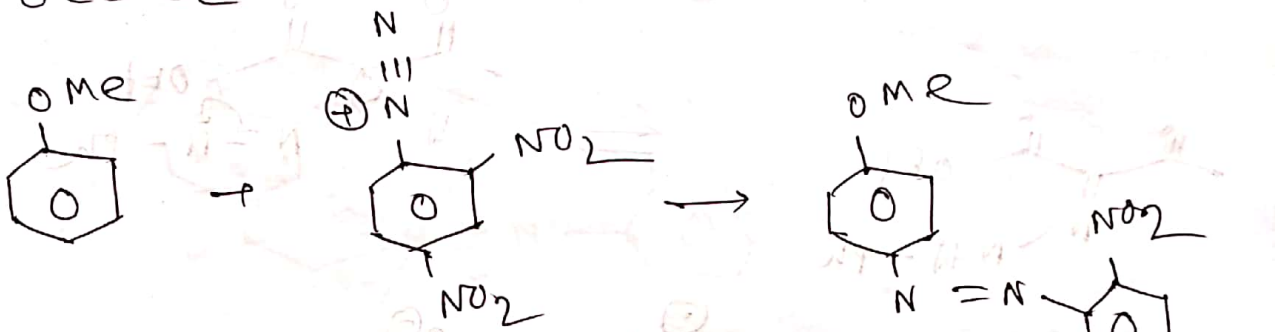


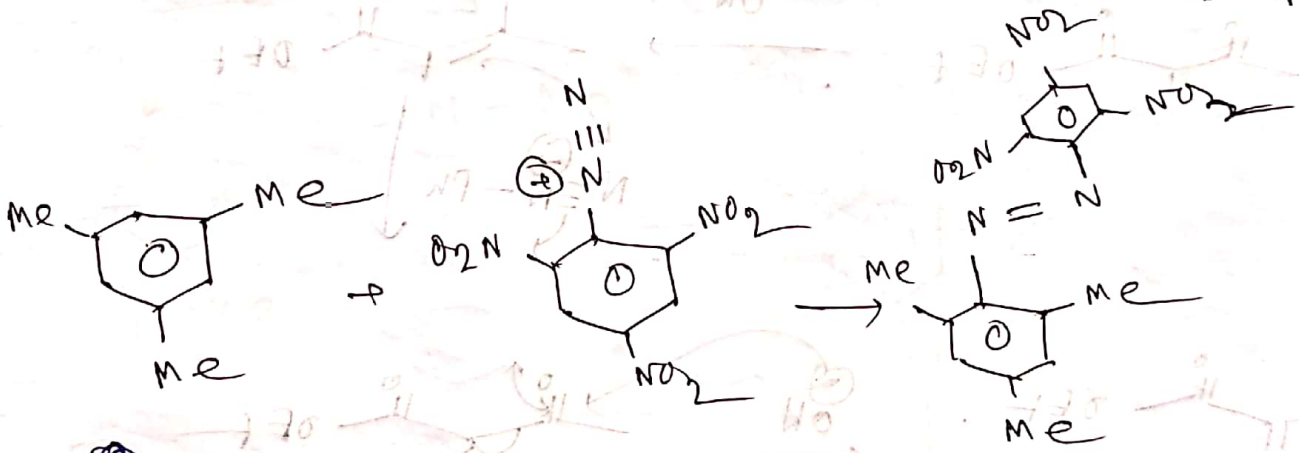




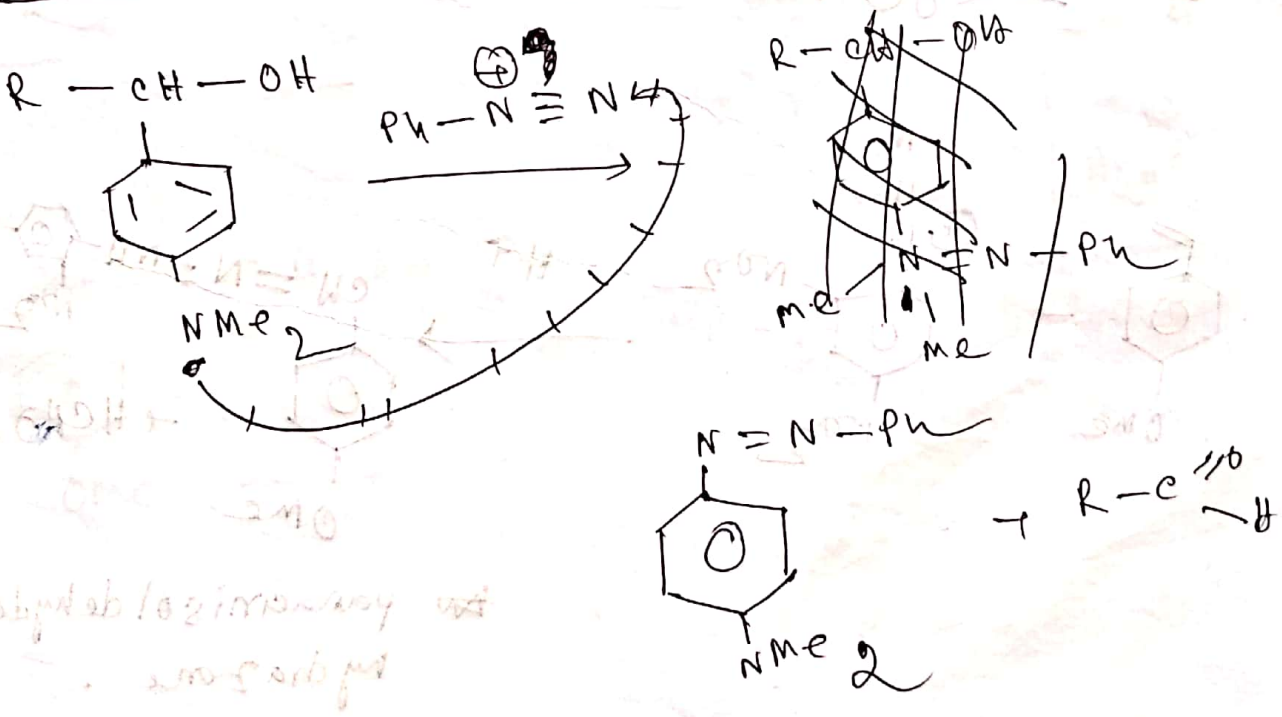
⟶ no rxn.

electrophilic property of $Ph-\overset{\oplus}{N_2}$ & nucleophilic " of Ph–OMe is not compatible. So, the rxn does not occur.



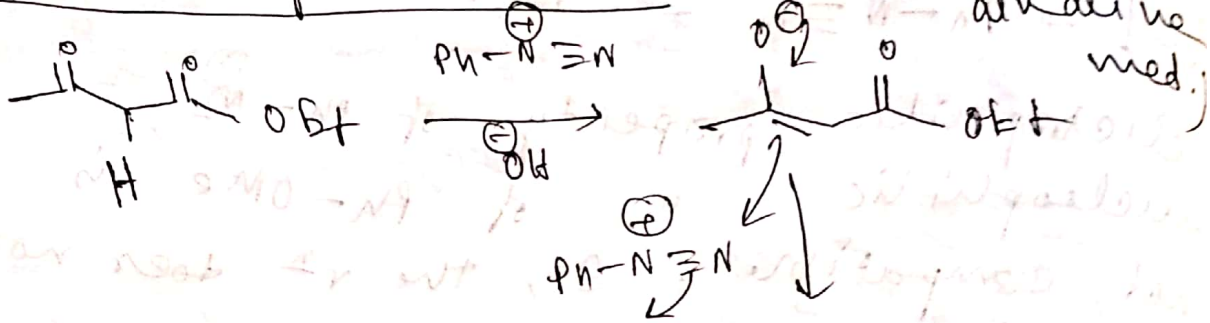


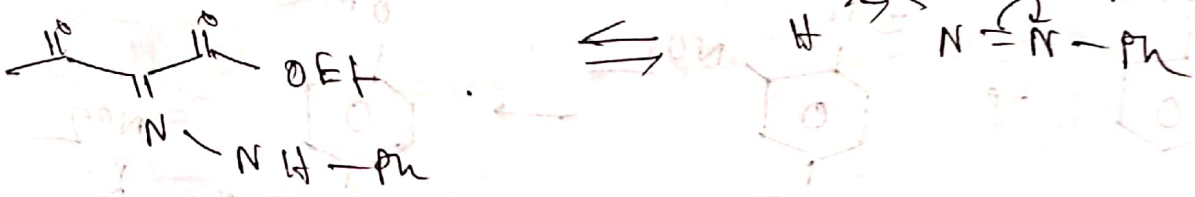
Stile–Sisti reaction :—

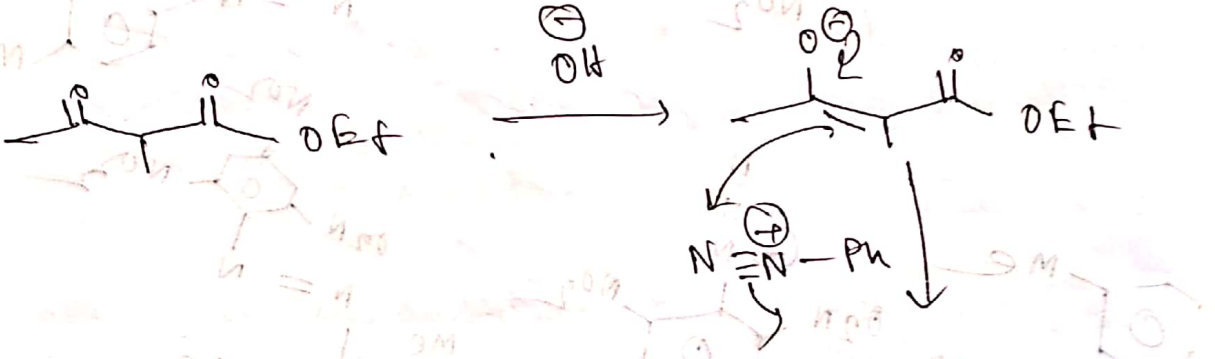


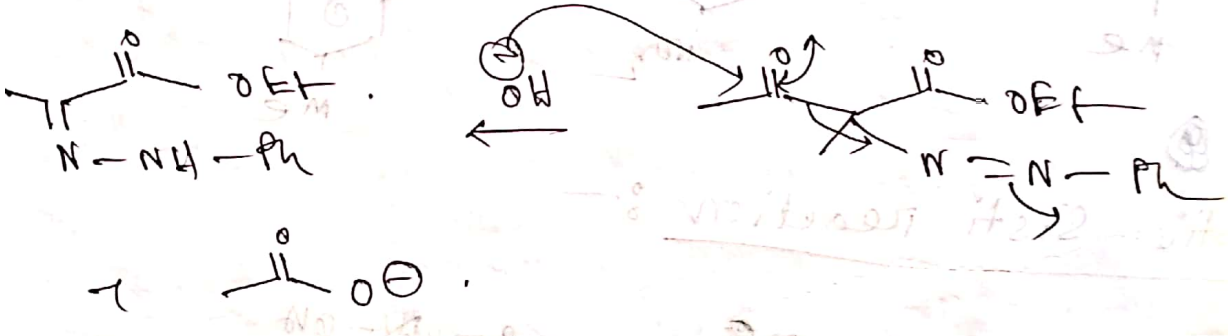
Japp-Klingemann rxn :-

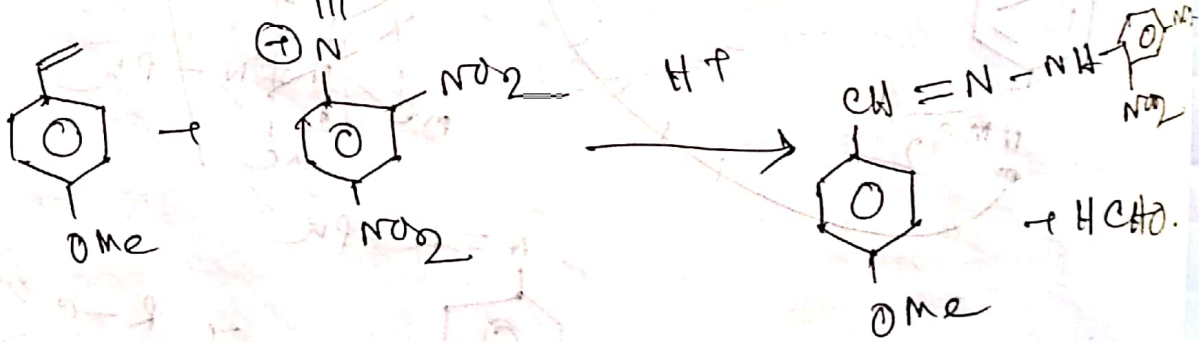
(weakly alkaline med.)





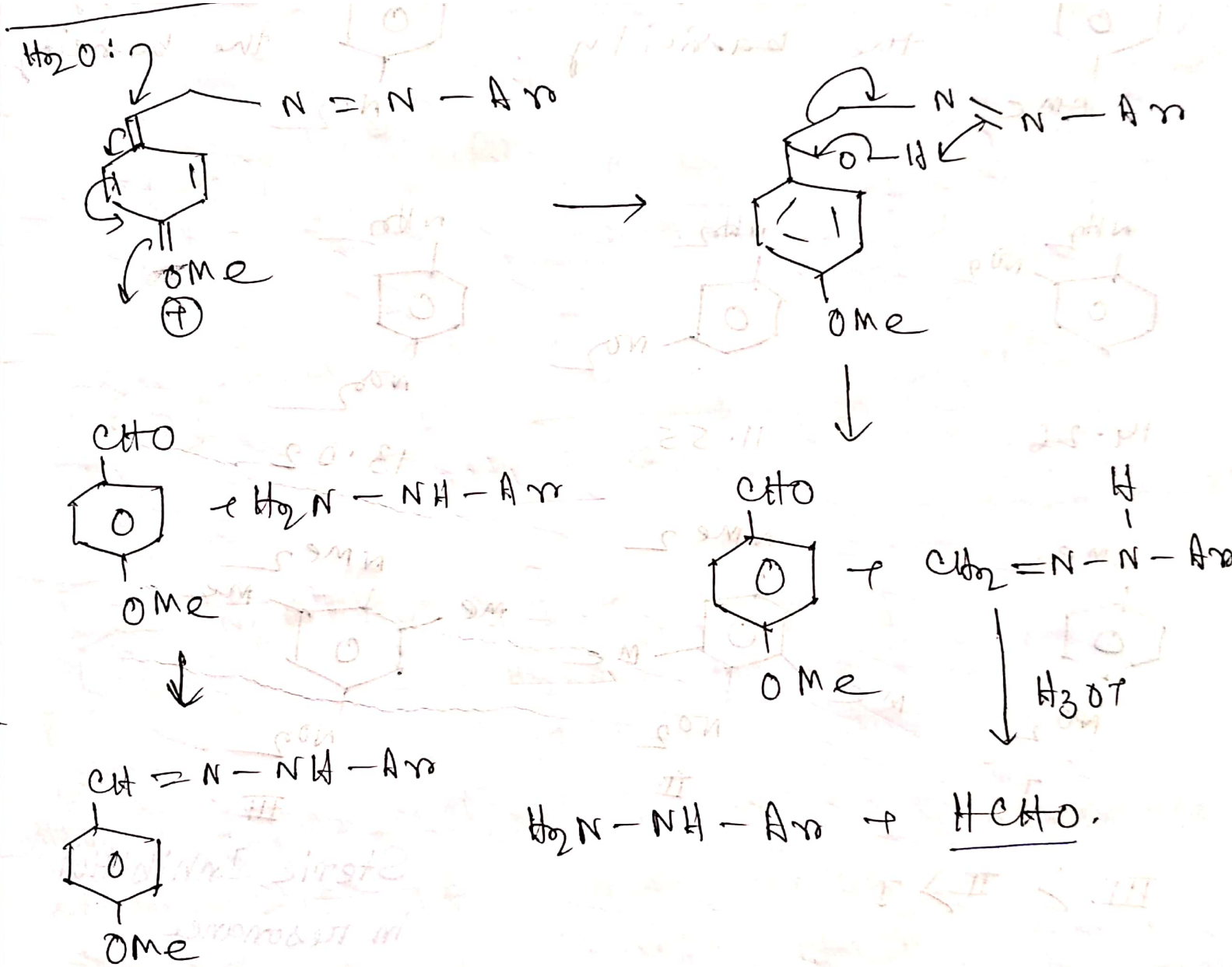






→ HCHO.

p-anisaldehyde hydrazone.



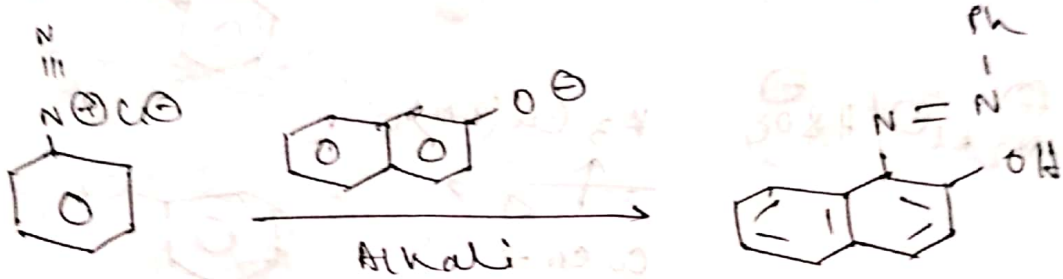
Diazonium salts (reaction) :—

Two types of RN occurs —

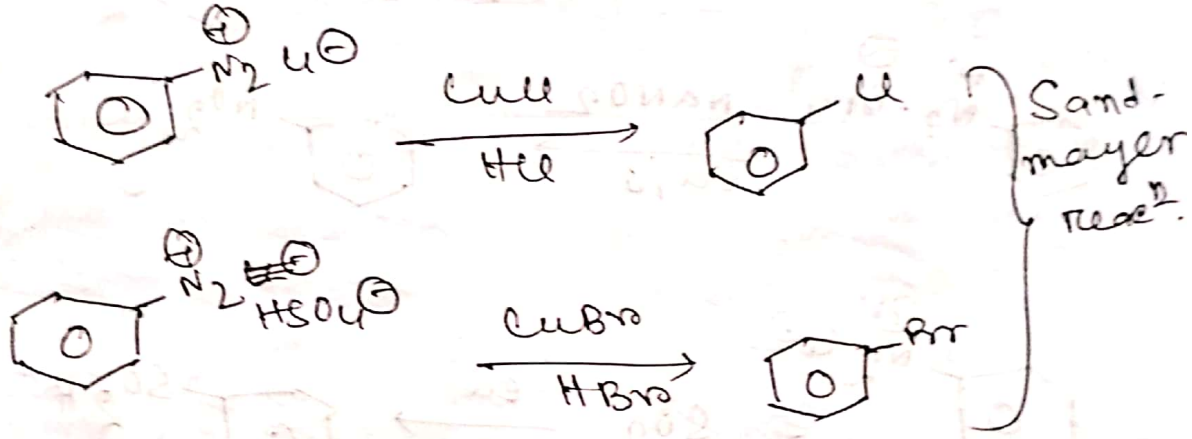
i) $-\overset{\oplus}{N_2}$ is present.

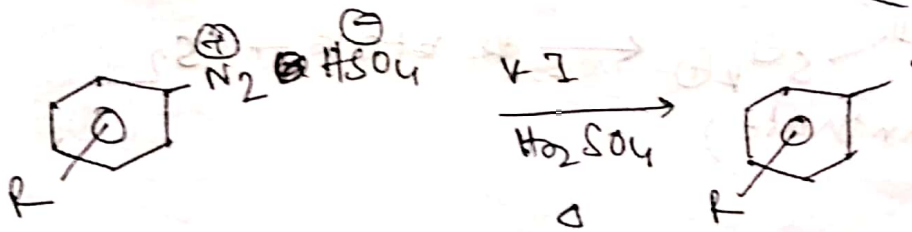
ii) $-\overset{\oplus}{N_2}$ is) loss of $-\overset{\ominus}{N_2}$.

i)

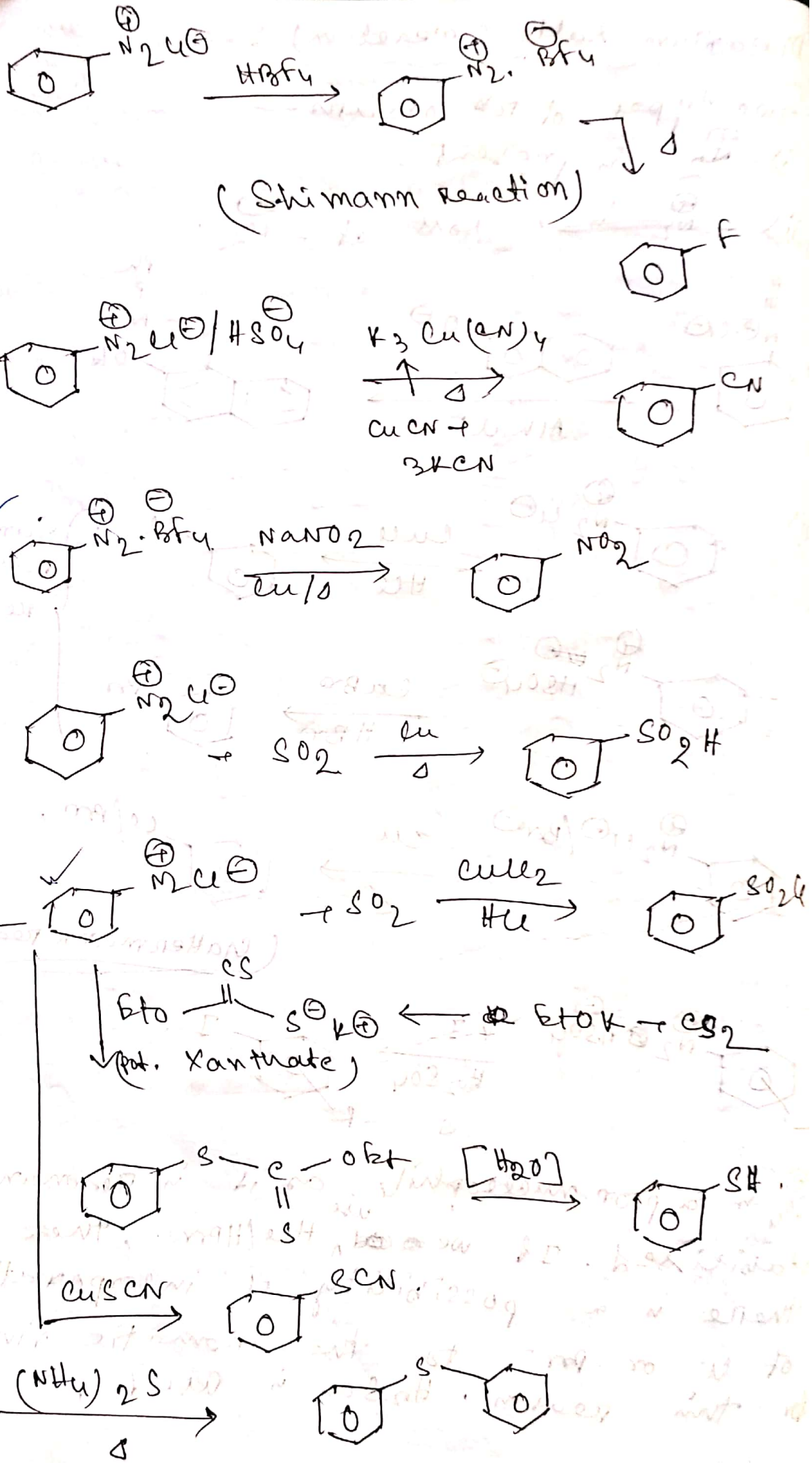


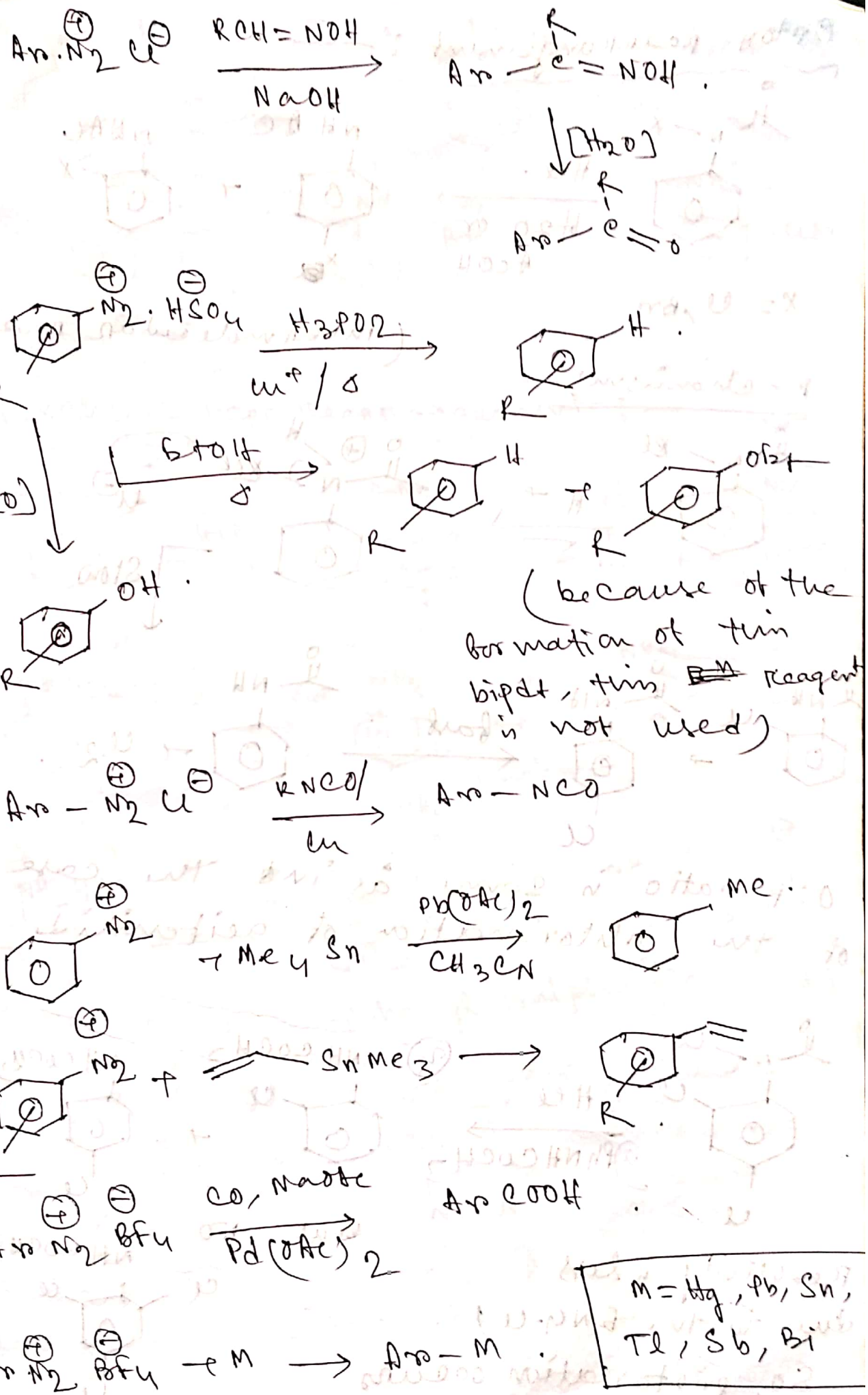
ii)





$HSO_4^{\ominus}$ is a poor nucleophile as it is resonance stabilised. If we use HCl/HBr, then there is a possibility of incorporation of Cl^- or Br^- to the aromatic ring. For this reason, H_2SO_4 is used.





Replacement by -OH gp:-

$Ar-NH_2 \xrightarrow[dil.\ H_2SO_4]{NaNO_2/} Ar-N_2^{\oplus} \xrightarrow[S_N1]{slow} Ar^{\oplus} + N_2$

$Ar^{\oplus} + X^{\ominus} \rightarrow Ar-X$

$Ar^{\oplus} + H_2O \rightarrow Ar-OH_2^{\oplus} \xrightarrow{-H^+} Ar-OH.$

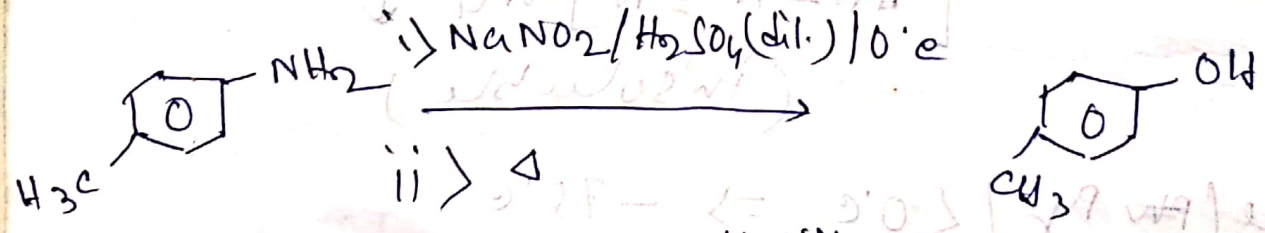
if we use dil. HCl for diazotisation, then there will be presence of $Cl^{\ominus}$ in the RM mixture. So, we get Ar-Cl instead of Ar-OH.

but for dil. H_2SO_4,

$Ar^{\oplus} \xrightarrow{HSO_4^{\ominus}} Ar-SO_3H \xrightarrow{H_2SO_4} Ar-OH.$

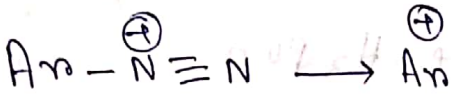
So, we use H_2SO_4 instead of HCl.

if there is excess of HNO_2 in the RM med. then the diazotisation is completed.

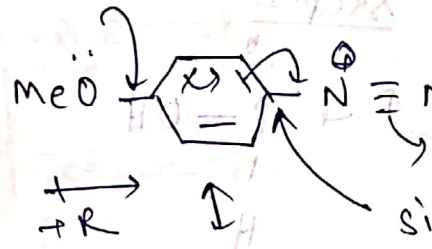


(insoluble in HCl)

* Test for HNO_2
* destruction of excess HNO_2 → pinch of urea → $CO_2 + N_2 + H_2O$
* blue colouration of KI-starch paper.

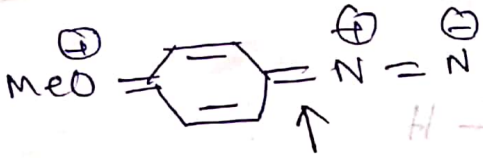


→ decomposition become slow due to e.w. effect of the $-COOH$ gr.



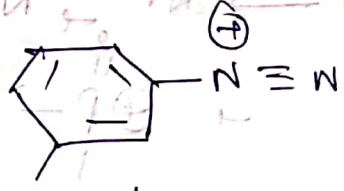
→ decomposition is slow.

single bond



double bond

(due to the double bond the $-N_2$ evolvation become harder)

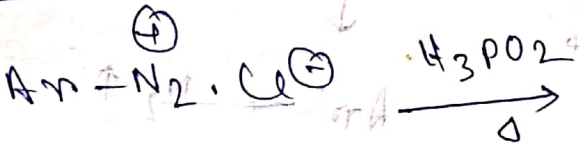


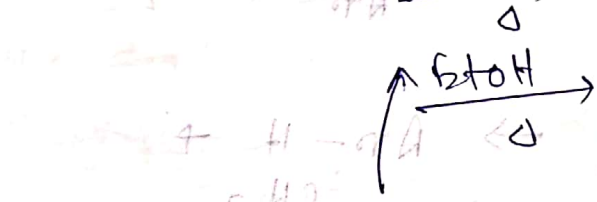
ome / me

(No mesomeric effect)

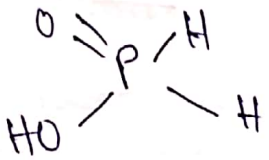
$\Rightarrow$ So, here the decomposition is almost comparable to $Ph-\overset{\oplus}{N}\equiv N$.

Replacement by H :—

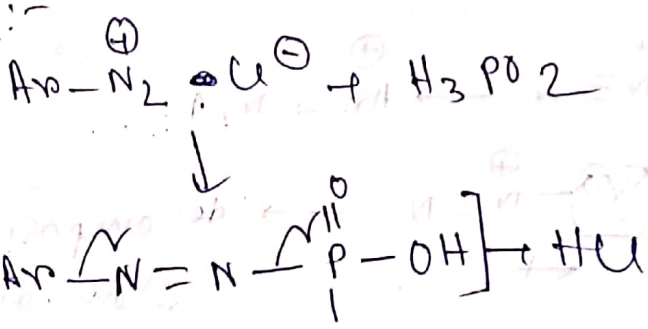


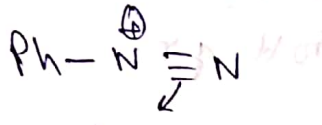


(Sometimes catalysed by transition metal like Cu)



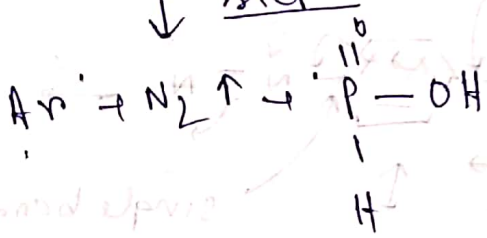
Step 1:-



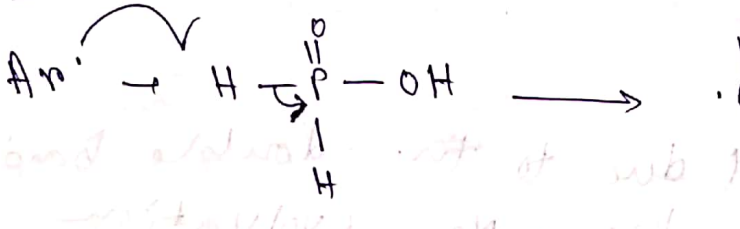


electrophilic nitrogen

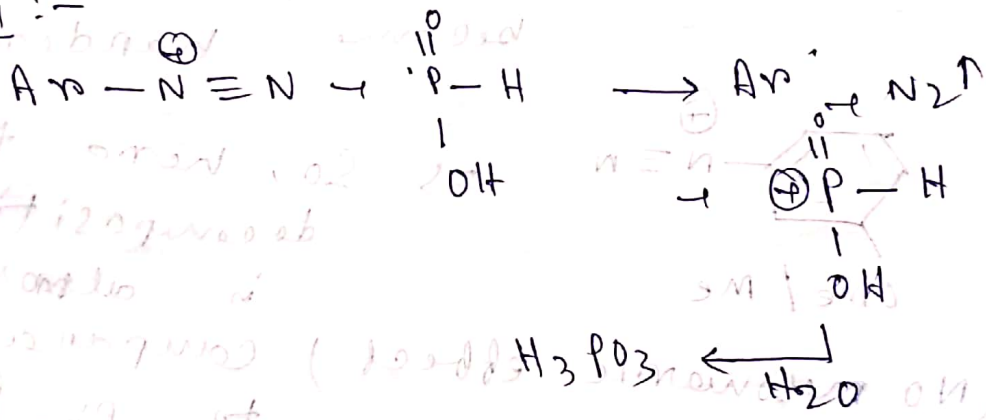
Step 2:-



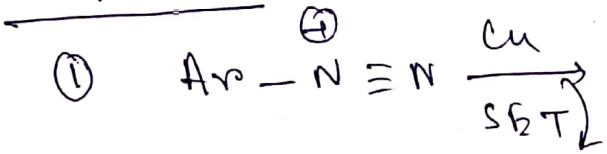
Step 3:-

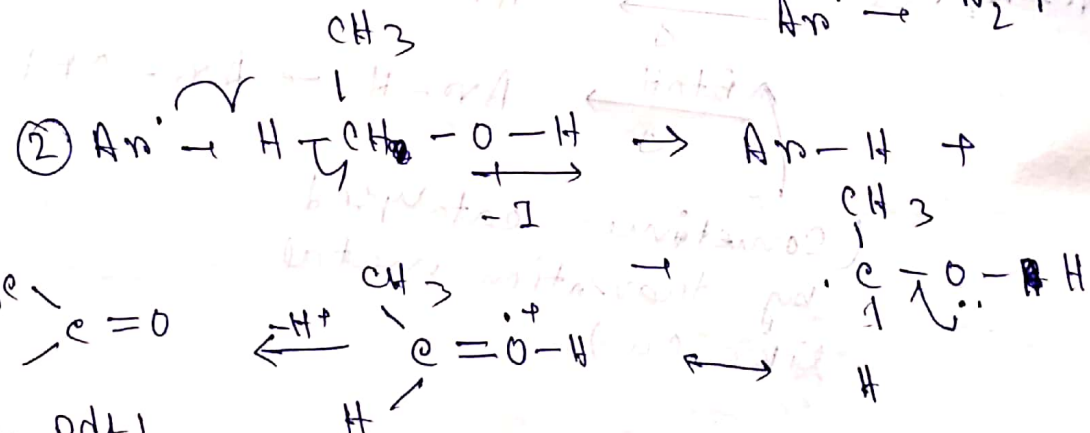


Step 4:-



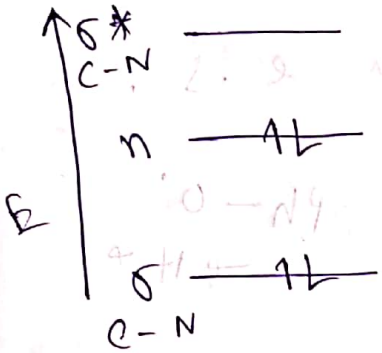
Cu / EtOH





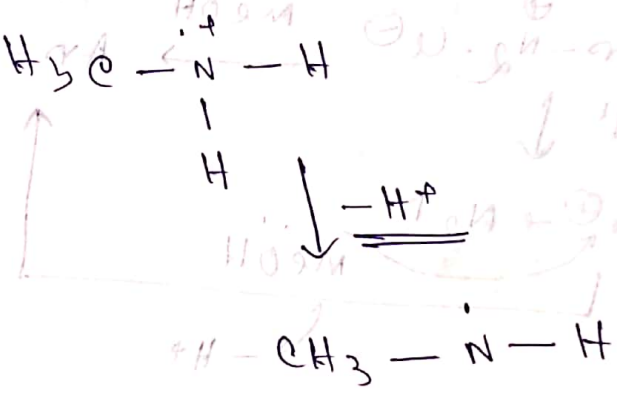
(overall a redox rx)

In U-V light (excited state)
the basicity of amines will be less.



if the strength of the light is sufficiently high to transfer a n-b e⁻ to the higher energy level then,

CH_3-NH_2 will be



$CH_3-\ddot{N}-H$

⊗ as a result, amines acts as a acid in the excited state.

Thermal / ground state → π^* → no e⁻ transition from low to high energy level.

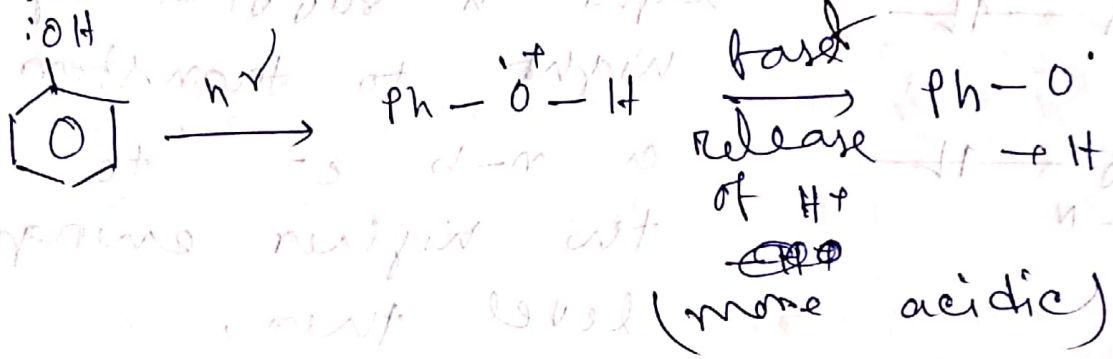
range - 269° c - x°c. } no. e⁻ transition.

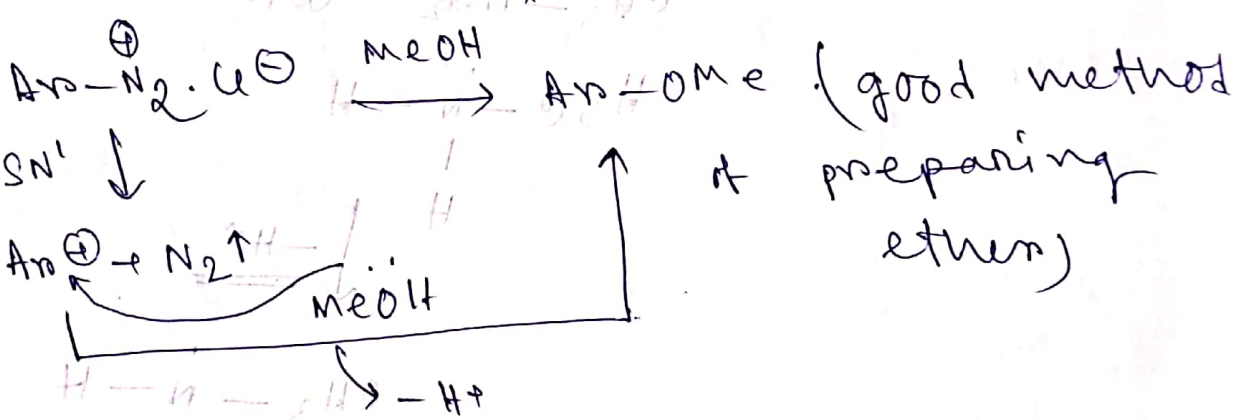
$Ph-NO_2$ is m-orienting gp in g.s
but " is o/p- " in e.s.

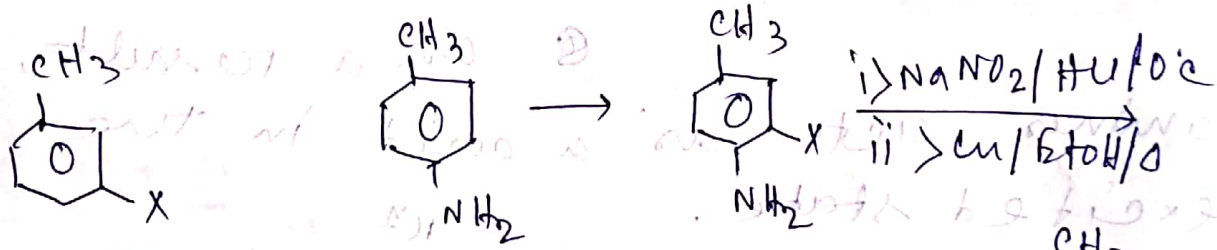
(complementary property)

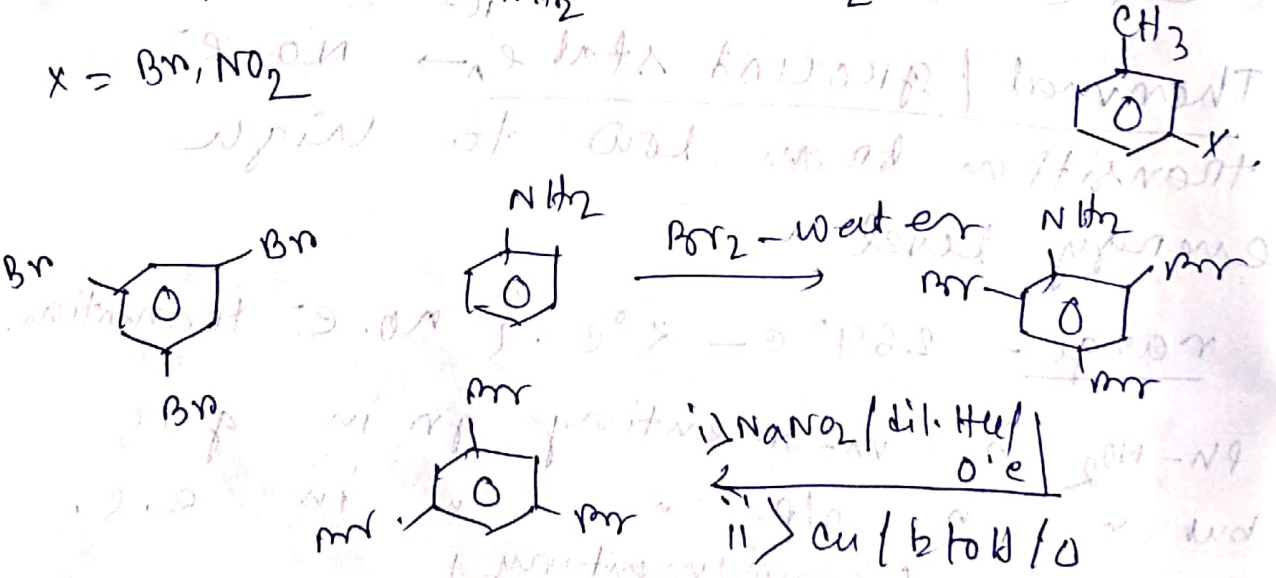
Similarly o/p orienting grp will be m-orienting in e.s.

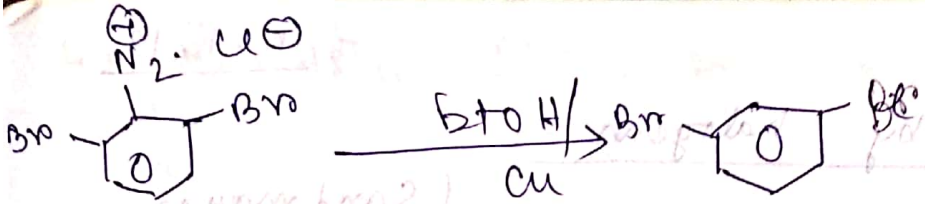
Phenol is acidic in g.s but it is more acidic in e.s.





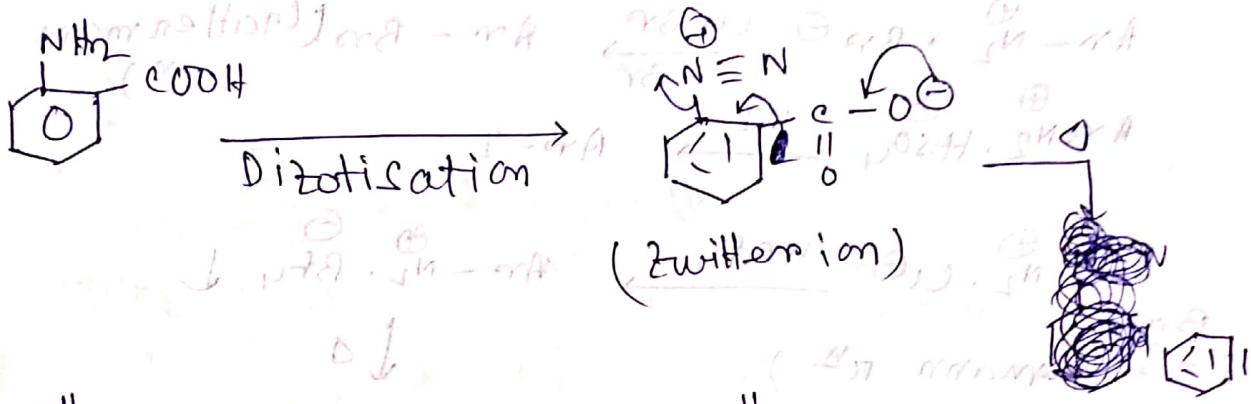




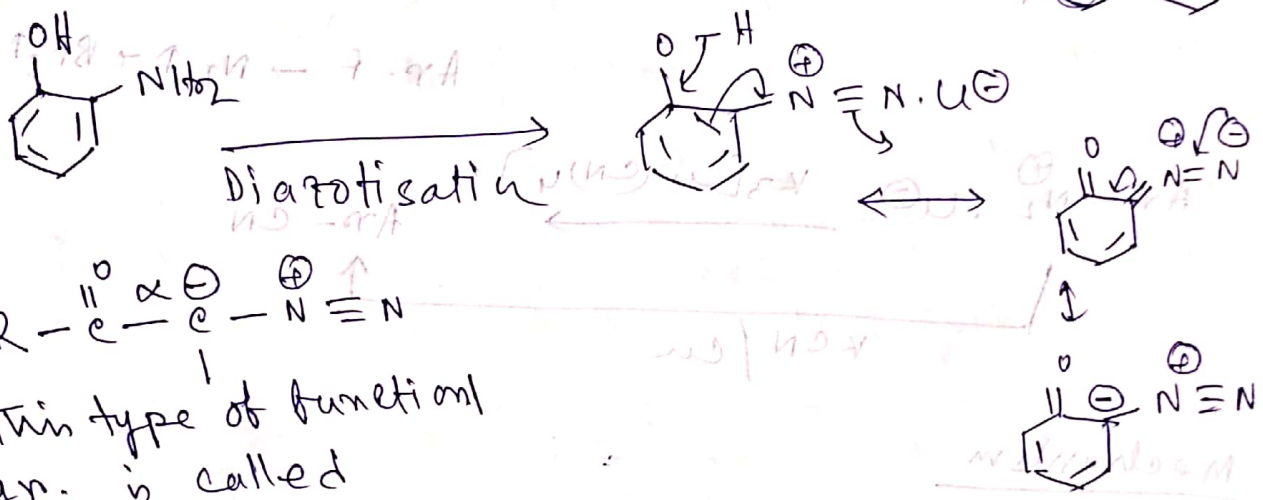


preparation?

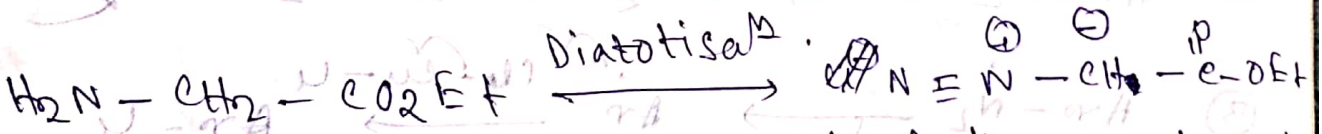
Mechanism?



(Zwitterion)



This type of functional gr. is called diazo-carbonyl comp. (α-diazoketone). or α-diazo carbonyl gr.



mechanism?

(ethyl diazo acetate)

* aromaticity is a property by which a comp do not undergo addition rn but do substitution rn & can show induced ring current.

Replacement by halogens :—

$Ar-N_2^{\oplus}Cl^{\ominus} \xrightarrow[HCl]{CuCl} Ar-Cl$ (Sandmayer rx)

$Ar-N_2^{\oplus}Br^{\ominus} \xrightarrow[HBr]{CuBr} Ar-Br$ (Gattermann rx)

$Ar-N_2^{\oplus}HSO_4^{\ominus} \xrightarrow{KI} Ar-I$

$Ar-N_2^{\oplus}Cl^{\ominus} \xrightarrow{HBF_4} Ar-N_2^{\oplus}BF_4^{\ominus} \downarrow$ (Balz-Schiemann rx)

$\downarrow \Delta$

$Ar-F + N_2\uparrow + BF_3\uparrow$

$Ar-N_2^{\oplus}Cl^{\ominus} \xrightarrow{K_3[Cu(CN)_4]} Ar-CN$

(KCN/Cu)

Mechanism

① $CuCl + Cl^{\ominus} \rightarrow CuCl_2^{\ominus}$ $\left[Cu\begin{matrix}Cl\\Cl\end{matrix}\right]^{\ominus}$

② $Ar-N_2^{\oplus}Cl^{\ominus} + CuCl_2^{\ominus} \rightarrow Ar-N_2 + CuCl_2$

③ $Ar-N_2 \rightarrow Ar^{\cdot} + N_2\uparrow$

$Ar^{\cdot} + Cl-Cu-Cl \rightarrow Ar-Cl + CuCl$

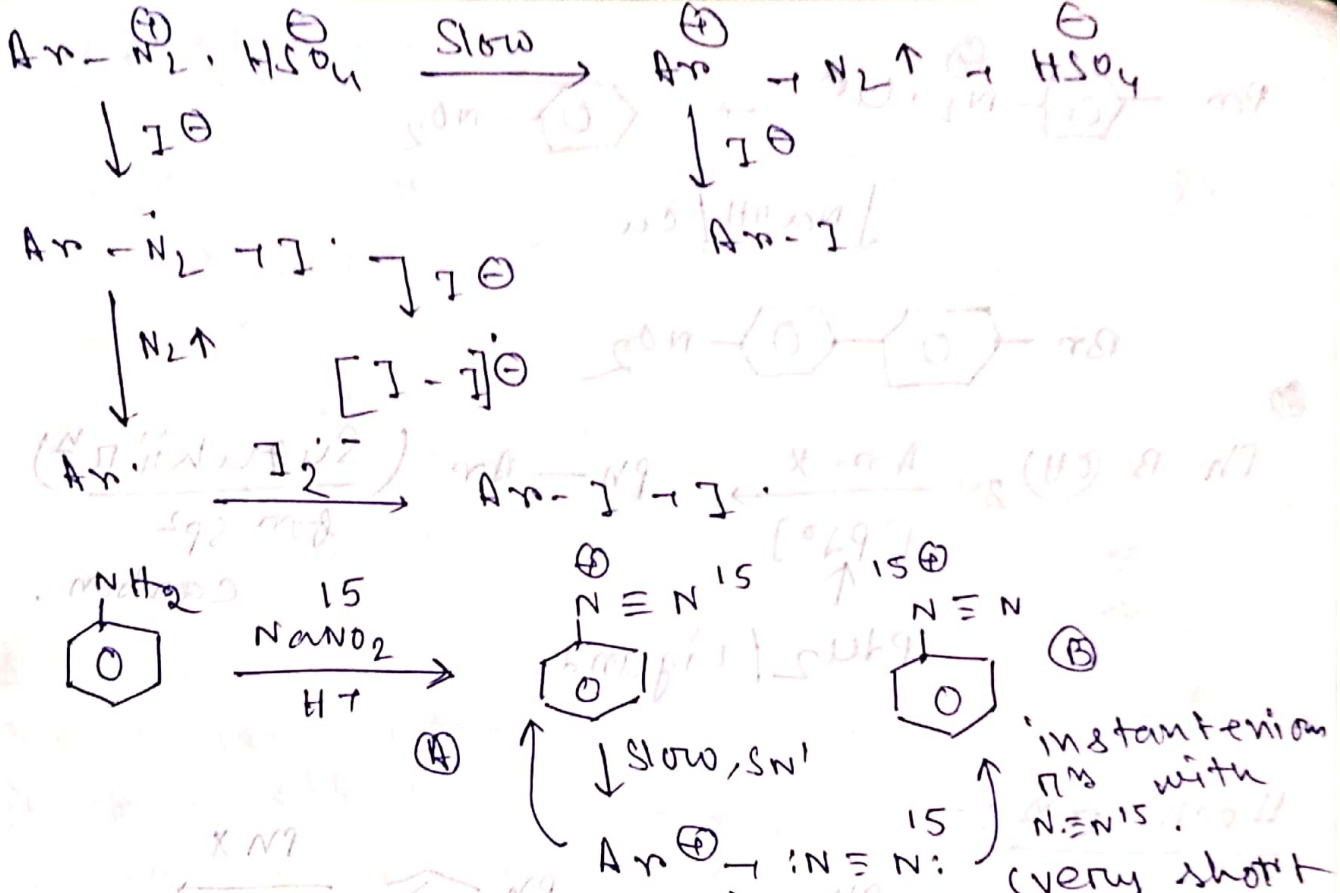
* For iodine :—

$Ar-N_2^{\oplus}HSO_4^{\ominus} \xrightarrow{KI} Ar-I$

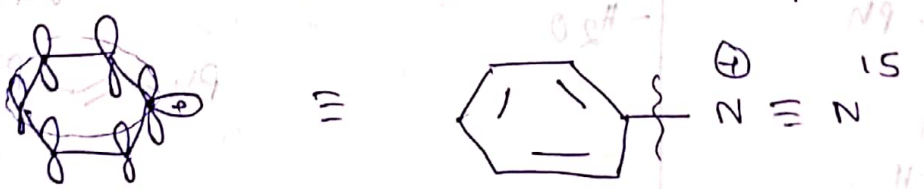
Δ

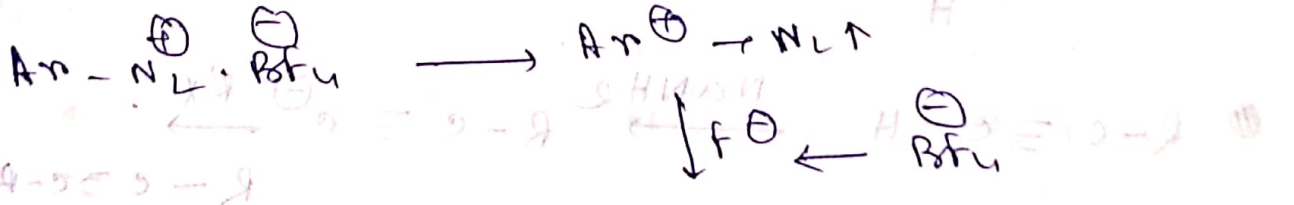
$KI \rightarrow I_2 \rightarrow KI_3$

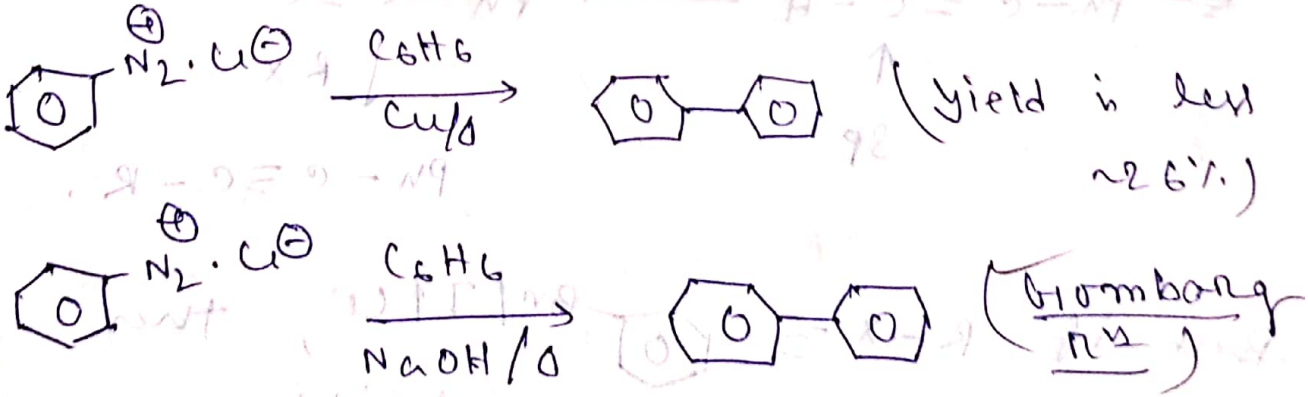
(I_3^- is better reagent)

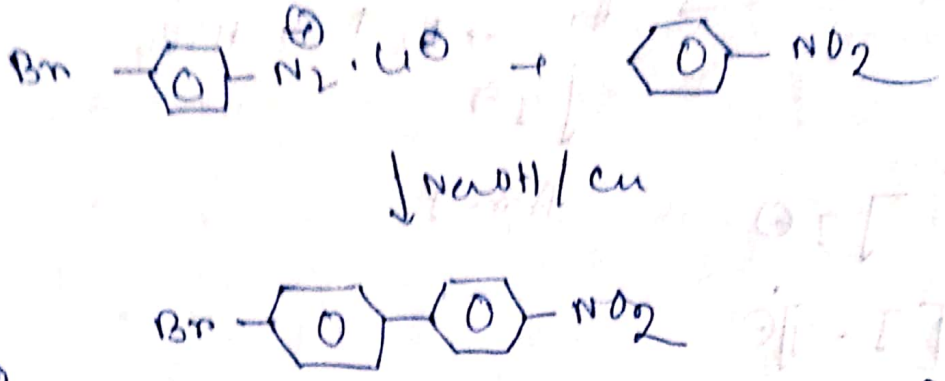


(*) Spectrochemical evidences.
shows that A & B both are possible.

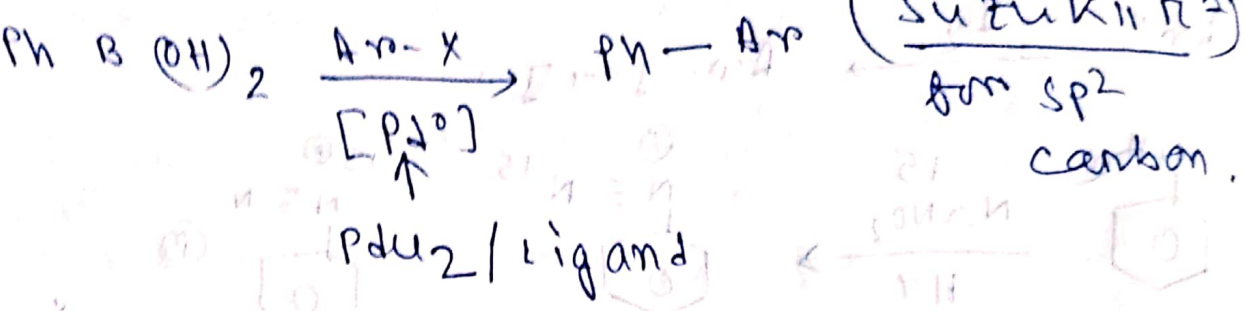




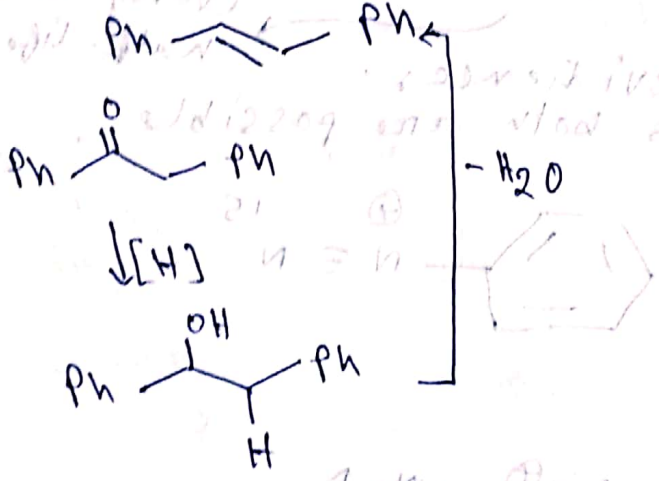


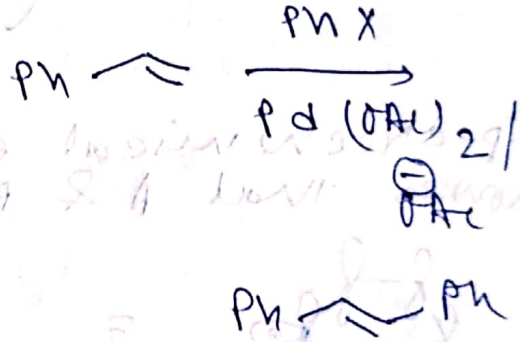


(iii)

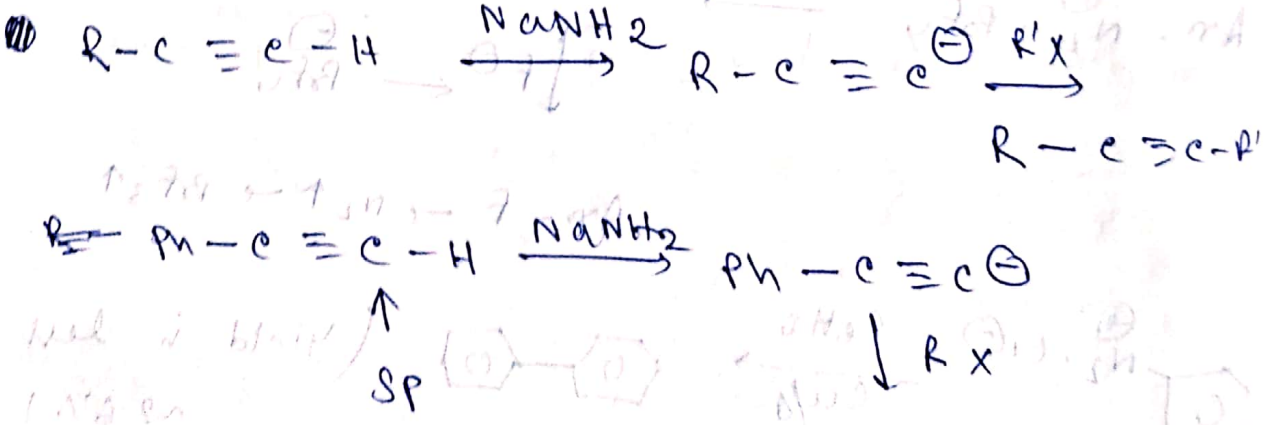


Hock rxn :-



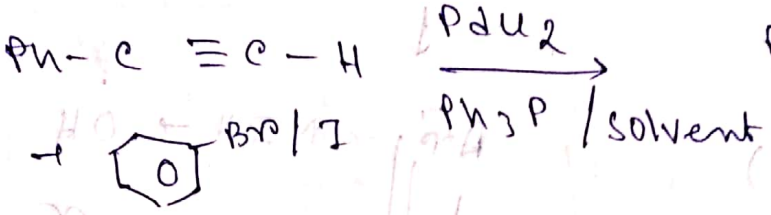


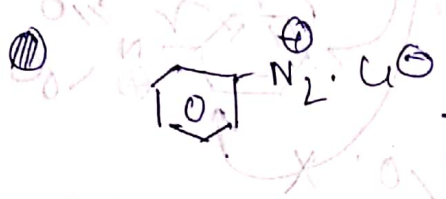
(iv)



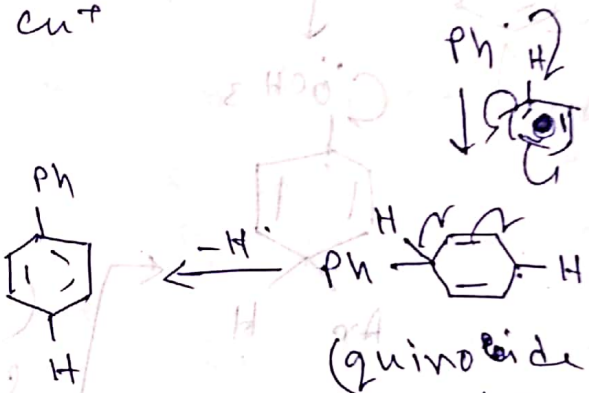
But if R-X =  then this classical method fail.

Sonogashira rxn :—

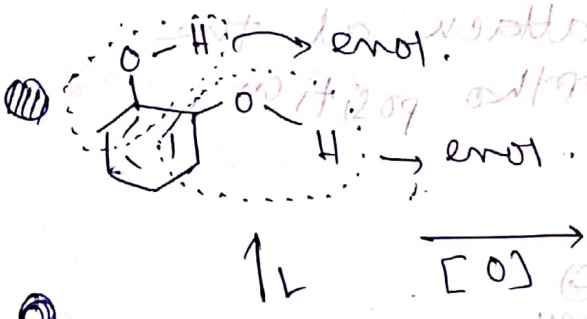


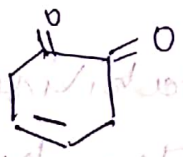


(*) p- pdt predominates over o- pdt due to—
1) Steric effect
2) Stability of p-quinoid form.

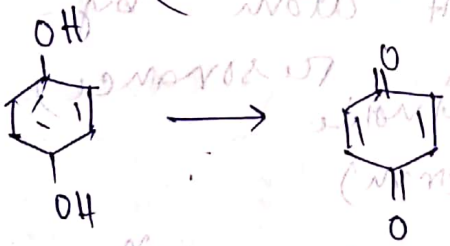


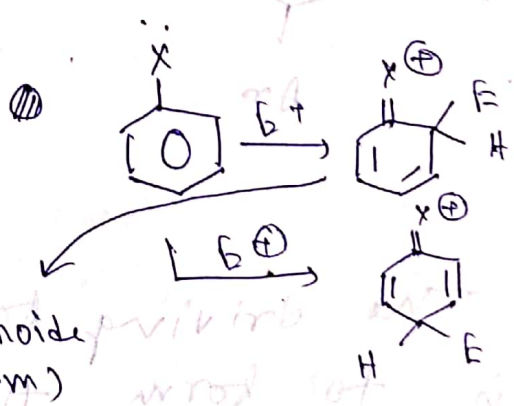
(p-quinoides are more stable than o-quinoidn)



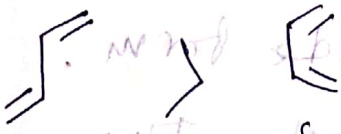

(keto form)

Conjugate double bond => cis => less stable.

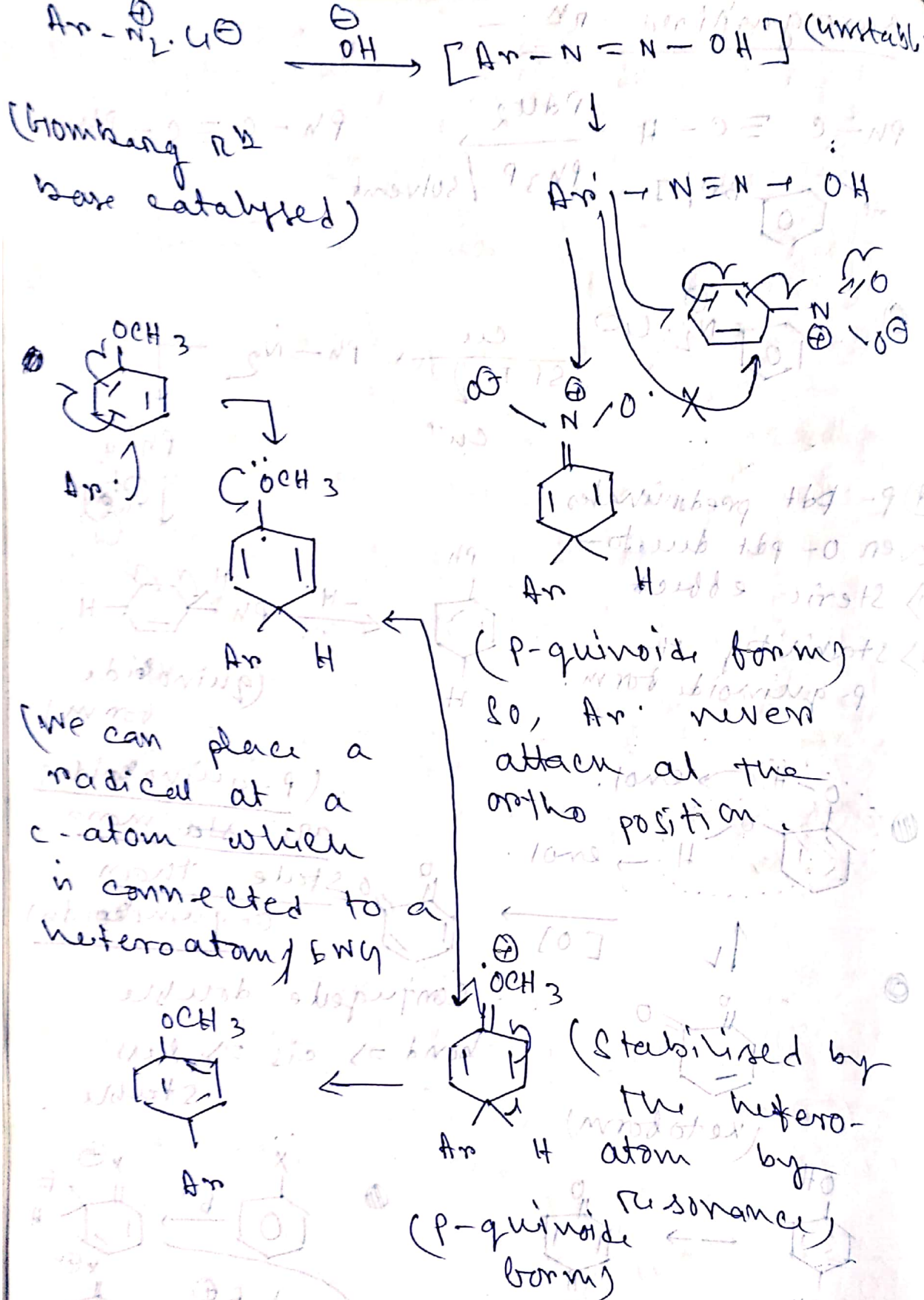




(o-quinoide form)

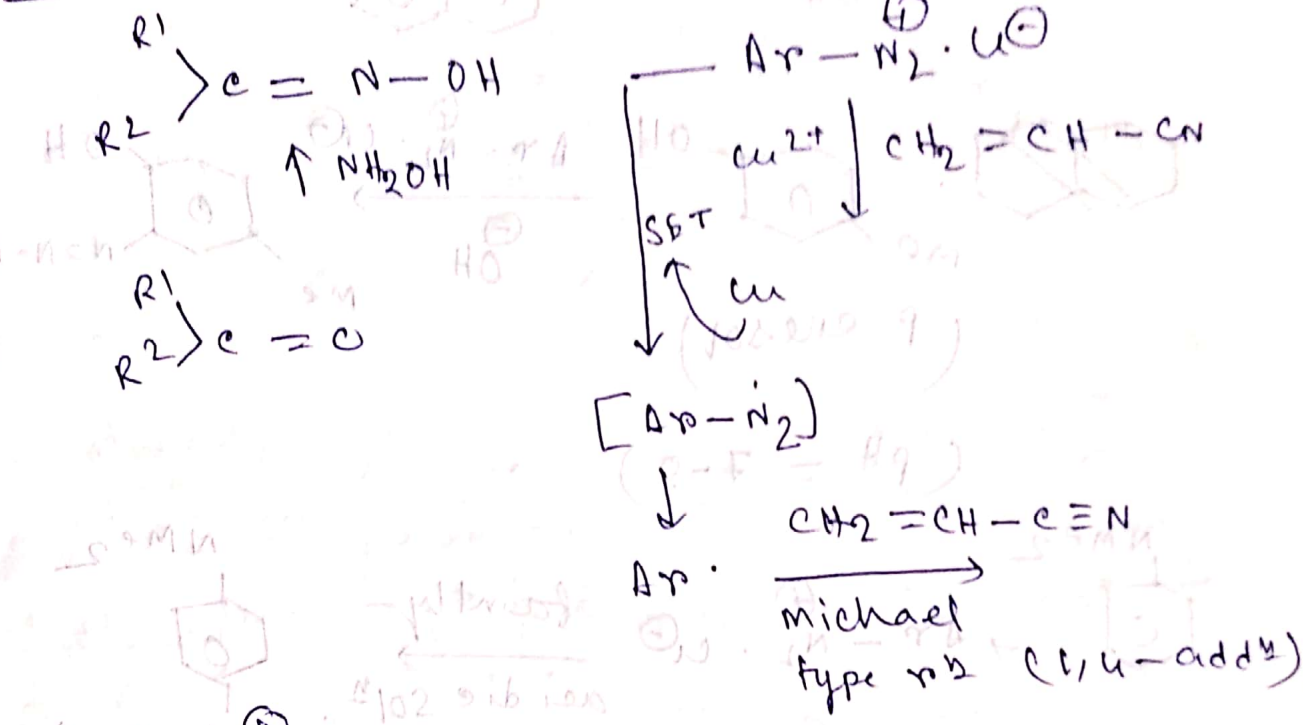


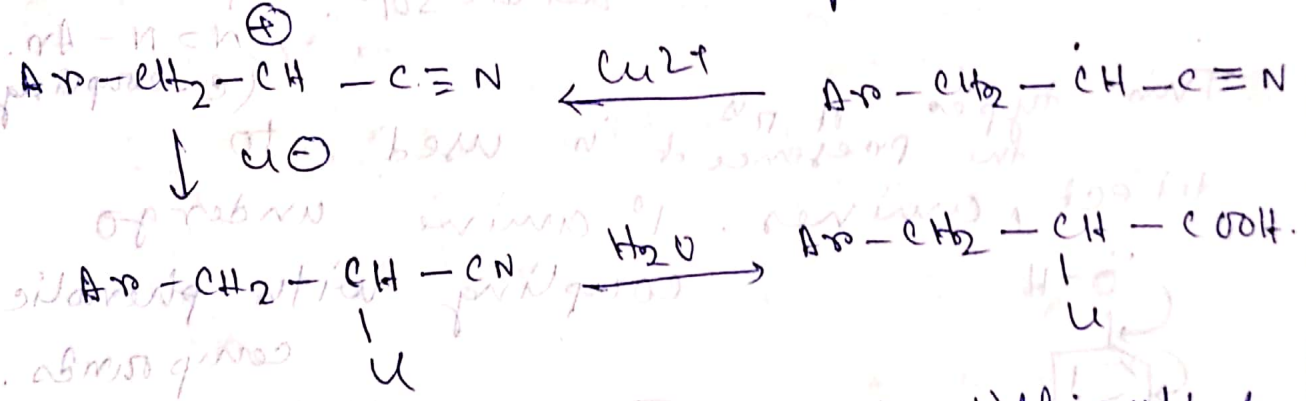
transoide (p-quinoide form) => energetically more stable



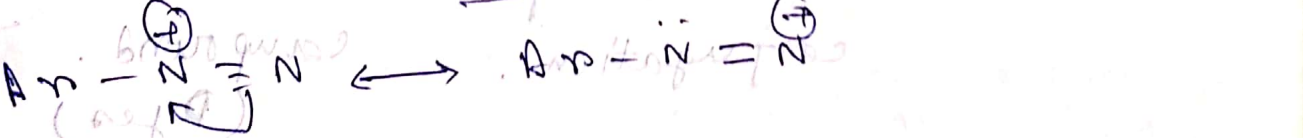
The driving force of the RN is to form the p-quinoide form. Irrespective of the nature of the gr. coupling takes place at p-position due to extended conjugation.

Meerwein Rn :-



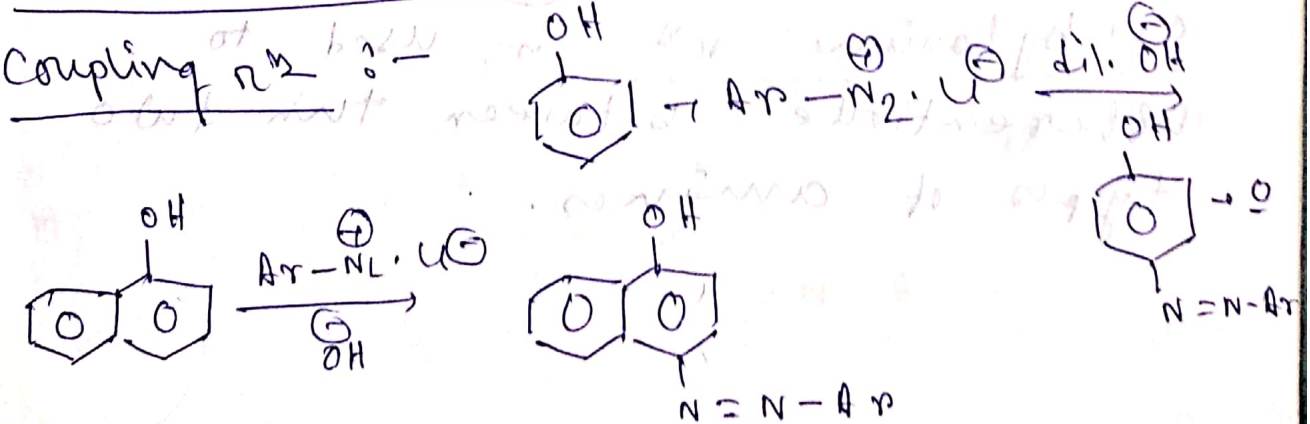


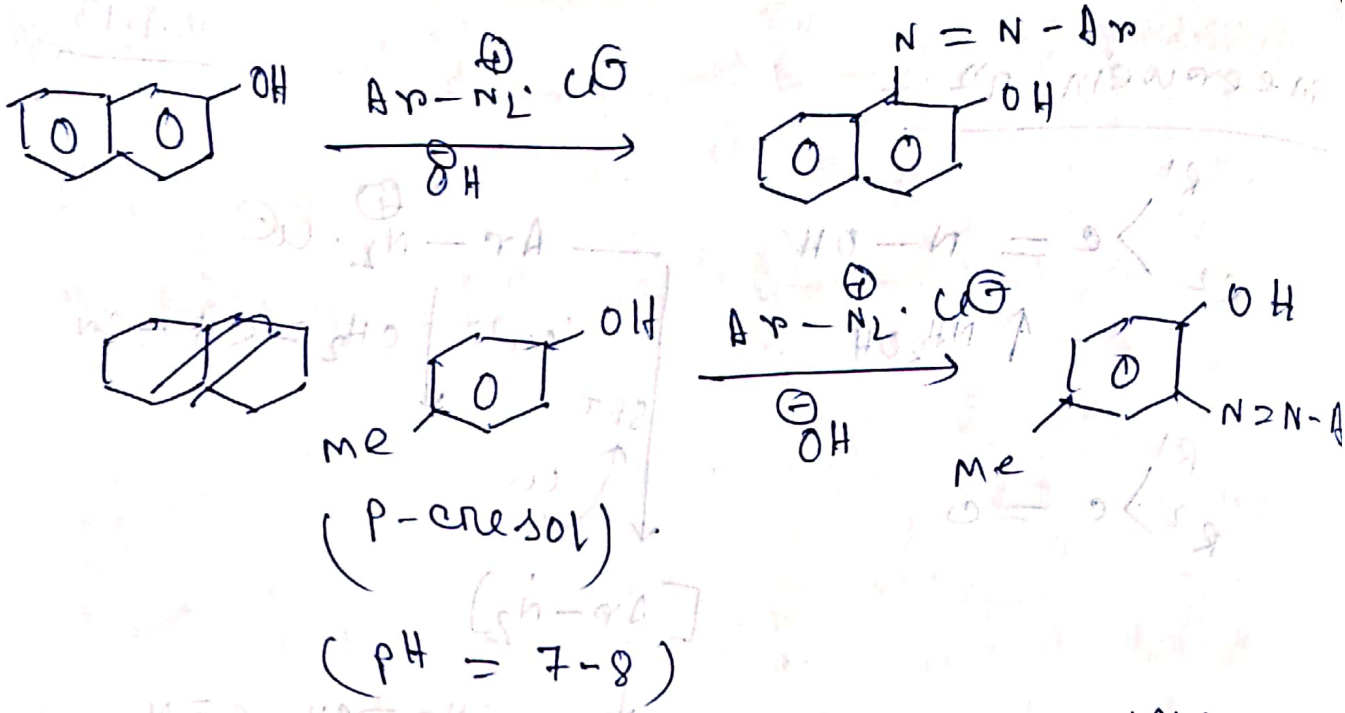
Side chain introduction is difficult for aromatic ring & here this method is used for side chain introduction.



Rn where $-N_2$ retained :-

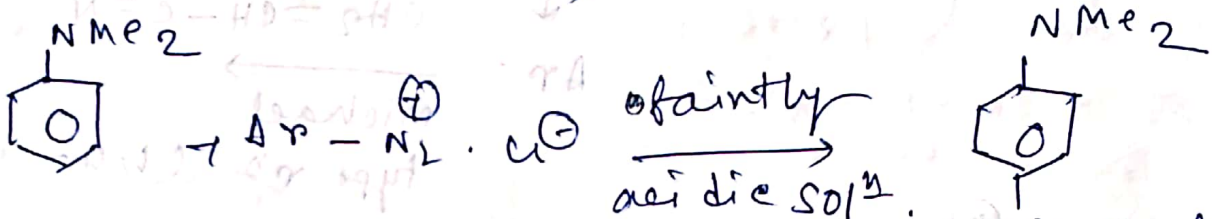
Coupling Rn :-





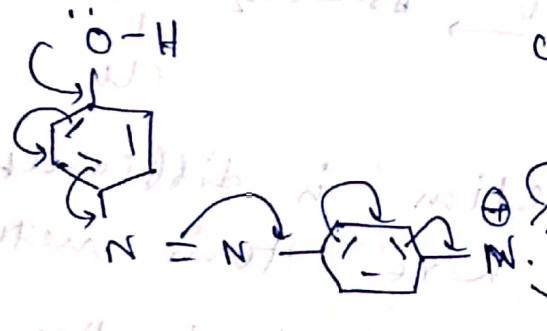
(p-cresol).

(pH = 7-8)



(e-coupling

Thin layer chromatography is used to detect the presence of 1° amines. 1° amine undergo coupling with phenolic compounds.

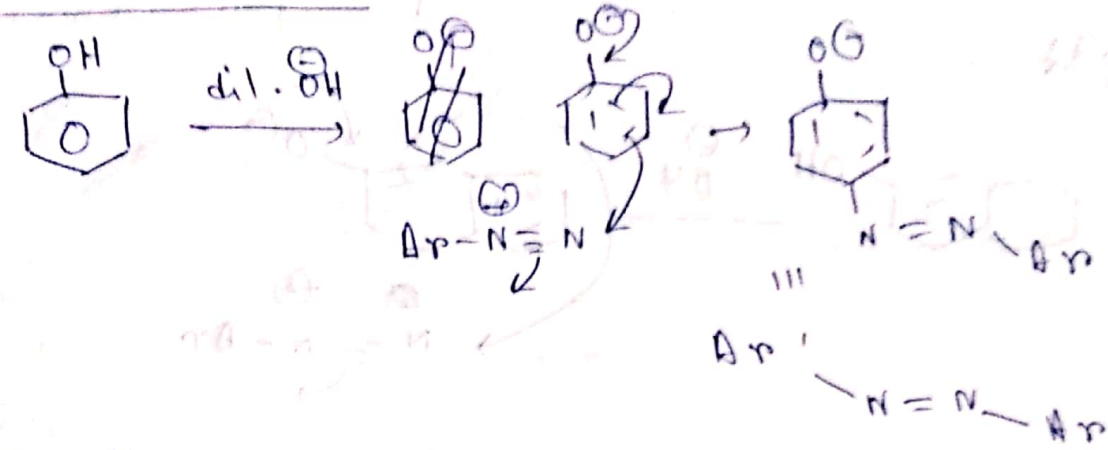


extended conjugation - colored compound. (Dyes)

$R-NH_2$, $Ar-NH_2$

Carbylamine rx is used to differentiate between thin two types of amines.

alkaline med.

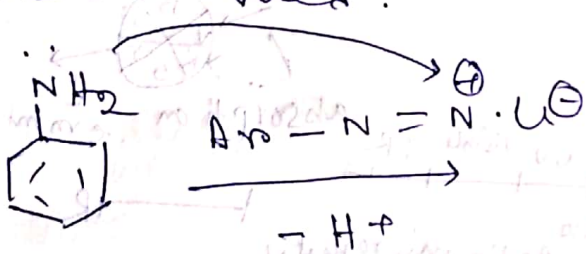


(anti form)

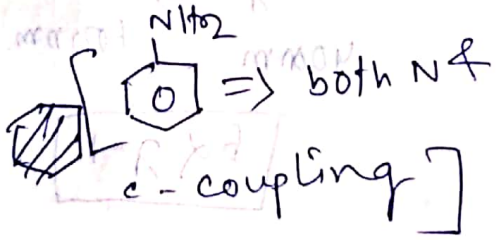
Faintly acidic soln

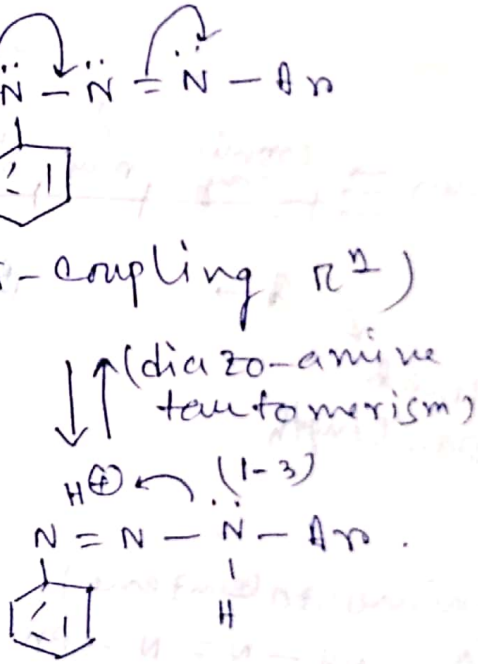
(pH ⇒ 5–6)

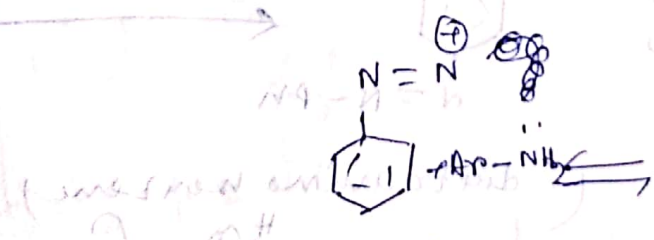
electrophilicity of amine is lost in acidic med.

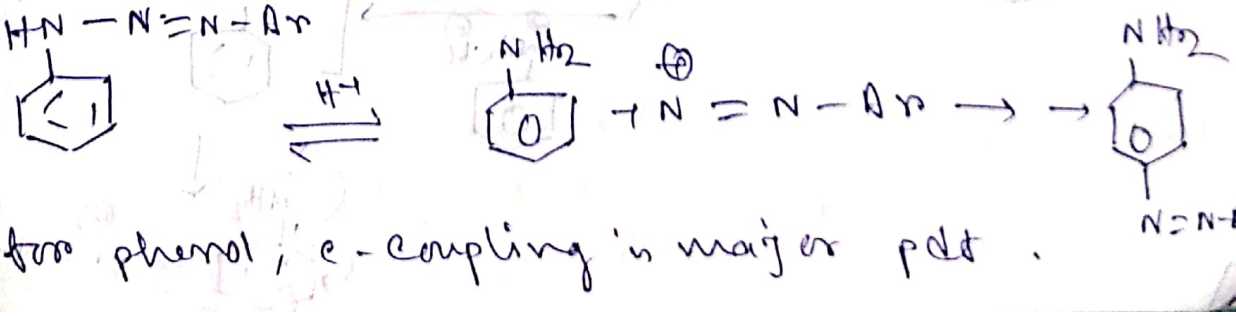


(N-coupling R^N)



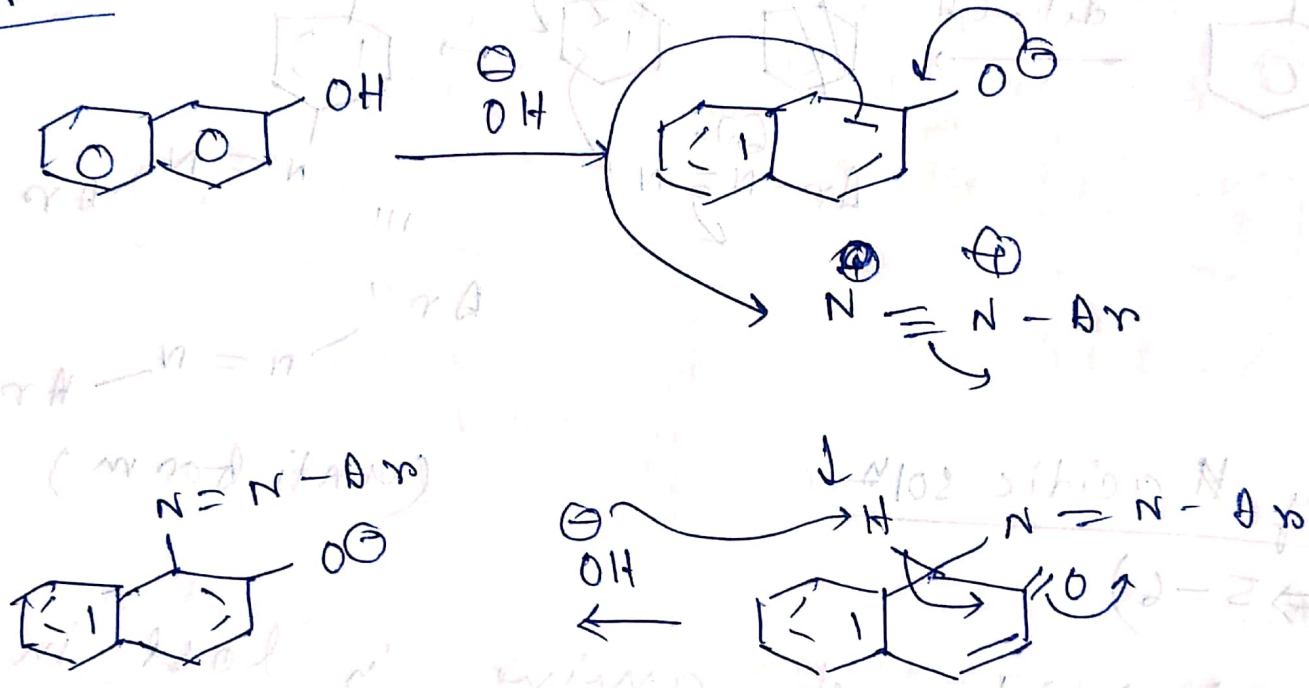


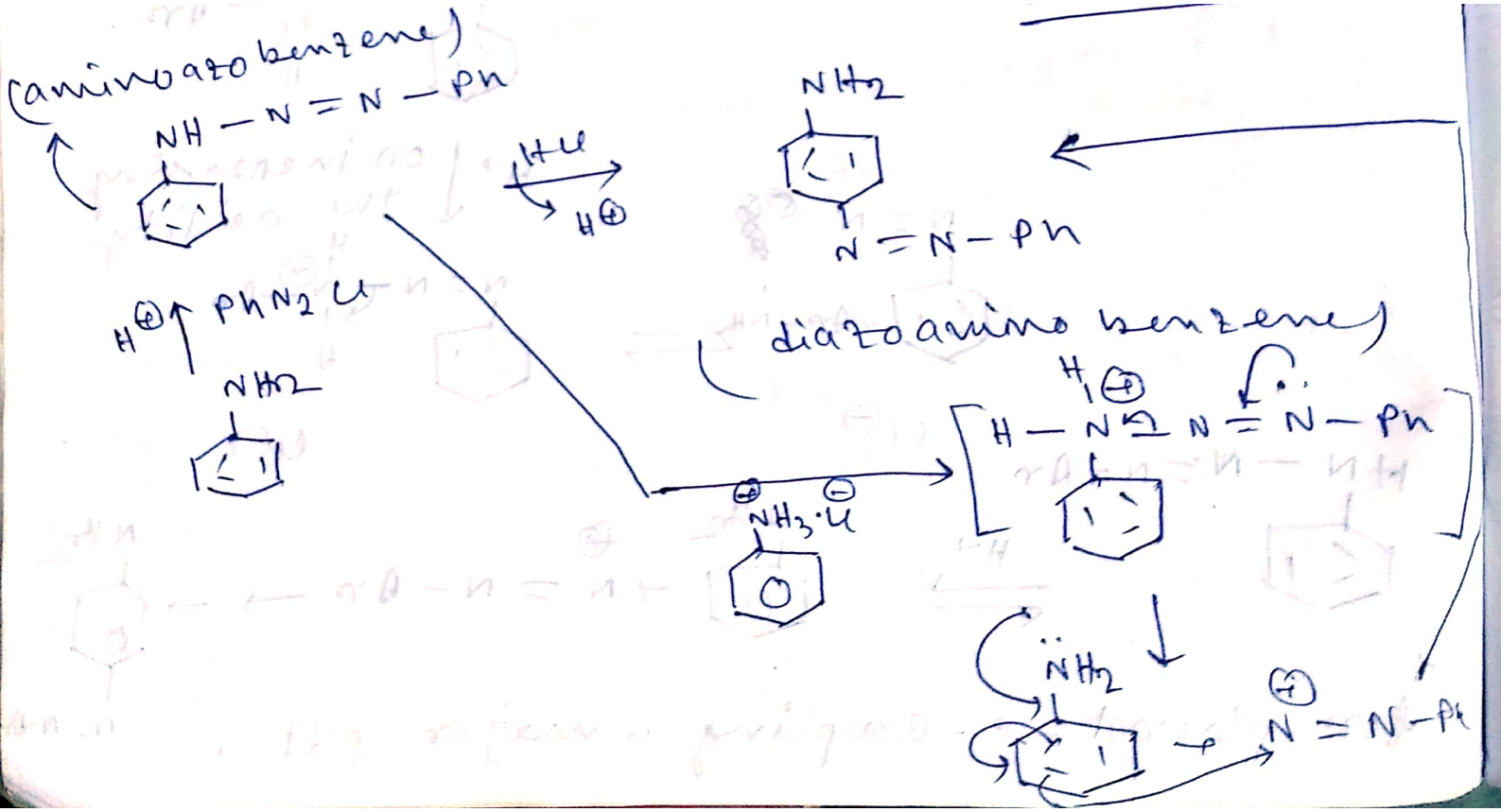


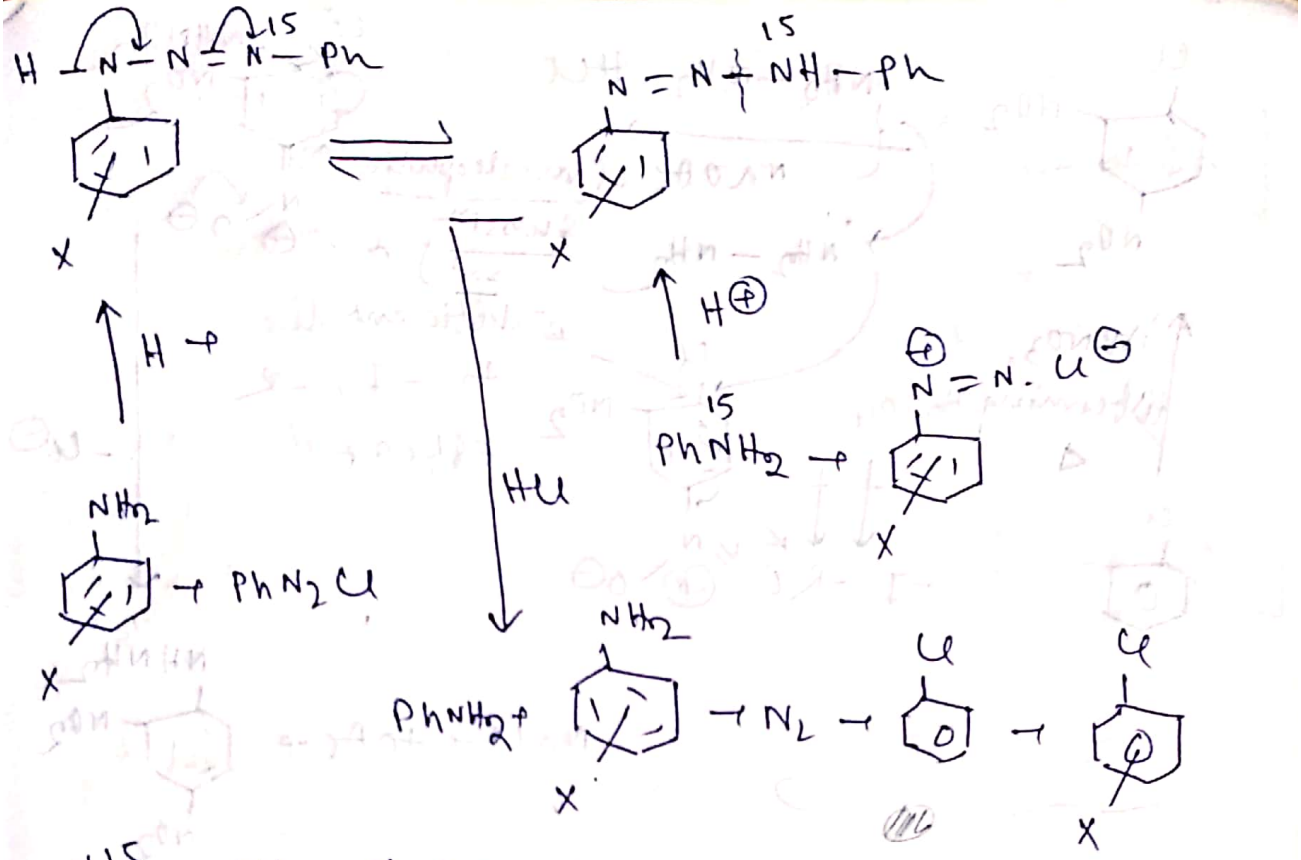


for phenol, c-coupling is major pdt.

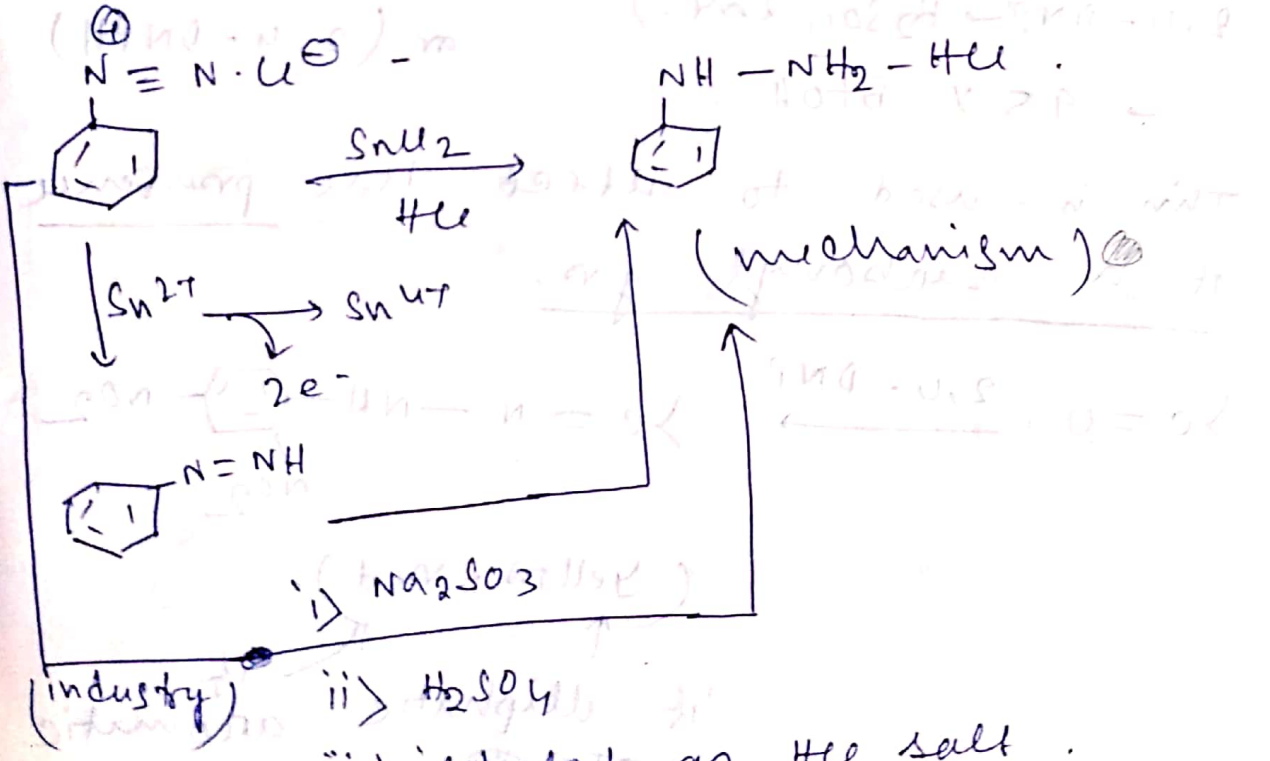
For 1° amine, C - coupling is minor pdt.







N^{15} will distributed in the two amines. This shows that, this is a tautomerism reaction.



(industry) ii) H_2SO_4

iii) isolated as HCl salt.