Important Reactions & Reagents in
Organic Chemistry

REAGENTS :

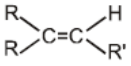
I - Oxidising Agents

(1) $KMnO_4$ or $K_2Cr_2O_7$

1° Alcohol ⟶ Acid

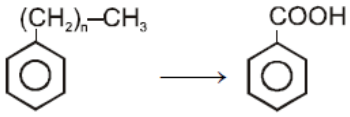
2° Alcohol ⟶ Ketone

3° Alcohol ⟶ No reaction

Alkene :  ⟶ $R_2C{=}O + R'COOH$

Alkyne : $R{-}C{\equiv}C{-}R' \longrightarrow RCOOH + R'COOH$

Oxidation of aromatic side chain :



(2) CrO_3/H^+/Pyridine (PCC)

(Pyridinium chloro chromate)

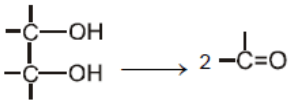
1° ROH ⟶ Aldehyde

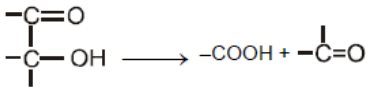
2° ROH ⟶ Ketone

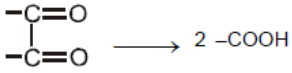
3° ROH ⟶ No reaction

(3) HIO_4 (Periodic Acid)

Condition : Vicinal diol, α- Hydroxy ketone, α-diketone & α-hydoxyacid can oxidise by HIO_4







(4) Cu/573 K

1°Alcohol ⟶ Aldehyde

2° Alcohol ⟶ Ketone

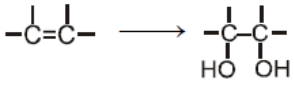
3° Alcohol ⟶ Alkene

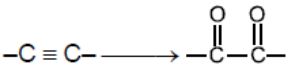
(5) $Al[OCMe_3]_3$/in Acetone (Oppeneur oxidation)

2° Alcohol ⟶ Ketone

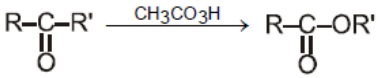
(6) Baeyer's reagent or $OsO_4 + NaHSO_3$

stereospecific syn addition





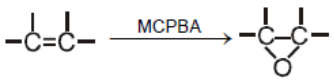
(7) Baeyer–Villiger oxidation (MCPBA or CH_3CO_3H)



Priority of shift (O accepting aptitude)

R' = H > Ph > 3° > 2° > 1° >Me

(8) Prilezhaev reaction

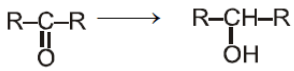


SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

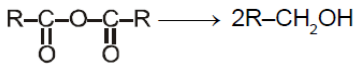
II - Reducing Agents

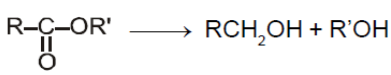
(1) $LiAlH_4$

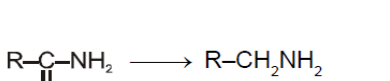
$R–CHO \longrightarrow RCH_2OH$

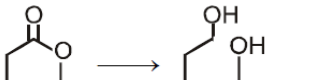


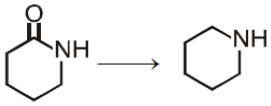
$RCOOH \longrightarrow R–CH_2OH$

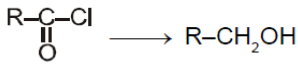












$R–CN \longrightarrow R–CH_2–NH_2$

$C = C \;/\; C{\equiv}C \longrightarrow$ No reaction

Exception

$Ph–CH{=}CH–COOH \longrightarrow Ph–CH_2–CH_2–CH_2OH$

(2) $NaBH_4$, EtOH

Aldehyde $\longrightarrow$ 1° Alcohol

Ketone $\longrightarrow$ 2 °Alcohol

Acid halide $\longrightarrow$ 1° Alcohol

(3) Na/EtOH

Aldehyde $\longrightarrow$ 1° Alcohol

Ketone $\longrightarrow$ 2° Alcohol

Acid halide $\longrightarrow$ 1° Alcohol

Ester $\longrightarrow$ Alcohol + Alcohol

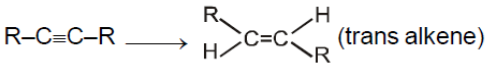
RCN $\longrightarrow RCH_2NH_2$

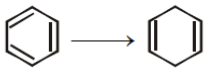
(4) Na–Hg/HCl or $Al[OCHMe_2]_3$ (MPV Reduction)

Aldehyde $\longrightarrow$ 1° Alcohol

Ketone $\longrightarrow$ 2° Alcohol

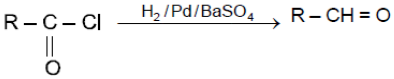
(5) Birch reduction (Li/Na/K + Liquid NH_3)



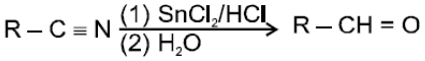


Terminal alkynes not reduced

(6) Rossenmund's Reduction

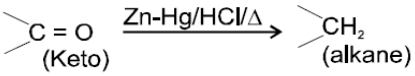


(7) Stephen's Reduction



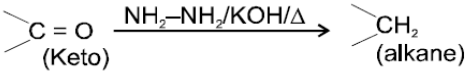
DIBAL-H used for same function

(8) Clemmensen Reduction



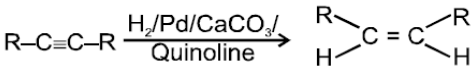
Avoid if acid sensitive groups are present in molecule.
e.g. C=C,C≡C,OH, OR, CN

(9) Wolff-Kishner Reduction



Avoid if base sensitive groups are present in molecule.
e.g.COOR,COX,$CONH_2$, –CO–O–CO–,CN,X

(10) Lindlar Catalyst



Syn addition
(Cis alkene)

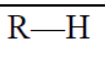
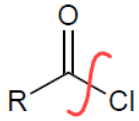
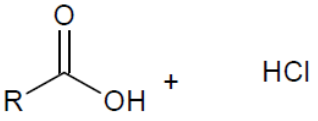
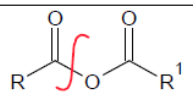
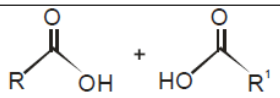
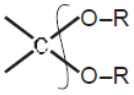
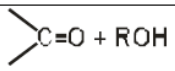
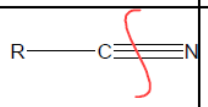
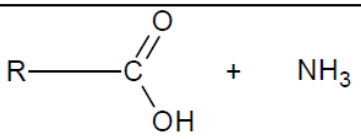
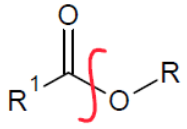
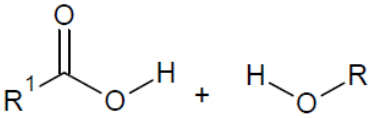
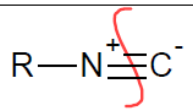
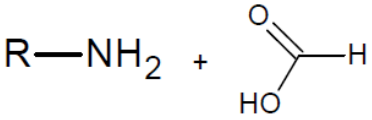
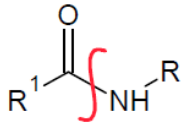
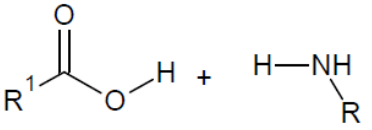
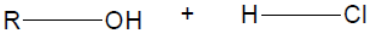
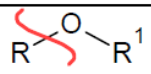
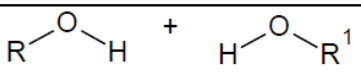
(11) Red Phosphorus and HI

All functional group contaning compounds converts into corresponding alkane by red P + HI.

- $R–CH_2OH \longrightarrow R–CH_3$
- $R–CHO \longrightarrow R–CH_3$
- $R_2CO \longrightarrow R_2CH_2$ (Alkane)
- $R–COOH \longrightarrow R–CH_3$

SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

III- HYDROLYSIS

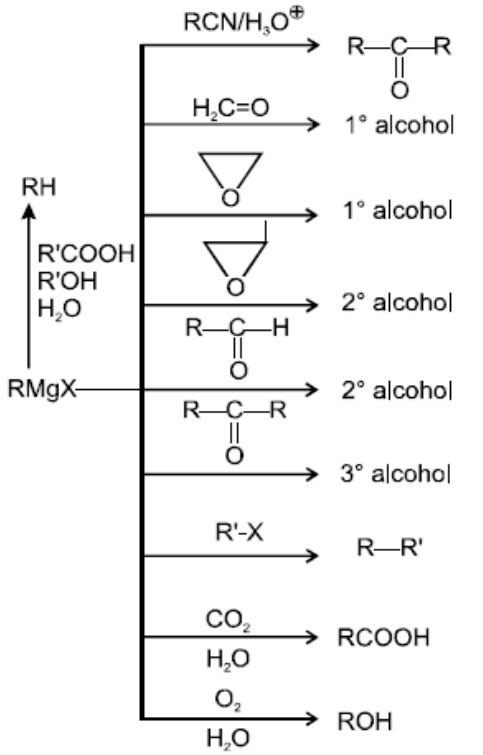
Functional Groups	Reactant	Products	Reagent / Catalyst	Remark
Organometallic Compound			**H_2O**	
Acid Halides			**Basic**	
Acid Anhydrides			**Acidic or basic**	
Acetals				
Nitriles/Cyanides			**Acidic**	
Esters			**Acidic or basic**	
Isonitriles/isocyanides			**Acidic**	
Amides **Amides and *N*-*substituted***			**Strong Acidic**	
Alkyl Halides			**Basic**	
Ethers			**Strong acidic HI**	

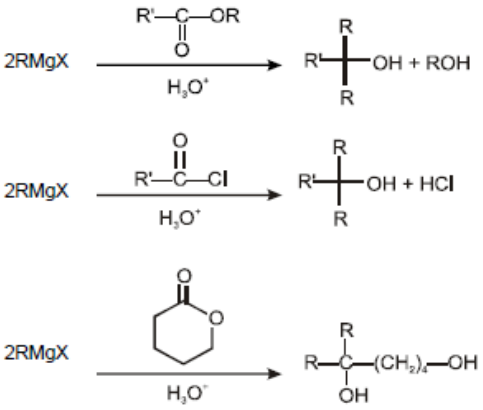
SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

IV - General Reagents

(1) Grignard's Reagent : RMgX (alkyl magnesium halide)

* Active – H Containing compounds $\xrightarrow{RMgX}$ R – H





(2) Decarboxylation reagents :

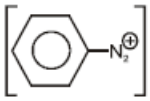
(I) Soda lime d-carboxylation (NaOH / CaO / Δ) decarboxylates all types of carboxylic acids

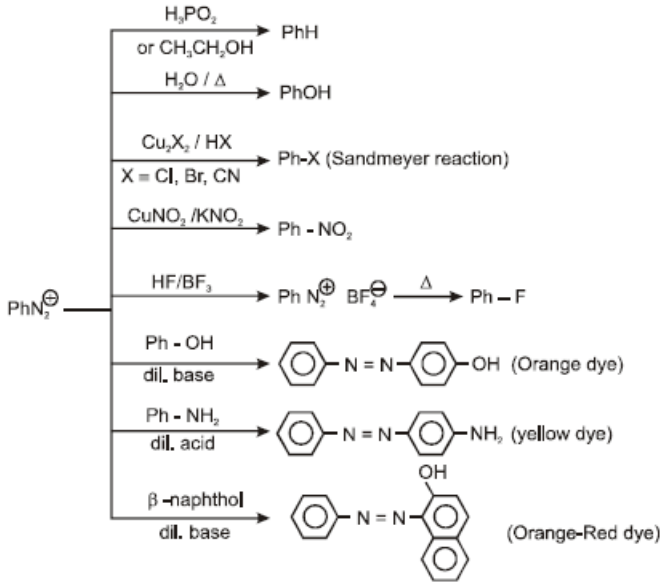
(II) β-keto acid and 1, 1-dicarboxylic acids decarboxylate only on heating

(3) P_2O_5: (Phosphorous pentaoxide) or Al_2O_3 (Alumina) : Dehydrating Agent

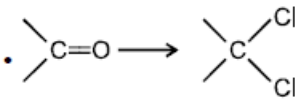
- $2CH_3COOH \xrightarrow{\text{dehydration}} (CH_3CO)_2O$
- $CH_3CONH_2 \xrightarrow{\text{dehydration}} CH_3CN$
- $C_2H_5OH \xrightarrow{\text{dehydration}} CH_2=CH_2$

SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

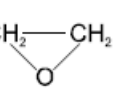
(4) Diazonium salt 



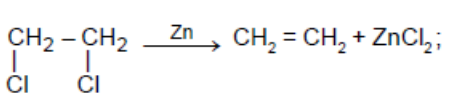
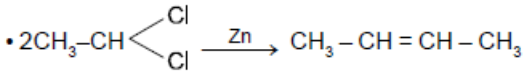
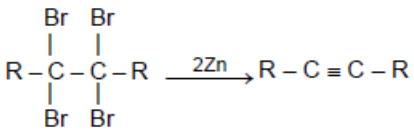
(5) PCl_5: (Phosphorous pentachloride) :

- $R-OH \longrightarrow R-Cl$; $R-COOH \longrightarrow R-COCl$; $R-CONH_2 \longrightarrow R-C \equiv N$
- 

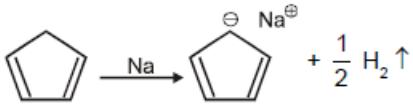
(6) Silver (Ag) metal :

- $2CHI_3 + 6\,Ag \longrightarrow HC \equiv CH + 6\,AgI$
- $CH_2 = CH_2 + \frac{1}{2}\,O_2 \xrightarrow{Ag}$ 

(7) Zinc (Zn) metal :

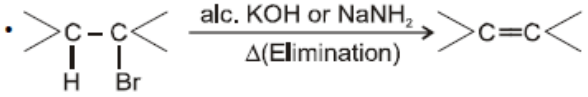
- $C_6H_5OH \xrightarrow[\text{Reduction}]{Zn,\Delta} C_6H_6 + ZnO$; $2RX \xrightarrow{Zn} R-R\ (\text{alkane}) + ZnX_2$
-  ; 
- 

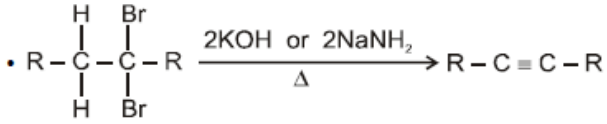
(8) Sodium (Na) metal :

- $2RX \xrightarrow[\text{Wurtz reaction}]{Na\,/\,\text{dryether}} R-R\ (\text{alkane}) + 2NaX$; $ROH \xrightarrow{Na} RONa + \frac{1}{2}\,H_2\uparrow$
- $R-C \equiv CH \xrightarrow{Na} R-C \equiv \overset{\ominus}{C}\overset{\oplus}{Na} + \frac{1}{2}\,H_2\uparrow$; $PhOH \xrightarrow{Na} PhONa + \frac{1}{2}\,H_2\uparrow$
- $RCOOH \xrightarrow{Na} RCOONa + \frac{1}{2}\,H_2\uparrow$; 

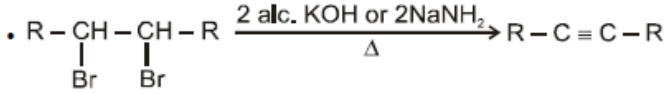
SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

(9) Alc. KOH or $NaNH_2$: (Sodium amide or sodamide)

- 

- 

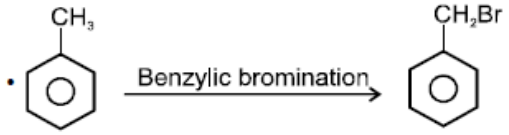
(Gem dihalide)

- 

(Vicinal dihalide)

- $CH_3–C\equiv C-CH_3 \xrightarrow[\text{Isomerisation}]{NaNH_2} CH_3–CH_2–C\equiv CH$
- $CH_3–CH_2–C\equiv CH \xrightarrow[\text{Isomerisation}]{\text{alc. KOH}} CH_3–C\equiv C–CH_3$
- $C_6H_5Cl + NaNH_2 \xrightarrow[\Delta]{\text{liq. } NH_3} C_6H_5NH_2 + NaCl$

(10) N-Bromo succinimide (NBS) :

- $CH_3–CH=CH_2 \xrightarrow{\text{Allylic bromination}} CH_2(Br)–CH=CH_2$
- 

- $R–CH_2OH \xrightarrow{\text{Oxidation}} R–CHO$ (aldehyde) ; • $R_2CHOH \xrightarrow{\text{Oxidation}} R_2CO$ (ketone)

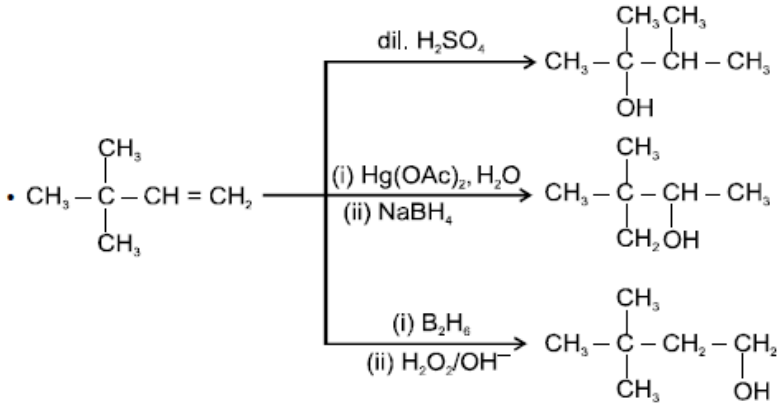
(11) KCN/AgCN :

- $R–X \xrightarrow{KCN} R–C\equiv N$ (Alkyl cyanide) ; • $R–X \xrightarrow{AgCN} R–N\rightleftarrows C$ (Alkyl isocyanide)

(12) KNO_2/$AgNO_2$:

- $R–X \xrightarrow{KNO_2} R–O–N=O$ (Alkyl nitrite) ; • $R–X \xrightarrow{AgNO_2}$  (Nitro alkane)

(13) Hydrating agents:

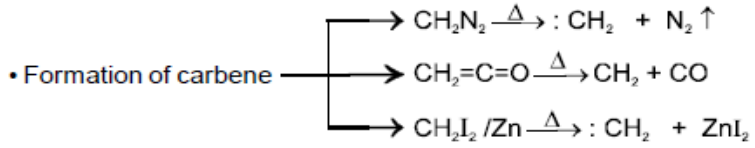


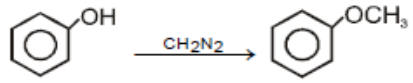
(14) Ziegler-Natta catalyst : $(C_2H_5)_3Al + TiCl_4$

(Propylene) (Polypropylene)

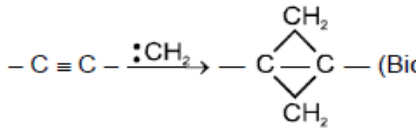
SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

(15) CH_2N_2 (Addition/insertion of carbene) :

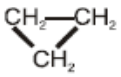


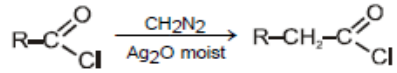


; $RCOOH \xrightarrow{CH_2N_2} R\text{–}COOCH_3$



; $CH_2=CH_2 \xrightarrow{CH_2N_2}$





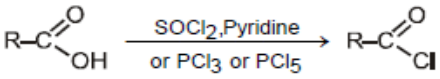
; $RO\text{–}H \xrightarrow{CH_2N_2} R\text{–}O\text{–}CH_3$

$R - NH - H \xrightarrow{:CH_2} R - NH - CH_3$ (N – methyl amine)

(16) $SOCl_2$:

R–OH $\xrightarrow[\text{or } PCl_3 \text{ or } PCl_5]{SOCl_2, \text{Pyridine}}$ **R–Cl (Inversion, S_N2 reaction)**

R–OH $\xrightarrow[S_Ni \text{ reaction}]{SOCl_2}$ R–Cl (Retention) ;



V - Name Reactions :

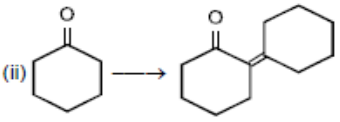
(1) Aldol condensation :

Reagents : dilute base (i) NaOH / KOH / Δ (ii) $Ca(OH)_2$ / $Ba(OH)_2$

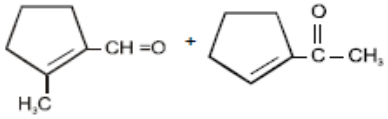
Conditions : α - H must be present w.r.t. carbonyl group

(i) $CH_3\text{–}\underset{\underset{O}{\|}}{C}\text{–}H \longrightarrow CH_3\text{–}CH{=}CH\text{–}CHO$;

(ii)



(iii) $H\text{–}\underset{\underset{O}{\|}}{C}\text{–}(CH_2)_4\text{–}\underset{\underset{O}{\|}}{C}\text{–}CH_3 \longrightarrow$



+ 7 member ring Product (minor)

(2) Arndt-Eistert reaction :

$RCOCl + CH_2N_2 \xrightarrow[-HCl]{} RCOCHN_2 \xrightarrow[(ii)H_2O]{(i)Ag_2O/\Delta} R\text{–}CH_2\text{–}COOH$

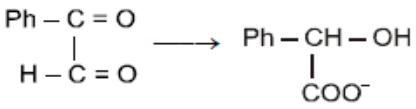
(3) Cannizzaro's Reaction (Redox or disproportion) :

Reagents : Conc. NaOH or KOH / Δ

Hydride (H^- ion) transfer is RDS

(i) $HCHO \longrightarrow HCOO^- + CH_3OH$

(ii)



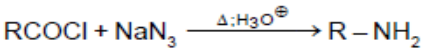
(iii) $CHDO \xrightarrow{NaOH} DCOO^- + CH_2DOH$

(iv) $HCHO + PhCHO \longrightarrow HCOO^- + PhCH_2OH$

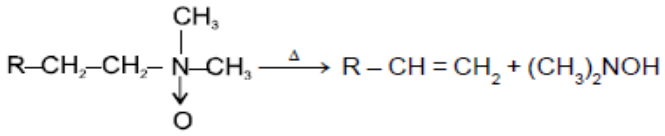
Note : (i) α - H absent is primary condition. **(ii)** If α - H present then aldol condensation occures.

SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

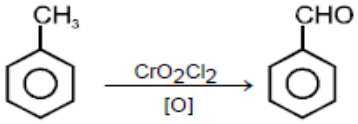
(4) Curtius reaction :



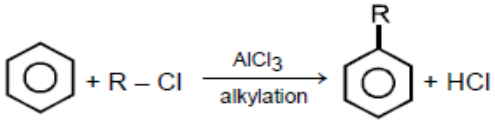
(5) Cope reaction :

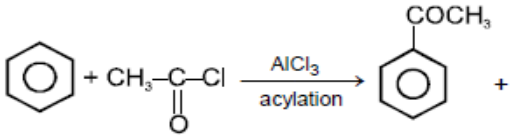


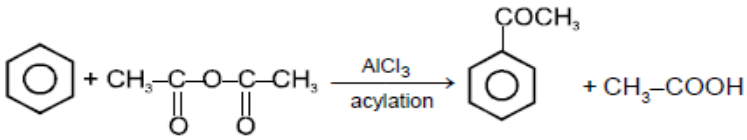
(6) Etard reaction :



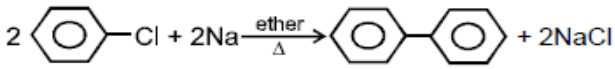
(7) Friedal-Craft's reaction :



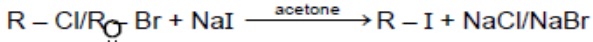




(8) Fittig reaction :

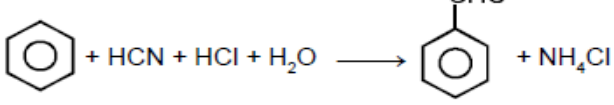


(9) Finkelstein reaction :

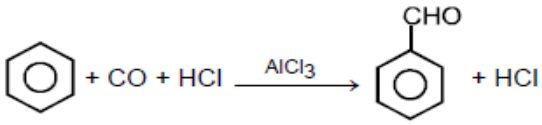


(10) Gabriel's phthalimide Synthesis :

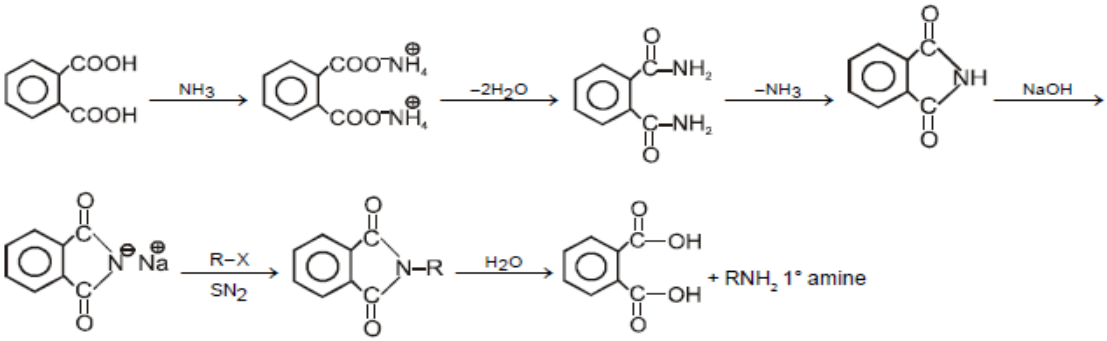
(11) Gattermann's aldehyde synthesis :



(12) Gattermann- Koch's reaction :



(13) Gabriel pthalimide reaction : (Preparation of 1° aliphatic amine) :



SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

(14) HVZ Reaction (α-halogenation of carboxylic acid) :

$$R-CH_2-COOH \xrightarrow[H_2O]{P/X_2} R-\underset{\displaystyle X}{\underset{|}{CH}}-COOH \qquad [X_2 \equiv Cl_2, Br_2 \text{ only}]$$

(15) Hydroboration Rxn. (No Rearrangement, Anti markownikoff's addition of H_2O)

$$R-CH=CH_2 \xrightarrow{B_2H_6/THF} (R-\underset{\displaystyle H}{\underset{|}{CH}}-CH_2)_3B \begin{cases} \xrightarrow[\text{Oxidation}]{H_2O_2/OH^-} R-\underset{\displaystyle H}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}} \\ \xrightarrow[\text{Reduction}]{CH_3COOH} R-\underset{\displaystyle H}{\underset{|}{CH}}-\underset{\displaystyle H}{\underset{|}{CH_2}} \end{cases}$$

(16) Haloform Reaction

$$R-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3 \Big/ R-\overset{\displaystyle O}{\overset{\|}{C}}-CH_3 \xrightarrow{I_2/OH^-} R-\overset{\displaystyle O}{\overset{\|}{C}}-O^{\ominus} + CHI_3$$

(17) Hunsdiecker reaction : $RCOOAg + Br_2 \xrightarrow[\Delta]{CCl_4} R-Br + CO_2\uparrow + AgBr$

(18) Oxymercuration – Demercuration (No Rearrangement, Markownikoff's Addition of H_2O)

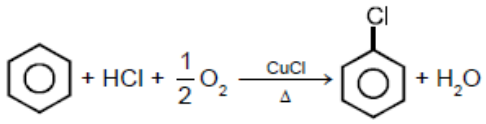
Reagent : (i) $(CH_3COO)_2Hg / H_2O$ (ii) $NaBH_4$

$$R-CH=CH_2 \xrightarrow[H_2O]{(i)(CH_3COO)_2Hg} \xrightarrow{(ii)NaBH_4} R-\underset{\displaystyle H}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{CH}}}}-CH_2$$

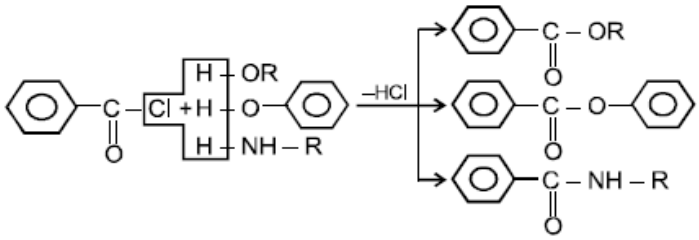
(19) Perkin Reaction :

$$PhCHO + (CH_3CO)_2O \xrightarrow[-CH_3COOH]{CH_3COO^-} Ph-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-\overset{\displaystyle O}{\overset{\|}{C}}-O-\overset{\displaystyle O}{\overset{\|}{C}}-CH_3 \xrightarrow[\Delta]{H_3O^+} PhCH=CH-COOH$$

(20) Raschig process :



(21) Schotten-Baumann reaction :



(22) Schmidt reaction : $RCOOH + N_3H \xrightarrow{H_2SO_4} R-NH_2 + CO_2\uparrow + N_2\uparrow$

(23) Swart reaction : $R-Cl + AgF/Hg_2F_2 \longrightarrow R-F + AgCl/HgCl_2$

(24) Streker reaction : $RX + Na_2SO_3 \longrightarrow RSO_3Na + NaX$

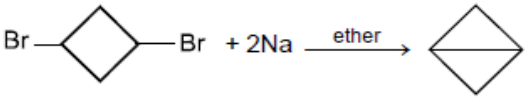
(25) Tischenko reaction : $2HCHO \xrightarrow{Al(EtO)_3} HCOOCH_3$

$2CH_3CHO \xrightarrow{Al(EtO)_3} CH_3COOC_2H_5$

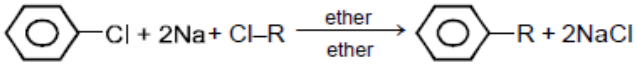
SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

(26) Wurtz reaction (Reagent : Na - ether)

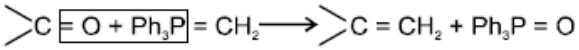
$R-X + 2Na \xrightarrow{ether} R-R$; $R-X + R'-X + 2Na \xrightarrow{ether} R-R' + R-R + R'-R'$



(27) Wurtz-Fittig reaction :



(28) Wittig reaction :



(29) Wacker process :

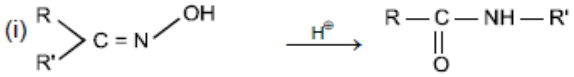
$CH_2 = CH_2 + H_2O + PdCl_2 \xrightarrow{Cu_2Cl_2} CH_3CHO + Pd + 2HCl$

$CH_3-CH=CH_2 + H_2O + PdCl_2 \xrightarrow{Cu_2Cl_2} CH_3COCH_3 + Pd + 2HCl$

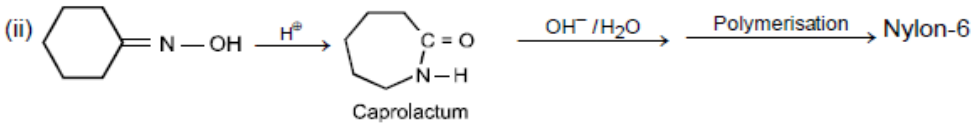
VI- Rearrangement Reactions

(1) Beckmann rearrangement:

Reagents : Conc. H^+ or H_2SO_4 or PCl_3 or PCl_5 or $SOCl_2$

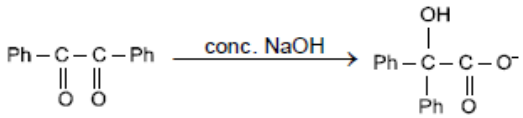
(i) 

group opposite to – OH migrates from carbon to nitrogen atom

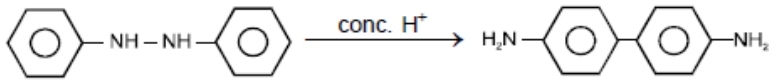
(ii) 

Caprolactum

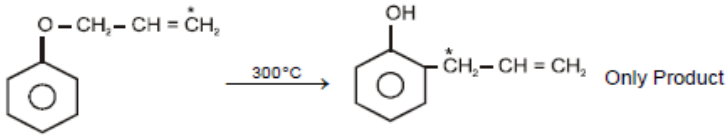
(2) Benzil - Benzilic Acid Rearrangement

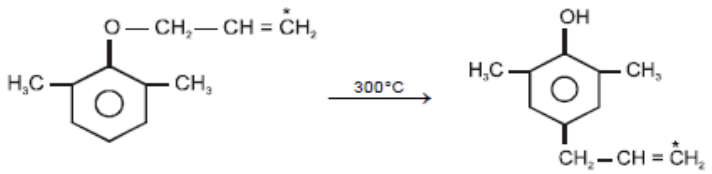


(3) Benzidine Rearrangement



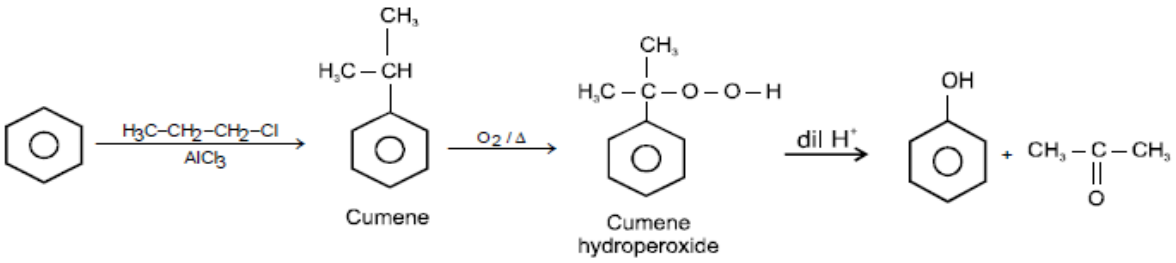
(4) Claisen Rearrangement (intramolecular) / Cross products are not formed)



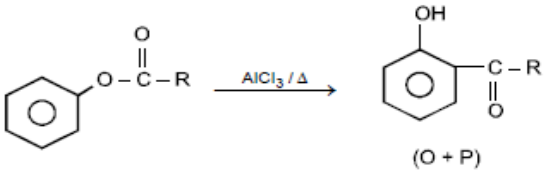


SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

(5) Cumene hydroperoxide Reaction :

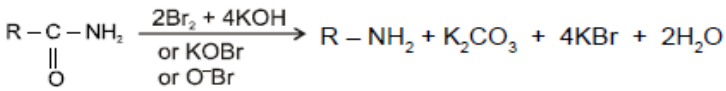


(6) Fries Rearrangement (Intermolecular Rearrangement / Cross products are also formed)

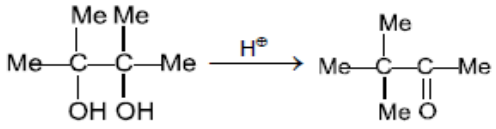


(Phenyl ester)

(7) Hofmann Bromamide Reaction

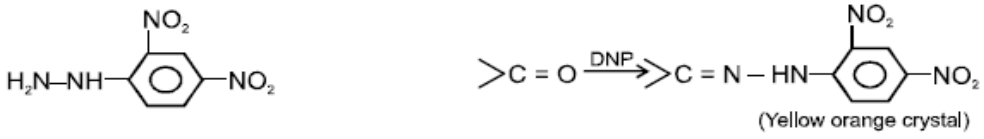


(8) Pinacol-Pinacolone Rearrangement

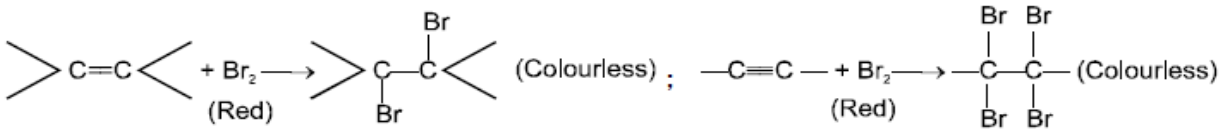


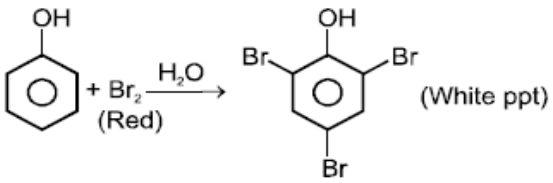
VII - Lab Tests

(1) 2, 4–Dinitro phenyl hydrazine (DNP) (Brady's Reagent) DNP test for carbonyl compounds



(2) Bromine water ($Br_2 + H_2O$) :

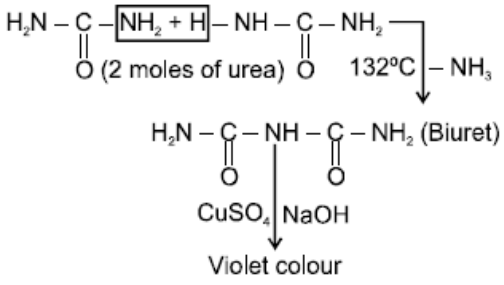




SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in

(3) Biuret Test :

• Compounds containing $-\overset{\overset{O}{\|}}{C}-NH^{-}-$ group gives this test.



(4) Hinsberg's Reagent : $C_6H_5SO_2Cl$ (Benzene sulphonyl chloride)

It is used to distinguish between 1º/2º/3º amines

* $R-NH_2 \xrightarrow{(i)\ C_6H_5SO_2Cl (ii) KOH}$ Soluble salt

* $R_2NH \xrightarrow{(i)\ C_6H_5SO_2Cl (ii) KOH}$ Insoluble

* $R_3N \xrightarrow{(i)\ C_6H_5SO_2Cl (ii) KOH}$ No reaction

(5) HNO_2 ($NaNO_2$ + HCl) : It is used to distinguish between 1º/2º/3º amines.

• $R-NH_2 \xrightarrow{HNO_2} R-OH + N_2\uparrow - H_2O$

• $R_2NH \xrightarrow{HNO_2} R_2NNO + H_2O$

(N-nitroso compound yellow oily liquid)

• $R_3N \xrightarrow[0°C]{HNO_2} R_3N_7HNO_2$(salt)

• $C_6H_5NH_2 \xrightarrow[0°–5°C]{HNO_2} C_6H_5N_2Cl$ (Benzene diazonium chloride)

• $CH_3-CONH_2 \xrightarrow{HNO_2} CH_3COOH + N_2\uparrow + H_2O$

(6) Schiff's Reagent : It is a pink coloured organic dye (p-rosaniline hydrochloride) which has been decolourised by passing SO_2 gas through it.

*R–CHO $\xrightarrow{\text{decolourised shiff reagent}}$ Pink colour (restored)

* $R-\overset{\overset{O}{\|}}{C}-R \longrightarrow$ No Pink colour

SCO 101, Phase-1, Urban Estate, Dugri, Near LIC Building, Ludhiana
SCO 14, Urban Estate, Phase-II, Main Market, Near Union Bank, Jamalpur, Ludhiana
Phone No : 0161-2490101/1101, 2675553/55 www.edusquare.co.in