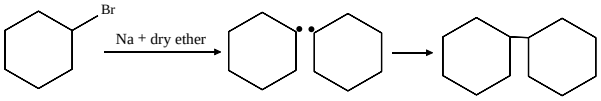
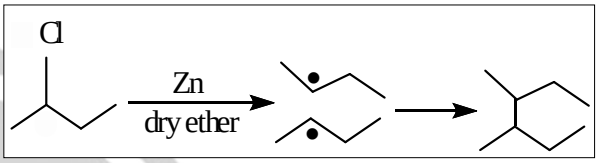
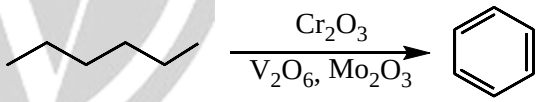
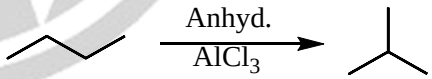
ALKANES

Reagent	Functions
1. Hydrogenation [H_2/Ni, Pt, Pd]	• π Bond को H, H से तोड़ो $CH_2=CH_2 \xrightarrow[Ni]{H_2} CH_3-CH_3$
2. From Alkyl halide [Zn + dil. HCl]	• X हटाओ, H लगाओ $CH_3-Cl \xrightarrow[dil\ HCl]{Zn} CH_4$
3. Wurtz Reaction [Na + dry ether]	• R – X bond को F.R. तोड़ो 2R° को जोड़ो 
4. Decarboxylation [NaOH + CaO sodalime]	• COOH हटाओ H लगाओ COONa हटाओ H लगाओ $CH_3-COOH \xrightarrow[CaO]{NaOH} CH_4$
5. Kolbe's Electrolysis/(e^-) (Same as wurtz Reaction)	• $\dot{C}$-$\dot{C}OOH$ $\quad \dot{C}+\dot{C} \rightarrow C-C$ even number
6. Frankland Reaction [Zn, dry ether]	• 
7. Corey-house synthesis- • Gilman's Reagent (R–Cu + $R^{\ominus}Li^{+}$) R_2CuLi	• X हटाओ Gilman का R लगाओ $CH_3-Cl \xrightarrow{EtCuLi} CH_3-Et$
8. Halogenation [X_2 /hν]	• 'H' हटाओ 'X' लगाओ $R-H \xrightarrow[h\nu]{X_2} R-X$
9. Aromatisation $[Cr_2O_3 / V_2O_6 / Mo_2O_3]$ 773 K, 10-20 atm	• 
10. Isomerisation [Anhydrous $AlCl_3$]	• 
11. Combustion	• $CH_4+2O_2 \xrightarrow{\Delta} CO_2+2H_2O$ [ΔH = –ve]
12. Controlled oxidation	• $2CH_4+O_2 \xrightarrow{Cu/523\ K} 2CH_3OH$ $CH_4+O_2 \xrightarrow{Mo_2O_3} HCHO+H_2O$ $2CH_3CH_3+3O_2 \xrightarrow[Mn]{(CH_3COO)_2} 2CH_3COOH+2H_2O$
13. Reaction with steam	• $CH_4+H_2O \xrightarrow[\Delta]{Ni} CO+H_2$
14. Pyrolysis	• $C_6H_{14} \xrightarrow{773K}$ $C_6H_{12}+H_2$; $C_4H_8+C_2H_6$; $C_3H_6+C_2H_4+CH_4$

Reagent

1. Hydrogenation of Alkynes
   [H_2 + Pd/C, H_2, + Pd/$BaSO_4$] Lindlar's Catalyst
   ↑
   Or H_2/Ni2B

2. Birch reduction [Na + Liq.NH_3/Li + Liq.NH_3]
   For Non-terminal alkeynes

3. Dehalogenation [Zn/CH_3COOH]

4. Dehydration of alcohols (E1)
   [H^+/Δ (443 K), Conc.H_2SO_4, H_3PO_4]

5. Dehydrohalogenation
   [Alc.KOH/Alc.NaOH/$NaNH_2$]
   [RO^-/ROH]

6. Halogenation
   - In non-polar solvent (CCl_4, CS_2)
   - X_2 Interhalogen (BrCl, ICl, IBr)
   - X_2 In polar solvent
     ($X_2 + H_2O \rightarrow HOX$)
     ($X \neq F$)

7. Addition of HX [HCl, HBr, HI]

8. Markovnikov's Rule [HX]
   –ve → Less hydrogen atom

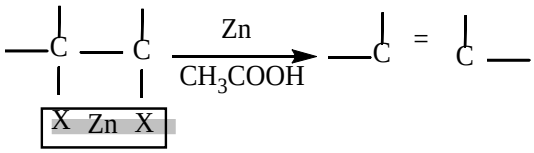
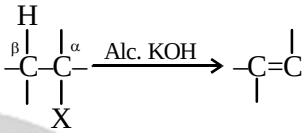
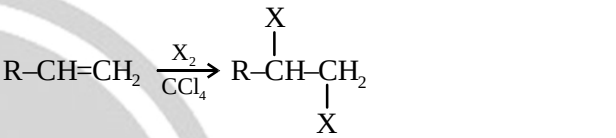
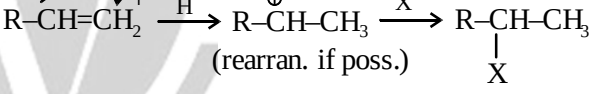
9. Addition of water [dil.H_2SO_4/H^+, H_2O/H_3O^+]

10. Hydroboration oxidaion (HBO)
    $\left[B_2H_6 / THF, H_2O_2 / \bar{O}H\right]$

12. Oxymercuration Demercuration (OMDM)
    $\left[Hg(OAc)_2 / H_2O, NaBH_4\right]$

13. Addition of HBr/ Peroxide

Functions

- $R-C\equiv C-R' \xrightarrow[Pd/C]{H_2}$ Cis-alkene (H, R; H, R')
- $R-C\equiv C-R' \xrightarrow[liq.NH_3]{Na}$ Trans-alkene (H, R; H, R')
- 
- $R-\ddot{O}H \xrightarrow[\text{protonation}]{H^+} R-\overset{\oplus}{O}H_2 \xrightarrow[\text{of } H_2O]{\text{Removal}} R^+ + H_2O$ → Rearran. if poss. → Alkene
- 
- 
- $R-CH=CH_2 \xrightarrow[CCl_4]{Br_2} R-CH(Br)-CH_2(OH)$ (Bromohydrin)
- 
- $CH_3-CH=CH_2 \xrightarrow{HX} CH_3-CH(X)-CH_3$
- $R-CH=CH_2 \xrightarrow{H^+} R-\overset{\oplus}{C}H-CH_3 \xrightarrow{H_2O/-H^+} R-CH(OH)-CH_3$
- $R-CH=CH_2 \xrightarrow{H^+} R-CH-CH_3 \xrightarrow{H_2O/-H^+} R-CH(OH)-CH_3$
- $3RCH=CH_2 \xrightarrow{BH_3} B(CH_2CH_2R)_3$
- $RCH_2CH_2 \xrightarrow[\text{Antimark.}]{H^+OH^-} R-CH_2-CH_2-OH + H_3BO_3$
- (Anti-Markovnikov addition of H_2O)
- $R-CH=CH_2 \xrightarrow[\text{N.A.R.}]{H^+OH^-} R-CH(OH)-CH_3$
- $R-CH=CH_2 \xrightarrow[\text{peroxide}]{\overset{\delta+}{H}\overset{\delta-}{Br}} R-CH_2-CH_2-Br$
- (Free radical addition) Anti-Markovnikov addition of HB6

Reagent

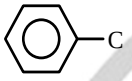
14. Addition of sulphuric acid
$[H_2SO_4, H^+/HSO_4^-]$

15 Oxidation [dil. Alk. $KMnO_4$]
Baeyer's reagent

16. Ozonolysis [O_3, H_2O, go]
(1) Reductive ozonolysis
$\left(\frac{O_3+CCl_4}{Zn}, \frac{O_3+CCl_4}{Me_2S}, \frac{O_3}{Zn,H_20}, \frac{O_3}{Zn+HCl}\right)$
(2) Oxidative ozonolysis
$\left(\frac{O_3+CCl_4}{H_2O} \text{ or } \frac{O_3+CCl_4}{H_2O_2}\right)$

* Strong oxidizing & rgenty
$\begin{bmatrix} \text{Hot } KMnO_4/K_2Cr_2O_7 \\ \text{Acidic } KMnO_4/K_2Cr_2O_7 \end{bmatrix}$

17. Allylic substitution

Chlorination	C = C – C
Bromination	
$Cl_2/h\nu$	$Br_2/h\nu$
t-buOCl	t-buOCl
Cl_2/500°C	Br_2/500°C
NCS	NBS

ALKYNES

1. From Carbides-

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2 \xrightarrow{C}$$
$$CaC_2 \xrightarrow{H_2O} CH \equiv CH$$

2. From Dehydrohalogenation-
[Alc.KOH/alc.KOH, $NaNH_2/NaNH_2$]

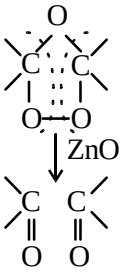
3. Test for unsaturation-
$[Br_2/CCl_4]$

4. Kucherov Reaction
[Addition of H_2O hydration]
$\begin{bmatrix} \text{dil } H_2SO_4, + \\ \text{dil } HgSO_4 \text{ or} \\ Hg^{2+}/H_2O \end{bmatrix}$

Functions

- $R–CH=CH_2 \xrightarrow{H^+} R–\overset{\oplus}{C}H–CH_3$ [Rearran. if poss.]
$\downarrow {}^-OSO_3H$
$R–CH(OSO_3H)–CH_3$

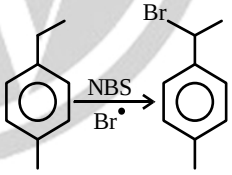
- $C \neq C \xrightarrow[KMnO_4]{\text{dil./Alk}} C(OH)–C(OH)$ addition
vicinal

- $C=C \xrightarrow{O_3}$  Ozonide
$\xrightarrow{ZnO}$ $C(=O)–C(=O)$
(aldehyde, lcetore)

- $R–C(H)=C(R)–R \longrightarrow C(=O)(R) + O=C(R)(HO)$
(ketones) (Carboxylic acids)

- $CH_3–C(H)=C(H)–H \longrightarrow CH_3–C(OH)=O + O=C(OH)–OH \longrightarrow CO_2$
Acetic acid Carbonic acid

- $Ph–CH_3 \xrightarrow[Cl^\bullet]{t-buOCl} Ph–CH_2Cl$

- 

ALKYNES

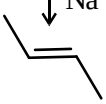
- $CaC_2 \xrightarrow[H_2O]{H_3O^+} Ca(OH)_2 + CH \equiv CH$
Acetylene

- $–\underset{X}{\overset{H}{C}}–\underset{X}{\overset{H}{C}}– \xrightarrow[NaNH_2]{\text{Alc. KOH}} –C \equiv C–$

- $R–C \equiv C–R' \xrightarrow[CCl_4]{Br_2} R–\underset{Br}{\overset{Br}{C}}–\underset{Br}{\overset{Br}{C}}–R'$
(Colorless)

- $R–\overset{+}{C} \equiv CH \xrightarrow[H_2SO_4, HgSO_4]{Hg^{2+}/H_2O} R–C(OH)=CH_2 \rightleftharpoons R–C(=O)–CH_3$
tautomerism

- Terminal allane Methyllcfrne

Reagent	Functions
5. Hydrohalogenation (RX)	• $R-C\equiv CH \xrightarrow{2HX} R-\underset{\displaystyle X}{\overset{\displaystyle X}{\overset{|}{\underset{|}{C}}}}-CH_3$ Geminal dihalide
6. Coupling reaction-	
a) Linear [Cu_2Cl_2/NH_4Cl]	• $2CH\equiv CH \xrightarrow[NH_4Cl]{Cu_2Cl_2} \underset{\displaystyle Cl\equiv CH}{\overset{\displaystyle CH=CH_2}{\overset{|}{\underset{|}{}}}}$ $\underbrace{CH_2=CH}_{\text{Vinyl}}-\underbrace{C\equiv CH}_{\text{acetylene}}$
b) Cyclic [Red hot tube]	• $3CH\equiv CH \xrightarrow[\text{or Fe tube}]{R.H.T.}$ 
c) Oxidative [O_2]	• $2R-C\equiv C-CH \xrightarrow{O_2} R-C\equiv C-C\equiv C-R$
7. Silver nitrate test [Tollen's Reagent]	• $R-C\equiv C-H \xrightarrow[NH_4OH]{AgNO_3} R-C\equiv CAg$ (white ppt)
[$AgNO_3 + NH_4OH$]	• $R-C\equiv C-H \xrightarrow[NH_4OH]{Cv_2,Cl_2} R-C\equiv CCu$ (Red ppt)
Ammoniacal silver nitrate	• $R-C\equiv C-H \xrightarrow[KMnO_4]{dil./AlK} R-\underset{\displaystyle OH\ OH}{\overset{\displaystyle OH\ OH}{\overset{|}{\underset{|}{C}}}}-\underset{\displaystyle OH\ OH}{\overset{\displaystyle OH\ OH}{\overset{|}{\underset{|}{C}}}}-H \longrightarrow R-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-H \xrightarrow{[O]} R-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-OH$
8. Cuprous chloride test	• $R-C\equiv C-H \xrightarrow[Zn]{O_3 + CCl_4} R-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-R'$
[$Cu_2Cl_2 + NH_4OH$]	• $R-C\equiv C-H \xrightarrow[H_2O]{O_3+CCl_4} R-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-\underset{\displaystyle O}{\overset{\displaystyle O}{\overset{\|}{\underset{\|}{C}}}}-OH \longrightarrow R-\underset{\displaystyle O}{\overset{\displaystyle }{\overset{\|}{\underset{}{C}}}}-OH + H_2CO_3 \downarrow H_2O + CO_2$
Ammonical cuprous chloride	• $R-C\equiv C-H \xrightarrow[NaNH_2]{Na/\Delta} R-C\equiv C^- Na^+$ or $\xrightarrow[1°/2°]{R'-X} R-C\equiv C-R'$
9. Baeyer's reagent [dil. alk. $KMnO_4$]	• $\overset{+}{C}H \overset{\|\|\|}{-} \overset{-}{C}H \xrightarrow{Cl^- - AsCl_2} \underset{\displaystyle CH-AsCl_2}{\overset{\displaystyle \beta\ CH-Cl}{\overset{\|}{\underset{\|}{}}}}$ β-Chlorovinyl dichloro arsine (Lewisite)
10. Ozonolysis-	• $CH_3-C\equiv C-CH_3 \xrightarrow{NaNH_2} CH_3-CH_2-C\equiv CH$ 
1) Reductive ozonolysis [$O_3 + CCl_4/Zn$]	• $CH_3-C\equiv C-CH_3$
2) Oxidative ozonolysis [$O_3 + CCl_4/H_2O$]	
11. Lower to higher alkynes	
[Na/Δ, $NaNH_2$]	
12. Lewisite Formation	
[$AsCl_3$ Anhydrous $AlCl_3$]	
14. Internal to Terminal	
15. Terminal to Internal	
$CH_3-CH_2-C\equiv CH \xrightarrow[KOH]{Alc}$	

Reagent	Functions

Method of preparation of Benzene-

1. Cyclic coupling of Alkyne
2. From phenol (Zn dust)
3. Decarboxylation (NaOH/CaO/Δ)

* **Properties of Benzene-**

1. E.S.R
   E.A.R
   S_tAr/ArS_t

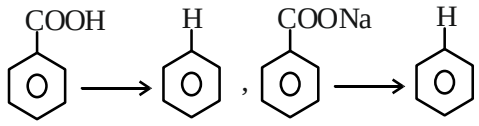
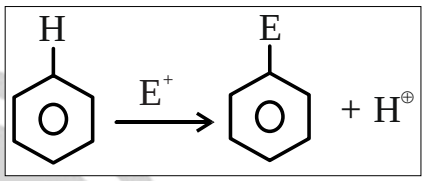
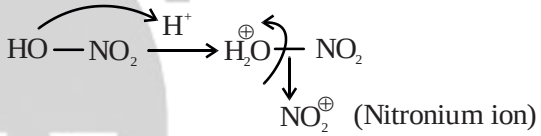
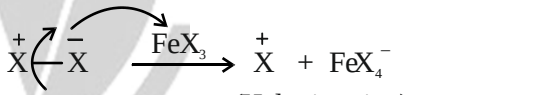
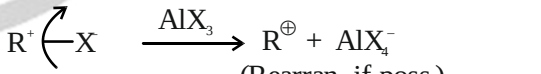
- **Nitration**
  Reagent
  (1) Conc. HNO_3 + Conc. H_2SO_4
  (2) $NO_2^+ BF_4^-$
  (3) $N_2O_5(NO_2^+ NO_3^-)$

- **Halogenaion**
  Reagent
  (1) X_2 + anhy. FeX_3(Cl, Br)
  (2) $\overset{\oplus}{X}\!-\!\overset{\ominus}{X}$, $\overset{\oplus}{Br}\!-\!\overset{\ominus}{Cl}$
  Polar

- **Fridel craft alkylation**
  Reagent
  (1) R–X + anhy. AlX_3
  (2) $R\!-\!\overset{\oplus}{C}H\!=\!\overset{\ominus}{C}H_2 + H^+ \longrightarrow R\!-\!\overset{\oplus}{C}H\!-\!CH_3$
  (3) $R\!-\!OH + H^+ \rightarrow R^+$

- **Fridel craft Acylation**
  Reagent
  (1) $R-\overset{\overset{O}{\|}}{C}-X$ + Anhy. AlX_3
  (2) $R^+\!-\!\overset{\overset{O}{\|}}{C}\!-\!O\!-\!\overset{\overset{O}{\|}}{C}\!-\!R + AlX_3$

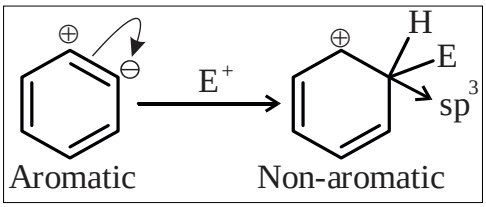
- **Sulphonation**
  Reagent
  (1) Conc. H_2SO_4
  (2) Oleum ($H_2S_2O_7$ – SO_3 + H_2SO_4)
  (3) SO_3

- $2CH_3{\equiv}CH \rightarrow$ ⬡ ; $CH_3{-}C{\equiv}CH \rightarrow$ ⬡
  $CH_3{-}C{\equiv}C{-}CH_3 \rightarrow$ ⬡
- $Ph{-}OH \xrightarrow[dust]{Zn} Ph{-}H$
- 
- 
- $H_2SO_4 \longrightarrow H^+ + HSO_4^-$
- 
  (Nitronium ion)
- 
  (Halonium ion)
- 
  (Rearran. if poss.)
- 
  No rearrang.
- $H_2SO_4 \rightarrow SO_3 + H_2O$

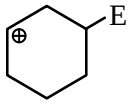
Generation of electrophile

Reagent	Electrophile
(1) Conc.HNO_3 + Conc.H_2SO_4	NO_2^+
(2) X_2 + Anhy. FeX_3	X^+
(3) R–X + Anhy.AlX_3	R^+
(4) $R-\overset{\overset{O}{\|}}{C}-X$ + Anhy. AlX_3	$R-\overset{\overset{O}{\|}}{C}^{\oplus}$
(5) Oleum ($H_2S_2O_7$)	SO_3

Formation of Carbocation

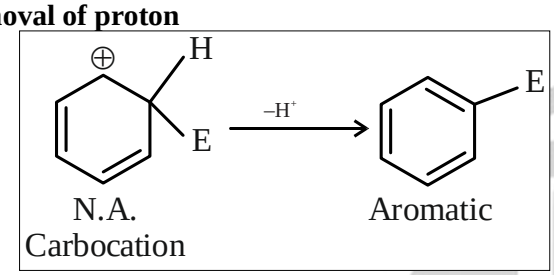


Resonance Resonance hybrid

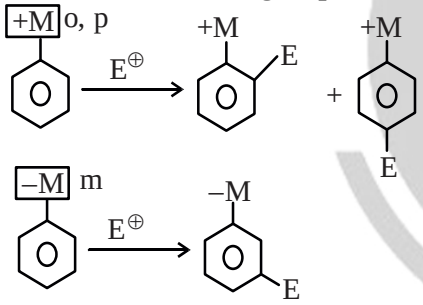


Wheland Intermediate

Removal of proton

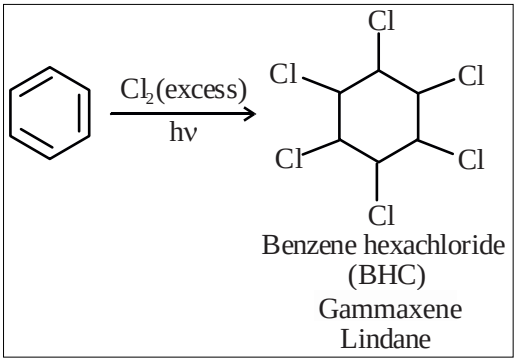


Directive influences of the group



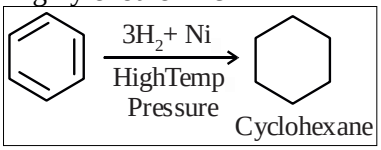
$$\left[\text{ROR} \propto +\text{M} \propto \frac{1}{-\text{M}}\right]$$

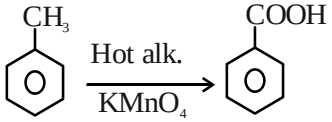
Addition of reaction



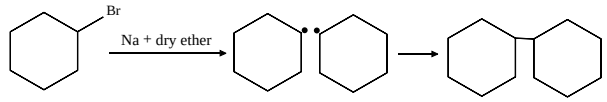
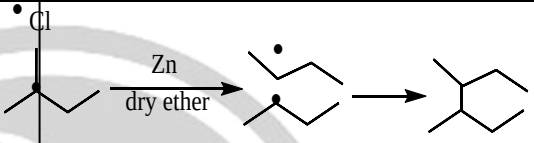
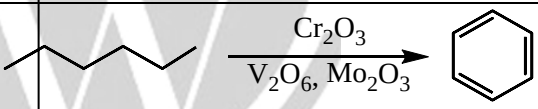
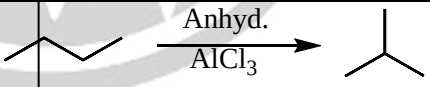
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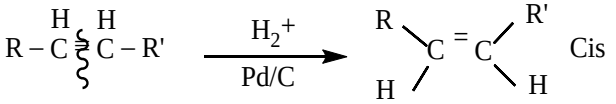
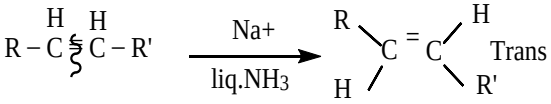
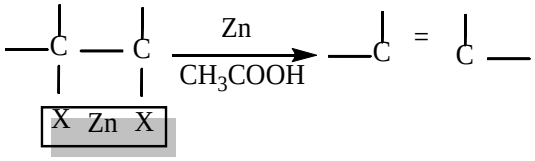
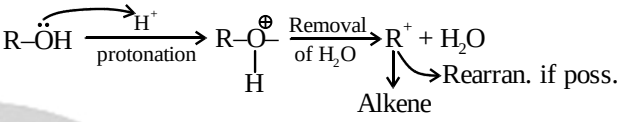
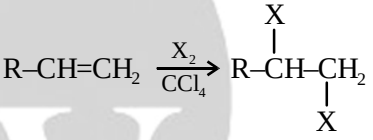
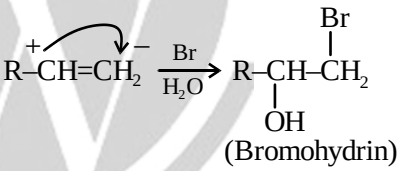
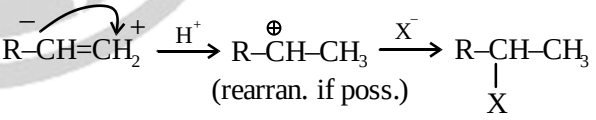
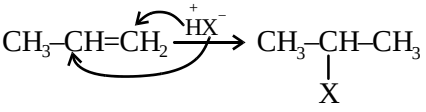
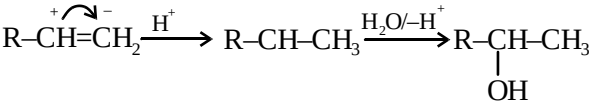
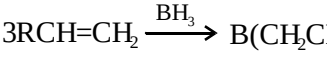
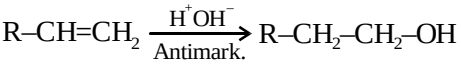
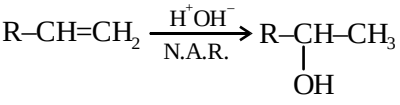
Highly exothermic

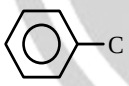
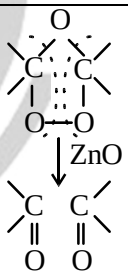
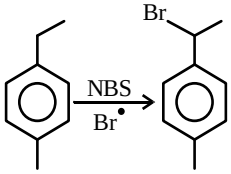




HYDROCARBONS

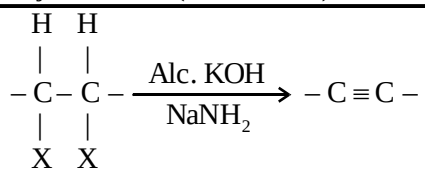
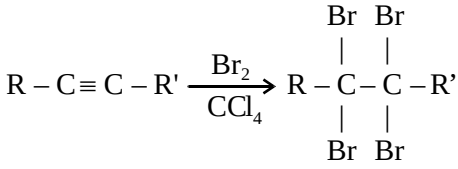
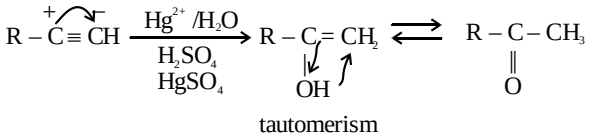
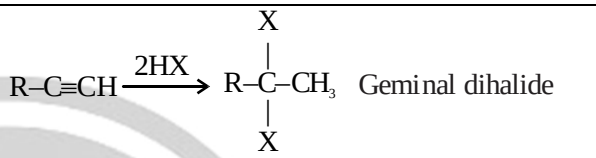
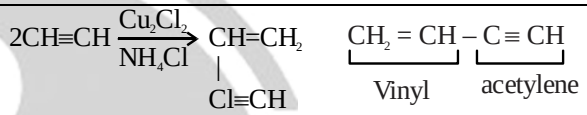
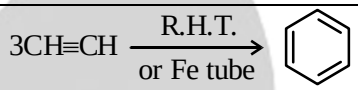
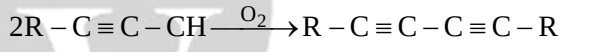
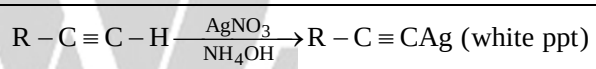
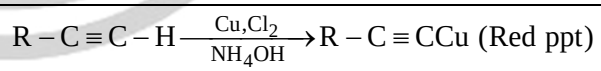
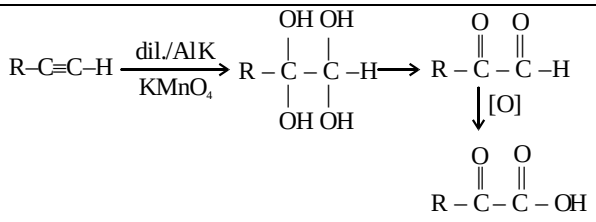
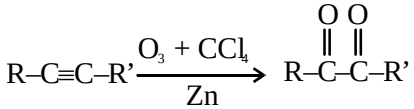
	REAGENT		FUNCTIONS
1.	Hydrogenation [H_2/Ni, Pt, Pd]	•	π Bond को H, H से तोड़ो $CH_2=CH_2 \xrightarrow[Ni]{H_2} CH_3-CH_3$
2.	From Alkyl halide [Zn + dil. HCl]	•	X हटाओ, H लगाओ $CH_3-Cl \xrightarrow[dil\ HCl]{Zn} CH_4$
3.	Wurtz Reaction [Na + dry ether] Intra.	•	R – X bond को F.R. तोड़ो 2R° को जोड़ो 
4.	Decarboxylation [NaOH + CaO sodalime]	•	COOH हटाओ H लगाओ COONa हटाओ H लगाओ $CH_3-COOH \xrightarrow[CaO]{NaOH} CH_4$
5.	Kolbe's Electrolysis/HCOOH (Same as wurtz Reaction)	•	$\dot{C}-\dot{C}OOH \qquad \dot{C}+\dot{C} \rightarrow C-C$ even number
6.	Frankland Reaction [Zn, dry ether]	•	
7.	Corey-house synthesis-		
	• Gilman's Reagent (R–Cu + $R^{\ominus}Li^{+}$) R_2CuLi	•	X हटाओ Gilman का R लगाओ $CH_3-Cl \xrightarrow{Et\,CuLi} CH_3-Et$
8.	Halogenation [X_2 /hν]	•	'H' हटाओ 'X' लगाओ $R-H \xrightarrow[h\nu]{X_2} R-X$
9.	Aromatisation $[Cr_2O_3 / V_2O_6 / Mo_2O_3]$ 773 K, 10-20 atm	•	
10.	Isomerisation [Anhydride $AlCl_3$]	•	
11.	Combustion	•	$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ [ΔH = –ve]
12.	Controlled oxidation	•	$2CH_4 + O_2 \xrightarrow{Cu/523\,K} 2CH_3OH$ $CH_4 + O_2 \xrightarrow{Mo_2O_3} HCHO + H_2O$ $2CH_3CH_3 + 3O_2 \xrightarrow[Mn]{(CH_3COO)_2} 2CH_3COOH + 2H_2O$
13.	Reaction with steam	•	$CH_4 + H_2O \xrightarrow[\Delta]{Ni} CO + H_2$
14.	Pyrolysis	•	$C_6H_{14} \xrightarrow{773K} C_6H_{12}+H_2$ $C_6H_{14} \xrightarrow{773K} C_4H_8 + C_2H_6$ $C_6H_{14} \xrightarrow{773K} C_3H_6 + C_2H_4 + CH_4$

	REAGENT	FUNCTIONS
1.	Hydrogenation of Alkynes [H_2 + Pd/C, H_2, + Pd/$BaSO_4$] Lindlar's Reagant ↑ Rosenmund Cl – CHO	• 
2.	Birch reduction [Na + Liq.NH_3/Li + Liq.NH_3] Terminal X	• 
3.	Dehalogenation [Zn/CH_3COOH]	• 
4.	Dehydration of alcohols (E^1) [H^+/Δ (443 K), Conc.H_2SO_4, H_3PO_4] (Ether, 413 K)	• 
5.	Dehydrohalogenation [Alc.KOH/Alc.NaOH/$NaNH_2$]	• 
6.	Halogenation • In non-polar solvent (CCl_4, CS_2) Interhalogen (BrCl, ICl, IBr) • In polar solvent ($X_2 + H_2O \rightarrow HOX$)	•  • 
7.	Addition of HX [HCl, HBr, HI]	
8.	Markovnikov's Rule [HX] –ve → Less hydrogen atom	• 
9.	Addition of water [dil.H_2SO_4/H_2, H_2O/H_3O^+]	• 
10.	Hydroboration oxidaion (HBO) $\left[B_2H_6 / THF, H_2O_2 / \bar{O}H\right]$	• 
11.	Oxidation [H_2O_2]	• 
12.	Oxymercuration Demercuration (OMDM) $\left[Hg(OAc)_2 / H_2O, NaBH_4\right]$	• 

13.	Addition of HBr/ Peroxide [HBr/ Peroxide] Anti markovnikov's	•	$R-CH=CH_2 \xrightarrow[\text{peroxide}]{\overset{\delta+}{H}\overset{\delta-}{Br}} R-CH_2-CH_2-Br$
14.	Addition of sulphuric acid $[H_2SO_4, H^+/HSO_4^-]$	•	$R-CH=CH_2 \xrightarrow{H^+} R-\overset{\oplus}{C}H-CH_3$ [Rearran. if poss.] $\xrightarrow{{}^-OSO_3H} R-CH(OSO_3H)-CH_3$
15.	Oxidation [dil. Alk. $KMnO_4$] Baeyer's reagent		
16.	Ozonolysis [O, O, go]		
	(1) Reductive ozonolysis $\left(\frac{O_3+CCl_4}{Zn}, \frac{O_3+CCl_4}{Me_2S}, \frac{O_3}{Zn}, \frac{O_3}{Zn+HCl}\right)$	•	$C=C \xrightarrow[KMnO_4]{\text{dil./Alk}} C(OH)-C(OH)$ (syn) vicinal dial
	(2) Oxidative ozonolysis $\left(\frac{O_3+CCl_4}{H_2O} \text{ or } \frac{O_3+CCl_4}{H_2O_2}\right)$ Ketone × Aldehyde ✓	•	$C=C \longrightarrow C=O + O=C$
	* Other reagent $\left[\begin{matrix}\text{Hot } KMnO_4/K_2Cr_2O_7\\ \text{Acidic } KMnO_4/K_2Cr_2O_7\end{matrix}\right]$	•	$CH_3-CH=CH-H \longrightarrow CH_3-CHO + O=C(OH)-OH \longrightarrow CO_2$ Acetic acid Carbonic acid
17.	Allylic substitution Chlorination $C=C-C$ Bromination  $Cl_2/h\nu$ $Br_2/h\nu$ t-buOCl t-buOCl $Cl_2/500°C$ $Br_2/500°C$ NCS NBS	•	$C=C \xrightarrow{O_3}$  Ozonide
		•	$Ph-CH_3 \xrightarrow[Cl^\bullet]{t-buOCl} Ph-CH_2Cl$
		•	

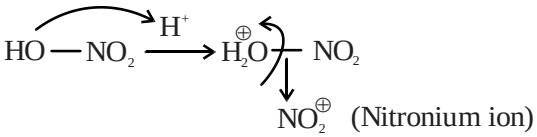
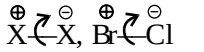
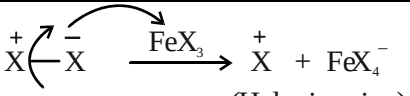
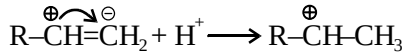
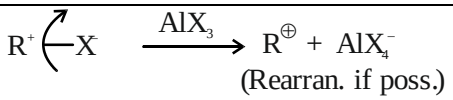
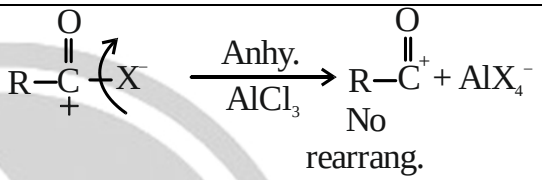
ALKYNES

	REAGENT		FUNCTIONS
1.	From Carbides- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2 \xrightarrow{C}$ $CaC_2 \xrightarrow{H_2O} CH \equiv CH$	•	$CaC_2 \xrightarrow[H_2O]{H_3O^+} Ca(OH)_2 + \underset{\text{Acetylene}}{CH \equiv CH}$

2.	From Dehydrohalogenation- [Alc.KOH/alc.KOH $NaNH_2/NaNH_2$]	•	
3.	Test for unsaturation- [Br_2/CCl_4]	•	
4.	Kucherov Reaction [Addition of H_2O hydration] $\begin{bmatrix} \text{dil}\, H_2SO_4, + \\ \text{dil}\, HgSO_4 \\ Hg^{2+}/H_2O \end{bmatrix}$	•	
5.	Hydrohalogenation (RX)	•	
6.	Coupling reaction- a) Linear [Cu_2Cl_2/NH_4Cl]	•	
	b) Cyclic [Red hot tube]	•	
	c) Oxidative [O_2]	•	
7.	Silver nitrate test [Tollen's Reagent] [$AgNO_3 + NH_4OH$] Ammoniacal silver nitrate	•	
8.	Cuprous chloride test [$Cu_2Cl_2 + NH_4OH$] Ammonical cuprous chloride	•	
9.	Baeyer's reagent [dil. alk. $KMnO_4$]	•	
10.	Ozonolysis-		
	1) Reductive ozonolysis [$O_3 + CCl_4/Zn$]	•	

	2) Oxidative ozonolysis [O_3 + CCl_4/H_2O]	•	$R-C\equiv C-H \xrightarrow[H_2O]{O_3+CCl_4} R-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-OH \longrightarrow R-\overset{O}{\overset{\|}{C}}-OH + H_2CO_3 \downarrow H_2O + CO_2$
11.	Lower to higher alkynes [Na/Δ, $NaNH_2$]	•	$R-C\equiv C-H \xrightarrow[NaNH_2]{Na/\Delta} R-C\equiv C^- Na^+$ $\xrightarrow{R'-X'} R-C\equiv C-R'$
12.	Lewisite Formation [$AsCl_3$ Anhydrous $AlCl_3$]	•	$^+CH \overset{\|\|\|}{} {}^-CH \xrightarrow{Cl^- - \overset{+}{A}sCl_2} \overset{\beta}{CH}-Cl \;\|\; \underset{\alpha}{CH}-AsCl_2$ β-Chlorovinyl dichloro arenes (Lewisite)
13.	British antilewisite BAL Sn OH Sn	•	$CH-Cl \;\|\; CH-As$ (Cl, HS; Cl, HS; HO) $\longrightarrow CHCl \;\|\; CHAs$ (S, S, HO)
14.	Internal to Terminal	•	$CH_3-C\equiv C-CH_3 \xrightarrow{NaNH_2} CH_3-CH_2-C\equiv CH$ $\downarrow Na + liq\ NH_3$
15.	Terminal to Internal $CH_3-CH_2-C\equiv CH \xrightarrow[KOH]{Alc} CH_3-C\equiv C-CH_3$	•	$CH_3-CH_2-C\equiv CH \xrightarrow[liq.NH_3]{Na+} CN_3CH_2C\equiv C^- Na^+$

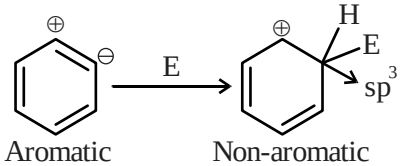
	REAGENT		**FUNCTIONS**
	Method of preparation of Benzene-	•	
1.	Cyclic coupling of Alkyne	•	$2CH_3\equiv CH \rightarrow$ ⬡ ; $CH_3-C\equiv CH \rightarrow$ ⬡ ; $CH_3-C\equiv C-CH_3 \rightarrow$ ⬡
2.	From phenol (Zn dust)	•	$Ph-OH \xrightarrow[dust]{Zn} Ph-H$
3.	Decarboxylation (NaOH/CaO/Δ)	•	COOH ⬡ → H ⬡ , COONa ⬡ → H ⬡
*	**Properties of Benzene-**	•	
1.	E.S.R E.A.R S_tAr/ArS_t	•	H ⬡ → E ⬡ + $H^{\oplus}$

	• **Nitration** Reagent (1) Conc. HNO_3 + Conc. H_2SO_4 (2) $NO_2 + BF_4^-$ (3) $N_2O_5(NO_2^+ NO_3^-)$	•	• $H_2SO_4 \longrightarrow H^+ + HSO_4^-$  $NO_2^{\oplus}$ (Nitronium ion)
	• **Halogenaion** Reagent (1) X_2 + anhy. FeX_3(Cl, Br) (2)  Polar	•	 (Halonium ion)
	• **Fridel craft alkylation** Reagent (1) R–X + anhy. AlX_3 (2)  (3) $R–OH + H^+ \rightarrow R^+$	•	 (Rearran. if poss.)
	• **Fridel craft Acylation** Reagent (1)  (2) 	•	 No rearrang.
	• **Sulphonation** Reagent (1) Conc. H_2SO_4 (2) Oleum ($H_2S_2O_7$ – SO_3 + H_2SO_4) (3) SO_3		

Generation of electrophile

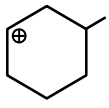
Reagent	Electrophile
(1) Conc.HNO_3 + Conc.H_2SO_4	NO_2^+
(2) X_2 + Anhy. FeX_3	X^+
(3) R–X + Anhy.AlX_3	R^+
(4) 	
(5) Oleum ($H_2S_2O_7$)	SO_3

Formation of Carbocation



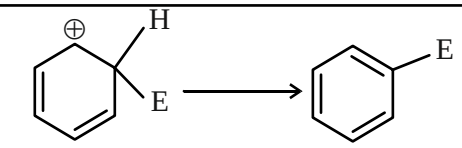
Aromatic Non-aromatic

Resonance Resonance hybrid



Wheland Intermediate

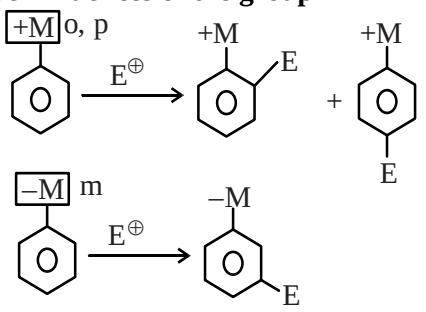
Removal of proton



N.A.
Carbocation

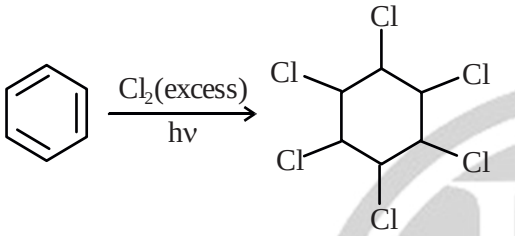
Aromatic

Directive influences of the group



$$\left[\text{ROR} \propto +\text{M} \propto \frac{1}{-\text{M}}\right]$$

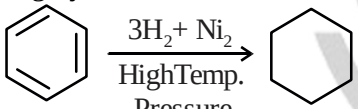
Addition of reaction



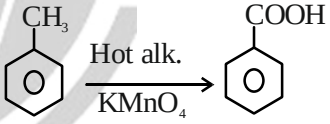
Benzene hexachloride
(BHC)
Gammaxane
Lindane

Hydrogenation

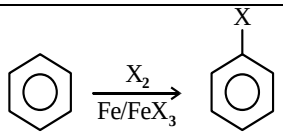
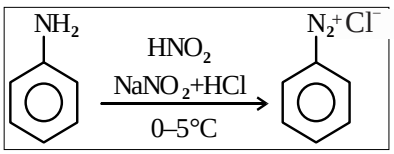
Highly exothermic

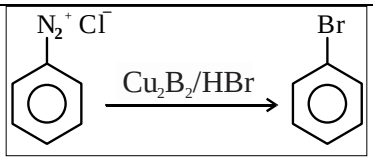
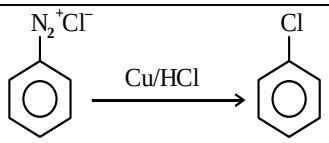
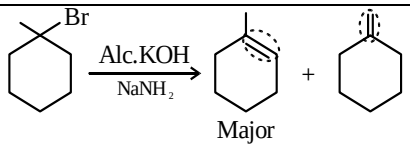
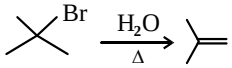
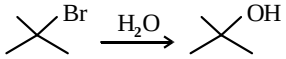
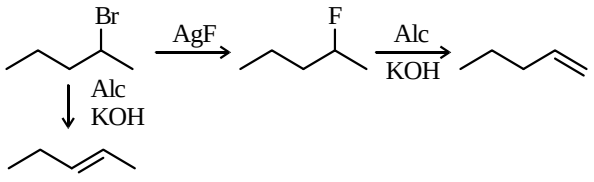


Cyclohexane

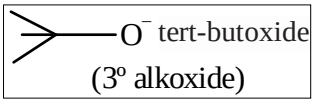


HALOALKANE AND HALOARENES

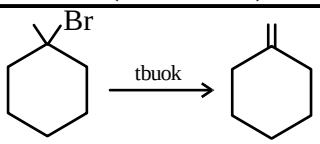
REAGENT		FUNCTIONS	
1.	From alcohol		
	• from HX [$HX \rightarrow H^+ + X^-$]	•	$R–\ddot{O}H \xrightarrow{H^+} R–\overset{\oplus}{O}H_2 \longrightarrow R^{\oplus} \xrightarrow{X^-} R–X$
	• Reaction with PX_3 , PX_5, SOX_2	•	
	(i) PX_3 / Red P + X_2	•	$3R–O–H + PX_3 \longrightarrow 3RX + H_3PO_3$
	(ii) PX_5	•	$R–O–H + X–OX_3–X \longrightarrow R–X + POX_3 + HX$
	(iii) SOX_2	•	$R–O–H + X–SO–X \longrightarrow R–X + SO_2 + HX$
*	**Darzen's Reaction : -** Best method of R–Cl	•	$R–OH \xrightarrow{SOCl_2} R–Cl + SO_2 + HCl\uparrow$
2.	From Halogenation of alkanes:-	•	$R–H \xrightarrow[HV]{X_2} R–X$
3.	Halogenation of alkeanes :- $X_2 + CCl_4$	•	$R–CH=CH_2 \xrightarrow[CCl_4]{X_2} R–\underset{X}{\overset{X}{CH}}–CH_2$
	$X_2 + H_2O$	•	$R–\overset{\oplus}{C}H=\overset{\ominus}{C}H_2 \xrightarrow[HO^{\ominus}X]{X_2+H_2O} R–\underset{OH}{\overset{X}{CH}}–CH_2$
4.	From Hydrohalogenation of alkenes :-	•	$R–CH=CH_2 \xrightarrow{\overset{+}{H}\overset{-}{X}} R–\overset{\oplus}{C}H–CH_3 \xrightarrow{X^-} R–\underset{X}{CH}–CH_3$
5.	From halogen exchange:- (a) From swartz reaction (Preparation of alkyl fluorides). Reagent : Inorganic fluorides. AgFf+, Hg_2Ff_2, $COFf_2$, $SbFf_3$, etc.	•	$R–X \xrightarrow{AgF} R–F$ X हटाओं F लगाओं
6.	(b) Frinkelstein reaction (Preparation of alkyl iodide) Reagent :- NaI acetone $\diagdown\!\!\diagup C=O$ DMSO (Dimethyl sulphoxide) $\diagdown\!\!\diagup S=O$	•	$R–X \xrightarrow[DMSO]{NaI} R–I$ X हटाओं I लगाओं
	MOP of Haloarenes :- (1) Electrophilic substitution reaction $X_2/Fe/FeX_3$	•	
	(2) **From aniline** Diazotization ($NaNO_2$ + HCl/HNO_2) 0 – 5°C	•	 BDC = Benzene diazonium chloride
	Diazotization		

(a) Sandmeyer reaction [Cu_2Cl_2/HCl] for Cl and Br. (Cv_2Br_2/HBr)	• $PhN_2^+ Cl^- \xrightarrow{Cu_2Cl_2/HCl} Ph–Cl$ / $PhN_2^+ Cl^- \xrightarrow[NaCl\ HCN]{CuCN} Ph–CN$
	• 
(b) Gattermann reaction [Cu/HCl]	• 
(c) Balz–Schiemann's reaction [$NaBF_4$] Fluoro Bromo	• $PhN_2^+ Cl^- \xrightarrow[NaBF_4]{H^+ BF_4^-} PhN_2 + BF_4^- \longrightarrow pHF$; $BF_3 + F^\ominus$ replace
(d) Aryl iodide [KI]	• $PhN_2^+ Cl^- \xrightarrow[NaBF_4]{H^+I^-} pH–I$
Halogenation [I_2 + OA] HIO_3, NIO_4, HNO_3	• $Ph–H \xrightarrow[O.A]{I_2} Ph–I$
Important reaction :- 1. Sn + HCl / Fe + HCl	• $Ph–NO_2 \xrightarrow[Fe+HCl]{Sn+HCl} pH–NH_2$(Aniline)
2. Benzonitrile $\xrightarrow{H_3O^+}$ Benzoic acid	• $Ph–C\equiv N \xrightarrow{H_3O^+} Ph–C(OH)_2–OH \longrightarrow P–C(=O)–OH$ Benzoic acid
Nucleophilic substitrution reaction (NSR)	• $R–\boxed{X} \xrightarrow{Nu^\ominus} R–Nu + X^\ominus$
* S_N1 → 2 step C^+,	• S_N1 – Racemic
* S_N2 → 1 step, backside, attack ROR $\propto \frac{1}{SN}$	• S_N2– Inversion
Elimination Reactions :- E^2 → Alc.KOH/ $NaNH_2$	•  Major
* E^1 Elimination :-	• **E^1**  **S_N1** 
* **E^{1cb} (Elimination via conjugate base):** * **Alkyl Fluorides** $F^- < Cl^- < Br^- < I^-$ (Worst L.G.; Transition) * E^{1cb} and E^2 → Same reagent Alc. KOH	• 

9. **Bulky Base in E^2**



* Less hindered alkene is the major-Product.



Reaction with Metals:

1. WURTZ Reaction (Na/dry ether)

$2R - X \xrightarrow[\text{dry ether}]{Na} R–R$ [alkyl halide]
R+R

2. Fittig Reaction (Na/dry ether)

$2Ph–X \xrightarrow[\text{dry ether}]{Na} Ph–Ph$ [aryl halide]

3. WURTZ Fittig Reaction (Na/dry ether)

$Ph–X + R–X \xrightarrow[\text{dry ether}]{Na} Ph–R$

4. Ullmann Reaction (Cu) (Same as fittig)

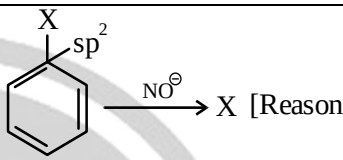
$2Ph–I \xrightarrow{Cu} Ph–Ph$

5. Grignard Reaction

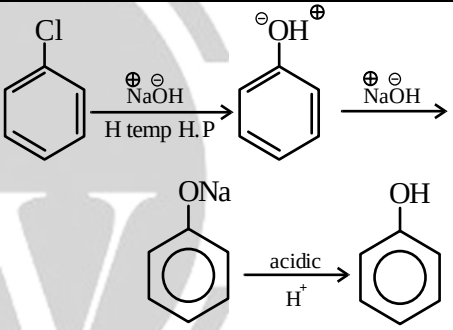
$R - X \xrightarrow[\text{dry ether}]{Mg} R–MgX$ → R–MgX 50% covalent
R–MgX 50% ionic

*** Properties of Haloarenes**

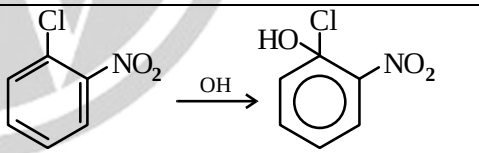
1. NSR in Aryl halide ($ArSN^2$)



2. Dow's process:
Na^+OH (H.T-625 k)
(H.P-300atm)
* EWG - nitrohalobenzene
* Carbanion, ROR-stability of C^-
* ROR ∝ nitro group

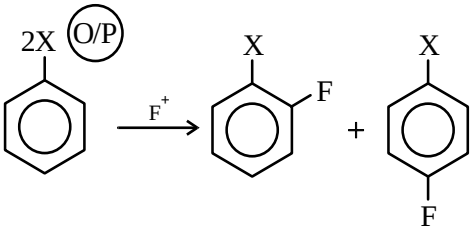


Meisenheimer Complex:



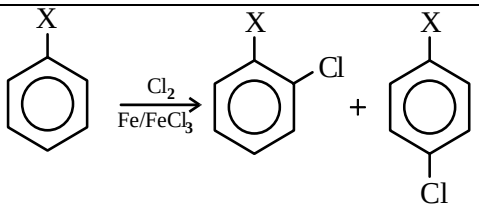
Meisenheimer complex

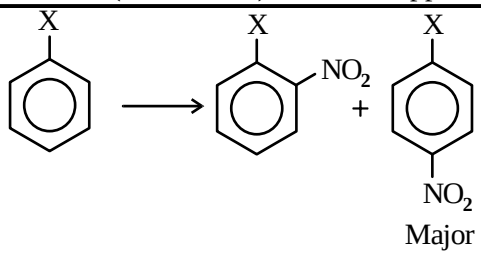
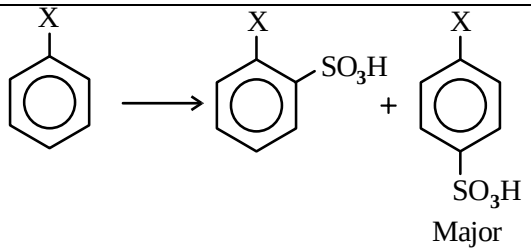
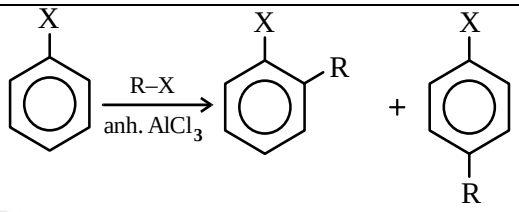
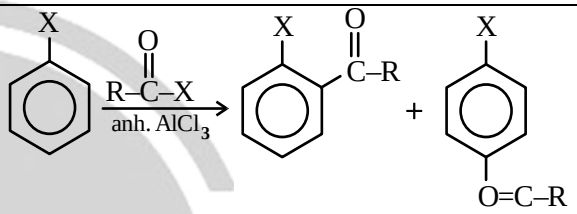
3. ESR -



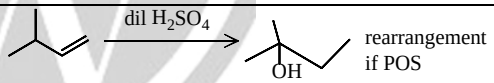
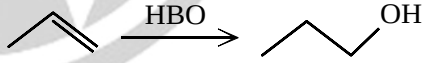
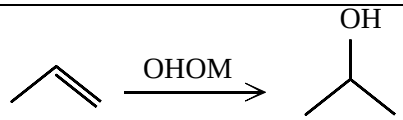
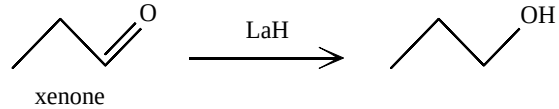
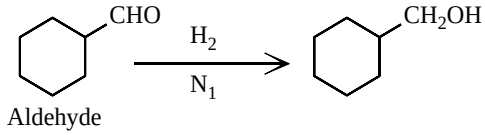
Major

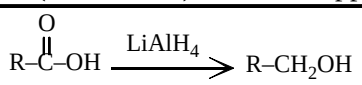
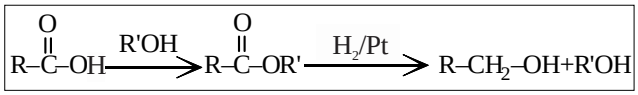
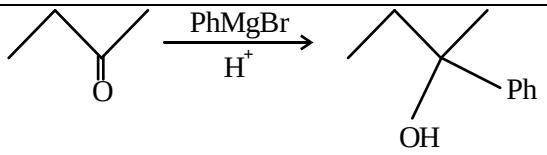
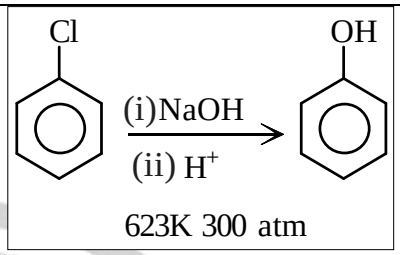
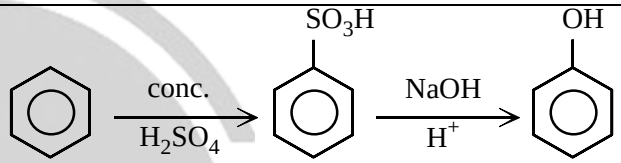
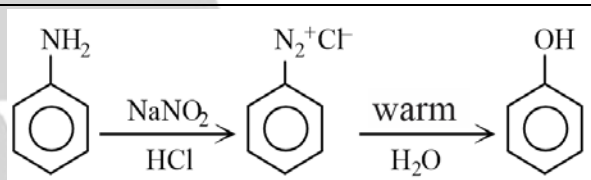
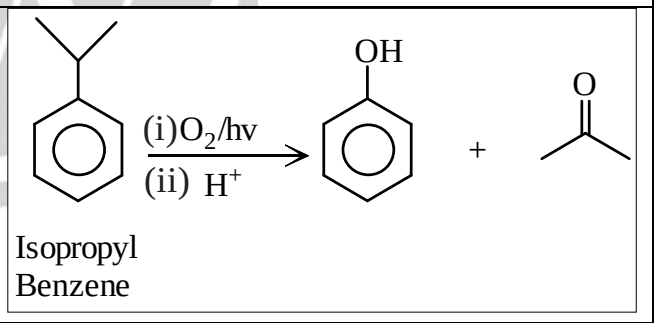
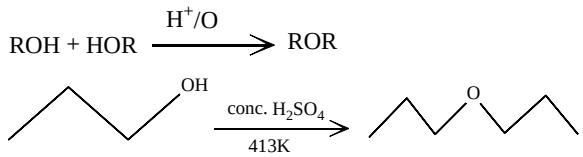
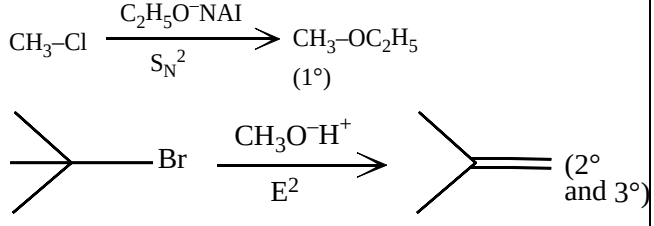
a. Chlorination- $Cl_2/Fe/FeCl_3$

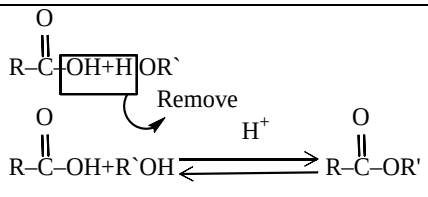
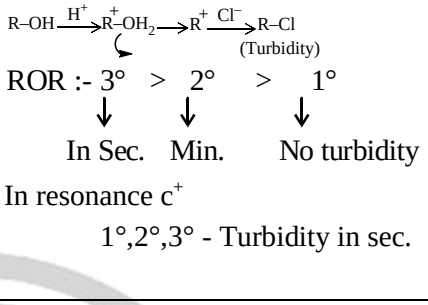
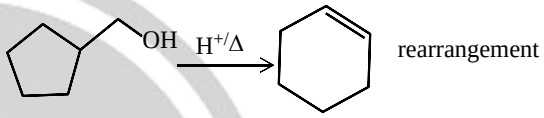
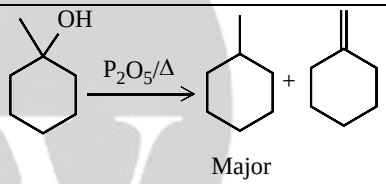
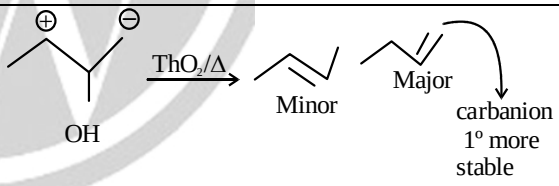


	b. Nitration - conc. HNO_3, conc. H_2SO_4	•	
	c. Sulphonation - $H_2S_2O_4$/Oleum/SO_3	•	
	d. Friedal Craft Alkylation- anhy. $AlCl_3$/R–CH–CH_2/HF/R–OH/H^+	•	
	e. Friedel craft Acylation  R–C–X, Anhy. AlX_5 	•	

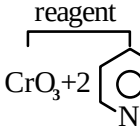
ALCOHOL PHENOLS AND ETHER

	Reagent		Function
(1)	**MOP of alcohol:-**		
1.	From alkenes (dil H_2SO_4/H^+ H_2O/H_3O^+) Markovnikov addition	•	
2.	**HBO Hydroboration oxidation** ↓ (B_2H_6/THF H_2O_2/OH^-) Antimarkovnikov	•	
3.	**OMDM ($Hg(OAC)_2$ / H_2O, $NaBH_4$)** ↓ Markovnikov	•	
*	**Reduction reaction:-**		
1.	Reduction of carbonyl compound. $LiAlH_4$(LAH) $NaBH_4$ (SBH) H_2/Catalyst	•	π बंध को H, H से तोड़ दों  
2.	By reduction of carboxylic acid and ester. $LiAlH_4$ – strong	•	COOH हटाओं CH_2OH लगाओं

			
	* $NaBH_4 \rightarrow$ mild reducing agent ↳ Only with carbonyl Carboxylic and ester ⊗	•	H_2 / catalyst → good yield. ↓ ester 
3.	By grignard reagent Ester – grignard → 3°	•	
(2)	**MOP of Phenol:-**		
	(1) Dow's process	•	
	(2) Benzene sulphonic acid	•	
	(3) Diazonium salt	•	
	(4) Frome cumene	•	
(3)	**MOP of ether:-**		
	(1) Dehydration of alcohol • Hydrocarbon – 413K (con H_2SO_4 H_3PO_4) → alkene	•	
	(2) Williamson ether synthesis $Ni^{\ominus}SN^2(i)_{Rx}$ $(2°,3°) \rightarrow C^2$ ↓ Alc.KOH, NaOH Alc.KOH NaOH	•	
	Properties of alcohol:-		
1.	Acidic Nature:-		* $ROH + Na / O \rightarrow RO^- Na^+ + H_2$

	$ROH \rightleftharpoons RO^- + H^+$		* $ROH + Al \rightarrow \left(RO^-\right)_3 Al^{3+} + H_2$ * $ROH + Na^+H^- \rightarrow RO^-Na^+ + H_2$ * $ROH^- + Na^+NH_2^- \rightarrow R^-ONa^+NH_3$ $\left[\begin{array}{l}\bullet\ ROH + NaOH \rightarrow R^-ONa^+ + H_2O \\ \bullet\ ROH + NaHCO_3 \rightarrow CO^-NaI + H_2CO_3\end{array}\right]\otimes$
2.	Esterification:-	•	
3.	Lucas test:- Conc.HCl anhy $ZnCl_2$. * to distinguish b/w 1, 2°, 3° ROH	•	
4.	Dehydration:- (1) VIA E_1 Conc $H_2SO_4/H^+\Delta$	•	
	(2) VIA E_2 Dehydrating agent :- P_2O_5/Δ $POCl_3/\Delta$ Al_2O_3/Δ	•	
	(3) VIA E_1cb ThO_2/Δ Thorium oxide	•	
5.	**DARZEN'S REATION**	•	
	a) VIA S_N1 (Intramolecular) * Retention.	•	$ROH \xrightarrow{SOCl_2} R-Cl + SO_2\uparrow + HCl\uparrow$ [Retention]
	b) VIA S_N2 • Pyridine + $SOCl_2$ • Inversion	•	$ROH \xrightarrow[N]{SOCl_2} R-Cl$ [Inversion]
6.	With PX_3	•	$ROH \xrightarrow{PCl_3} R-Cl$ $\xrightarrow{PCl_5} R-Cl$
7.	**Oxidation:** [HOA] → PCC, POC, CrO_3 + Acetone,		**[MOA]** • Ion → Aldehyde • $RCH_2OH \rightarrow R-CHO$ • 2° → Ketone **[SOA]** • Ion → Acid • $R-CH_2OH \rightarrow R-COOH$ • 2° → Ketone

Collin's reagent



CrO_3+2 , Cu/36ºC

[SOA] → $KMnO_4/H^+$, HO + $KMnO_4$, $K_2Cr_2O_7/H+$,

$\frac{Cr_2O_3 + H_2SO_4}{\text{Jone's reagent}} H_2Cr_2O_4$

• $R–CH_2–OH \rightarrow R–\overset{\overset{O}{\|}}{C}–R$

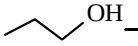
• $R–CH_2–OH \rightarrow R–\overset{\overset{O}{\|}}{C}–R$

* $3° \xrightarrow[300°\ C]{Cu/Ag} \underset{E^2}{\beta\text{-}\alpha\text{-OH}} \xrightarrow{Cu/300°C}$ 

* For allylic or Benzylic alcohol (MnO_2)

• $R–CH=CH–CH_2OH \xrightarrow{MnO_2} R–CH=CH–CHO$

• $ph–CH_2OH \xrightarrow{MnO_2} ph–CHO$

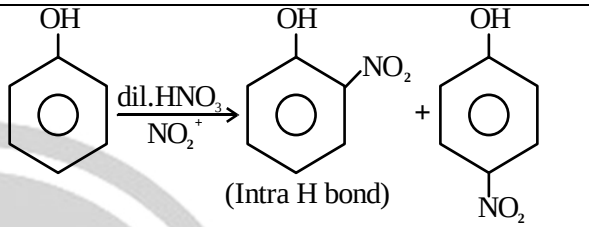
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Properties of Phenol

1. NITRATION:-

(1) With dil HNO_3 [Low temperature 298K O/P]

* Steam distillation

• 

(Intra H bond)

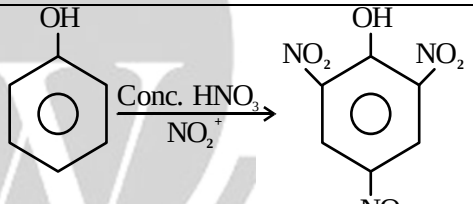
(Inter H bond)

* B. Point P >O

* Volatility P < O

(2) With Conc. HNO_3 [Picric acid]

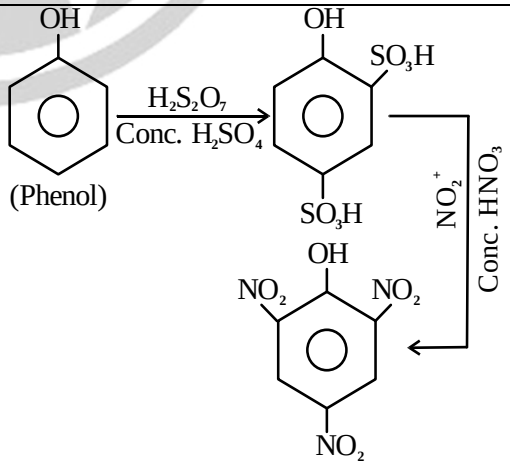
yield → Poor

• 

(Picric acid)

* Now days $H_2S_2O_7 \rightarrow SO_3H$

(1) Sulphonation from nitrodisulphide

• 

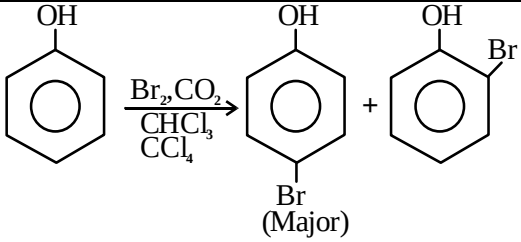
(Phenol)

2. HALOGENATION:

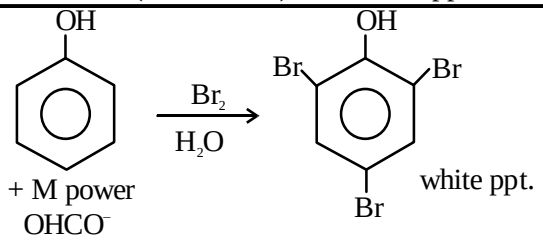
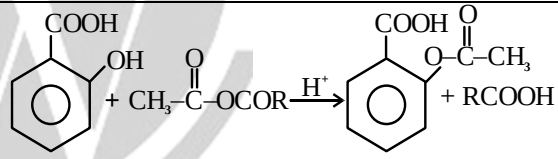
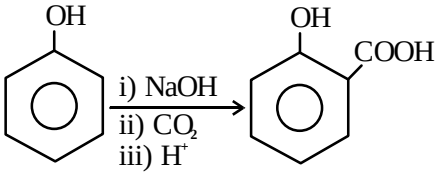
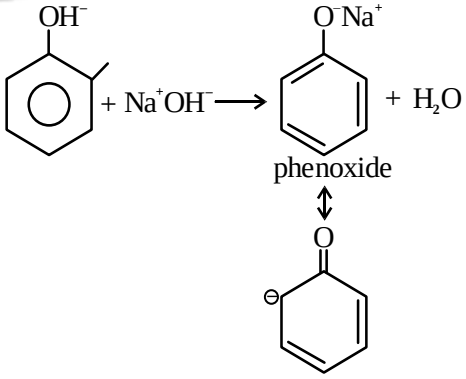
(1) Mono bromination

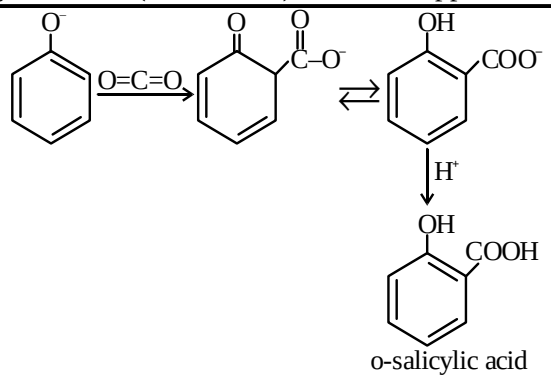
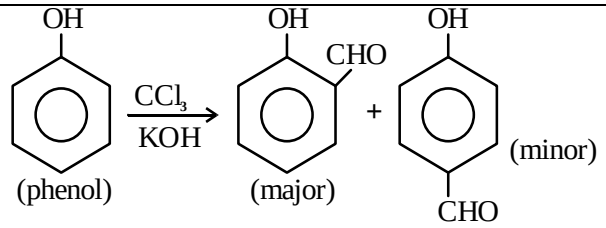
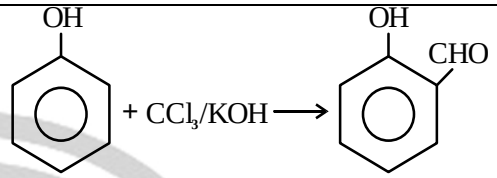
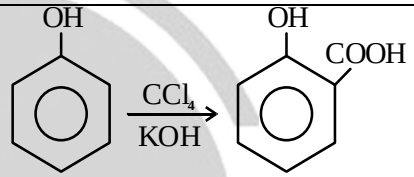
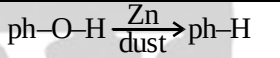
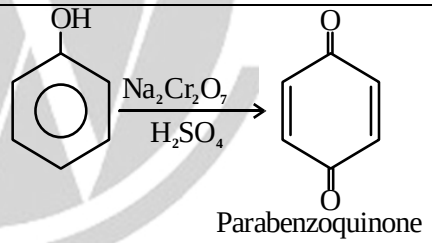
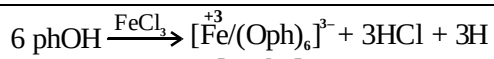
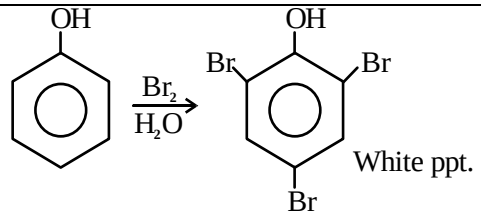
Br_2, CS_2, $CHCl_3$, CCl_4

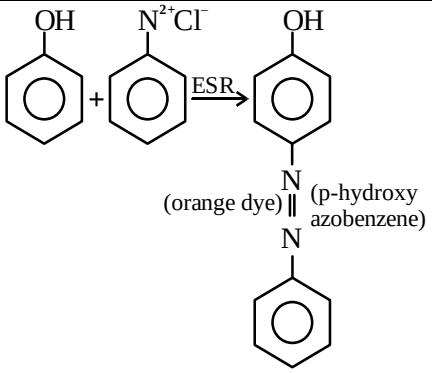
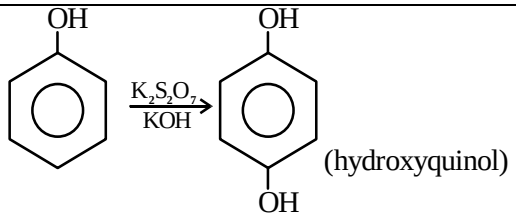
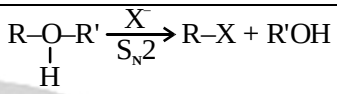
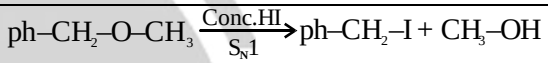
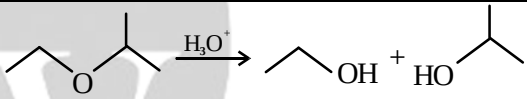
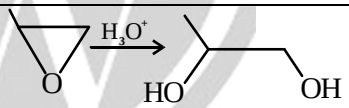
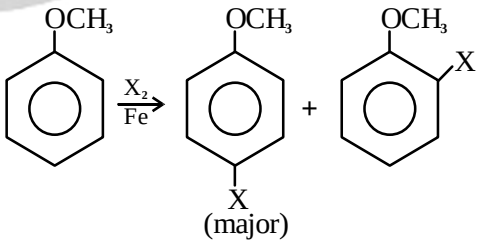
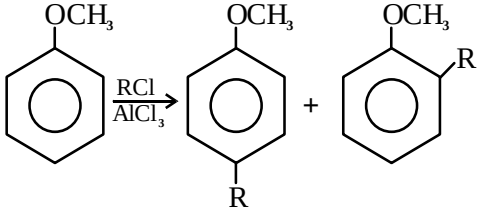
Solvent — low polarity

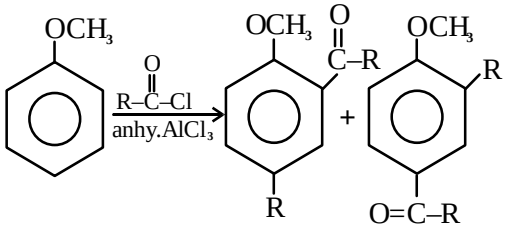
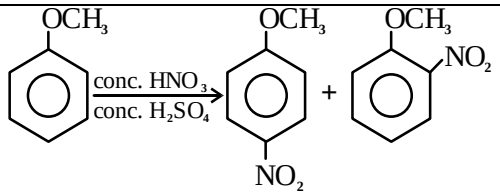
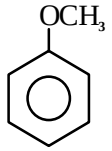
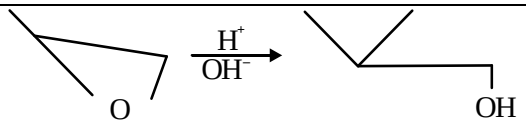
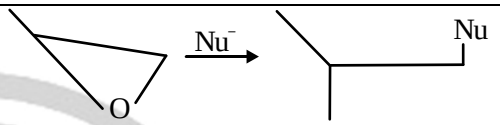
• 

(Major)

	(2) Tri bromination Br_2, H_2O (Bromine water)	• 
3.	**ACIDIC NATURE:** $phOH \rightleftharpoons phO^- + H^+$	• $phOH \xrightarrow{Na/\Delta} phO^- Na^+ + H_2$ • $phOH \xrightarrow{NaH} phO^- Na^+ + H_2$ • $phOH \xrightarrow{NaNH_2} phONa^+ + NH_3$ • $phOH \xrightarrow{NaOH} phONa^+ + H_2$ • $phOH \xrightarrow{NaHOOH} phO^- Na^+ + H_2CO_3$ × ↓ more acidic
4.	**ESTERI FICATION:**	• $R-\overset{O}{\overset{\|}{C}}-OH + H-Oph \longrightarrow R-\overset{O}{\overset{\|}{C}}-O-ph$ • $R-\overset{O}{\overset{\|}{C}}-Cl + H-Oph \longrightarrow R-\overset{O}{\overset{\|}{C}}-O-ph + HCl$ • $R-\overset{O}{\overset{\|}{C}}-OCOR + H-Oph \longrightarrow R-\overset{O}{\overset{\|}{C}}-O-ph + RCOOH$ anhydride
5.	**ASPIRIN FORMATION:** * Acetylation of salicylic acid - aspirin $[CH_3-\overset{O}{\overset{\|}{C}}]$ acetyl	•  Salicylic acid o-acetyl salicylic acid o-hydoxy benzoic acid [Aspirin]
6.	**KOLBE'S REACTION:**  H हटाओं → ऑर्थो COOH लगाओं	• 

		•	 o-salicylic acid
7.	**REIMOR TIEMANN REACTION:** Intermediate → Benzal chloride	•	 (phenol) (major) (minor)
	Important: phOH + CCl_3/HOH → salicylic aldehyde	•	
	phOH + CCl_4/HOH → salicylic acid	•	
8.	Oxidation of phenol with Zn dust	•	
9.	Oxidation of phenol	•	 Parabenzoquinone
10.	**Test of Phenol:**		
	(i) $FeCl_8$ Test	•	 [Voilet]
	(ii) Br water test	•	 White ppt.

11.	**Coupling reaction** ESR. [p-hydroxy azo benzene] Couple bangs	•	
12.	**Elb's reaction** $H_2S_2O_6$/HOH hydroxyquinol	•	
	PROPERTIES OF ETHER		
1.	**Reaction with HX** 1º and 2º alkyl – S_N2 ↓ Nucleophilic attack on less hindered alkyl	•	
	3º and Reso – S_N1 Anhydrous Hx – S_N2 Ion HX – S_N1	•	
2.	**Hydrolysis of ether**	•	
		•	
3.	**Electrophilic substitution reaction:**		
	(i) Halogenation [X_2/Fe]-para major always	•	
	(ii) Friedel craft reaction: • Alkylation ($RCl/AlCl_3$)	•	

	• Acylation (R–C(=O)–Cl/Anhy. $AlCl_3$)	• 
	• Nitration (Conc. HNO_3/H_2SO_4)	• 
4.	**Reaction with PCl_5**	• $CH_3–O–C_2H_5 \xrightarrow{PCl_5} CH_3Cl + POCl_3 + C_2H_5Cl$
5.	**Reaction with cyclic ether**  (Anisole)	•  • 

1. VIA E_1cb

ThO_2/Δ Thorium oxide

5. DARZEN'S REATION

a) VIA S_N1 (Intramolecular)

* Retention.

b) VIA S_N2

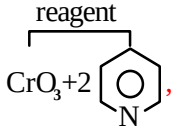
- Pyridine + $SOCl_2$
- Inversion

6. With PX_3

7. **Oxidation:**

[HOA] → PCC, POC, CrO_3 + Acetone,

Collin's reagent



, Cu/36°C

[SOA] → $KMnO_4/H^+$, HO + $KMnO_4$, $K_2Cr_2O_7/H+$,

$\underset{\text{Jone's reagent}}{Cr_2O_3 + H_2SO_4}$ $H_2Cr_2O_4$

Properties of Phenol

1. **NITRATION:-**

(1) With dil HNO_3 [Low temperature 298K O/P]

* Steam distillation

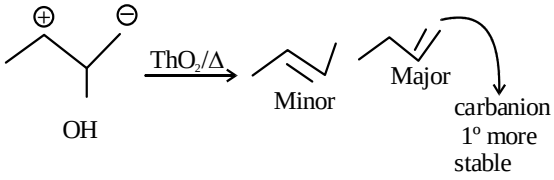
(2) With Conc. HNO_3 [Picric acid]

yield → Poor

* Now days $H_2S_2O_7 \rightarrow SO_3H$

(1) Sulphonation from nitrodisulphide

Function:

- 

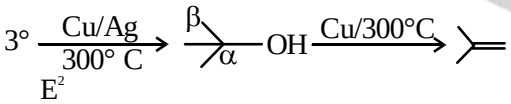
- $ROH \xrightarrow{SOCl_2} R-Cl + SO_2\uparrow + HCl\uparrow$ [Retention]
- $ROH \xrightarrow[N]{SOCl_2} R-Cl$ [Inversion]
- $ROH \xrightarrow{PCl_3} R-Cl$
  $\xrightarrow{PCl_5} R-Cl$

[MOA]

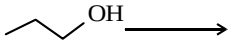
- Ion $\rightarrow$ Aldehyde
- $RCH_2OH \rightarrow R-CHO$
- $2^o \rightarrow$ Ketone
- $R-CH_2-OH \rightarrow R-\overset{\overset{O}{\|}}{C}-R$

[SOA]

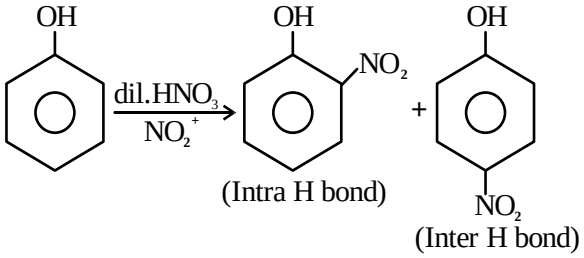
- Ion $\rightarrow$ Acid
- $R-CH_2OH \rightarrow R-COOH$
- $2^o \rightarrow$ Ketone
- $R-CH_2-OH \rightarrow R-\overset{\overset{O}{\|}}{C}-R$

* 

* For allylic or Benzylic alcohol (MnO_2)

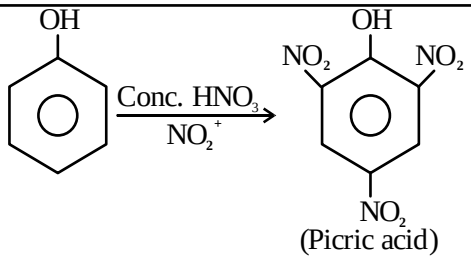
- $R-CH=CH-CH_2OH \xrightarrow{MnO_2} R-CH=CH-CHO$
- $ph-CH_2OH \xrightarrow{MnO_2} ph-CHO$
- 

$\rightarrow$ ×

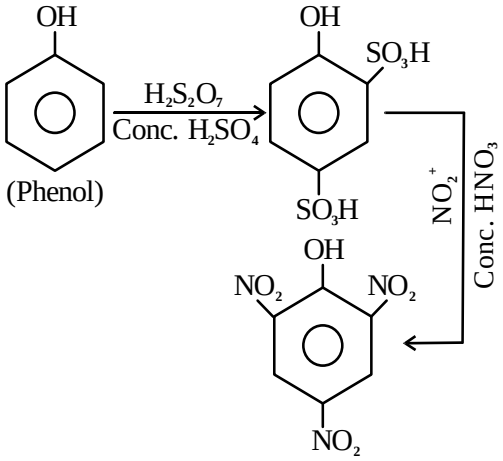


* B. Point P >O

* Volatility P < O



(Picric acid)



(Phenol)

2. HALOGENATION:

(1) Mono bromination

Br_2, CS_2, $CHCl_3$, CCl_4

Solvent — low polarity

(2) Tri bromination

Br_2, H_2O (Bromine water)

3. ACIDIC NATURE:

$phOH \rightleftharpoons phO^- + H^+$

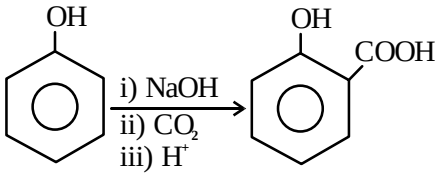
4. ESTERI FICATION:

5. ASPIRIN FORMATION:

* Acetylation of salicylic acid - aspirin

$[CH_3\text{–}\overset{\overset{O}{\|}}{C}]$ acetyl

6. KOLBE'S REACTION:



H हटाओं → ऑर्थो COOH लगाओं

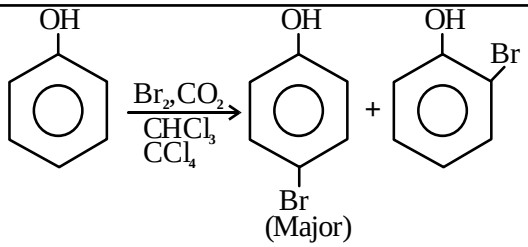
7. REIMOR TIEMANN REACTION:

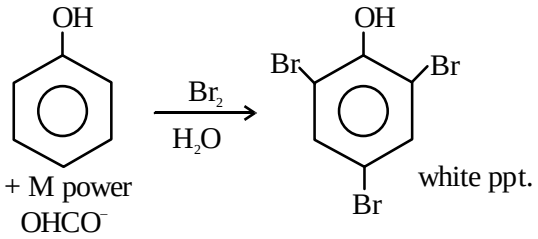
Intermediate → Benzal chloride

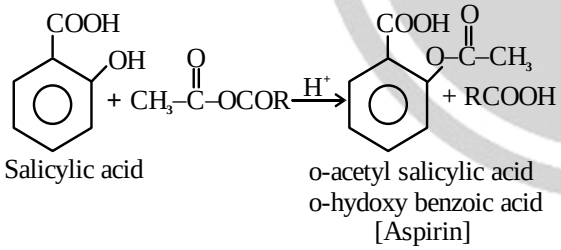
Important:

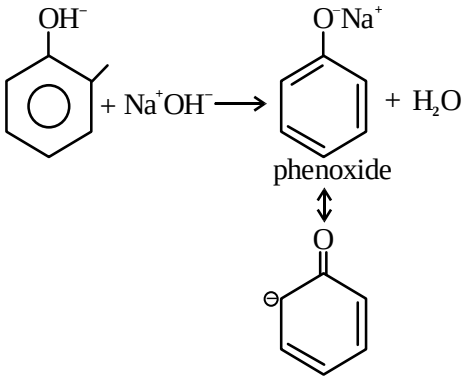
$phOH + CCl_3/HOH \rightarrow$ salicylic aldehyde

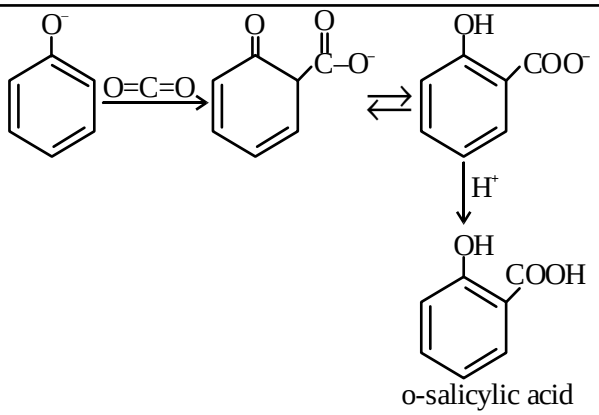
$phOH + CCl_4/HOH \rightarrow$ salicylic acid



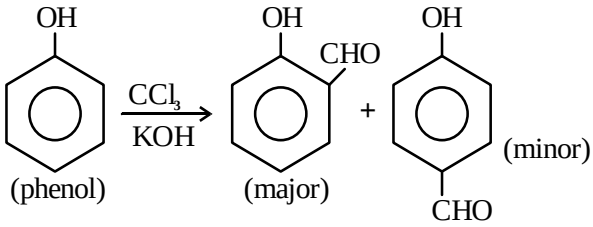


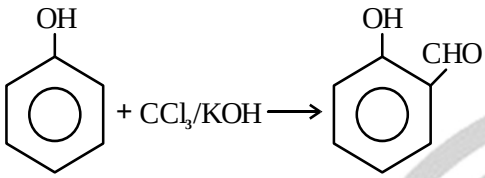
- $phOH \xrightarrow{Na/\Delta} phO^{-}Na^{+} + H_2$
- $phOH \xrightarrow{NaH} phO^{-}Na^{+} + H_2$
- $phOH \xrightarrow{NaNH_2} phONa^{+} + NH_3$
- $phOH \xrightarrow{NaOH} phONa^{+} + H_2$
- $phOH \xrightarrow{NaHOOH} phO^{-}Na^{+} + H_2CO_3$ ✕ (more acidic)
- $R-\overset{O}{\overset{\|}{C}}-OH + H-Oph \longrightarrow R-\overset{O}{\overset{\|}{C}}-O-ph$
- $R-\overset{O}{\overset{\|}{C}}-Cl + H-Oph \longrightarrow R-\overset{O}{\overset{\|}{C}}-O-ph + HCl$
- $R-\overset{O}{\overset{\|}{C}}-OCOR + H-Oph \longrightarrow R-\overset{O}{\overset{\|}{C}}-O-ph + RCOOH$ (anhydride)
- 

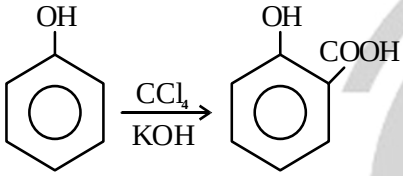
- 

- 

o-salicylic acid

- 

- 

- 

Reactant

Oxidation of phenol with Zn dust

9. Oxidation of phenol

10. **Test of Phenol:**

(i) $FeCl_8$ Test

(ii) Br water test

11. **Coupling reaction**

ESR. [p-hydroxy azo benzene]

Couple bangs

12. **Elb's reaction**

$H_2S_2O_6$/HOH hydroxyquinol

PROPERTIES OF ETHER

(1) Reaction with HX

1º and 2º alkyl – S_N2

↓

Nucleophilic attack
on less hindered alkyl

3º and Reso – S_N1

Anhydrous Hx – S_N2

Ion HX – S_N1

(2) Hydrolysis of ether

(3) Electrophilic substitution reaction:

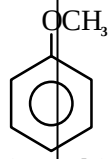
(i) Halogenation [X_2/Fe]-para major always

(ii) Friedel craft reaction:

- Alkylation ($RCl/AlCl_3$)
- Acylation ($R-\overset{\overset{O}{\|}}{C}-Cl$/Anhy. $AlCl_3$)
- Nitration (Conc. HNO_3/H_2SO_4)

(4) Reaction with PCl_5

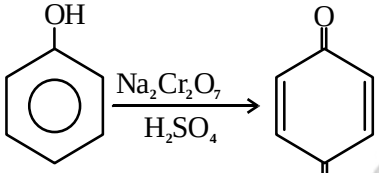
(5) Reaction with cyclic ether



(Anisole)

Functions

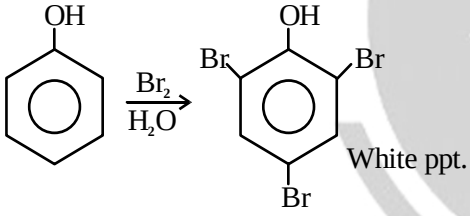
$ph-O-H \xrightarrow[dust]{Zn} ph-H$

- 

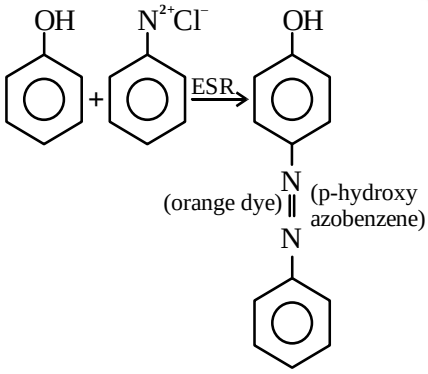
Parabenzoquinone

- $6\ phOH \xrightarrow{FeCl_3} [\overset{+3}{Fe}(Oph)_6]^{3-} + 3HCl + 3H$

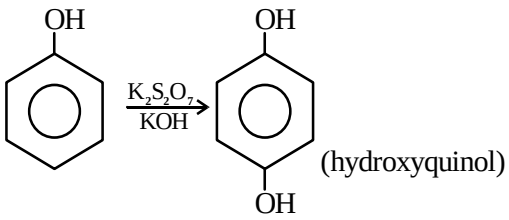
[Voilet]

- 

White ppt.

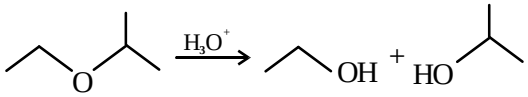
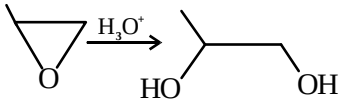
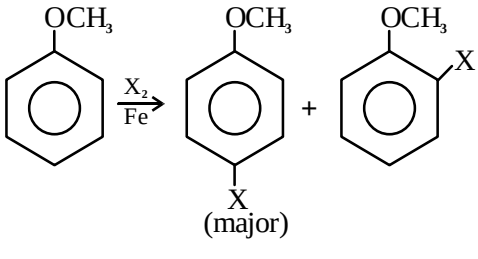
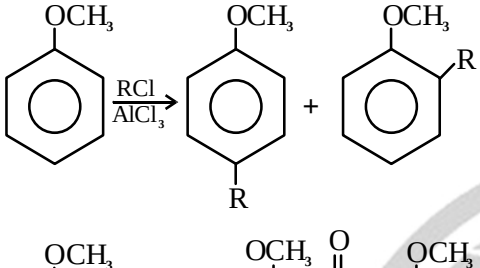
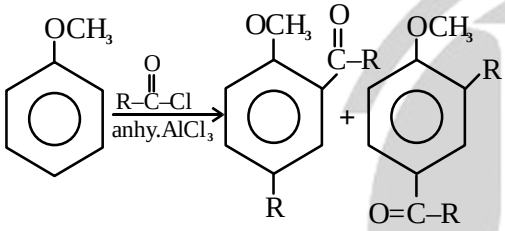
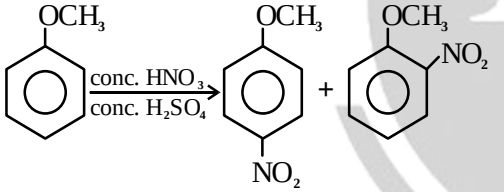
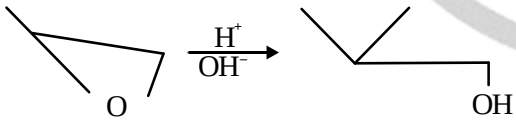
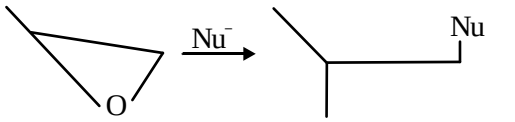
- 

(orange dye) (p-hydroxy azobenzene)

- 

(hydroxyquinol)

- $R-\underset{\underset{H}{|}}{O}-R' \xrightarrow[S_N2]{X^-} R-X + R'OH$

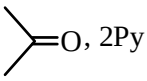
- $ph–CH_2–O–CH_3 \xrightarrow[S_N1]{Conc.HI} ph–CH_2–I + CH_3–OH$
- 
- 
- 
-
- 
- 
- 
- $CH_3–O–C_2H_5 \xrightarrow{PCl_5} CH_3Cl + POCl_3 + C_2H_5Cl$
- 
- 

Organic Chemistry

REAGENT

MOP of Carbonyl Compound

1. By oxidation of alcohols:

MOA — PCC, PDC, Cu, O_3 , 2Py

Cu/Ag 300°C

* Allylic benzylic $\longrightarrow$ MnO_4

2. By dehydrogenation of alcohols:-

Cu/Ag 300°C

3. Form hydrocarbons:-

(a) ozonolysis (Reductive):-

$O_3 + CCl_4/Zn/Me_2S$

(b) Kucherov reaction:-

Hg^{2+}/H_2O/dil. $HgSO_4$/dil. H_2SO_4

MOP of Aldehydes

1. Rosenmund reaction:-

H_2+Pd/$BaSO_4$

2. Stephen's reduction:-

$SnCl_2$ + HCl/Steam/H_3O^+

3. DIBAL-H:-

* di isobutyl aluminium hydride/H_3O^+
* mild reducing agent.

4. From hydrocarbons:-

(1) Etard reaction:-

CrO_2Cl_2/Cs_2 or CCl_4

(2) Side chain oxidation:-

$2Cl_2/h\nu$ – aq. HOH(SN^2) × 2 times

$$\begin{bmatrix} 1Cl_2 & \rightarrow & \text{alcohol} \\ 2Cl_2 & \rightarrow & \text{aldehyde} \\ 3Cl_2 & \rightarrow & \text{acid} \end{bmatrix}$$

(3) Alternate of Etard:-



$CH_3–C–OCOCH_2/C_2O_3$

(4) Gatterman Koch reaction

CO + HCl/Anhy. $AlCl_3$

MOP OF KETONES

1. From acyl chloride

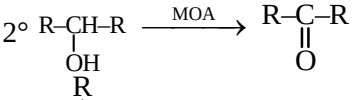
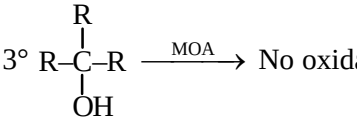
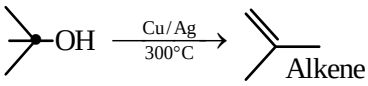
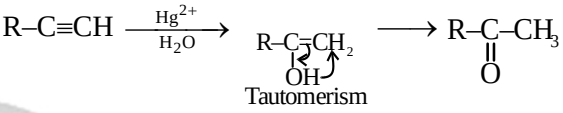
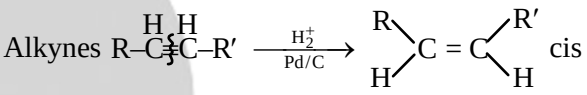
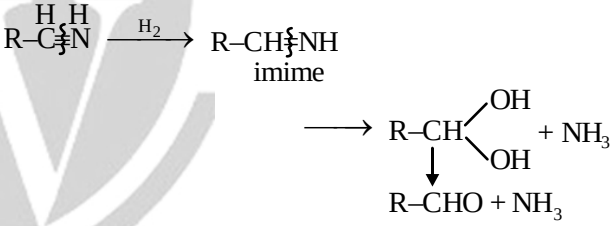
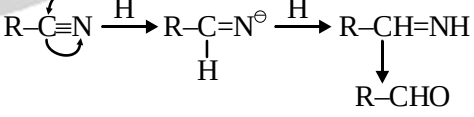
Cadmium Chloride ($CdCl_2$)

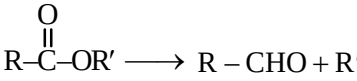
2. Grignard reagent

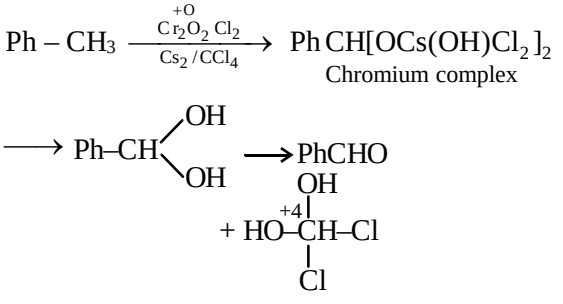
Reaction with cyanide

3. Friedel Crafts acylation

FUNCTION

- 1° $R–CH_2–OH \xrightarrow{MOA} R–CHO$ (aldehyde)
- 2°  (ketone)
- 3° 
- 
- 
- 
- Alkynes 
- 
- 
- Ester $\longrightarrow$ Aldehyde



- 

Properties of Carbonyl compound

1. Nuclophilic addition reactions:-

Reactivity:- $ROR \propto \frac{1}{S \cdot H}$

$ROR \propto$ Electrophilicity, – M, – I

Aldehyde > ketones $\propto \frac{1}{+M}, \frac{1}{+I}$

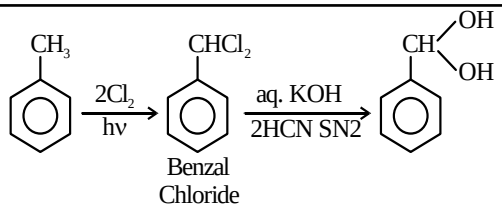
Eg of NAR:-

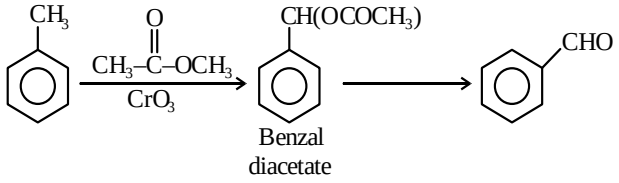
1. Addition of hydrogen cycnide (HCN):-

DM:- $CH_3-\overset{\overset{O}{\|}}{C}-H \longrightarrow CH_3-\overset{\overset{OH}{|}}{\underset{\underset{CN}{|}}{C}}-H$ Racemic mix

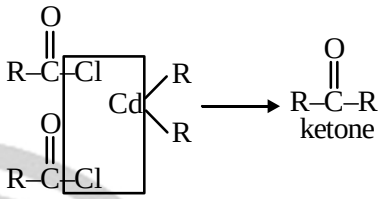
λ and L

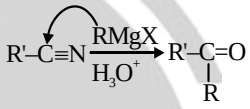
2. Addition of sodium hydrogen sulphide ($NaHSO_3$)

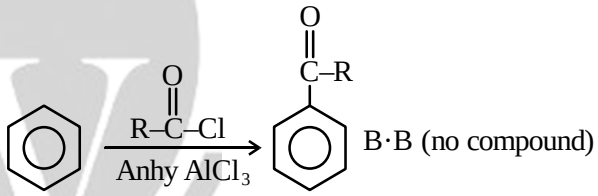
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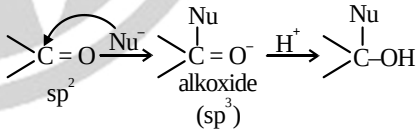
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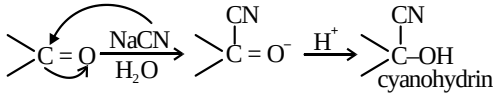
- $CO + HCl \xrightarrow{AlCl_3} CHO$

- 

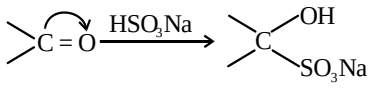
- 

- 

- 

- 

- $R - CN \xrightarrow{H_3O^+} R - COOH$

- 

All aldehyde + methyl ketone $\left[R-\overset{\overset{O}{\|}}{C}-CH_3\right]$

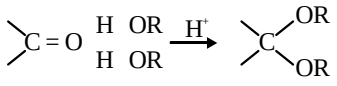
REAGENT

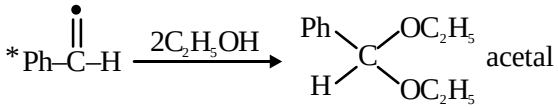
1. Addition of Alcohol

(ROH)

Direct method:

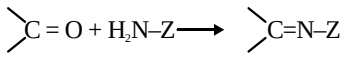
2 mole ROH





4. Hydrolysis of hemi acetal, acetal, ketal, hemi acetal
All will become carbonyl again.

5. Addition of ammonia and its derivatives.



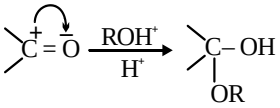
Reduction Reactions

1. Reduction by LAH, SBH and Catalytic hydrogenation.

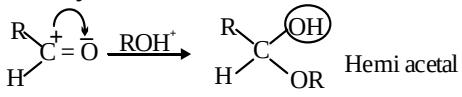
2. Clemmenson's Reduction
[Zn(Hg)con HCl] acidic zinc amulgum.

FUNCTION

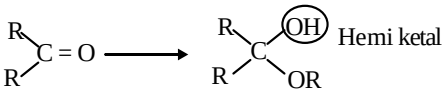
1. Reaction with 1 mole ROH



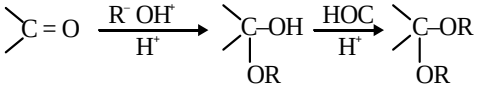
Aldehyde – hemi acetal

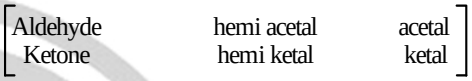


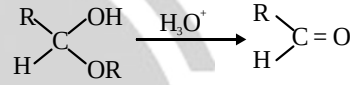
Ketone — Hemi ketal

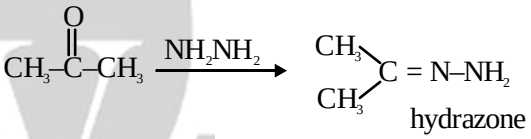


2. Reaction with 2 mole ROH

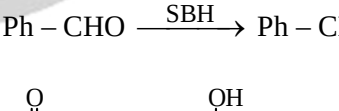




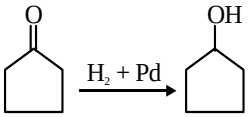
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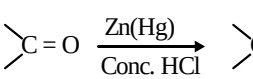


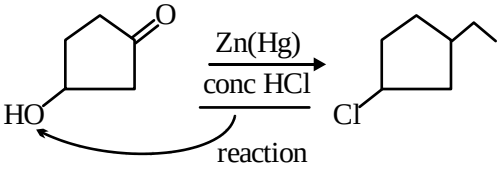
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- Ph – CHO $\xrightarrow{SBH}$ Ph – CH_2OH

- 

- 

- 

3. Wolff-Kishner reduction

$NH_2–NH_2$ / (OH, OH) glycol (basic medium)

Oxidation Reaction

1. TOLLEN'S TEST:

* Aliphatic and aromatic aldehyde

$AgNO_3 + NH_4OH$ (Ammoniacal silver nitrate)

2. FEHLING TEST:

* Aliphatic aldehyde:

Fehling A — aq $CuSO_4$

Fehling B: — NaI (sodium K tartals) (Rochell's salt)

3. BENDICT'S TEST:

*** Aliphatic aldehyde:**

aq $CuSO_4$ + Sodium nitrate

CH_3COONa

$HO–C–COONa$

CH_2COONa

4. HALOFORM TEST:

(i) $X_2 + \overline{O}H$ (NaOH/HOH)

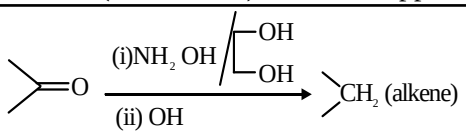
(ii) NaOX or HOX

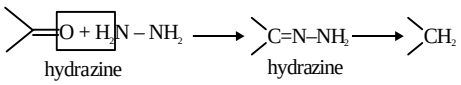
- Carbanion intermediate
- ROR ∝ stability of e^-
- ROR $Cl_2 \approx Br_2 \approx I_2$

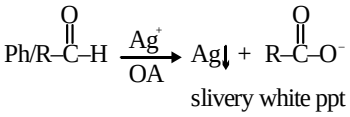
5. POPOFF'S RULE:

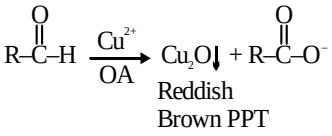
Oxidation of ketone $KMnO_4/\Delta$hightra

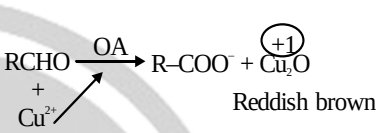
- 2° alcohol ⟶ ketone
- Ketone ⟶ carboxylic acid

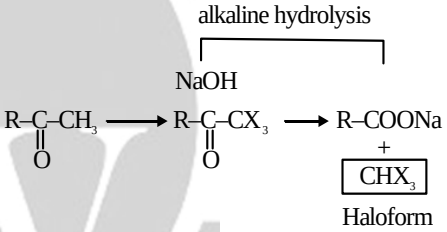


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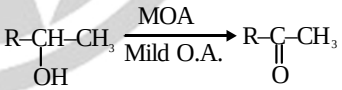
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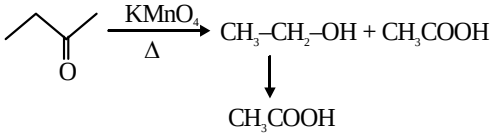
- 2° Alcohol → ketone



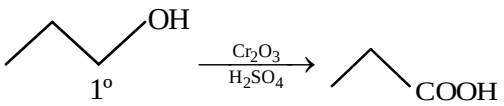
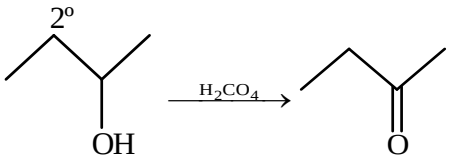
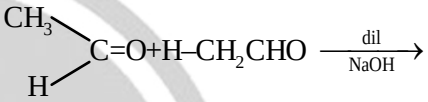
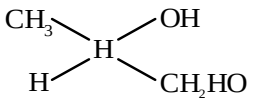
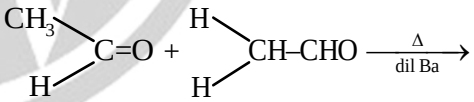
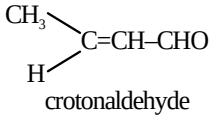
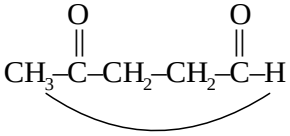
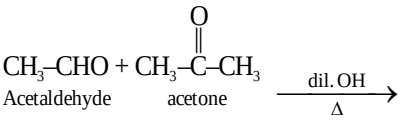
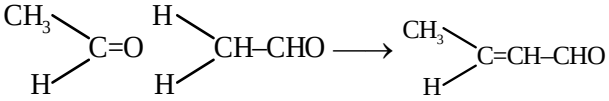
- 1° Alcohol → Acetal dehyde

$CH_3CH_2–OH \xrightarrow{HOA} CH_3CHO$

ethanol — acetaldehyde

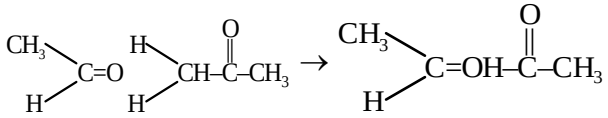
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(Section-I) PHYSICS

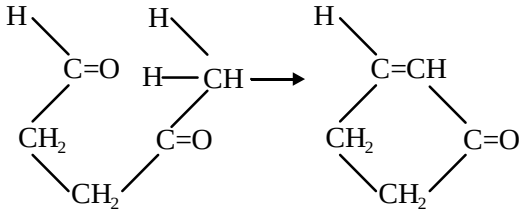
REAGENT	FUNCTION
6. STRONG OXIDISING REAGENT	$1^o \longrightarrow$ Acid, $2^o \longrightarrow$ Ketone $3^o \longrightarrow$ reaction.
	•  $CH_2OH \longrightarrow COOH$ reaction
	• 
ALDOL CONDENSATION **1. Aldol Condensation :-** * Carbonyl Compounds having αH * Reagent → dil NaOH/HOH or Na_2CO_3/H_2CO_3 Carbonyl compound (αH) $\xrightarrow[NaOH]{dil}$ β hydroxycarbonyl compound • β hydroxy Carbonyl Compound $\xrightarrow{\Delta}$ α, β, unsaturated carbonyl compound	1. $2CH_3CHO \xrightarrow[NaOH]{dil} CH_3\underset{OH}{\underset{\vert}{\beta CH}}-\alpha CH_2-CHO$ β-hydroxycarbonyl
	•  
	2. $2CH_3CHO \longrightarrow CH_3-CH=CH-CHO$ Crotonaldehyde
2. Cross-aldol condensation:- * 2self + 2 ions = 4	•   crotonaldehyde
3. Intramolecular aldol condensation  * 6 > 5 > 7 > 4 ring NAR Ald > Ket.	•  Total no of structural product (4)
4. Cannizzaro Reaction :- * Opp. of aldol * Req. – Aldenyde (not having αH) Ketone – Hydride Shift Reagent → conc.KOH/NaOH 50% KOH/NaOH	* 2 self 

5. Cross Cannizzaro: -
Conc KOH.

* 2 ions



6. Intramolecular Cannizzaro: -



$$H-CHO \xrightarrow[KOH]{50\%} H-COOH$$

7. Electrophilic Substitution Reaction :-

* Aromatic aldehyle and ketone.

$$H-CHO \xrightarrow[KOH]{50\%} H-CH_2OH$$

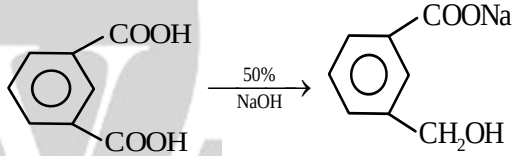
- $H-CHO$ (always oxidise) $+$ ph CHO $\xrightarrow{conc.\ KOH}$

$$H\text{-}COOR + pH\ CH_2OH$$

CARBOXYLIC ACID
Method of preparation of carboxylic acid

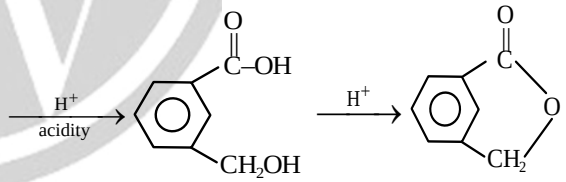
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1. From oxide of OH, aldehyde, Ketones

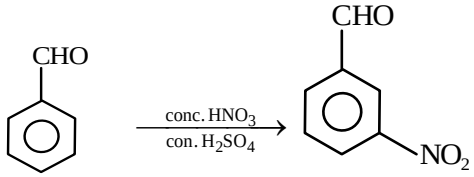
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SOA: - $KMnO_4/H^+$, not $KMnO_4/H_2Cr_2O_7/H^+/Cr_2O_3 + H_2SO_4$

$CrO_3 + H_2O \rightarrow H_2\ Cr_2O_4$ /con HNO_3.



2. From oxidation of alkylated benzene:

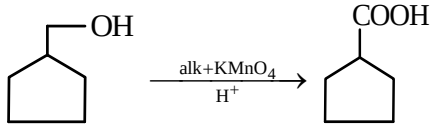
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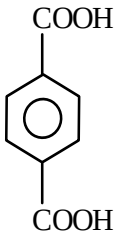
* Atleast 1 Benzylic H.

–M
meta dine

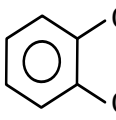
* Reagent $\dfrac{\text{Alc } KMnO_4}{H^+} \Big/ \dfrac{KMnO_4 - KOH}{H^+}$

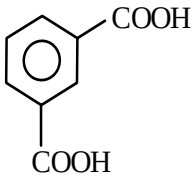
- 1º alcohol ⟶ Acid
- Ald. ⟶ Acid
- Ketone ⟶ Acid (popoa)

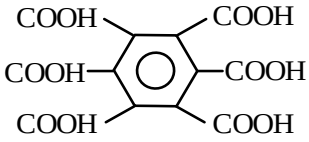
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→ Terephthalic acid

-  → Phthalic acid

-  Isophthalic acid

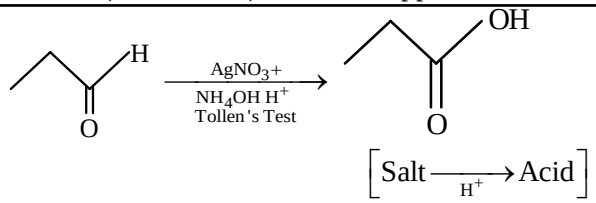
-  Helithelic acid

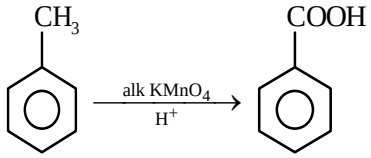
3. From hydrolysis of acid derivatives:-

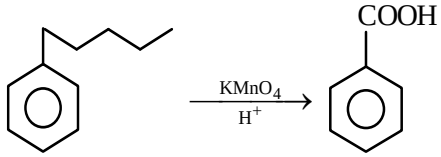
   (a) Nitrile

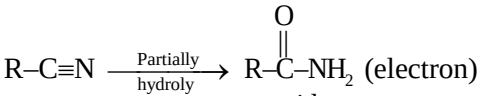
   (b) Acid chloride

   (c) Anhydride

- 

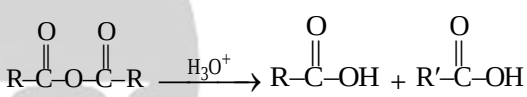
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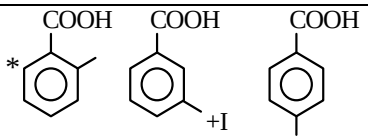
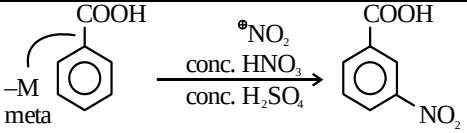
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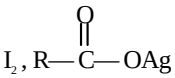
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S. No.	Reagent	Functions
	d) Ester e) Amides	• $R-\overset{O}{\overset{\|\|}{C}}-OR \xrightarrow{H_3O^+} R-\overset{O}{\overset{\|\|}{C}}-OH + R'OH$ • $R-\overset{O}{\overset{\|\|}{C}}-NH_2 \xrightarrow{H_3O^+} R-\overset{O}{\overset{\|\|}{C}}-OH$ * Compound $\xrightarrow[H_3O^+]{\text{Acidic}}$ RCOOH $\downarrow$ Alkaline OH^-/H_2O $R-COO^-$
9.	From Grignard reagent :-	$R^{\ominus}MgX \xrightarrow{O=C=O} R-\overset{O}{\overset{\|\|}{C}}-O^{\ominus}MgX \rightarrow RCOOH$
	Properties of Carboxylic acid	
1)	Acidic Strength : • Acidic Strength : $\propto -M \quad \propto -I \quad \propto \frac{1}{+M} \quad \propto \frac{1}{+I}$	*  1 > 2 > 3 +M > +I
2)	Reaction with PCl_3, PCl_5, $SOCl_2$:- $-OH \rightarrow Cl$	
3)	Anhydride formation:- P_2O_5/conc. H_2SO_4	$R-\overset{O}{\overset{\|\|}{C}}-OH \xrightarrow[\text{conc. } H_2SO_4]{P_2O_5/} R-\overset{O}{\overset{\|\|}{C}}-O-\overset{O}{\overset{\|\|}{C}}-R$
4)	Esterification :-	$R-\overset{O}{\overset{\|\|}{C}}-OH + HOR' \underset{}{\overset{H^+}{\rightleftharpoons}} R-\overset{O}{\overset{\|\|}{C}}-OR' + H_2O$
5)	Reaction with Ammonia :-	$R-\overset{O}{\overset{\|\|}{C}}-OH + NH_3 \rightleftharpoons R-\overset{O}{\overset{\|\|}{C}}-O^{\ominus}NH_4^+ \xrightarrow{\Delta,\ -H_2O} R-\overset{O}{\overset{\|\|}{C}}-NH_2$ DM : - OH hatao, NH_2 lagao $R-\overset{O}{\overset{\|\|}{C}}-OH + H-NH_2 \longrightarrow R-\overset{O}{\overset{\|\|}{C}}-NH_2$
6)	HVz Reaction :- Red P – X_2/H_2O Hell volhard zeheinskey. Acid having α-H	$R-CH_2-COOH \xrightarrow[(2)\ H_2O]{(1)\ \text{Red P}-X_2} R-\underset{\displaystyle X}{\underset{\|}{CH}}-COOH$ DM : - H hatao, X lagao.
7)	Kolbe's Electrolysis :-	$R-COOH \xrightarrow{\text{enetro}} R^{\bullet} \xrightarrow{R^{\bullet}} R-R$
8)	Decarboxylation :- NaOH, CaO	$R-COOH \xrightarrow[CaO]{NaOH^+} R-H$ $R-COONa \xrightarrow[CaO]{NaOH^+} R-H$
9)	ESR :- Conc. HNO_3, conc H_2SO_4	
	REAGENT	LAH / B_2H_6
	REDUCTION:-	

HUNSDIECHER REACTION :-

Br_2 / CCl_4
DM– COOAg hatao, Br lagao

SIMONINI REACTION :-



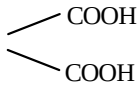
SCHOTTEN BAUMAN REACTION:-

Py  (Basic)

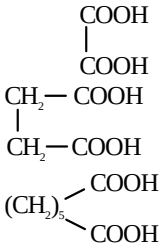
HEATING EFFECT :-

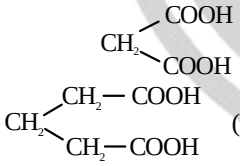
β–keto acid

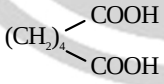
Dicarboxylic acid.

General formula 

n =	0	1	2	3	4	5
	O	M	S	G	A	p
	Oxalic	Malic	Succinic	Glutamic		
	Adipic acid		pamelic acid			

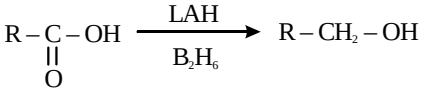


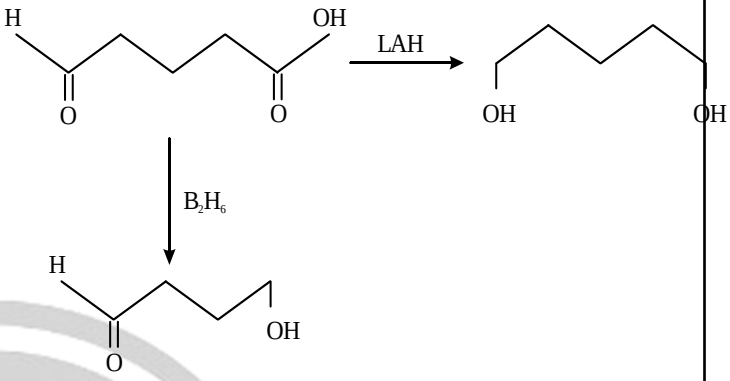


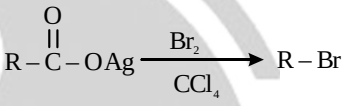


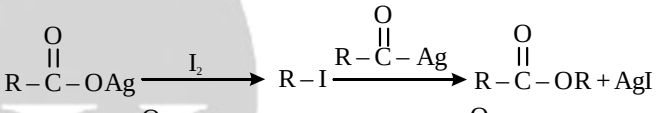
n = 0 CO, CO_2, H_2O
n = 1 CO_2
n = 2,3 H_2O
n = 4,5 CO_2 , H_2O

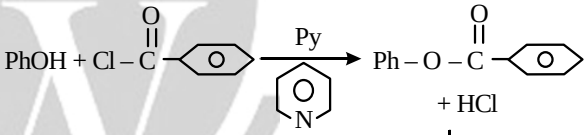
FUNCTION

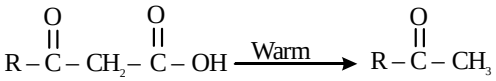


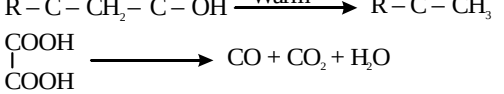


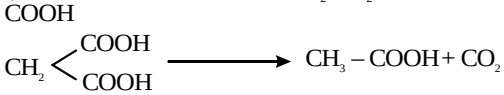


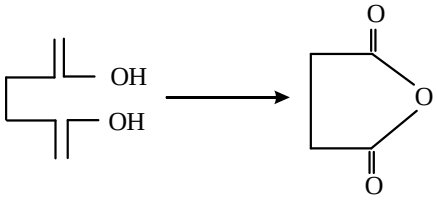












MOP Of AMINES:-

(1) Reduction of nitro compounds:

Sn/HCl or Fe/HCl
H_2 +Pd/OH

(2) Ammonolysis of alkyl halide:-

(3) Reduction of nitrile:-
LAH/| Na(Ag) + EtOH /H_2 + Ni

(4) Reduction of amide:-

LAH

(5) GABRIEL PHTHALIMIDE SYNTHESIS:-

- Aliphatic iamine

(6) HOFFMAN BROMAMIDE DEGRADATION REACTION:-

[Br_2/HOH] $\begin{bmatrix} O \\ \| \\ C \end{bmatrix}$ chupa do

4 mole HOH

PROPERTIES OF AMINES:-

(1) Basic strength :-

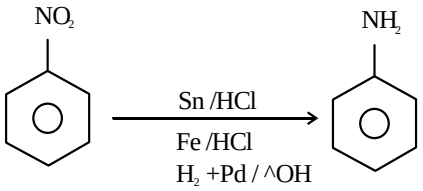
Availability of *l*.p. on N ↑	S1B –BS ↓ 1° and 0
B.S $\propto$ + M $\propto \frac{1}{-I,-M}$	S1B –BS ↑ 2° and 3°

(2) Alkylation:-

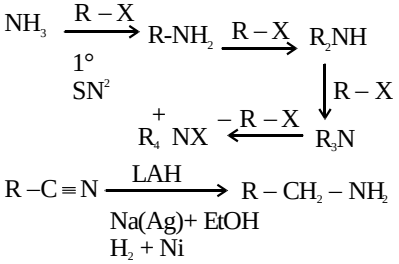
(3) Acylation:- only time

Py – to neutralize HCl

SN_{At}



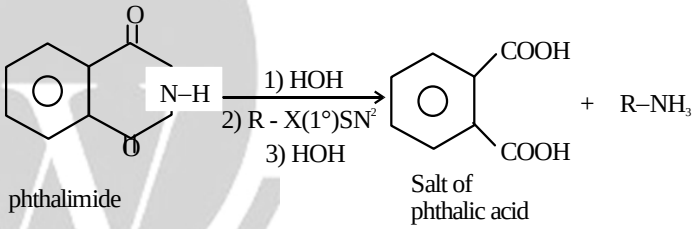
NO_2 hatao, NH_2 lagao.

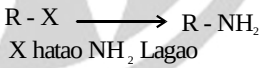


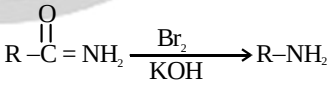
CN hatoa, CH_2 NH_2 lagao

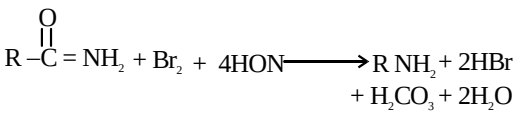


C = O hatao, CH_2 lagao

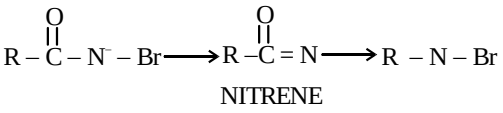


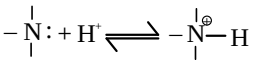


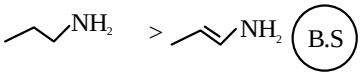


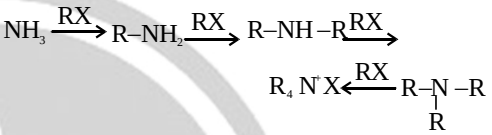


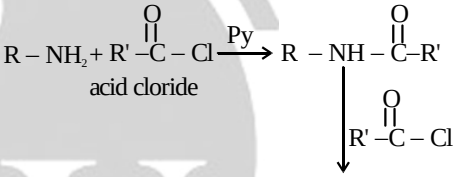
Alternate pattern:-

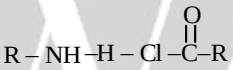




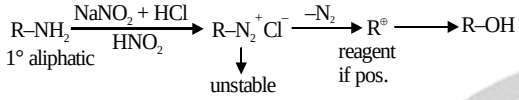




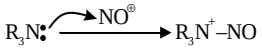




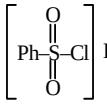
4. Carbyl amine test
Isocyanide test
Aliphatic and 1° aromatic amine
Reimer tiemann reaction
intermediate CCl_2 (dcc)
Reaction with nitrous acid
1° aromatic amine (diazotionsation)
2° aromatic amine / Aliphatic
3° aromatic



Aliphatic 3°:-



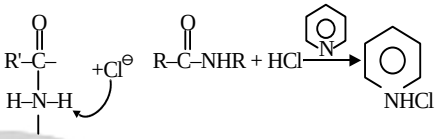
5. Hinsberg test

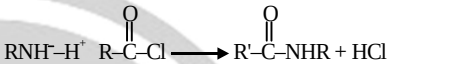


Hingberg's Reagent

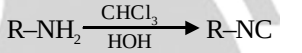
Benzene sulphonyl chloride

6. ESR
(i) Bromination
$Br_2 + Cs_2$ – Tribromo
$Br_2 + H_2O$ – Tribromo
Phenol – monobromo
Phenol-Tribromo



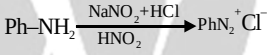


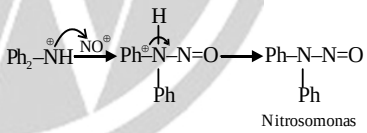


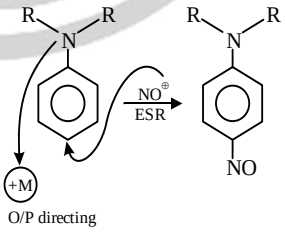


2HOH

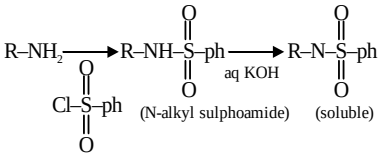
$NaNO_2 + HCl \longrightarrow HNO_2 + NaCl$



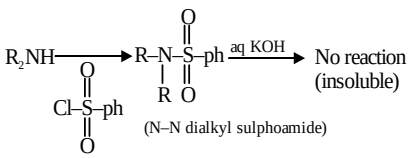




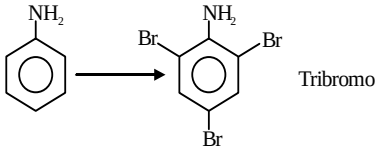
1° amine

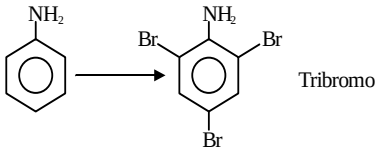


2° amine



3° amine $\longrightarrow$ No reaction



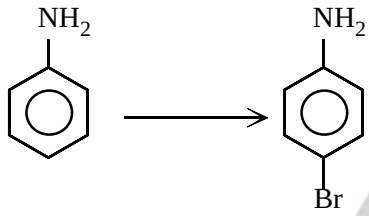


Nitration :- NO_2^+

To get monobromide in aniline:-

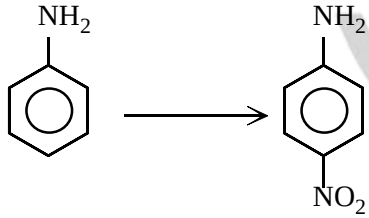
Case I :- for monobromination:-

$$CH_3\text{–}\overset{\overset{O}{\|}}{C}\text{–Cl},\ Br^+, H_3O^+$$



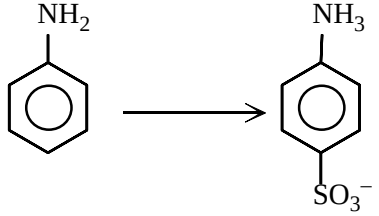
Case II :- For mononitration

$$CH_3\text{–}\overset{\overset{O}{\|}}{C}\text{–Cl},\ NO_2^+, H_3O^+$$



3. Sulphonation :-

* H_2SO_4, Acid Base — Zooithrtion / Bipolanion.



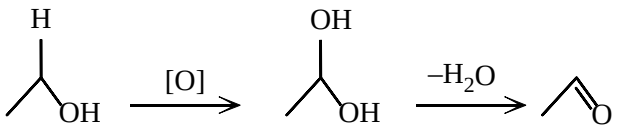
* MOP of Diazonium salt :-

$$Ph - NH_2 \xrightarrow[H_2SO_4]{NaNO_2} PhN_2 + HSO_4^-$$

* Reducing Reaction:-

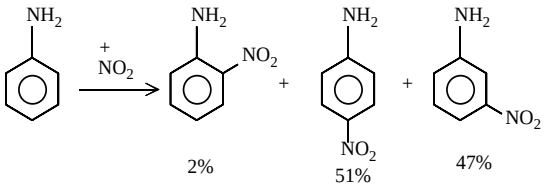
* $\overset{aq\ H_3PO_2\ /}{\wedge}$ OH

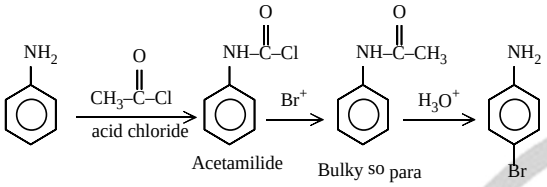
* alcohol — aldehyde.

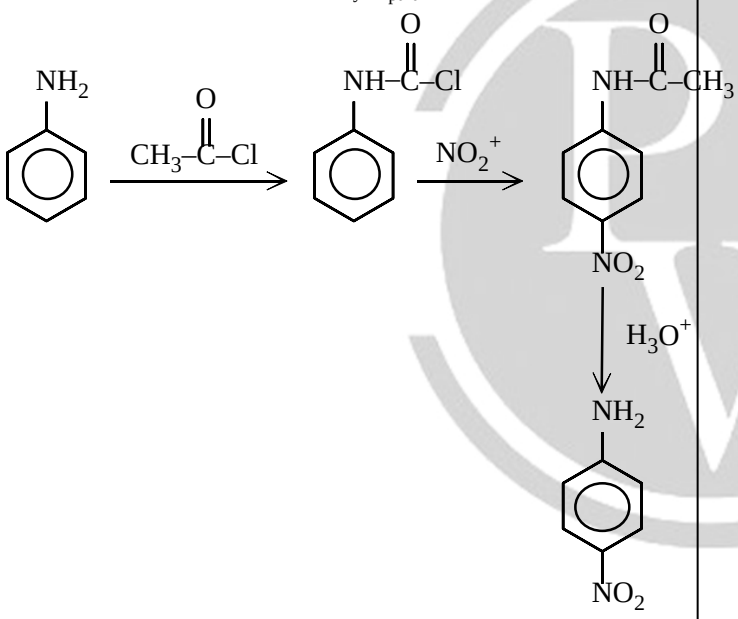


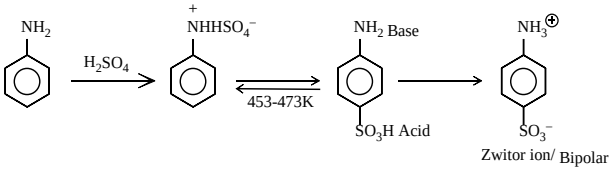
Formation of nitrobenzene:-

$NaBF_4$ / $NaNO_2$ / CuΔ





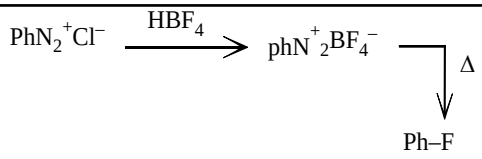


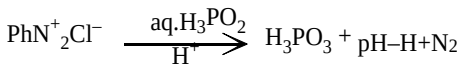


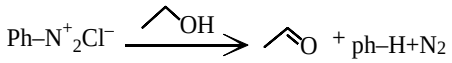
* $Ph - NH_2 \xrightarrow[0-5°C]{NaNO_2 + HCl} \underset{BDC}{Ph - N_2^+Cl^-}$
* $Ph - N_2^+Cl^- \xrightarrow{Cu_2Cl_2 / HCl} Ph - Cl$
* $PhN_2^+Cl^- \xrightarrow{Cu_2Br_2 / HBr} Ph - Br$
* $PhN_2^+Cl^- \xrightarrow{CuCN / HCN} Ph - CN$
* $PhN_2^+Cl^- \xrightarrow{Cu / H_2O} PhOH$
* $PhN_2^+Cl^- \xrightarrow{Cu / HBr} PhBr$

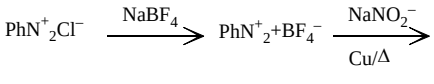
* $PhN_2^+Cl^- \xrightarrow{HI} PhI$

* $PhN_2^+Cl^- \xrightarrow{Cu/HCl} Ph-Cl$

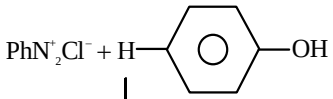




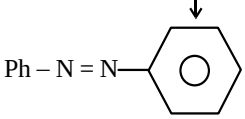






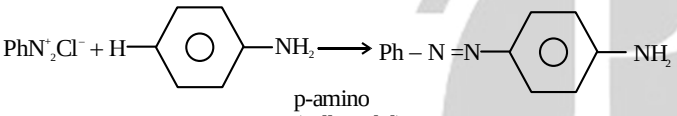


(1)



p-hydroxyoxobenzene
(orange red)

(2)



p-amino
(yellow dyl)