

# ALCOHOL PHENOL & ETHER

Class XII  
BOARD EXAM

↳ These notes  
have been verified by  
top faculties & CBSE  
Science Toppers

↳ As per  
updated  
syllabus

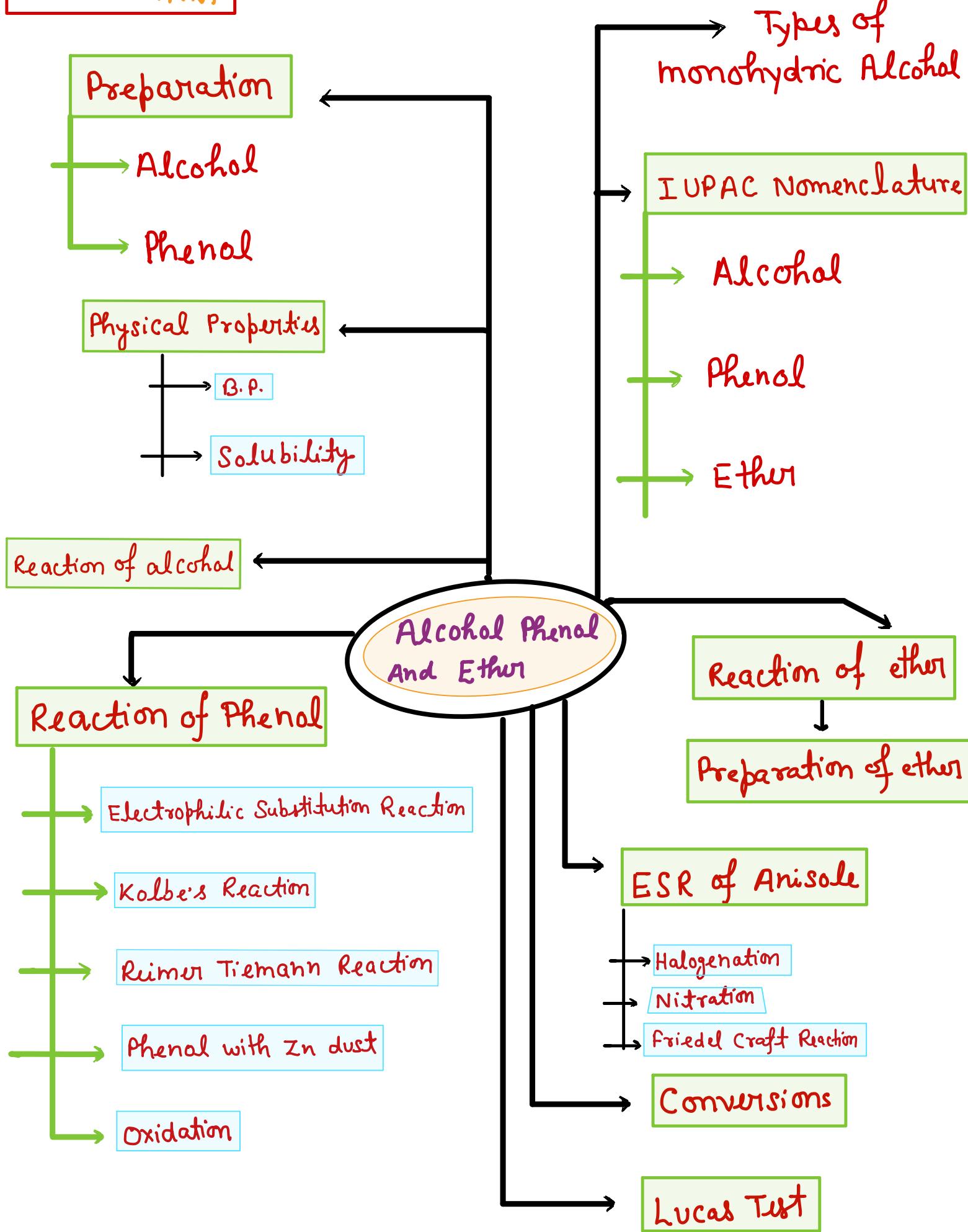
↳ Target 100  
↳ Previous Year Q's

JAO AB  
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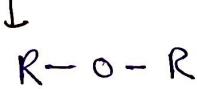
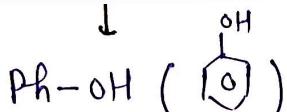
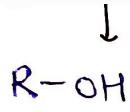


*Aman  
Dhatarwal*

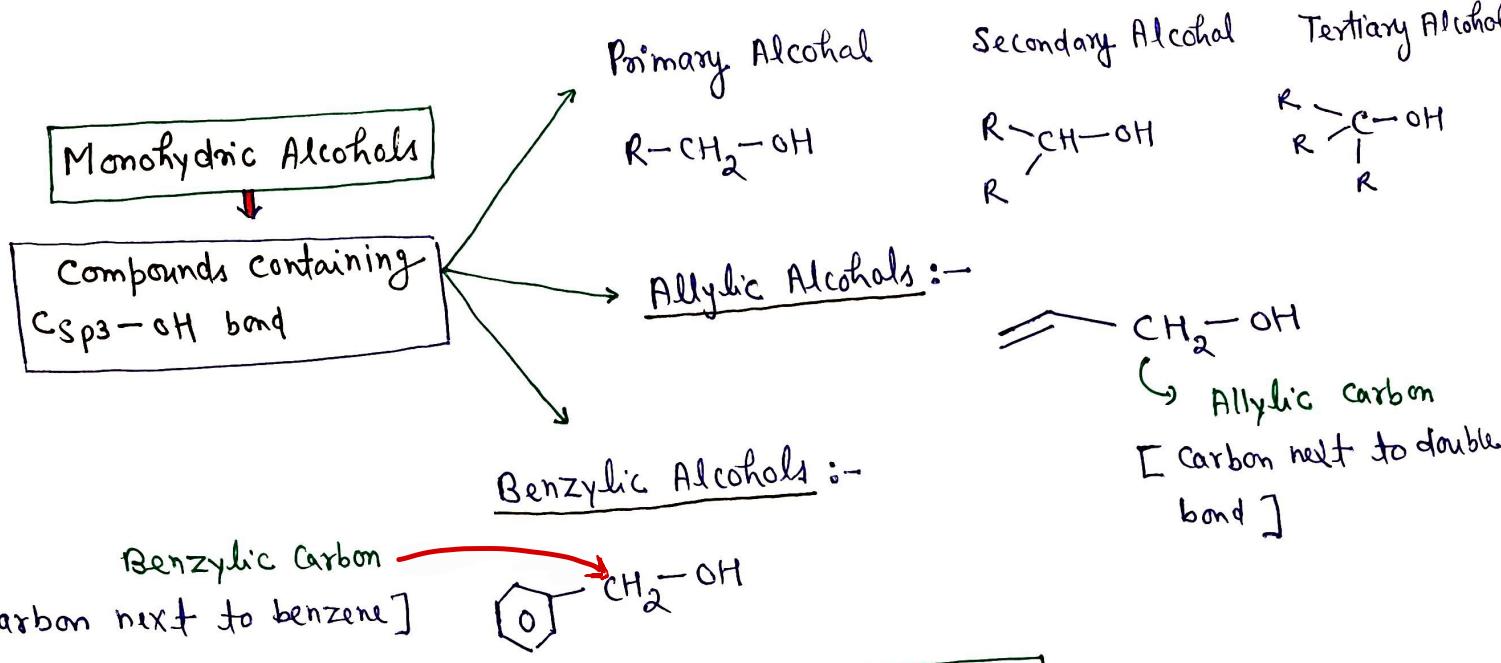
## FLOW CHART



# Alcohols, Phenols and Ethers



Apni Kaksha



## IUPAC Nomenclature of Alcohols

→ The longest carbon chain is numbered starting at the end nearest to the hydroxyl group (-OH).      Alkane - e + ol = Alkanol

Examples :—  $CH_3-OH$  : Methanol (Methyl alcohol) ;  $CH_3-\overset{\underset{OH}{|}}{CH}-CH_3$

$CH_3-\overset{1}{CH_3}-\overset{2}{C}-\overset{1}{OH}$  : 2-Methylpropan-2-ol  
(tert-Butyl alcohol) : [Delhi 2012] 1M

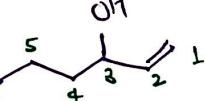
→  $\text{C}_6\text{H}_5-\overset{2}{CH_2}-\overset{1}{CH_2}-OH$  : 2-Phenylethan-1-ol →  $\overset{OH}{CH_2}-\overset{1}{CH}-\overset{2}{C}=\overset{3}{C}-\overset{CH_3}{CH_3}$  [2015]  
[CBSE 2016] 1M

: 3-Methylbut-2-en-1-ol

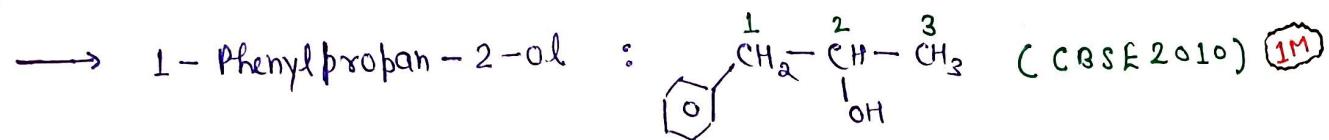
→  $CH_3-\overset{CH_3}{C}(\overset{3}{CH_3})-\overset{2}{CH}-\overset{1}{CH_3}$  : 3,3-Dimethylpentan-2-ol  
[2018] 1M

→  $\overset{1}{CH_2}-OH$   
 $\overset{2}{CH}-OH$   
 $\overset{3}{CH_2}-OH$  : Propan-1,2,3-triol  
(Glycerol) 1M

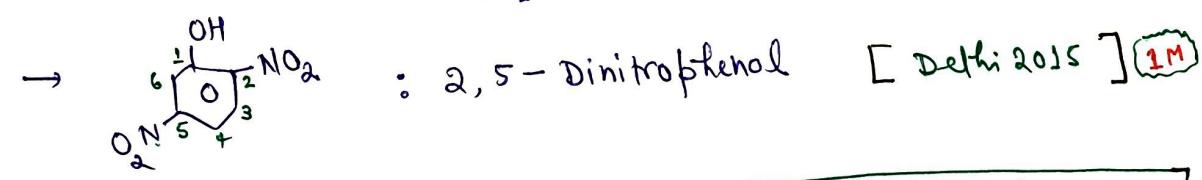
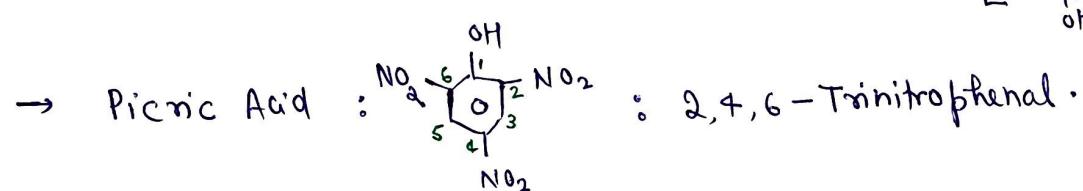
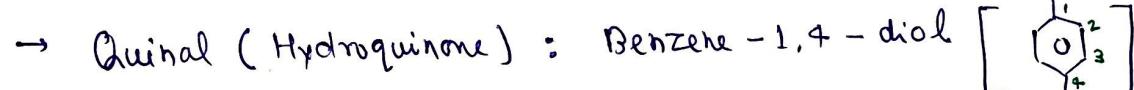
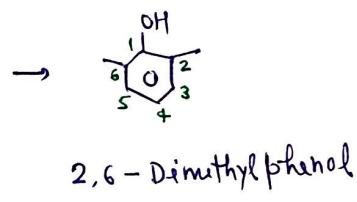
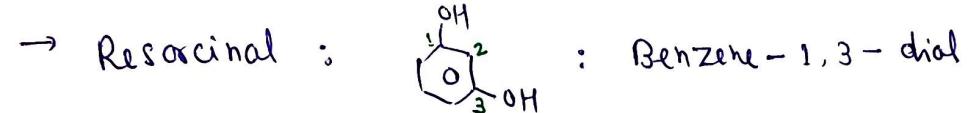
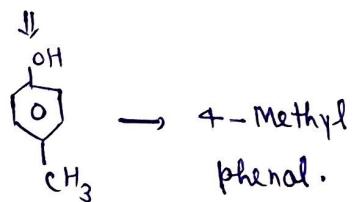
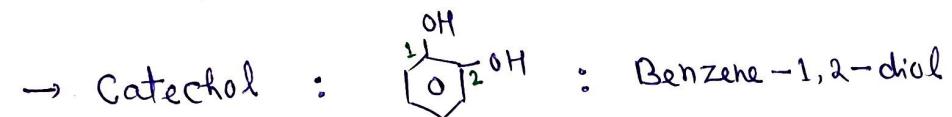
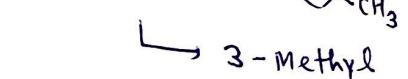
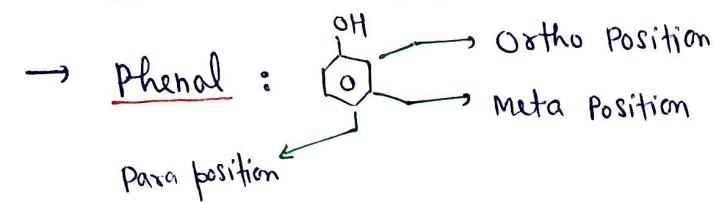
→ Hex-1-en-3-ol

Delhi 2012] 1M Structure → 

Apni Kaksha



### IUPAC Nomenclature of Phenols



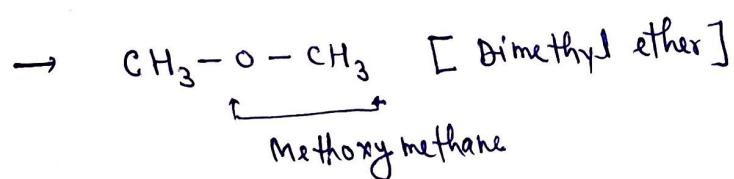
[2011]

**1M**

### IUPAC Nomenclature of Ethers

Alkoxy Alkane  
R-O-R'

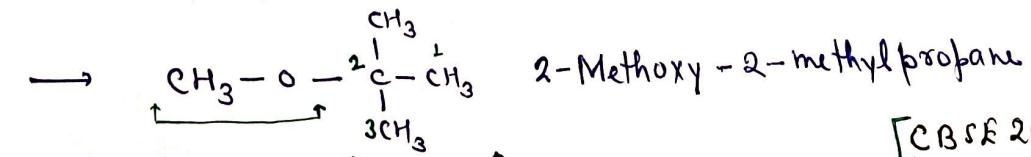
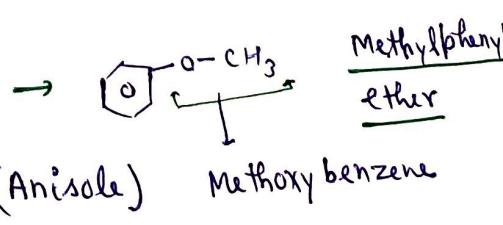
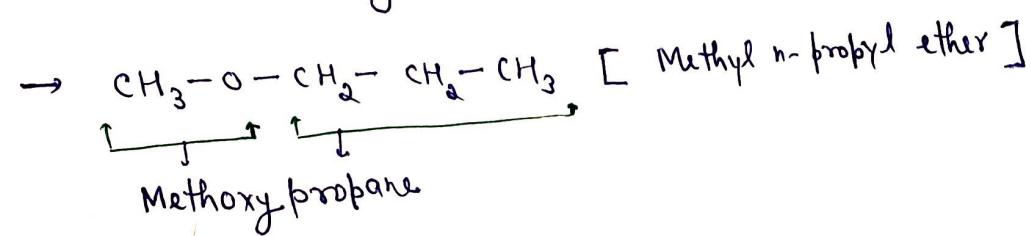
→ Common name of ethers are derived from the names of alkyl groups written as separate words in alphabetical order and adding the word "ether" at the end.

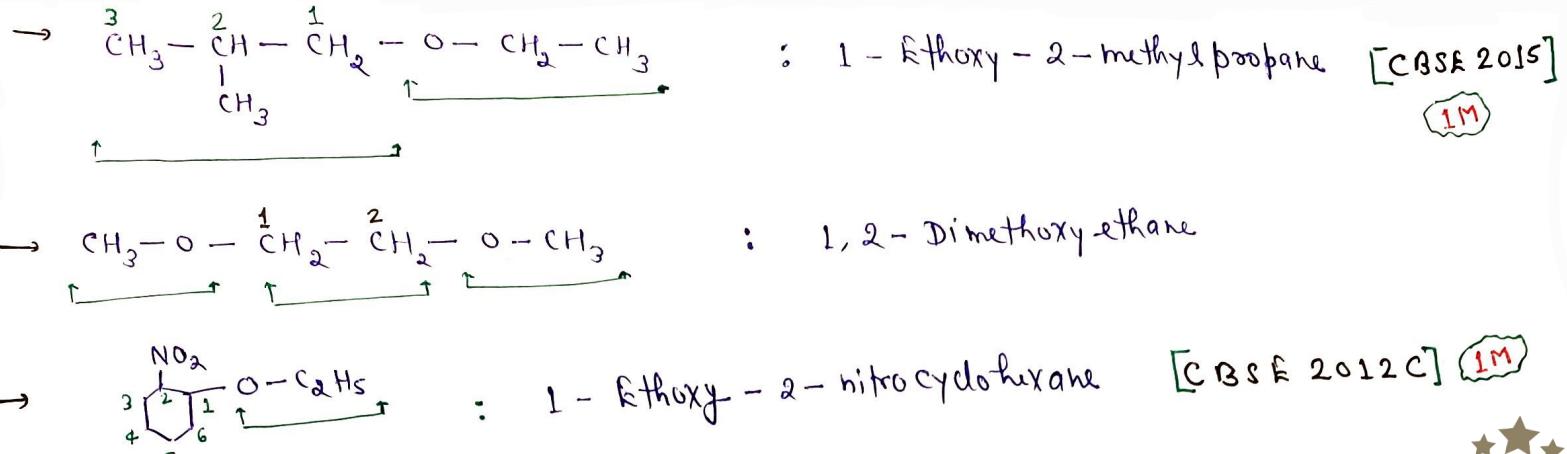


Less no. of Carbon  
More no. of carbon



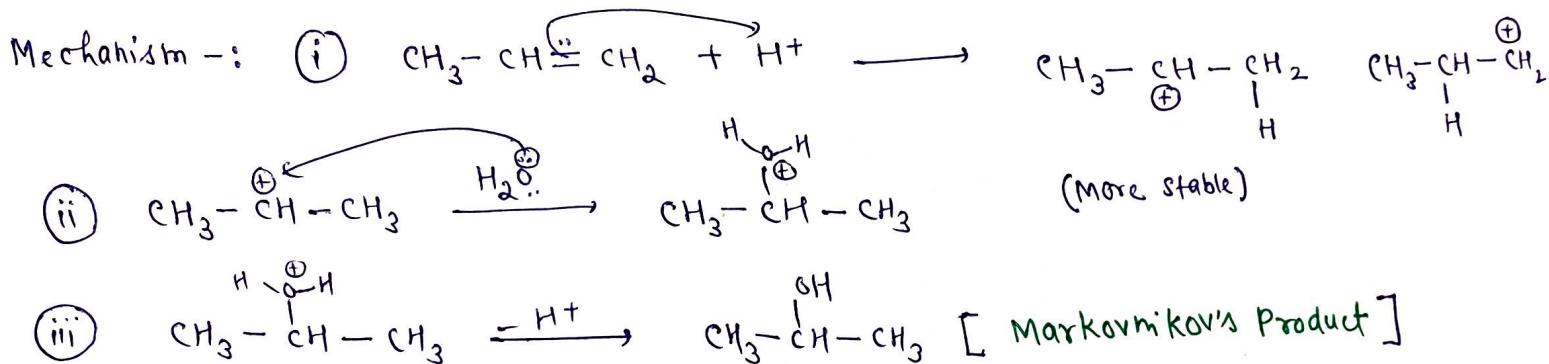
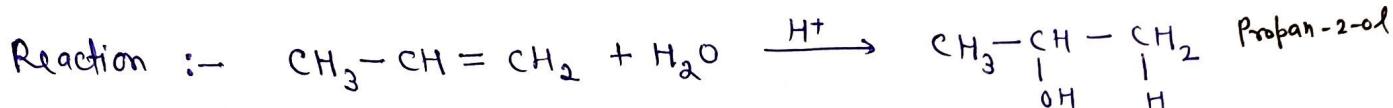
Alkane Alkoxy





### Preparation of alcohols

1.] From alkenes :- [a.] Acid catalysed hydration :-



[b.] Hydroboration - Oxidation Method :-



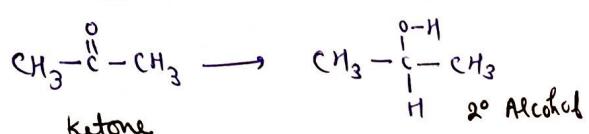
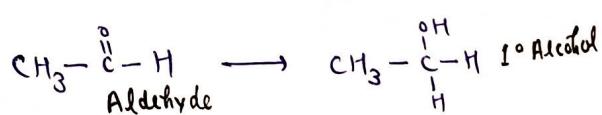
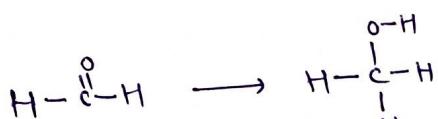
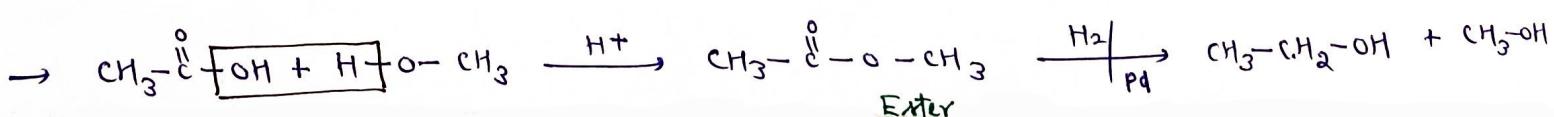
[Delhi 2013] 1M [CBSE 2016]

2.] From Carbonyl Compounds :-

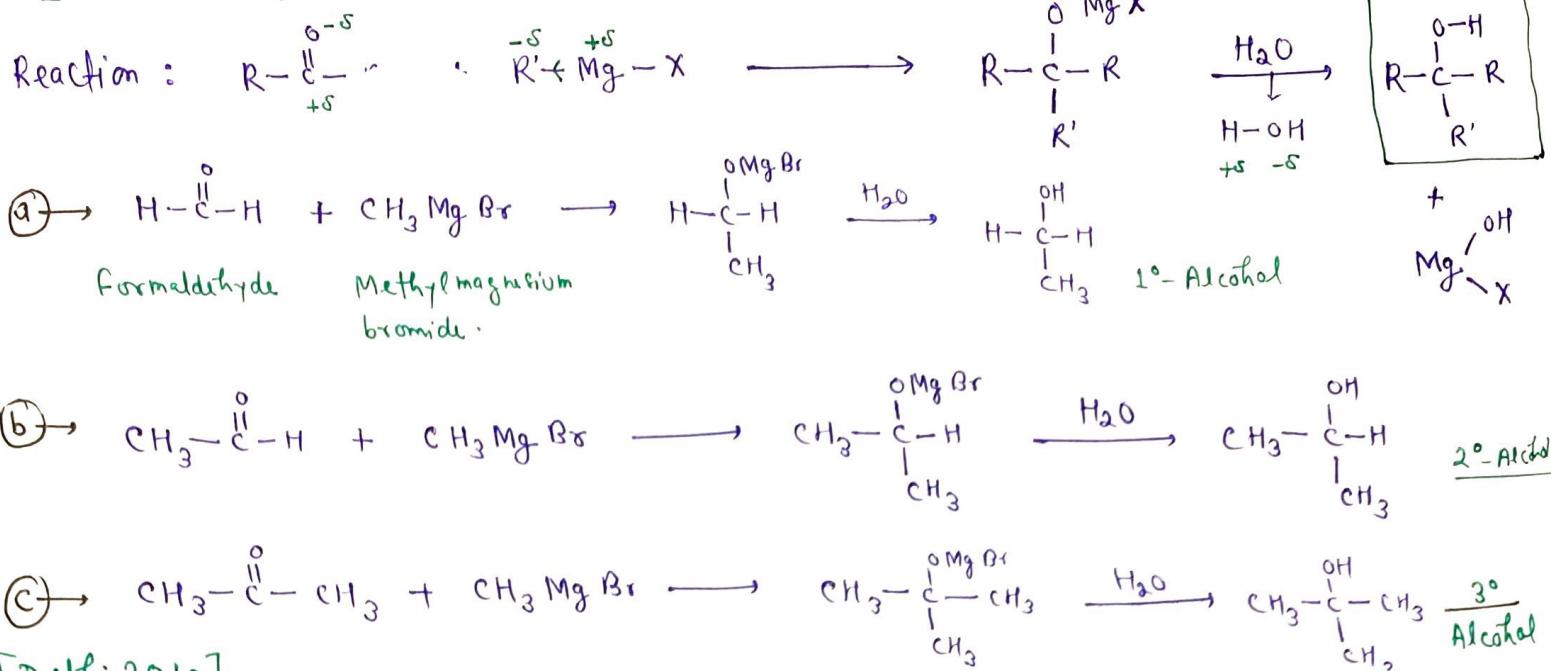
(a)  $\rightarrow$  Reduction of aldehyde and ketone :-

Reducing agent :  $\text{NaBH}_4$  |  $\text{LiAlH}_4$  |  $\text{H}_2$  with Pd  
only for ketone/aldehyde  $\hookrightarrow$  Ketone/Aldehyde/Acid

(b)  $\rightarrow$  Reduction of carboxylic Acid :-



### 3.] From Grignard Reagents -:

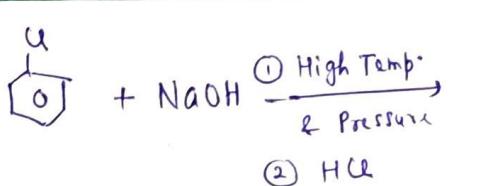


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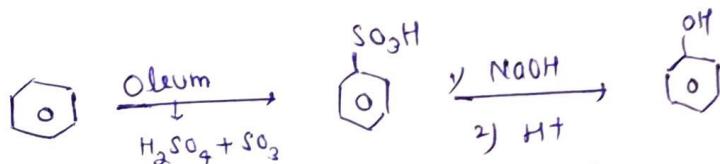


### Preparation of Phenol

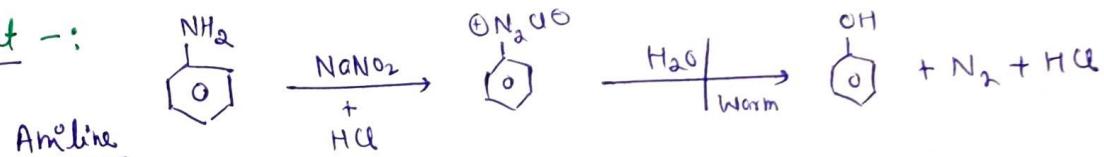
#### 1. From Haloarenes -:



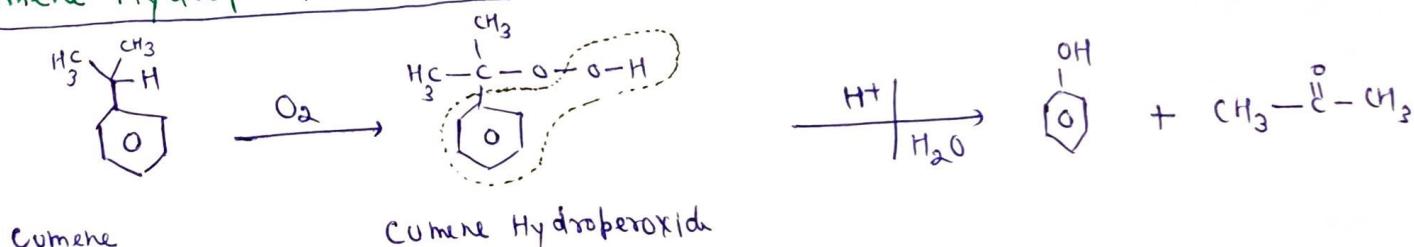
#### 2. From Benzenesulphonic Acid -:



#### 3. From diazonium salt -:



#### 4. Cumene Hydroperoxide Method -:

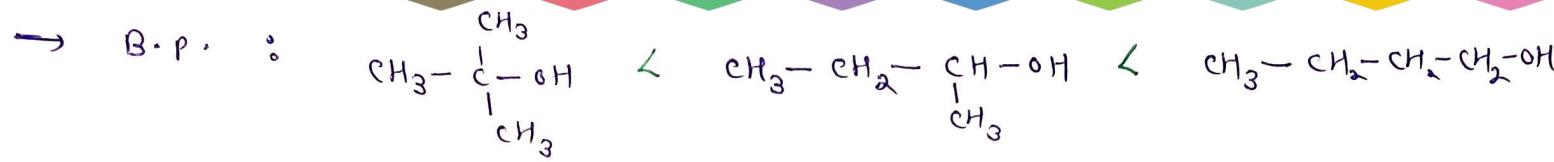


### Physical Properties

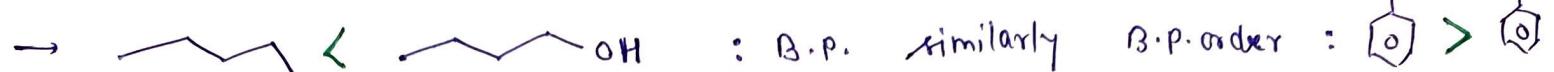


Boiling Point -: B.P. of alcohols and phenols  $\uparrow$  as no. of carbon atoms increases

→ In alcohols -: As branching  $\uparrow \Rightarrow$  B.P.  $\downarrow$  es : This is because of decrease in Vander Waals forces with decrease in surface area.

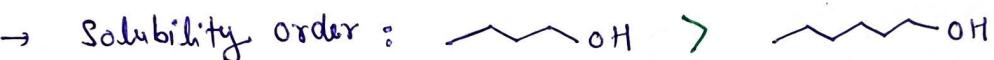
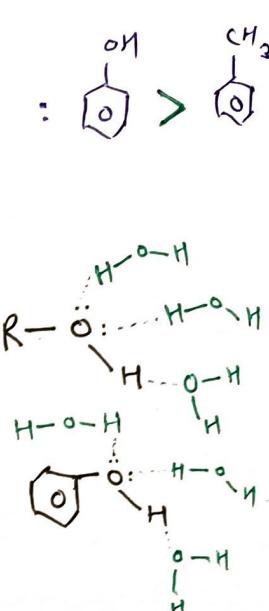


→ B.P. of alcohols and phenols are higher in comparison to hydrocarbons, ethers, haloalkanes and haloarenes of comparable molecular masses. This is because of hydrogen bonding in alcohols and phenols. [CBSE 2012] **1M**

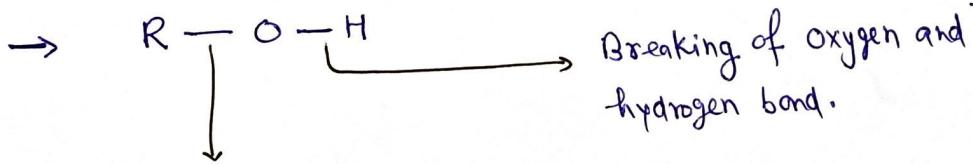


Solubility :- Solubility of alcohols and phenols in water is due to their ability to form hydrogen bonds with water.

→ Solubility  $\propto \Rightarrow$  size of alkyl / aryl group  $\uparrow \downarrow$   
 (Hydrophobic part.)

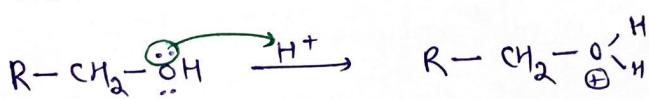
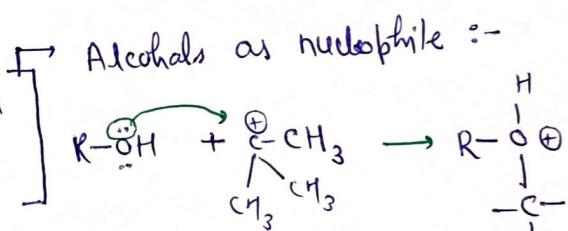


### Chemical Reactions



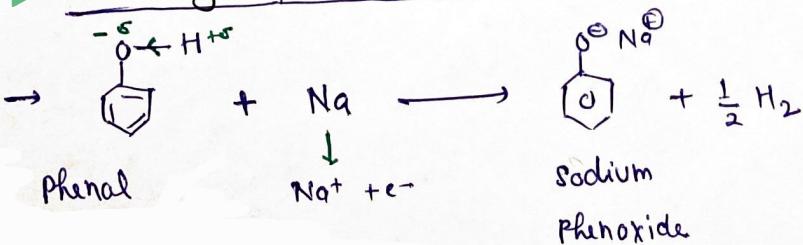
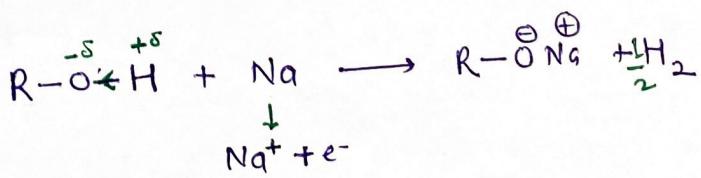
Breaking of carbon and oxygen bond

→ Protonated alcohols as electrophiles

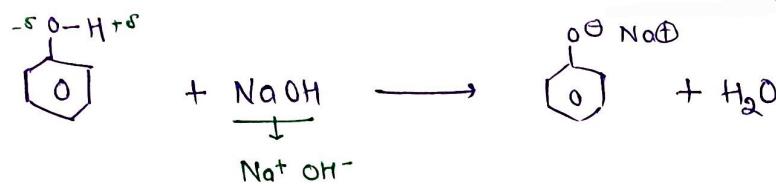


**Apni Kaksha :-**

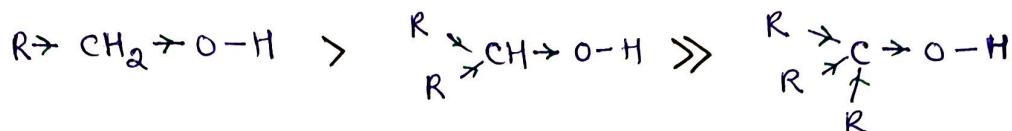
Acidity of alcohols & phenols :-



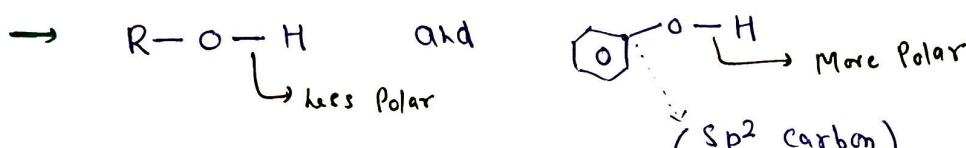
# This reaction shows that alcohols and phenols can donate  $\text{H}^+$ , means that they are acidic.



#] The acidic character of alcohols is due to the polar nature of  $-O-H$  bond. An electron releasing group ( $-CH_3$  /  $-C_2H_5$  etc.) increases the  $\delta$  density on oxygen tending to decrease the polarity of  $-O-H$  bond. This decreases the acidic strength.



#] Phenols are more acidic than alcohols? [CBSE 2015] 1M



This  $\ominus$  charge is localised on oxygen atom.

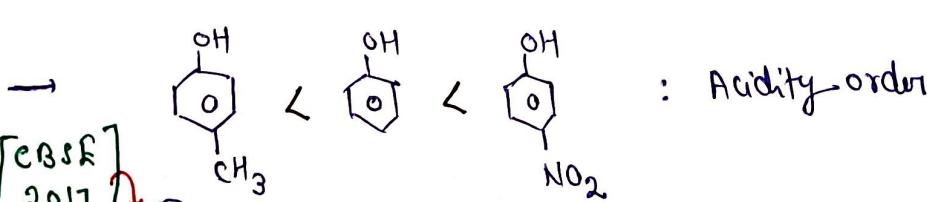
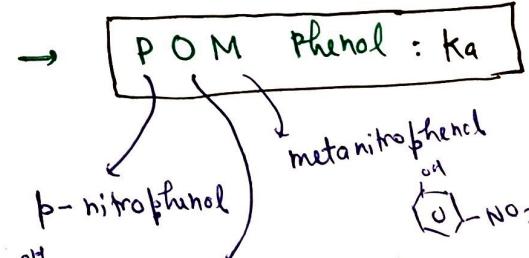
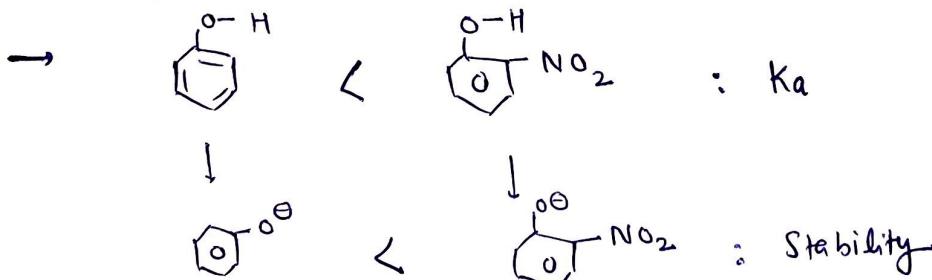


Due to resonance phenoxide is stable This  $\ominus$  charge is delocalised due to conjugation.

than alkoxide.  
Resonating structure of phenoxide ion.



NOTE :- In resonating structure of phenoxide ion  $\ominus$ ve charge is present at ortho and para position. So,  $\ominus$ ve charge stabilising groups (-I / -M) can increase stability of substituted phenoxide ion. Thus it can increase the acidity.

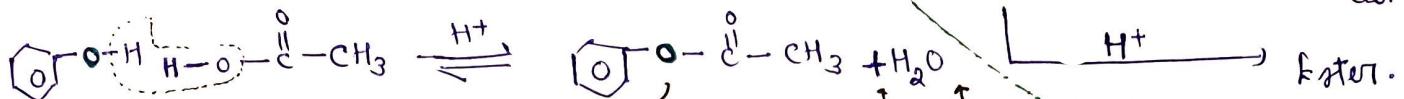


[CBSE 2017]

1M

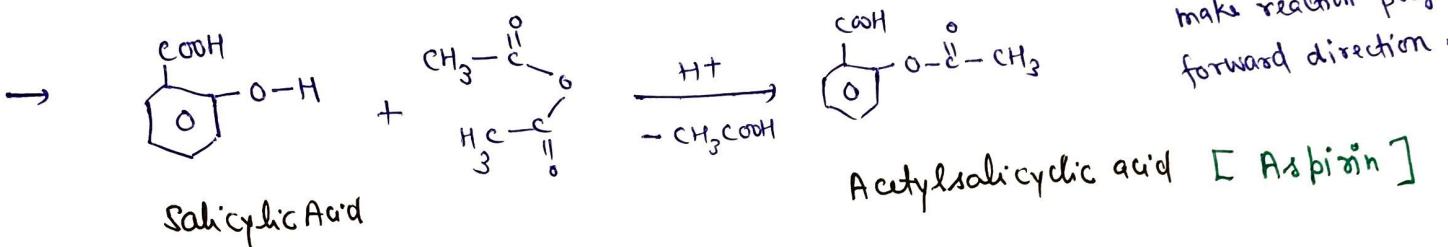
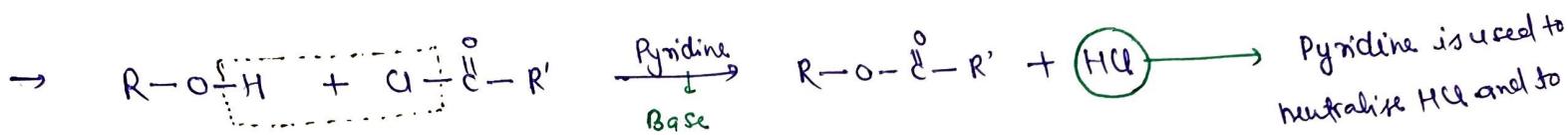
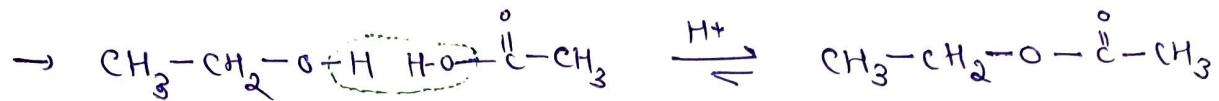
Apni Kaksha :-

→ Esterification :- (Formation of ester) # Alcohols / Phenols + carboxylic acid or its derivative



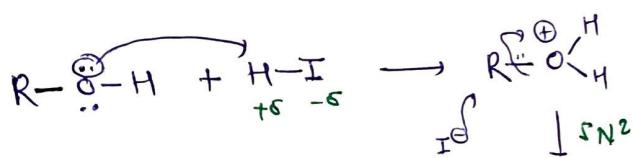
This oxygen comes from alcohol phenol.

Because reaction is reversible, so remove the water as soon as it formed.

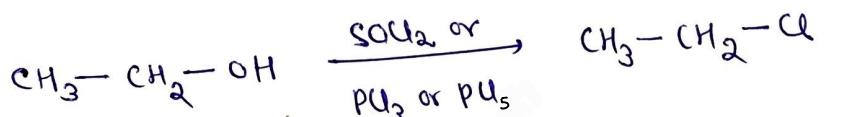


→ Reactions involving cleavage of carbon - carbon bond in alcohols :-

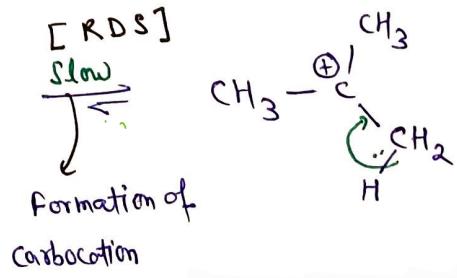
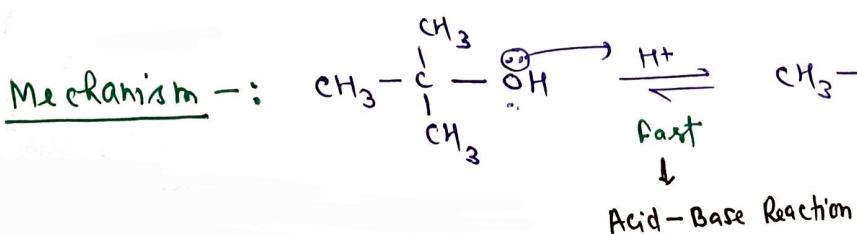
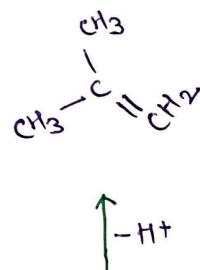
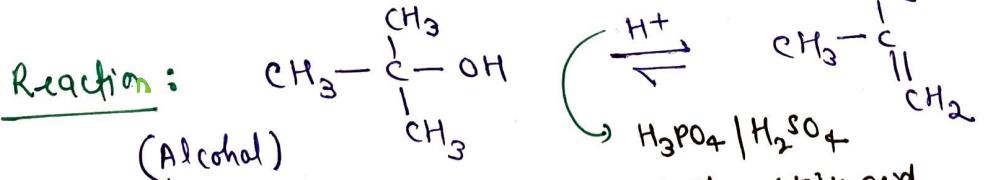
1. Reaction with HX [ HCl | HBr | HI ] :-

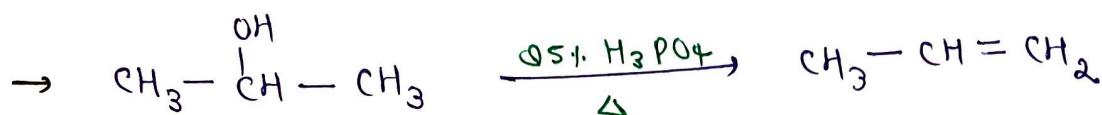
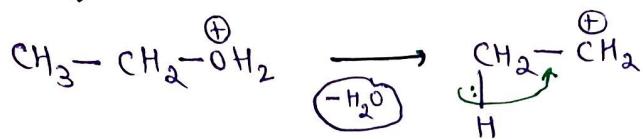
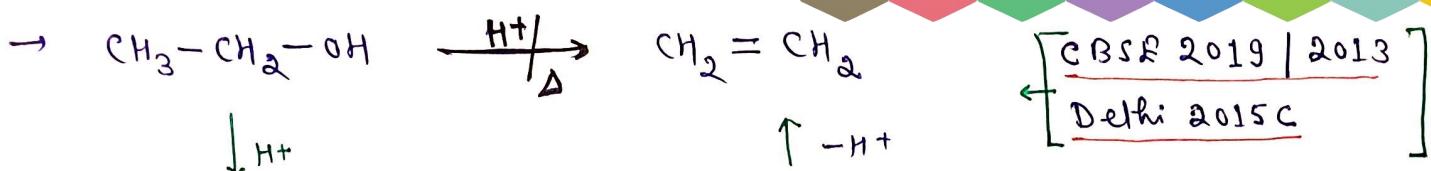


2. Reaction with SOCl<sub>2</sub> | PCl<sub>3</sub> | PCl<sub>5</sub> :-



3. Dehydration :- [ Removal of H<sub>2</sub>O from a molecule ]



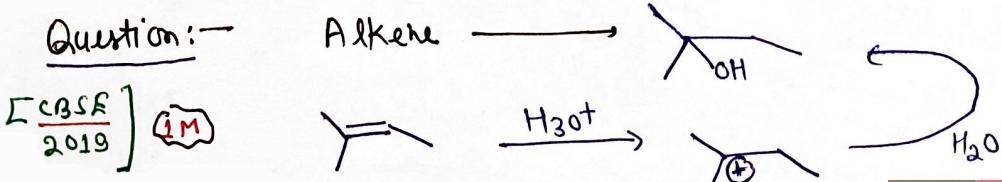
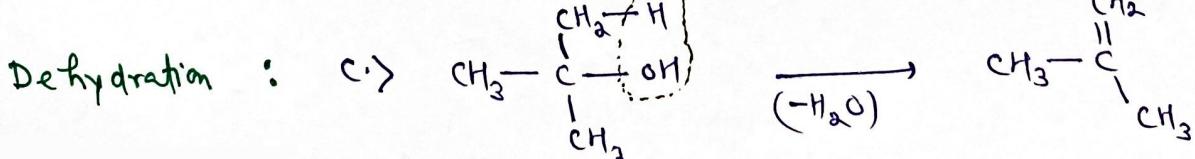
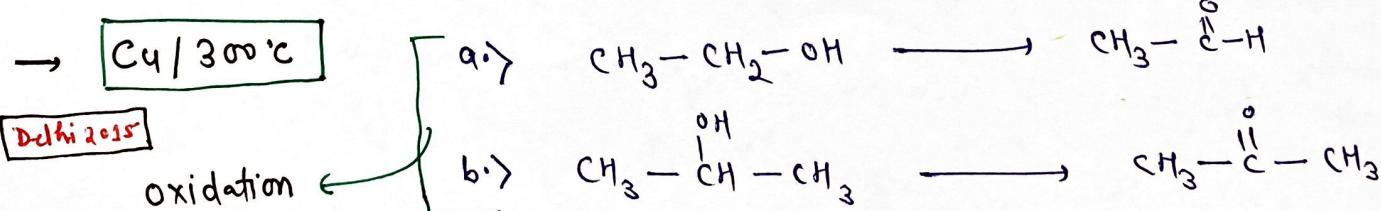
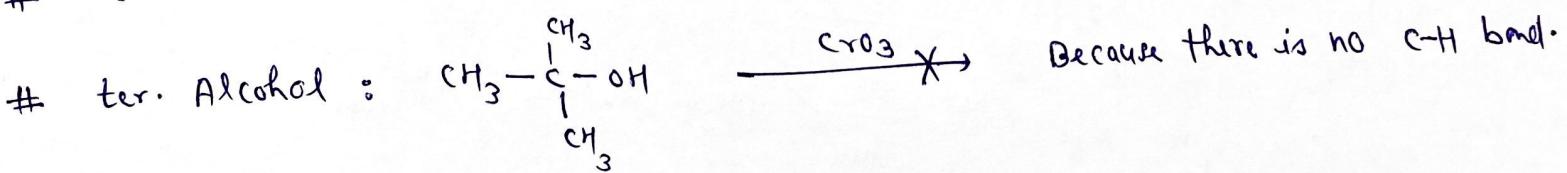
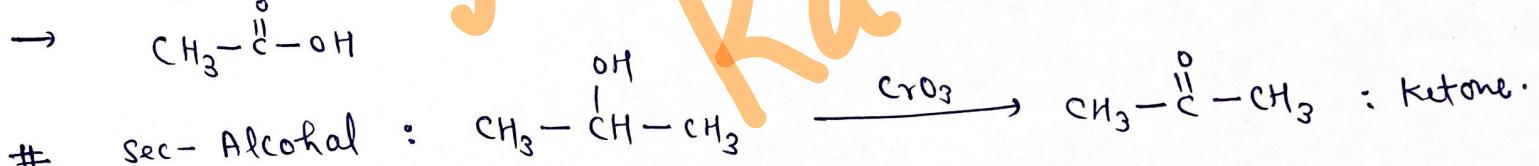
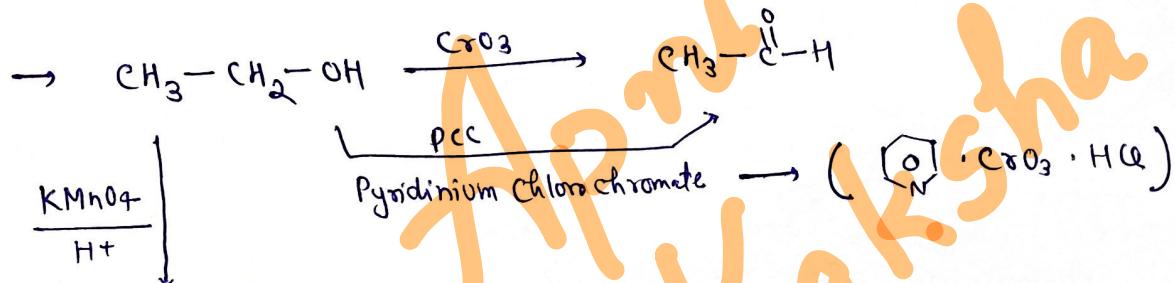
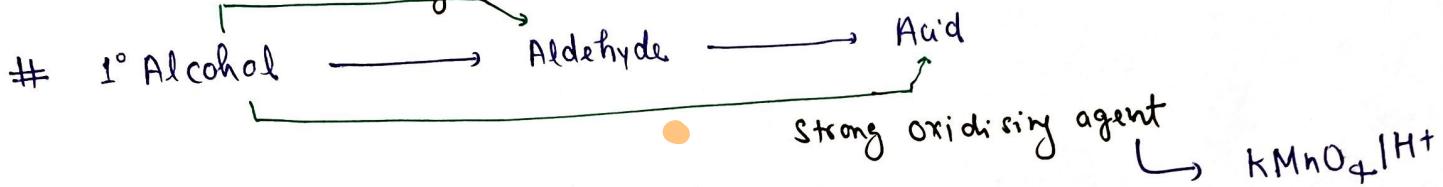


#### 4.7 Oxidation :-



: Removal of di-hydrogen

$\downarrow$   
Dehydrogenation



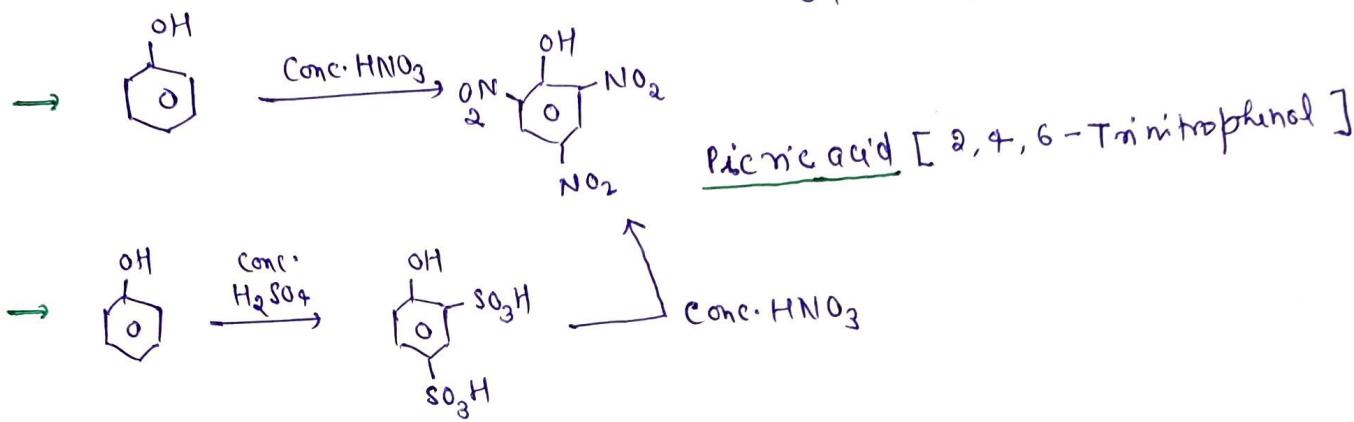
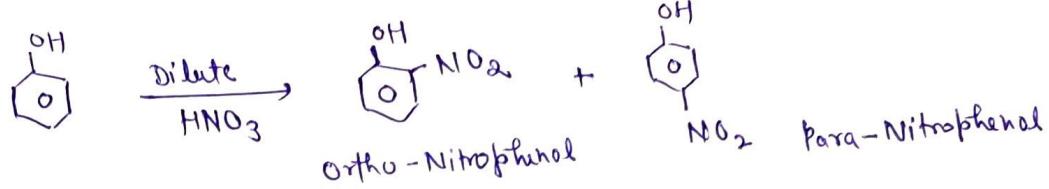
[CBSE 2019] 1M

Apni Kaksha

## Reactions of Phenol

① Electrophilic aromatic substitution :- Phenol and phenoxide ion, direct the incoming electrophile to ortho and para positions in the ring as these position becomes electron rich due to resonance effect caused by  $-OH$  &  $-O^-$  group.

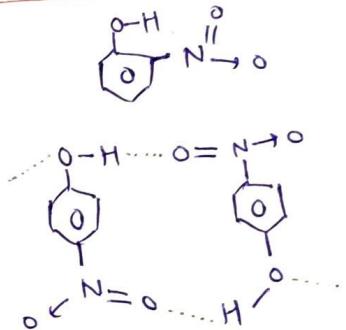
a) Nitration :-



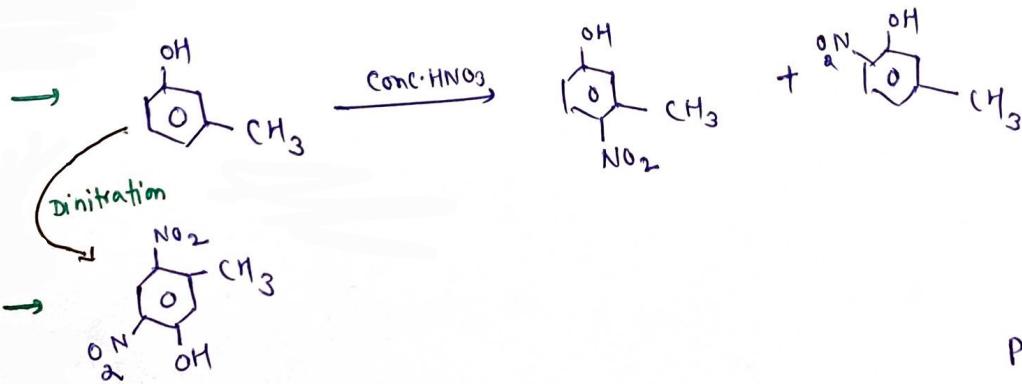
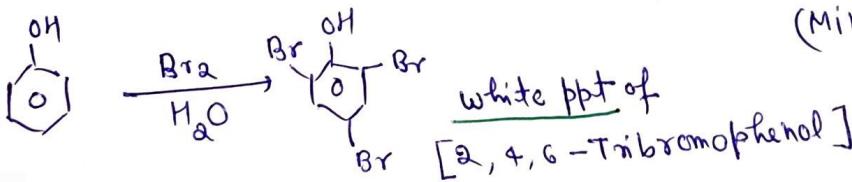
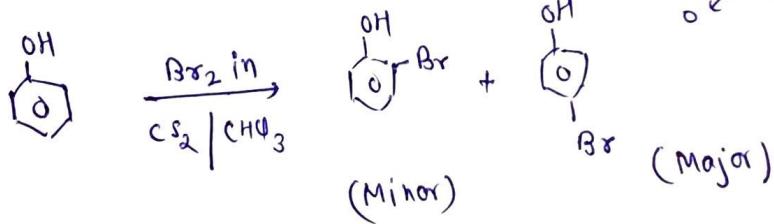
Question :-  $\alpha$ -Nitrophenol is more steam volatile than  $\beta$ -Nitrophenol, Why?

[Delhi 2019 / CBSE 2014]

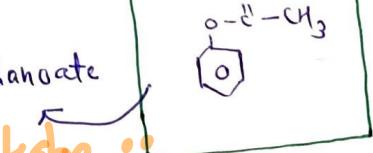
Answer :-  $\alpha$ -Nitrophenol is steam volatile due to intramolecular hydrogen bonding while  $\beta$ -nitrophenol is less volatile due to intermolecular hydrogen bonding which causes the association of molecules.

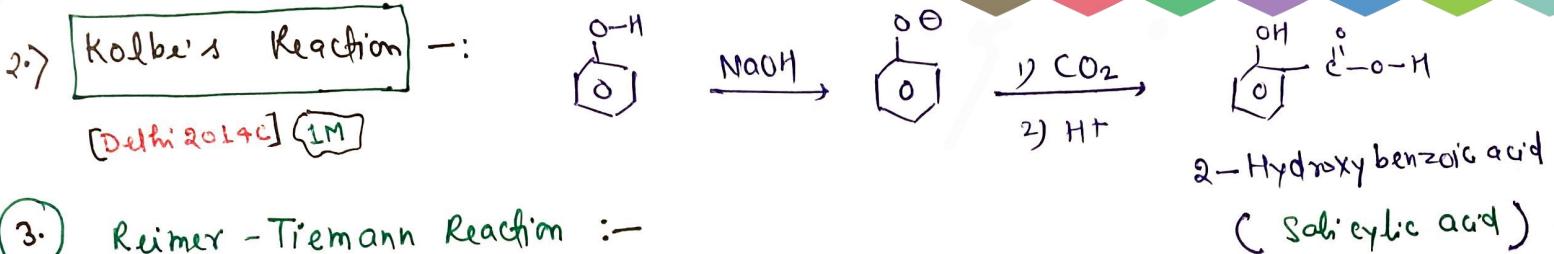


b) Halogenation :-

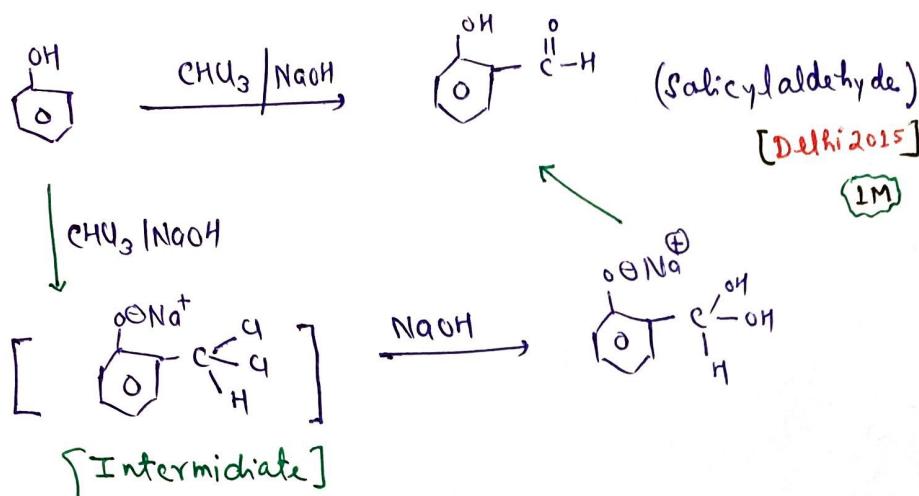


Abni Kaksha :)





3.) Reimer - Tiemann Reaction :-

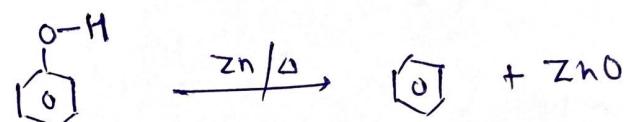


# On treating phenol with chloroform and NaOH, a  $-\overset{\delta}{\text{C}}\text{H}$  group is introduced at ortho position of benzene ring. This reaction is known as RT Reaction.

CBSE

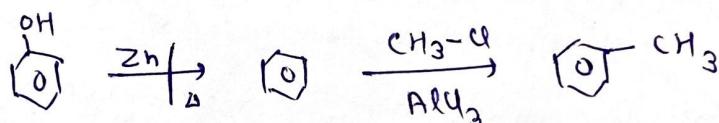
[2011 / 2012 / 2019]

4.) Phenol with Zn dust :-

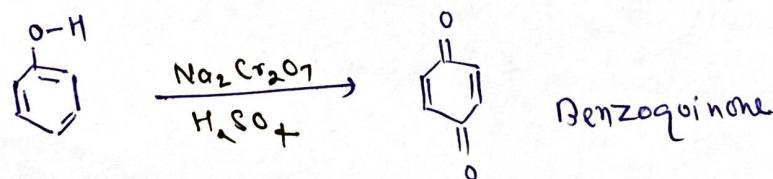


→ Phenol to toluene :

[Delhi 2013C] 1M



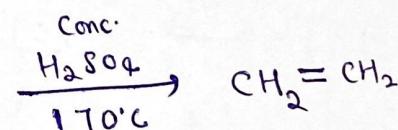
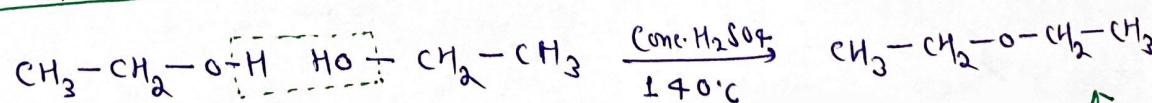
5.) Oxidation :-



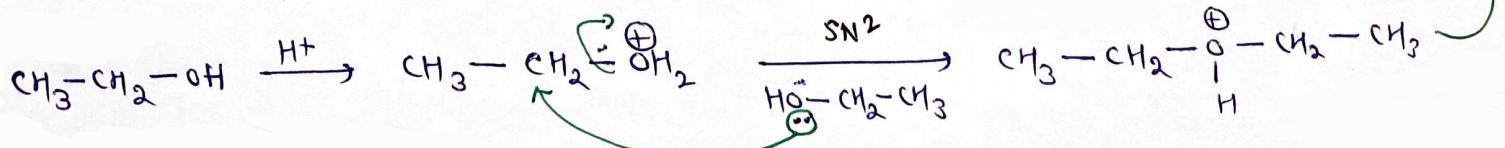
Ethers

Preparation of ethers :-

① By dehydration of alcohols :-



→ Formation of ether [Mechanism]



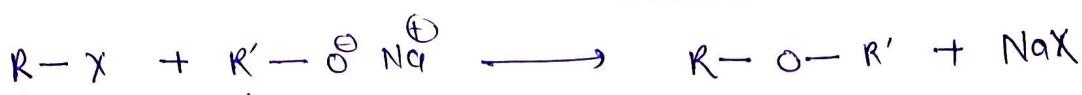
Apni Kaksha :-



②

## Williamson Synthesis :-

Alkyl halide + Sodium Alkoxide  $\rightarrow$  Ether

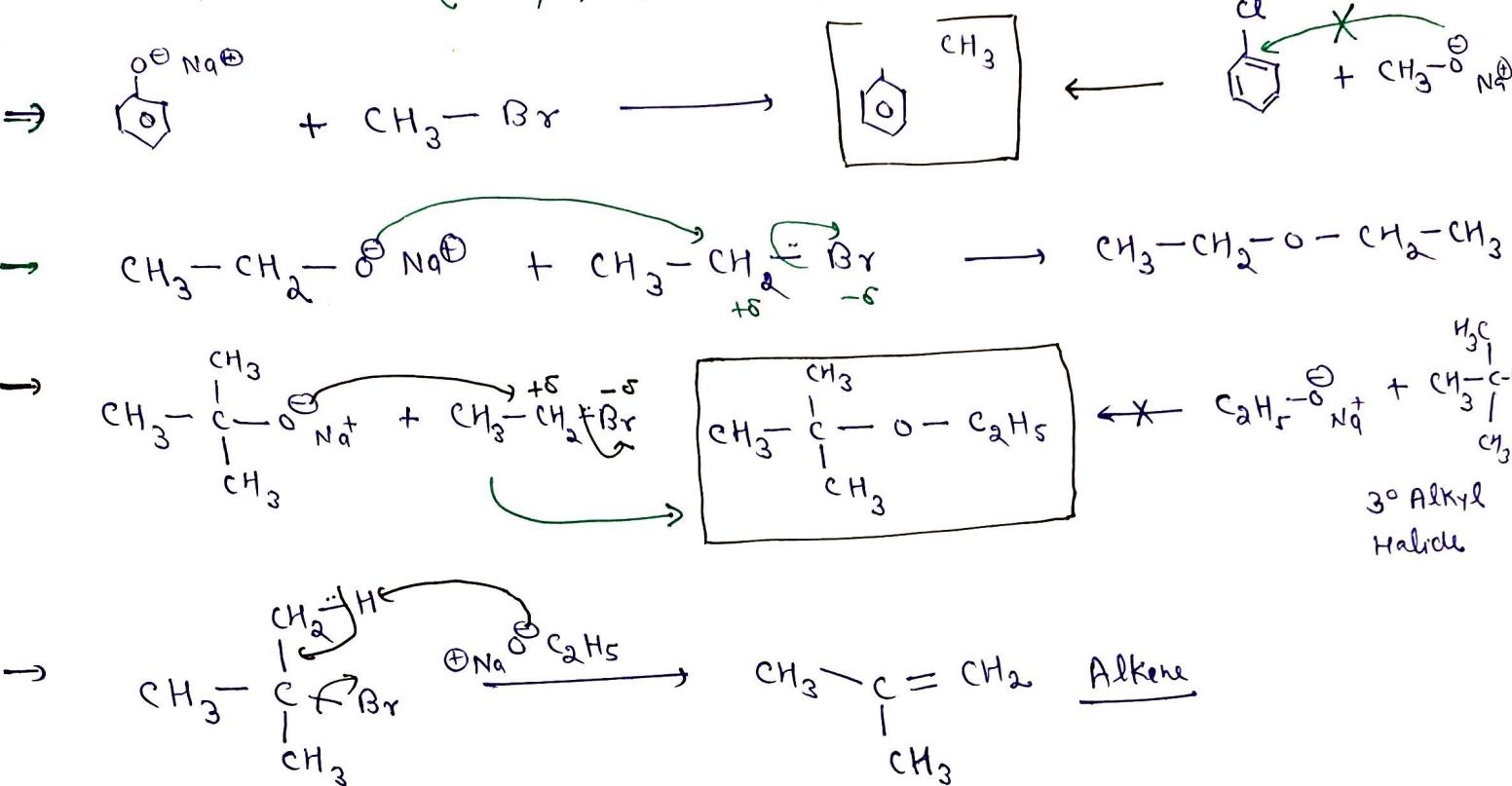


(Methyl / 1° / 2°) (Phenyl / 1° / 2° / 3° / Methyl)

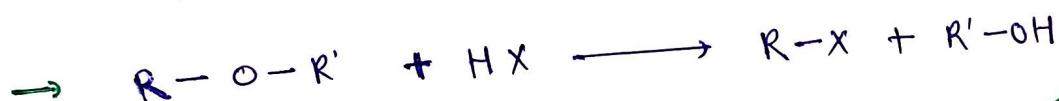
Delhi 2010

CBSE 2010

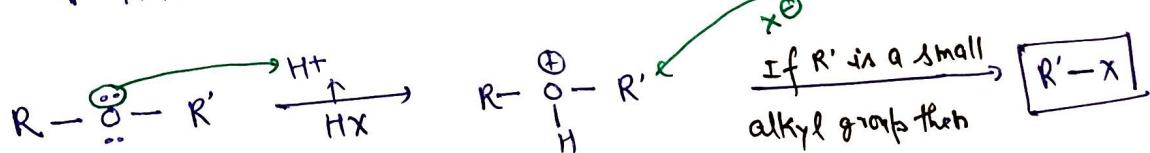
1M



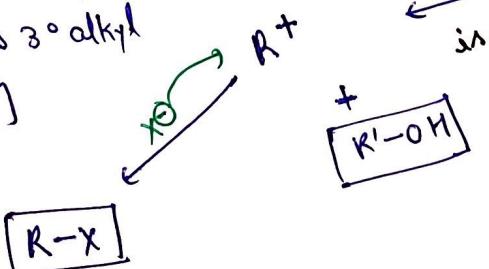
## Chemical Reaction of ether



Mechanism :-



[If R is 3° alkyl group]

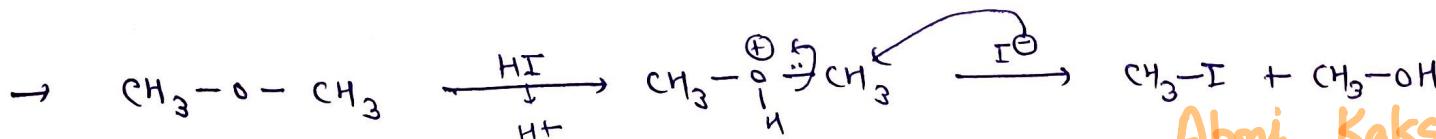


If R or R'  
in 3° alkyl halide

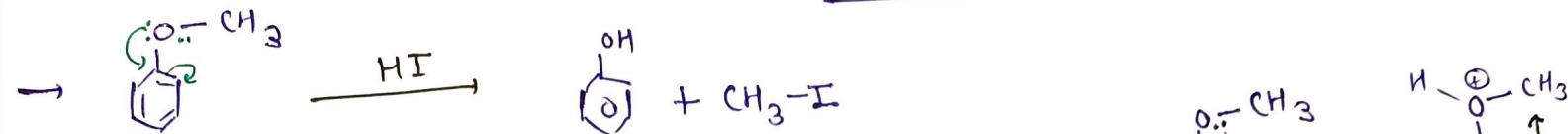
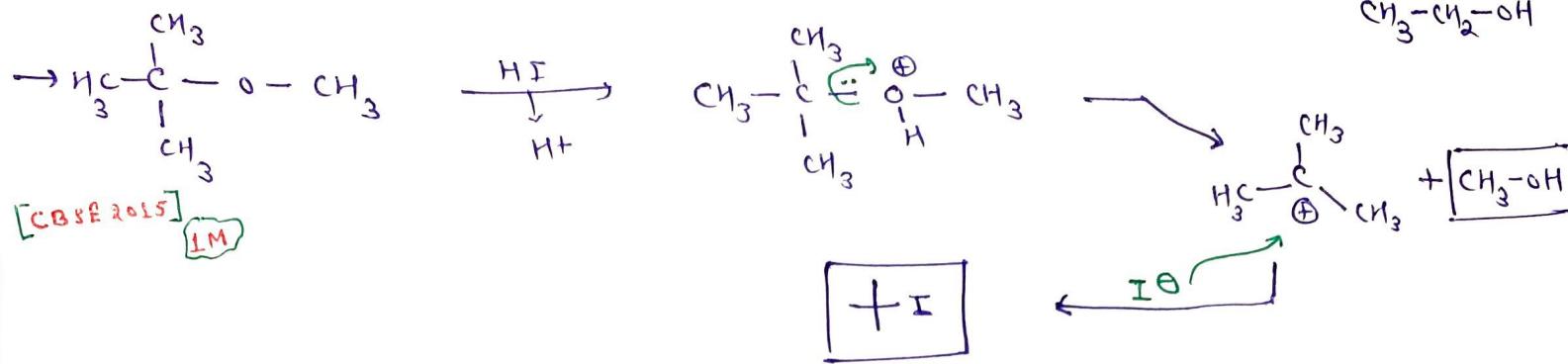
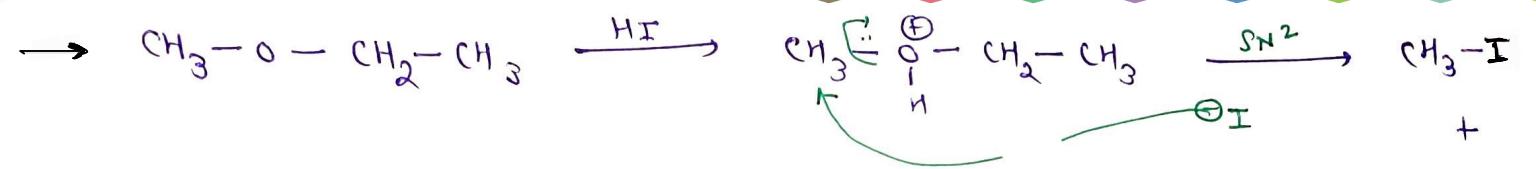
$\downarrow$   
 $\text{S}^{\text{N}}\text{1}$

$\downarrow$   
 $\text{S}^{\text{N}}\text{2}$

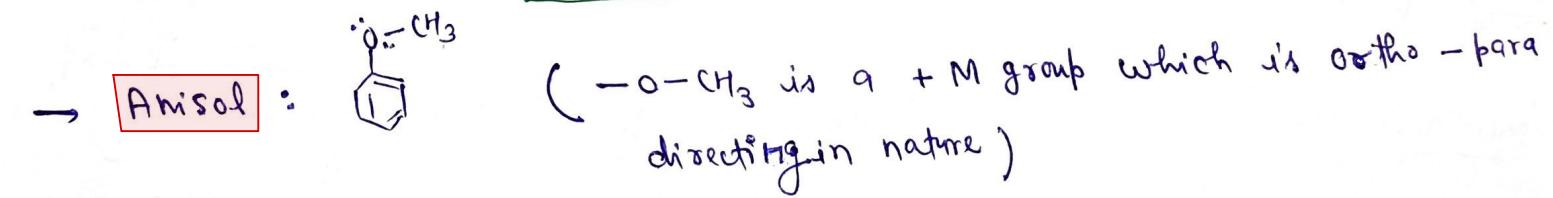
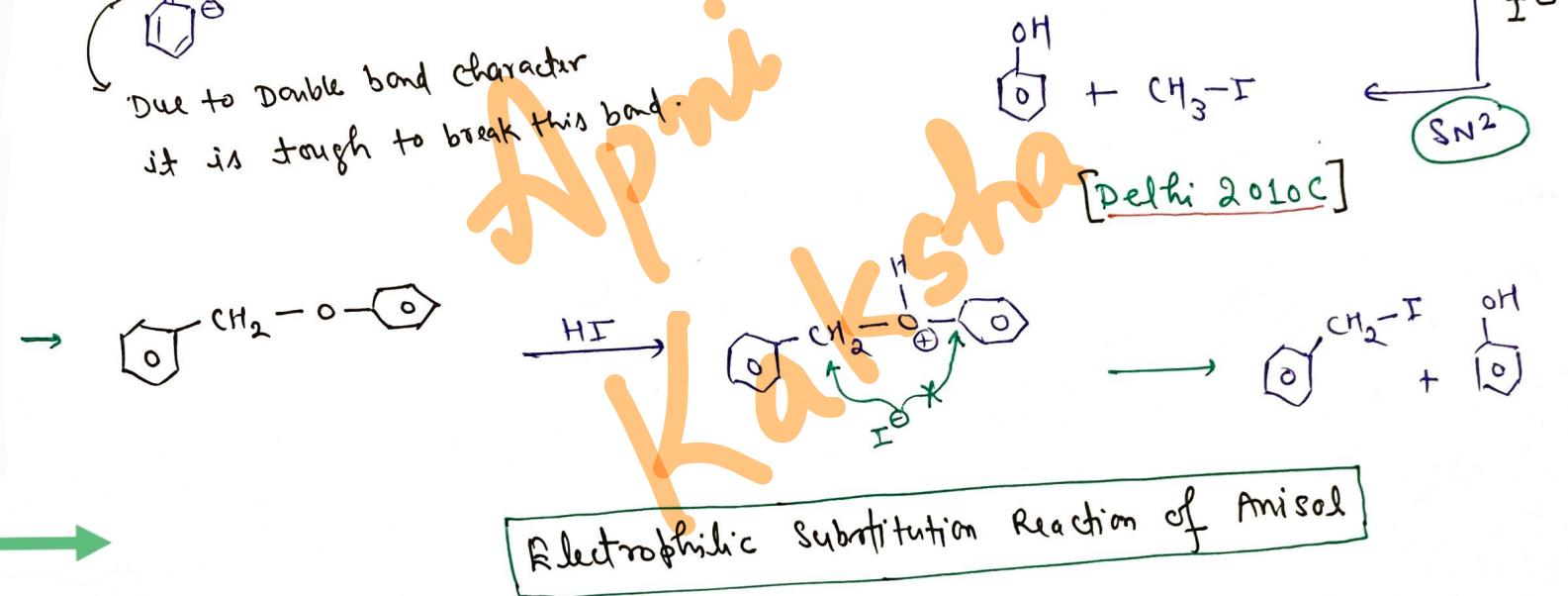
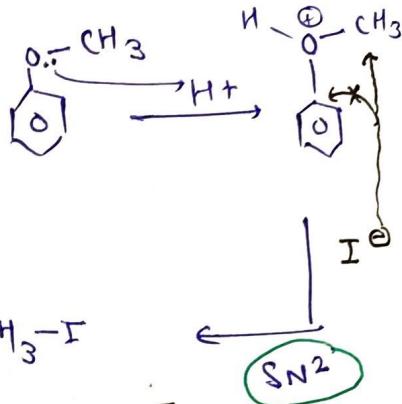
$\downarrow$   
 $\text{R}-\text{OH}$



Apni Kaksha :-

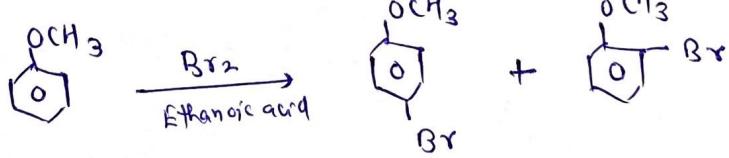


Mechanism :-



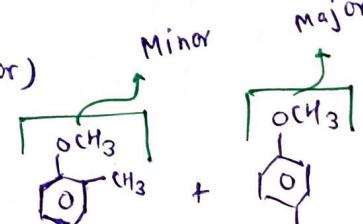
a.) Haloformation :-

[Delhi 2015C]  
1M



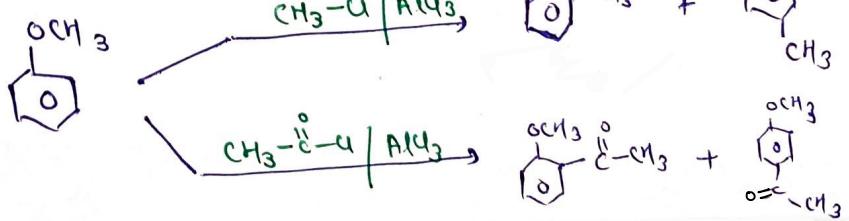
(Major)

(Minor)

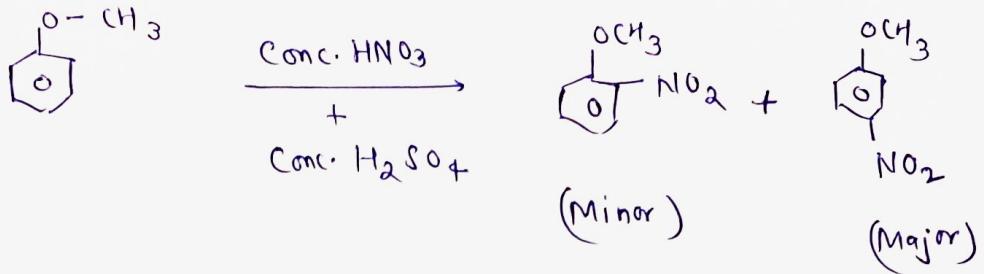


b.) Friedel-Crafts reaction :-

[Delhi 2011 / 2010] 1M

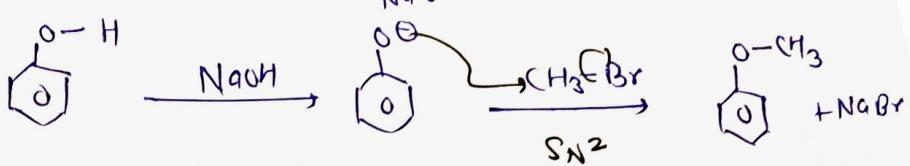


### c) Nitration :-

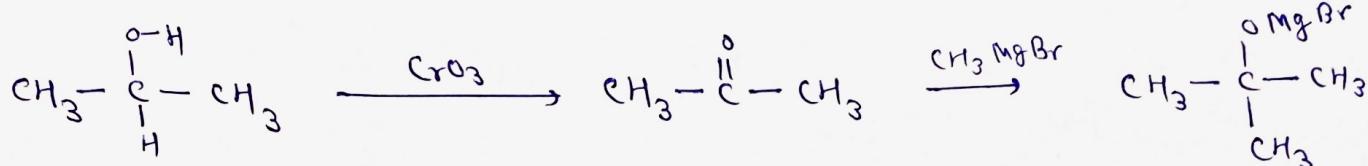


### Conversions

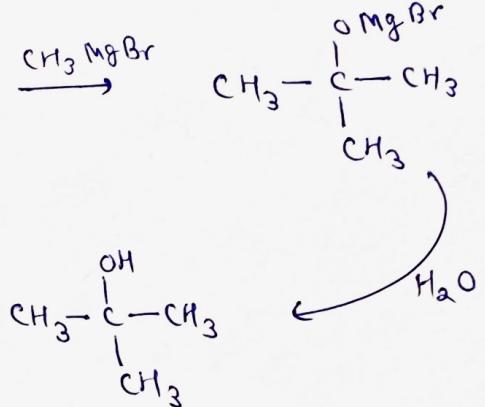
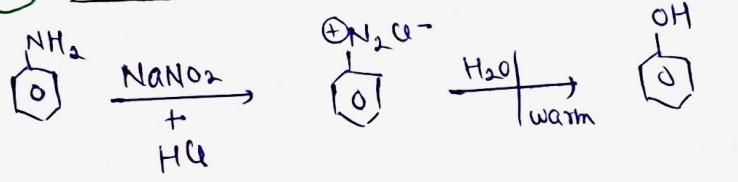
#### i) Phenol to Anisole :-



#### ii) Propan-2-ol to 2-methylpropan-2-ol :-

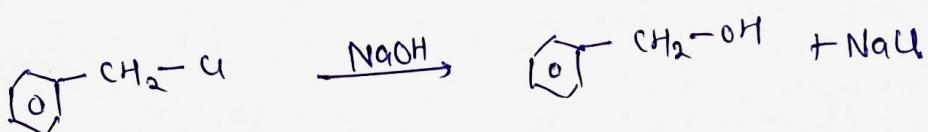


#### iii) Aniline to Phenol :-



Above three ← [Delhi 2015] (3M)

#### iv) Benzyl chloride → Benzyl Alcohol

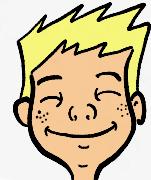
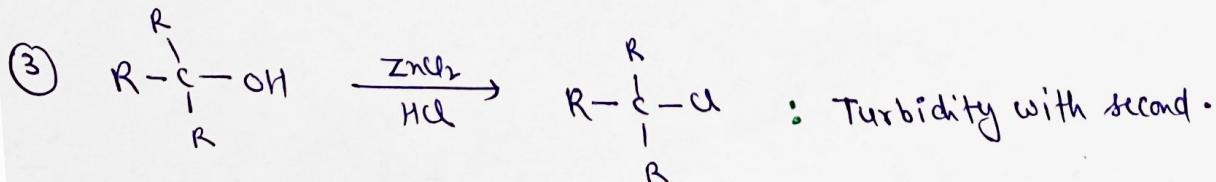
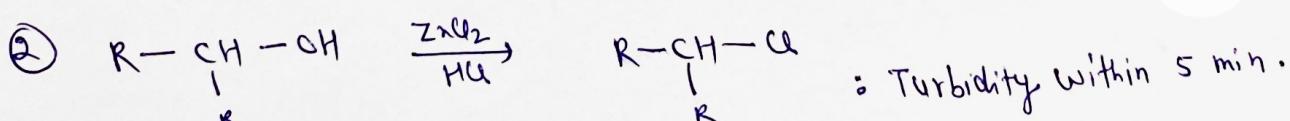
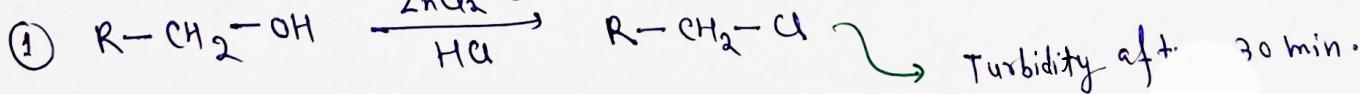


Lucas Reagent

Lucas Test

To differ. 1°/2°/3° Alcohol

phenol does not give this test.



समाप्त