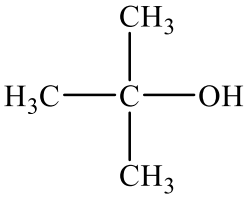
ALCOHOLS

1-The structure

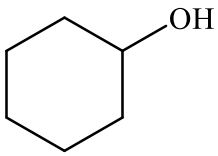
Alcohols are compounds of the general formula **ROH** where R is aryl or alkyl group or substituted alkyl group . the group may be primary , secondary , or tertiary ; it may be open chain or cyclic ; it may contain a double bond , a halogen atom, or an aromatic ring .

For example :-

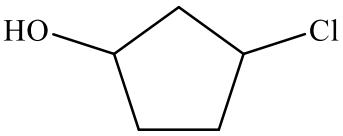


tert - Butyl alcohol

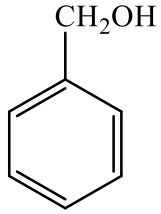
allyl alcohol



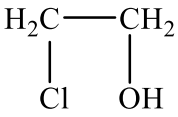
Cyclohexanol



3-chloro-1-cyclopentanol

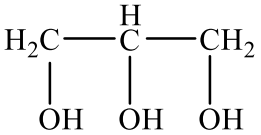


Benzyl alcohol



Ethylene chloro hydrin

β-chloroethylalcohol

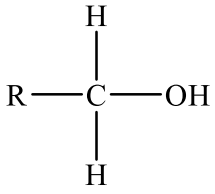


Glycerol

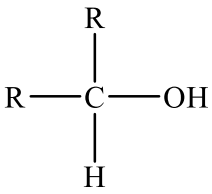
- All alcohols contain the hydroxyl group (-OH) , which as the functional group , determine the properties and Characteristic of this family.

2-**Classification**

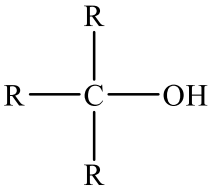
We classify a carbon atom as primary , secondary, tertiary according to the number of other carbon atoms attached to it.



Primary (1^o)



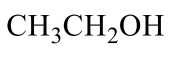
Secondray (2^o)



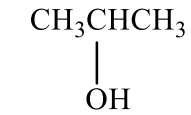
Tertiary (3^o)

3-**Nomenclature**

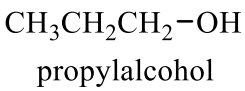
Alcohols are named by three different systems . for the simpler alcohols the common names, which we have already encountered. Are most often used . these consist simply of the name of the alkyl group followed by the word alcohol for example :-



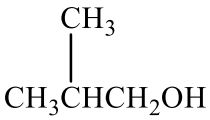
ethyl alcohol



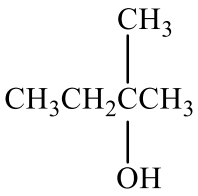
isopropyl alcohol
2-propanol



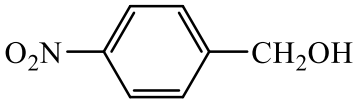
propylalcohol
1-propanol



isobutyl alcohol

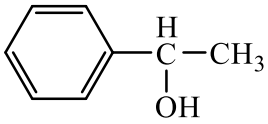


tert- pentyl alcohol



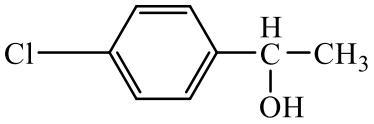
ρ-nitrobenzylalcohol

(4-nitrophenyl)methanol



α-phenylethyl alcohol

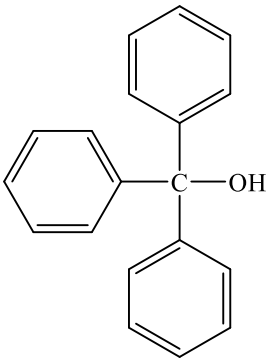
1-phenyl-1-ethanol



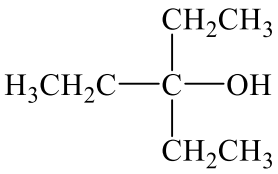
1-(4-chlorophenyl)ethan-1-ol

ρ-chloro-α-phenylethylalcohol

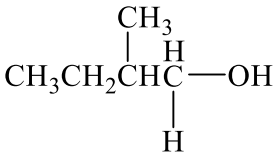
- It is sometimes convenient to name alcohols by the **carbinol system** :-



triphenylcarbinol

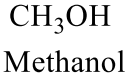


triethylcarbinol

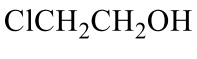


sec-butylcarbinol

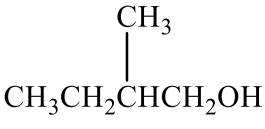
- The most versatile system ; IUPAC system :-
  (a) Select as the parent structure the longest continuous carbon chain . that contain the –OH group the parent structure is known as ethanol, propanol, butanol, etc ----.
  (b) Indicate by a number the position of the –OH group in the parent chain generally using the lowest possible number for this purpose .
  (c) Indicate by numbers the positions of other groups attach to the parent chain.
  Examples:-



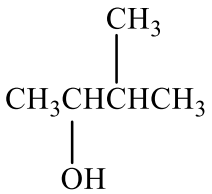
Methanol



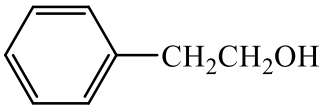
2-chloroethanol



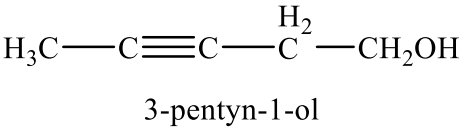
2-methyl-1-butanol



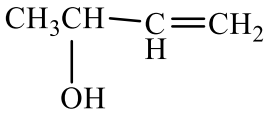
3-methyl-2-butanol



2-phenylethanol

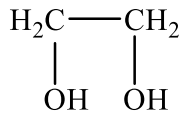


3-pentyn-1-ol

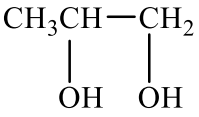


3-buten-2-ol

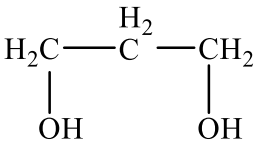
- Alcohols containing two hydroxyl groups are called **glycols** they have common names and IUPAC names.
  Examples:-



ethylene glycol
ethane-1,2-diol
1,2-ethandiol



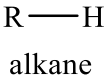
propylene glycol
propane-1,2-diol
1,2- propandiol



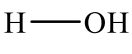
tri methylene glycol
propane-1,3-diol
1,3-propandiol

4- Physical properties

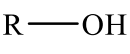
The physical properties of an alcohol are best understood if we recognize this simple fact :structurally ,an alcohol is a composite of an alkane and water it contains An alkane – like alkyl group and a water like hydroxyl group of these two structural units it is the –OH group that gives the alcohol its characteristic physical properties and the alkyl group that depending upon its size and shape , alcohols from hydrogen bonds, and hence they have relatively high boiling points, this also makes the lower alcohols miscible with water . As the R group becomes larger the solubility of alcohols in water decrease dramatically.



alkane



water



alcohol

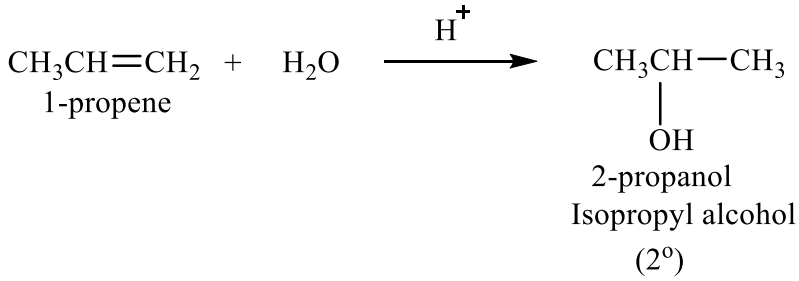
Table (1) : Boiling point and water solubility of some alcohols

Name	Formula	bp C^o	Solubility in water g/100g at $20C^O$
methanol	CH_3OH	65	compeletly miscible
ethanol	CH_3CH_2OH	78	compeletly miscible
1-propanol	$CH_3CH_2CH_2OH$	97	compeletly miscible
1-butanol	$CH_3CH_2CH_2CH_2OH$	118	7.9
1-pentanol	$CH_3CH_2CH_2CH_2CH_2OH$	138	2.7
1-hexanol	$CH_3CH_2CH_2CH_2CH_2CH_2OH$	156	0.59

5-Industrial source

We have already seen that alkenes can be separated from the mixture obtained from the cracking of petroleum .

We have also seen that alkenes are readily converted into alcohols either by direct addition of water , or by addition of sulfuric acid followed by hydrolysis . by this process these can obtained.

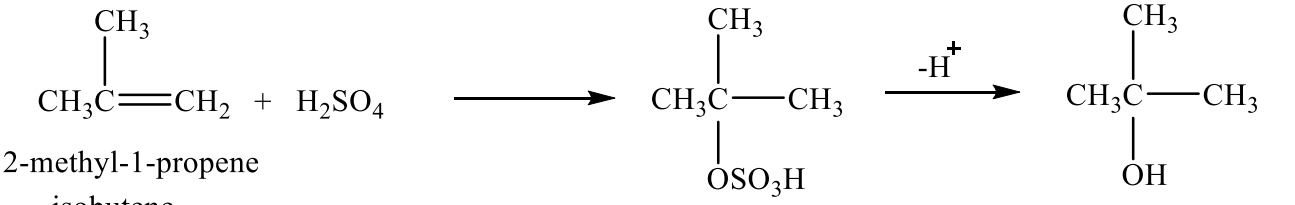


1-propene

2-propanol

Isopropyl alcohol

(2^o)



2-methyl-1-propene

isobutene

tert-butyl hydrogen sulfate

2-methyl-2-propanol

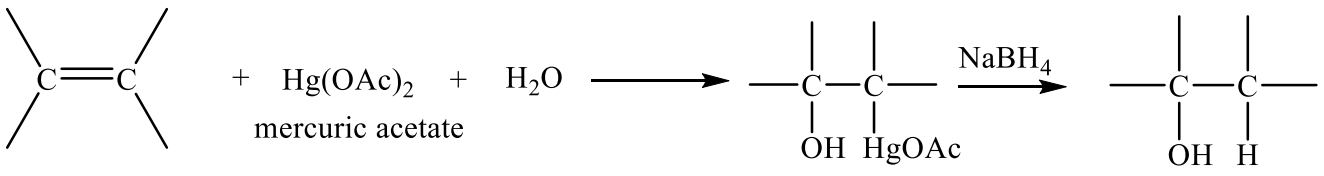
tert-butyl alcohol

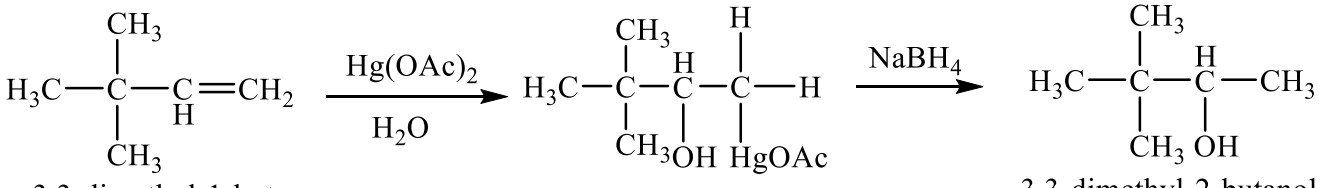
(3^o)

6-Preparation of alcohols

(a) Oxymercuration – demercuration

Alkenes interact with mercury acetate in the presence of water to give hydroxyl mercury compounds and then reduce it using sodium borate to give alcohols.





3,3-dimethyl-1-butene

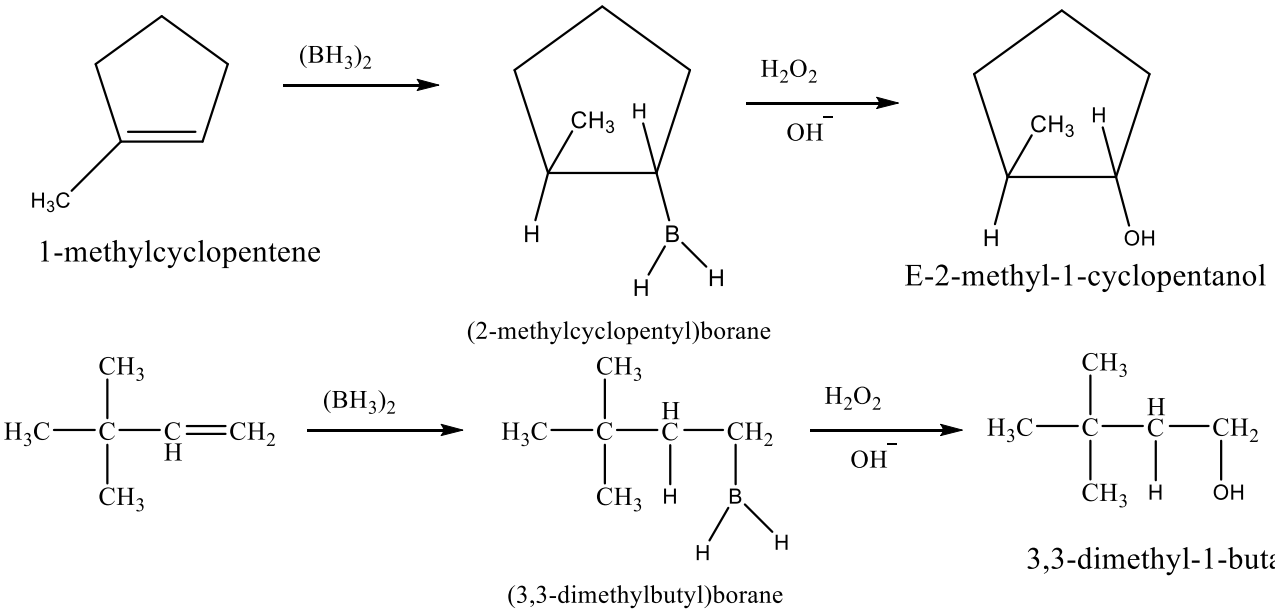
3,3-dimethyl-2-butanol

-OAc = CH_3COO-

acetyl(2-hydroxy-3,3-dimethylbutyl)(oxo)mercury

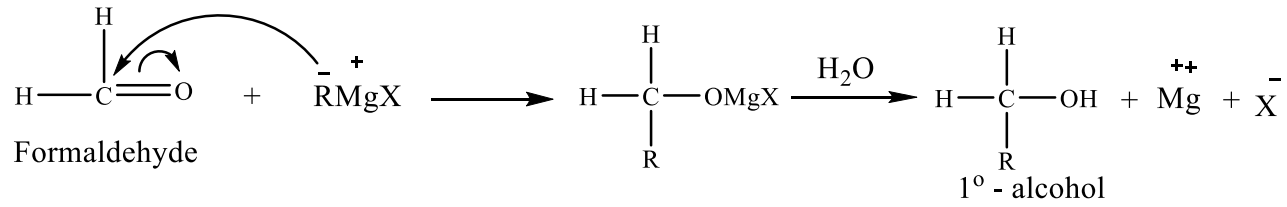
(b) Hydroboration- Oxidation

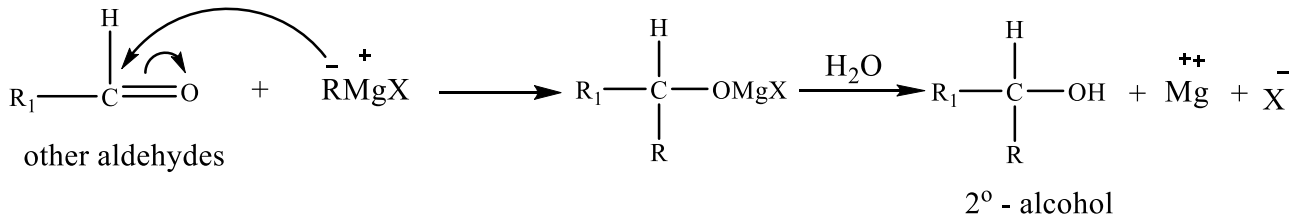
Adding borane to alkene and the oxidizing the product using an oxidizing agent such as hydrogen peroxide to give alcohols. The oxidation process take place in a basic medium and the addition of the borane is anti Markovnikove addition.

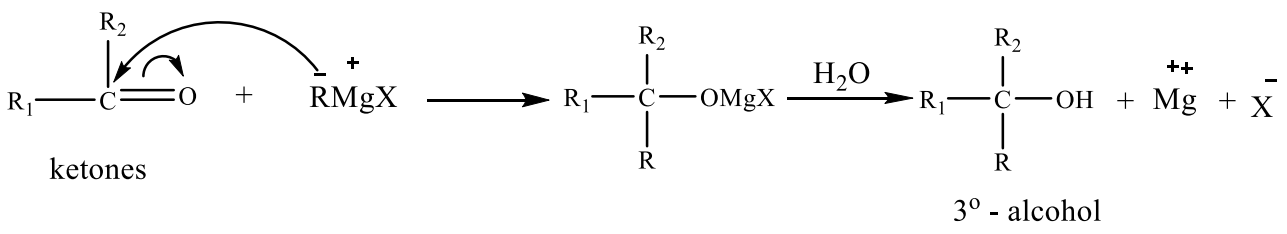


(c) Grignard synthesis

The reaction of the Grignard reagent with the a carbonyl compounds (aldehydes or ketones) from the corresponding alcohols . therefore tertiary alcohol is made up of ketones, while compensated aldehydes give secondary alcohols, while non-compensated aldehydes give primary alcohols.

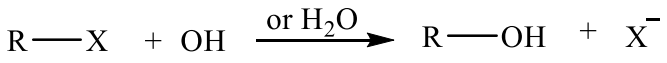




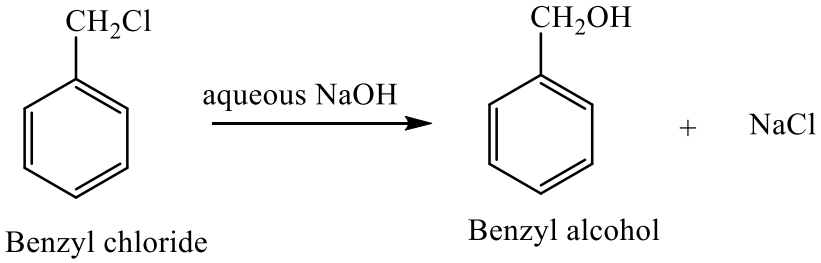


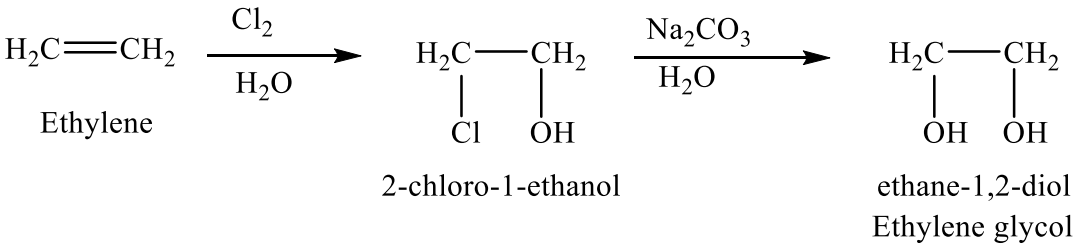
(d) Hydrolysis of alkyl halides

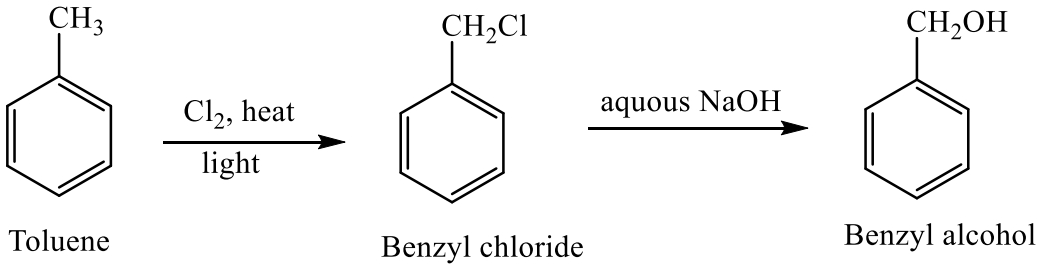
Alkyl halides are decomposed by diluted bases or water to give alcohols.



Examples







7-Reactions of alcohols

Reactions of an alcohol can involve the breaking of the C----OH bond; removal of –OH group, Either kind of reaction can involve substitution; In which a removal groups replaces the –OH elimination.

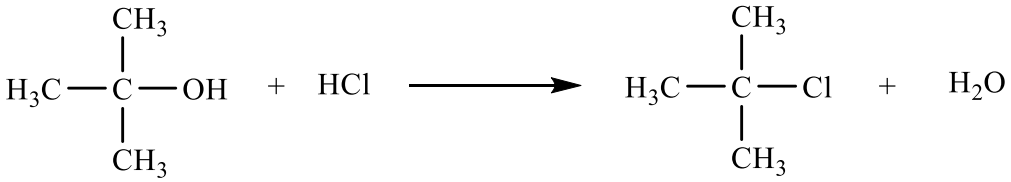
- The order reactivity of ROH is :- $3^o > 2^o > 1^o$

(a) Reaction with hydrogen halides

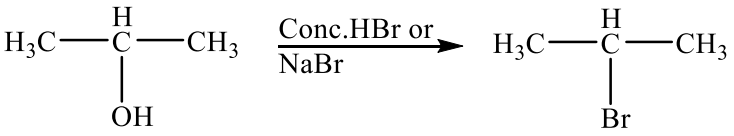
One of the reactions in which the hydroxyl group displaces alcohol is with alcohol reaction with hydrogen halides, so alcohol can be converted in one step to alkyl halide.

- The order reactivity of halogen (X) = I > Br > Cl

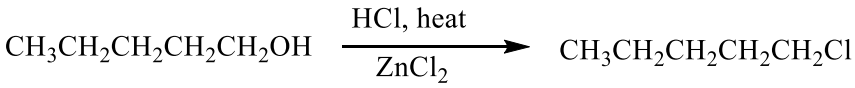
Examples :-



2-methyl-2-propanol — 2-chloro-2-methylpropane



2-Propanol — Iso propyl bromide

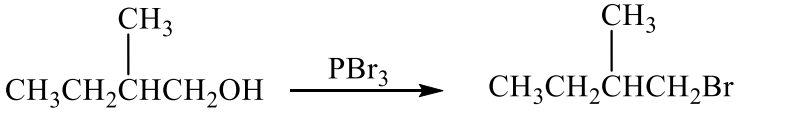


n-pentyl alcohol — n-pentyl chloride

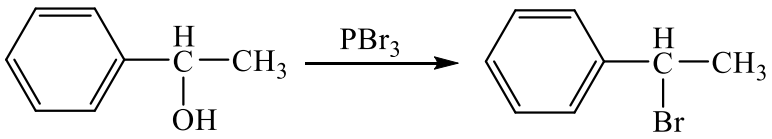
(b) Reaction with phosphorus tri halides

Interaction of phosphorous halides with alcohol, this method is one of the best ways to prepare alkyl halides , and phosphorous tri bromide is used in this type of reaction.

Examples:-



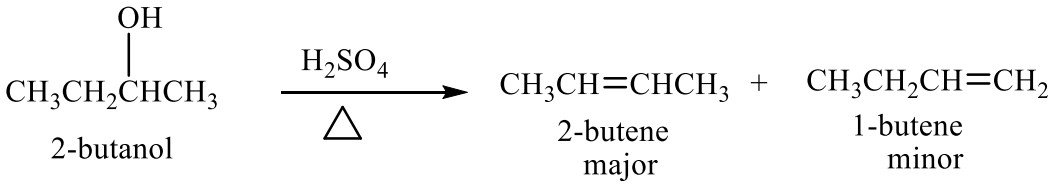
2-Methyl-1-butanol — 1-bromo-2-methylbutane



1-pheylethyl alcohol — 1-bromo-1-phenylethane

(c) Dehydration

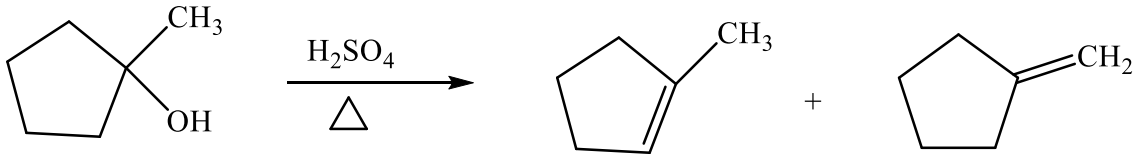
Acidic dehydration produces alkenes with the more stable . OH group is bad leaving group , but H_2O is a good leaving group , so the reaction starts by protonation of the OH group.



2-butanol

2-butene
major

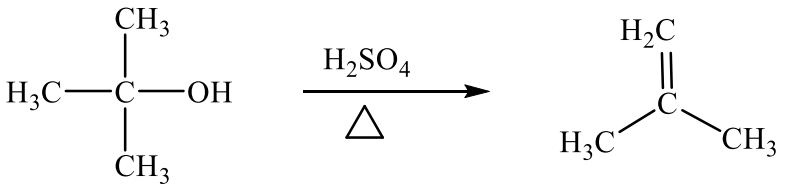
1-butene
minor



1-methyl-1-cyclopentanol

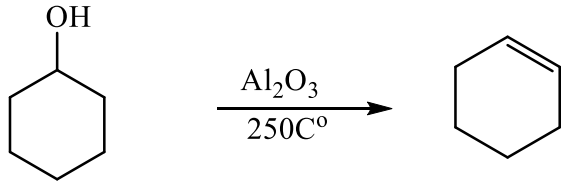
1-methyl-1-cyclopentene
major

methylenecyclopentane
minor



tert-butylalcohol

2-methyl-1-propene
isobutene



cyclohexanol

Cyclohexene