- except diastase enzyme other enzymes like maltase, zymase, etc. are produced from yeast

* Physical Properties:

1.) Boiling Point:

- alcohols have high boiling point than those of comparable molecular masses of alkanes, haloalkanes and ethers.
- it is because, alcohols have intermolecular Hydrogen bond (H-bond).

Carboxylic acid > Alcohol > Ether > R–X > Alkane

- in isomeric alcohols;

$CH_3CH_2CH_2CH_2OH$ > $CH_3CH_2\underset{OH}{CH}CH_3$ [Surface area ↑] [BPT ↑]

2.) Solubility:

- first three members of alcohol [i.e. ethanol, metanol, propanol] are completely soluble in water.
- their ability of making hydrogen bond (H-bond) with water is the reason behind their complete solubility.

H_2CO_3 = Bicarbonic Acid (acidic)
Phenol = Converts litmus to red color.

* Composition of power alcohol:
20% (abs ethanol) + 80% (petrol)

i) Rxn due to cleavage of R-O-H
ii) Rxn due to cleavage of R-OH
iii) Oxidation
iv) β- elimination

* Chemical Properties:

acidic behaviour

1.) **Rxn involving cleavage of Oxygen-Hydrogen Bond:** R-O-H in the following chemical property, an alcohol acts as a nucleophile and because of H^+ ion's releasion it acts as an acid.

Reaction with metals & metal's bases.

A.) **Rxn with Sodium metal:**

- $2RO^-H^+ + 2Na \longrightarrow 2RONa + H_2$

  Alcohol — Sodium — Sodium alkoxide.

B.) **Rxn with Aluminium:**

- $6R-OH + 2Al \longrightarrow 2(RO)_3Al + 3H_2$

- $6\,CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-OH + 2Al \longrightarrow 2\left(CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-O\right)_3Al + 3H_2$

  Isopropyl alcohol — Aluminium tertiary butyloxide

C.) **Rxn with Sodium Amide:** $NaNH_2$

- $RO^-H^+ + NaNH_2 \longrightarrow RONa + NH_3$

  Sodium alkoxide

D.) **Rxn with $NaHCO_3$:**

- $ROH + NaHCO_3 \longrightarrow RONa + H_2CO_3$ (Strong Acid)

  Sodium bicarbonate — Bicarbonic Acid

→ * Strong Acid cannot be formed from Weak Acid. Hence, above rxn is not carried out.

E.) Rxn with Sodium Hydroxide:

$$ROH + NaOH \longrightarrow RONa + H_2O$$

Sodium hydroxide

***NOTE:**

- The reaction is carried out by methanol (CH_3OH) as it is slightly acidic compared to H_2O.

$$CH_3OH > H_2O > C_2H_5OH > C_3H_7OH \quad [\text{Acidic Strength}]$$

- $CH_3OH + NaOH \longrightarrow CH_3ONa + H_2O$

$[+I \uparrow \; AS \downarrow]$

↳ $CH_3OH > C_2H_5OH > C_3H_7OH$.

↳ $H_2CO_3 > OH\text{-}C_6H_5 > CH_3OH > H_2O > C_2H_5OH$

F.) Esterification:

i) Rxn with Carboxylic Acid:

- $R\text{-}\overset{\overset{O}{\|}}{C}\text{-}OH + R'OH \xrightarrow{\text{conc. } H_2SO_4} R\text{-}\overset{\overset{O}{\|}}{C}\text{-}OR' + H_2O$.

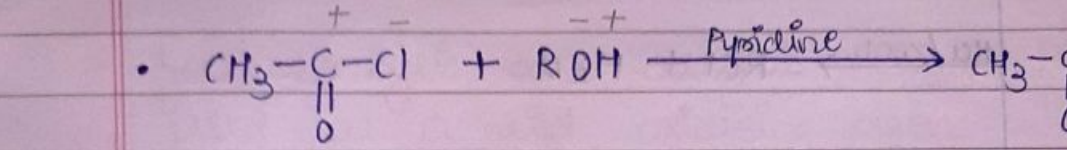
Ester

***NOTE:**

#naming — Schotten-Bomann Rxn

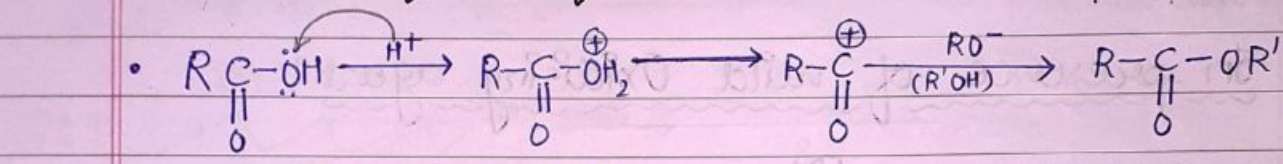
- $C_6H_5\text{-}\overset{\overset{O}{\|}}{C}\text{-}OH + R'OH \xrightarrow{\text{conc. } H_2SO_4} C_6H_5\text{-}\overset{\overset{O}{\|}}{C}\text{-}OR' + H_2O$

ii) Rxn with Alkanoyl Chloride:



Ethanoyl Chloride — Ester

⟹ Mechanism of Esterification:



unstable

*** NOTE:**

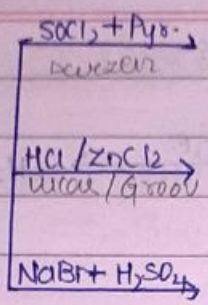
- $R\text{-}OH \longrightarrow R^+$
- $R\text{-}\overset{\overset{O}{\|}}{C}\text{-}OH \longrightarrow R\text{-}\overset{\overset{O}{\|}}{C}^{\oplus}$ (Back Bonding Stability).

* here, $R\text{-}\overset{\overset{O}{\|}}{C}^{+}$ is more stable than R^+.

* hence, $R\text{-}\overset{\overset{O}{\|}}{C}^{+}$ is more likely to form during esterification of carboxylic acid with alcohol.

2) Rxn due to cleavage of R–OH Bond:

- R–OH
  - $\xrightarrow{PCl_3}$ $R\text{-}Cl + H_3PO_3$
  - $\xrightarrow{PCl_5}$ $R\text{-}Cl + POCl_3 + HCl$
  - $\xrightarrow{Red\ P + Br_2}$ $RBr + H_3BO_3$



- $R-OH \xrightarrow{SOCl_2 + Pyr,\ benzen} R-Cl + SO_2 + HCl$
- $R-OH \xrightarrow{HCl/ZnCl_2,\ Lucas/Groove} RCl + H_2O$
- $R-OH \xrightarrow{NaBr + H_2SO_4} R-Br + NaH_2SO_4$

3.) Oxidation:

⟹A) In presence of mild Oxidising agent:

1° alcohol • $RCH_2OH \xrightarrow[PCC\ /PDC]{[O]} R-CHO + H_2O$

2° alcohol • $R-\underset{R}{\underset{|}{CH}}-OH \xrightarrow[PCC/PDC]{[O]} R-\underset{O}{\overset{||}{C}}-R$

$\because R-\overset{OH}{\overset{|}{CH}}-OH \xrightarrow{-H_2O} RCHO.$

• $R-\underset{R}{\overset{R}{\overset{|}{\underset{|}{C}}}}-OH \xrightarrow[PCC/PDC]{[O]} X$

- above reaction is also known as Dehydrogenation of alcohol (H-removal)

here,

- PCC: Pyridinium chloro chromate $\left[\text{pyridinium} + HCl + CrO_3 \right]$
- PDC: Pyridinium Dichromate $\left[\text{pyridinium} + Cr_2O_7^{2-} \right]$
- John's reagent: Pyridine + Acetone
- Collin's reagent: 2 Pyridine + CrO_3

• copper at 300°

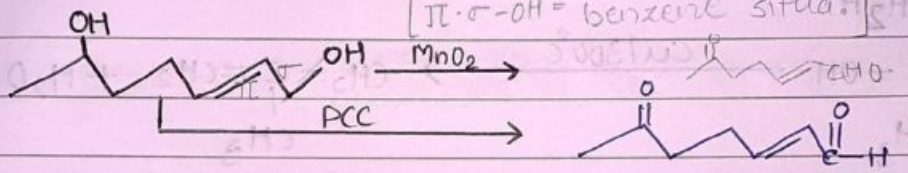
- for benzylic and allylic alcohol MnO_2 is also used as a mild oxidising agent.

• $C_6H_5CH_2OH \xrightarrow{MnO_2} C_6H_5CHO$

• $RCH=CH-CH_2-OH \xrightarrow{MnO_2} RCH=CH-CHO$.

[π-σ-OH = benzene situa.]

Q:7

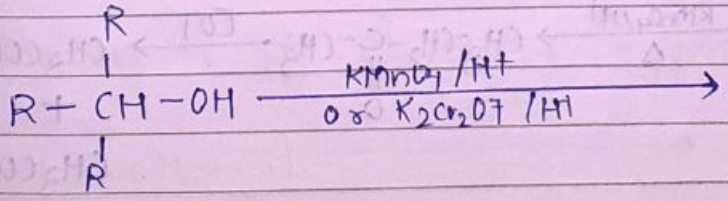


⟹ B) In presence of strong oxidising agent:

• Some of the strong OA's:
- $KMnO_4$ - $K_2Cr_2O_7$ - Conc. H_2SO_4
- Jone's reagent : Pyridine + conc. H_2SO_4

1° alcohol • $RCH_2OH \xrightarrow[KMnO_4]{[O]} RCHO \xrightarrow{[O]} RCOOH$

• $R-\underset{R}{\underset{|}{CH}}-OH \xrightarrow[KMnO_4]{[O]} R-\overset{O}{\overset{||}{C}}-R$

•


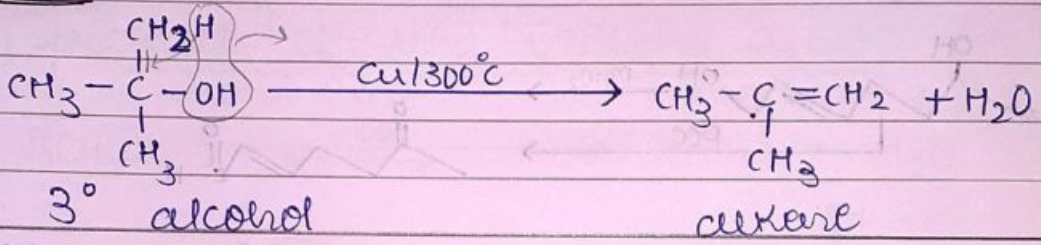
- under the condition of strong oxidising agent and elevated temperature, cleavage of various C-C bond of tertiary alcohol takes place and a mixture of carboxylic acid containing less number of carbon atom is formed.

⟹C) In the presence of copper at 300°C temp:

1° alcohol • $RCH_2OH \xrightarrow{Cu/300^\circ C} RCHO$

2° alcohol • $R\underset{R}{\underset{|}{C}}H-OH \xrightarrow{Cu/300^\circ C} R-\overset{\overset{O}{\|}}{C}-R$

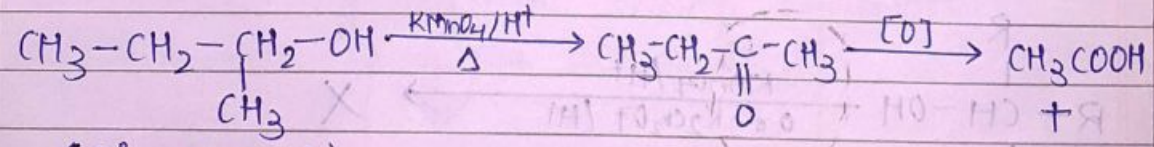
*** NOTE:**

•


3° alcohol — alkene

*** NOTE:** POPOFF'S RULE

- hot concentrated acidified $KMnO_4$ acts as oxidising agent.
- oxidation of secondary alcohol is carried out according to Popoff's rule.
- a/c to this rule, carbonyl group goes with smaller alkyl group.
  [applicable for unsymmetric ketones oxidⁿ]



(2° alcohol)

⟹D) In the presence of Pere-Iodic acid / Tetraacetate lead:

- Pere iodic acid: HIO_4
- Tetraacetate lead: $Pb(CH_3COO)_4$

- CH_2-OH (vicinal) CH_2-OH $\xrightarrow{HIO_4}$ $HCHO + HCHO$.

- CH_2-OH (vicinal) $CH-OH$ (vicinal) CH_2-OH $\xrightarrow[\text{cleavage of molecule.}]{HIO_4}$ $HCHO + HCHO + HCOOH$.

4.) β-elimination (Dehydration):

- $CH_3CH_2OH \xrightarrow[170°C \text{ or } 443K]{\text{conc. } H_2SO_4} CH_2=CH_2 + H_2O$.

⟹ Mechanism:

1.) Formation of protonated alcohol:

- $CH_3CH_2\ddot{O}H \xrightarrow[\text{conc. } H_2SO_4]{H^+ \text{ (fast)}} CH_3-CH_2-\overset{\oplus}{O}H_2$

ethanol.

2.) Formation of ethyl carbocation:

- $CH_3-CH_2-\overset{\oplus}{O}H_2 \xrightarrow[(RDS)]{\text{slow rxn}} CH_3\overset{\oplus}{C}H_2$

ethyl carbocation

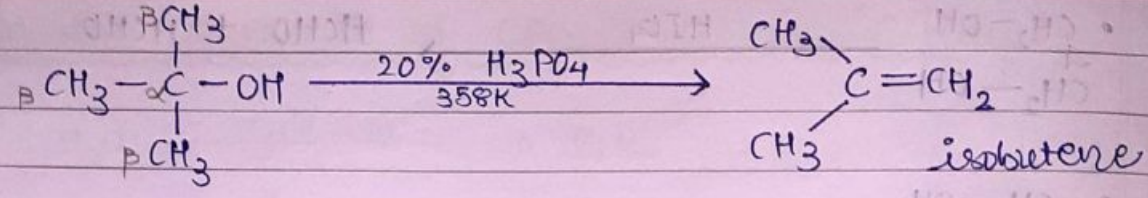
3.) Formation of ethene: (by proton elimination)

- $CH_2(H)-CH_2 \longrightarrow CH_2=CH_2 + H^{\oplus}$

ethene.

- secondary and tertiary alcohols are dehydrated under mild condition.

eg: $CH_3-\overset{\alpha}{C}H(CH_3)-OH \xrightarrow[440K]{85\%\ H_3PO_4} CH_2=CH-CH_3$



***NOTE:**
- the relative order of dehydration of alcohol is:
  ⟶ 3°OH > 2°OH > 1°OH.

most imp

* Test for identification of alcohol:

1.) Lucas test.
→ Groove's process ⟶ reagent: $ZnCl_2 + HCl$

2.) Victor Mayer test.
→

1° Alcohol	2° Alcohol	3° Alcohol
RCH_2-OH	$R-\underset{R}{CH}-OH$	$R-\underset{R}{\overset{R}{C}}-OH$
↓ Red P + I_2 or HI	↓ Red P + I_2 or HI	↓ Red P + I_2 or HI
RCH_2-I	$R-\underset{R}{CH}-I$	$R-\underset{R}{\overset{R}{C}}-I$
↓ $AgNO_2$	↓ $AgNO_2$	↓ $AgNO_2$
RCH_2-NO_2	$R-\underset{R}{CH}-NO_2$	$R-\underset{R}{\overset{R}{C}}-NO_2$
↓ HNO_2 ($-H_2O$)	↓ HNO_2 ($-H_2O$)	↓ HNO_2
$R-\underset{\|\|}{C}(N-OH)-NO_2$	$R-\underset{N=O}{\overset{R}{C}}-NO_2$	$R-\underset{R}{\overset{R}{C}}-NO_2$ (Colorless)
Nitrolic Acid (blue)	Pseudo nitrole (blue)	NO Rxn.
↓ NaOH	↓ NaOH	
$R-\underset{\|\|}{C}(N-ONa)-NO_2$ (red)	NO rxn.	
Sodium nitrolate		

3.) Dichromate test.

- $RCH_2OH \xrightarrow[(Cr^{+6})\ (orange)]{K_2Cr_2O_7/H^+} RCHO \xrightarrow{[O]} R\text{-}COOH + Cr^{+3}$ (Green)

  1° alcohol

- $R\text{-}\underset{\underset{R}{|}}{CH}\text{-}OH \xrightarrow[(Cr^{+6})]{K_2Cr_2O_7/H^+\ (orange)} R\text{-}\underset{\underset{O}{||}}{C}\text{-}R + Cr^{+3}$ (Green).

  2° alcohol

- $R\text{-}\underset{\underset{R}{|}}{\overset{\overset{R}{|}}{C}}\text{-}OH \xrightarrow[(Cr^{+6})]{K_2Cr_2O_7/H^+\ (orange)} No\ rxn$ [Orange color of $K_2Cr_2O_7$ doesn't chng]

  3° alcohol

* Identification test for methanol & ethanol:

	CH_3OH	CH_3CH_2OH
	65°C	78°C
I.) Boiling point		
II.) Iodoform test.	X	✓ (yellow ppt)
III.) Rxn with Cu (300°C)	HCHO. (Formalin) (smell)	CH_3CHO. (no smell)

—X— Alcohol finish —X—