# Aldehyde, ketones and carboxylic acids

## 1. Aldehydes and Ketones:

- Nomenclature, structure, and physical properties.
- Conversion between aldehydes, ketones, and carboxylic acids.
- Mechanisms of nucleophilic addition (e.g., Grignard, HCN).
- Key reactions: Aldol condensation, Cannizzaro, Fischer esterification.

## 2. Carboxylic Acids (Detailed Focus):

- Introduction and Properties
- Key Reactions of Carboxylic Acids
- Derivatives of Carboxylic Acids

## 3. Conversion and Comparison of Functional Groups:

**Preparation:**

Oxidation of 1° Alcohol.

$$CH_3-CH_2-OH \xrightarrow{CrO_3} CH_3COOH$$

2° alcohol.

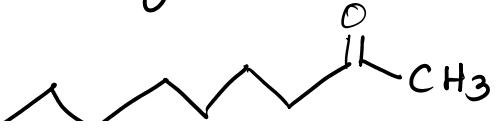
$$CH_3-\underset{\underset{OH}{|}}{CH}-CH_3 \xrightarrow{CrO_3} CH_3-\overset{\overset{O}{||}}{\underset{|}{C}}-CH_3$$

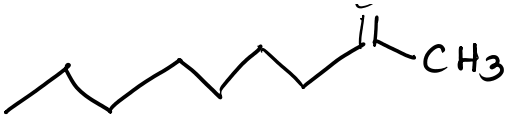
$$CH_3-\overset{\overset{O}{||}}{\underset{|}{C}}-CH_3 \xrightarrow{\text{Strong (O)}} HCOOH + CH_3COOH$$

**Haloform Reaction:** $CHX_3 \Rightarrow CHCl_3, CHI_3$

$$R-\overset{\overset{O}{||}}{C}-CH_3 \xrightarrow{X_2/OH^-} R-COOH + CHX_3$$

+ve





$CH_3CHO \longrightarrow$ +ve.

$CH_3-CH_2-\underset{\underset{O}{\|}}{C}-CH_2-CH_3 \not\longrightarrow$ -ve

## Hydrolysis of alkyl Cyanides:

$$R-C\equiv N + HOH \longrightarrow R-C(OH)(NH)$$

Imidol.

Rearrang.

$$NH_3 + R-COOH \xleftarrow{H_2O} R-\underset{\underset{O}{\|}}{C}(OH)(H)-NH_2$$

Amides

3. terminal trihalogen

$$R-CX_3 + 3NaOH \xrightarrow[-3NaX]{} R-C(OH)_3$$

Unstable

$$R-\underset{\underset{O}{\|}}{C}-OH \xleftarrow{NaOH} RCOONa$$

$-H_2O$

## Grignard Reagent:

$$O=C=O + R^{\ominus}MgX \longrightarrow O=\underset{\underset{R}{|}}{C}-OMgX$$

$H_2O$

$$Mg(OH)X + O=\underset{\underset{R}{|}}{C}-OH$$

J

I
R

$(CH_3)_3C-Cl \xrightarrow[ether]{Mg} A \xrightarrow[ether]{CO_2} B.$

$(CH_3)_3C-MgCl$ $\quad$ $HO-C(=O)-C-(CH_3)_3$

Hydrolysis of Ester:

$RCOOR' + H_2O \longrightarrow RCOOH + R'OH$

(OH, H)

Action of heat

$H_2C(COOH)(COOH) \xrightarrow[-CO_2]{\Delta} H_3C-COOH$

$R-X + Na\,CH(COOC_2H_5)(COOC_2H_5) \xrightarrow[-NaX]{} R-CH(COOC_2H_5)(COOC_2H_5)$ Ester

$R-CH(COOC_2H_5)(COOC_2H_5) \xrightarrow{H_2O} R-CH(COOH)(COOH) \xrightarrow[-CO_2]{\Delta} R-CH_2-COOH$

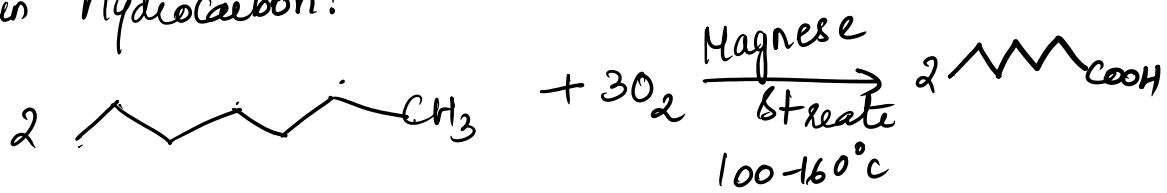
Koch reaction:

$H_2C=CH_2 + CO + H_2O \xrightarrow[Pressure, 350^\circ C]{H_3PO_4} CH_3CH_2COOH$

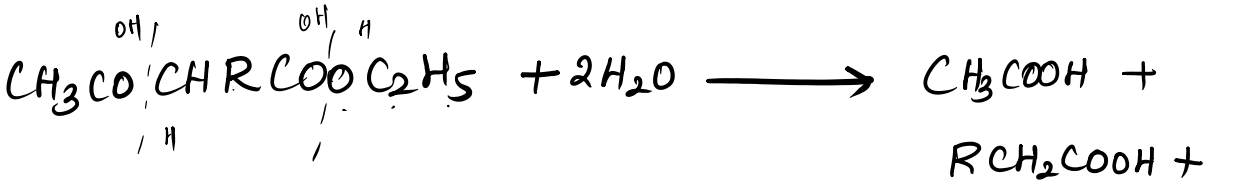
long chain Hydrocarbon:

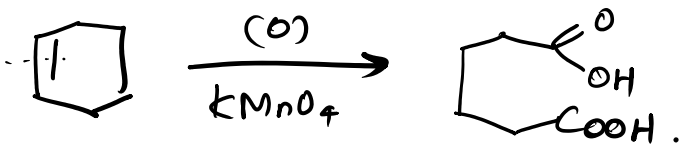
Magnese

## long chain Hydrocarbon:

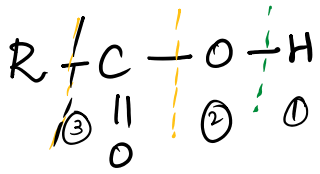



## Aceto acetic Ester:




## Chemical Prop:

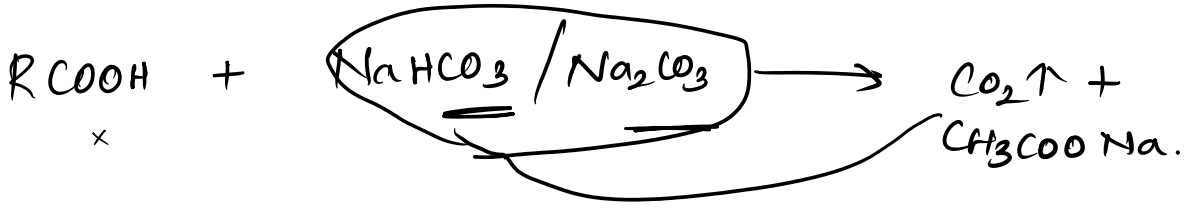


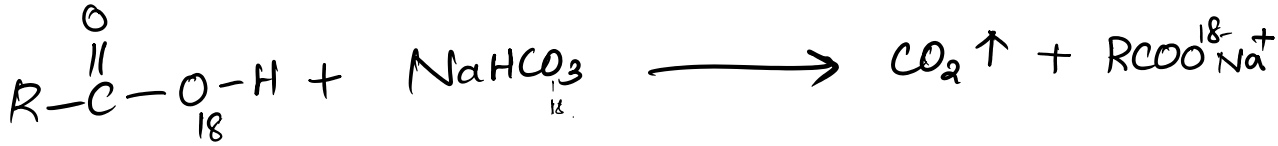

| | HCOOH | $CH_3COOH$ | $CH_3CH_2COOH$. |
|---|---|---|---|
| Ka ↓ | $1.77\times10^{-5}$ | $1.75\times10^{-5}$ | $1.4\times10^{-5} \Rightarrow$ Pka ↑ |

1. $RCOOH + Na \longrightarrow RCOO^- Na^+ + \frac{1}{2}H_2\uparrow$

2. $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O.$

$\xrightarrow{HCl}$



(2) Esterification:

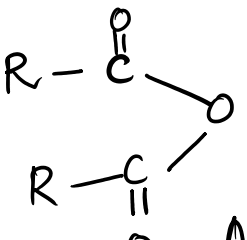
1) $RCOOH + R'OH \underset{}{\overset{conc.H_2SO_4}{\rightleftharpoons}} R-COOR' + H_2O$.

$3^0\,OH < 2^0\,OH < 1^0\,OH < CH_3OH$.

2) $CH_3COOH + PCl_5 \xrightarrow{Pyridine} CH_3CO-Cl + POCl_3$

$\xrightarrow{SOCl_2} CH_3\overset{\overset{O}{\|}}{C}-Cl + SO_2\uparrow + HCl\uparrow + HCl.$

$\xrightarrow{PCl_3} CH_3\overset{\overset{O}{\|}}{C}-Cl + H_3PO_3$

(3) $R-COOH + RCOOH \xrightarrow[P_2O_5]{\Delta}$ 

Acid anhydride.

Formic Acid will undergo this process / or not

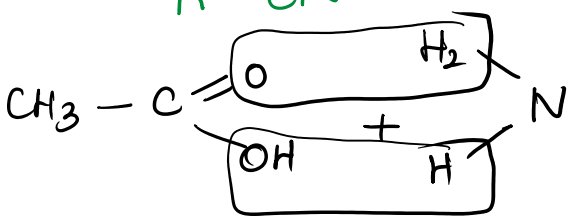
$R-COOH + NH_3 \longrightarrow RCOONH_4$

$RCOONH_4 \xrightarrow{\Delta} RCONH_2 + H_2O$

Amide

$350^\circ C$, $Al_2O_3$

R−CN

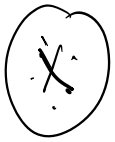


$CH_3-CN$.

a) Redn: $LiAlH_4$, $BH_3/THF$, $Ru/H_2$, $CuCr_2O_4/H_2$.

$$R-COOH + H_2 \xrightarrow{LiAlH_4} 1^{\circ}\ OH.$$

decarboxylation:



$$R-COOH \xrightarrow[-CO_2]{\Delta} R-H$$

Alkane.

$$R-\underset{\underset{O}{\|}}{\overset{\beta}{C}}-\overset{\alpha}{C}H_2-COOH \xrightarrow[-CO_2]{\Delta} R-\underset{\underset{O}{\|}}{C}-CH_3$$

β-keto acid.

Dry distillation:

$$(R-COO)_2Ca \xrightarrow{\text{distill}} R-\underset{\underset{O}{\|}}{C}-R + CaCO_3$$

Hunsdiecker's Reaction.

$$CH_3COOAg + Br_2 \xrightarrow[\text{heat}]{CCl_4} CH_3Br + AgBr + CO_2\uparrow$$

Schmidt rxn: $N_3H$:

$$RCOOH + N_3H \xrightarrow{Conc.\ H_2SO_4} RNH_2 + CO_2 + N_2.$$

Rxn with $CH_2N_2$: → Diazomethane

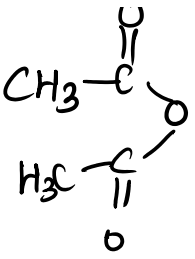
$$RCOOH + CH_2N_2 \xrightarrow{\Delta} RCOOCH_3 + N_2\uparrow$$

R'xn with ketene: $CH_2=C=O$

$$\longrightarrow CH_2-\overset{O}{\overset{\|}{C}}$$

Rxn with

$$CH_3COOH + H_2C=C=O \longrightarrow$$



Arndt-Eistert Rxn:

$$R\text{-}COOH \xrightarrow{PCl_5} R\text{-}COCl \xrightarrow{CH_2N_2} R\text{-}C(=O)\text{-}CH\text{-}N_2 \xrightarrow{H_2O} R\text{-}CH_2\text{-}COOH$$

Homologation.

HVZ rxn: "$\alpha$-H"

$$CH_3COOH + Cl_2 \xrightarrow[\Delta]{\text{Red P}} \underset{\underset{Cl}{|}}{CH_2}\text{-}COOH + HCl.$$

$\alpha$-halo carb. acid.