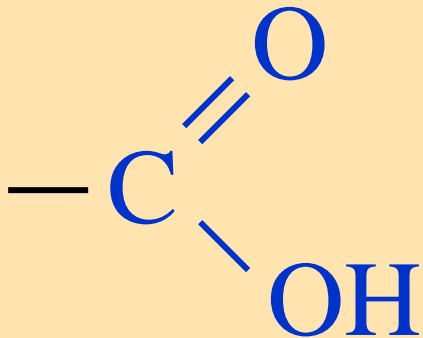




Carboxylic Acids

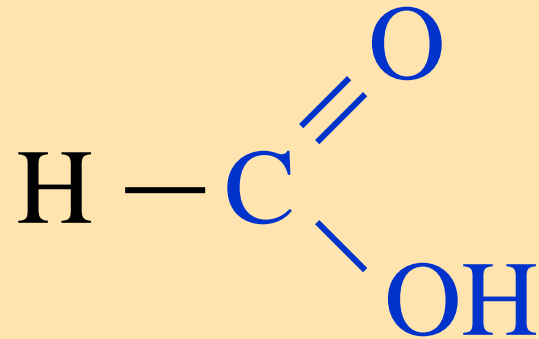
The Carboxyl Group



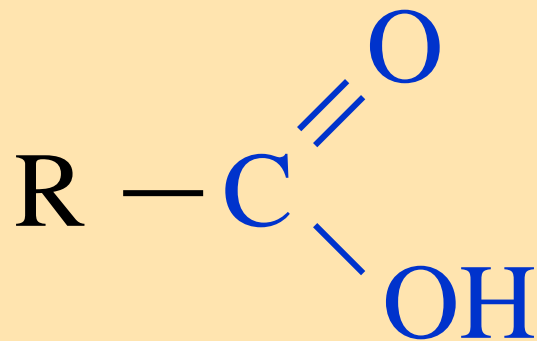
or



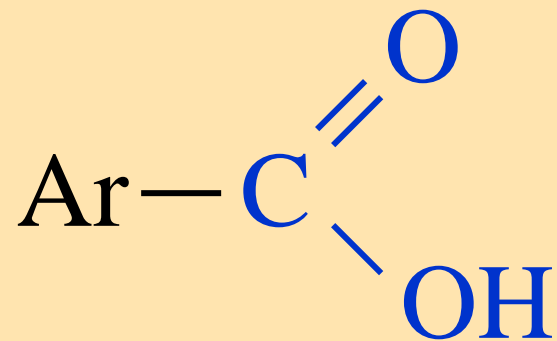
Attachment to Hydrogen



Attachment to an Alkyl Group

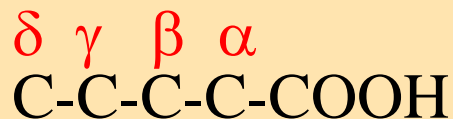


Attachment to an Aryl Group



Nomenclature

- Common Names
 - Named for their sources
 - Known for a long time
 - well ingrained
 - Branched chains are named and their position indicated by Greek letters
 - Aromatic acids are named as derivatives of the parent acid (benzoic acid)



Nomenclature

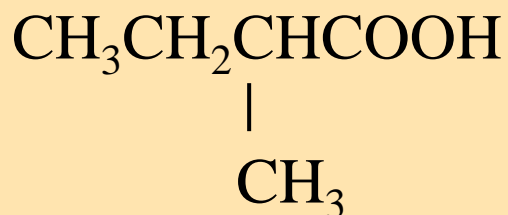


• Common Names	# carbon atoms
Formic	1
Acetic	2
Propionic	3
Butyric	4
Valeric	5
Isovaleric	5

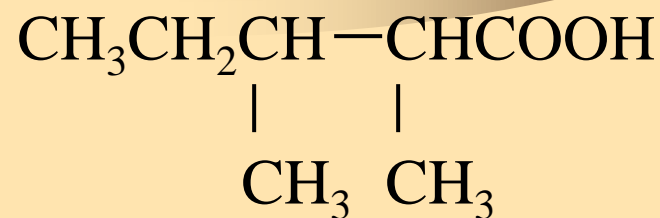
Nomenclature



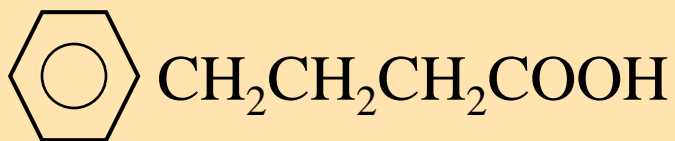
• Common Names	# carbon atoms
Caproic	6
Caprylic	8
Capric	10



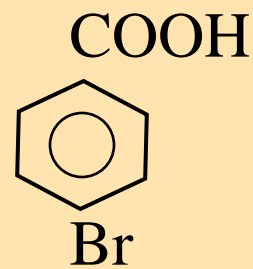
α -Methylbutyric



α,β -Dimethylvaleric



γ -Phenylbutyric

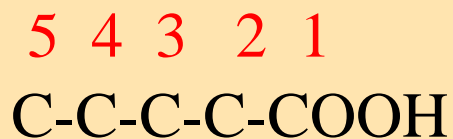


p-Bromobenzoic acid

Nomenclature



- IUPAC
 - Name the longest chain
 - replace **-e** with **-oic acid**
 - Position of substituent groups is indicated by number with the carboxyl carbon as C-1

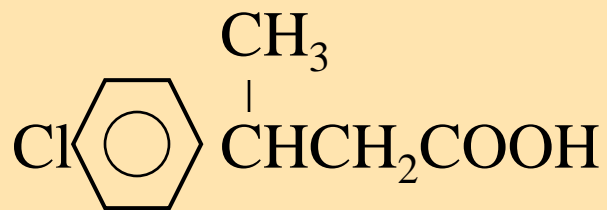




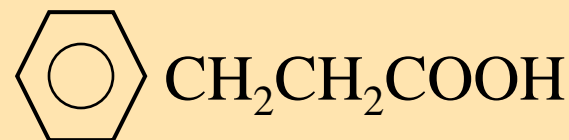
Pentanoic



2-Butenoic



3-(*p*-Chlorophenyl)butanoic



3-Phenylpropanoic

Nomenclature

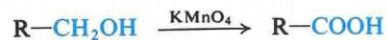


- Salts
 - Name the cation
 - name the acid replacing **-ic** with **-ate**

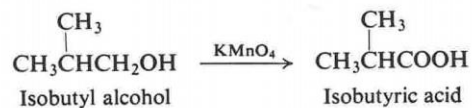
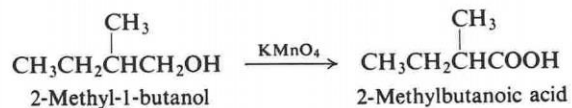
Preparation of Organic Acids

PREPARATION OF CARBOXYLIC ACIDS

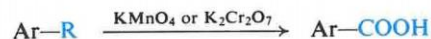
1. Oxidation of primary alcohols. Discussed in Sec. 6.15.



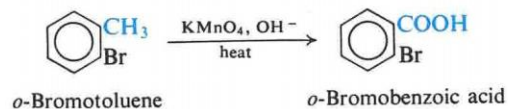
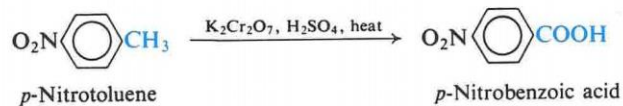
Examples:



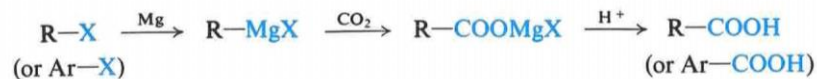
2. Oxidation of alkylbenzenes. Discussed in Sec. 16.11.



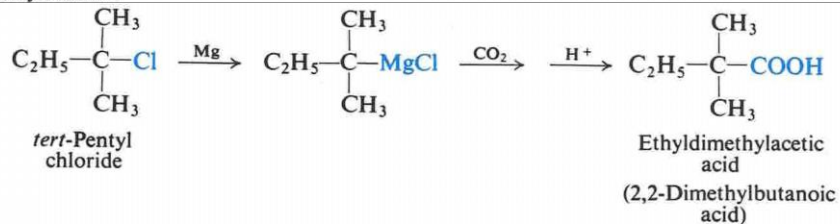
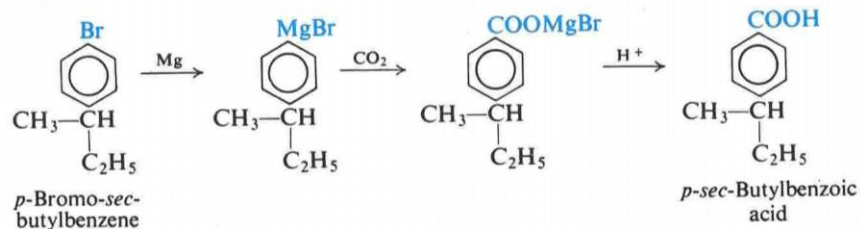
Examples:



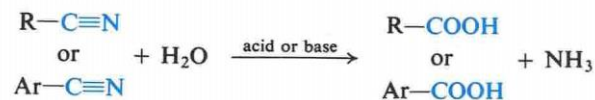
3. Carbonation of Grignard reagents. Discussed in Sec. 19.7.



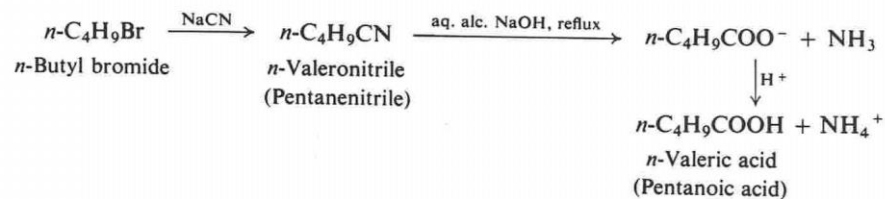
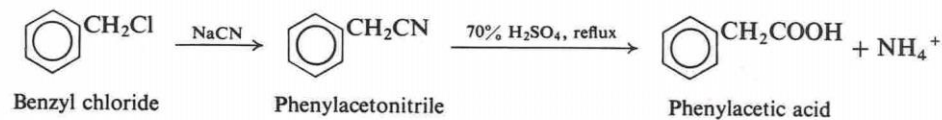
Examples:

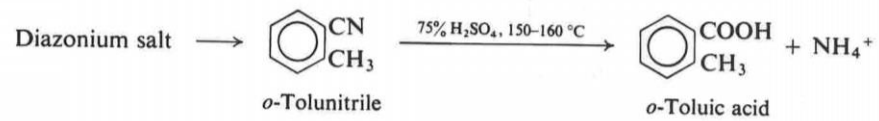


4. Hydrolysis of nitriles. Discussed in Sec. 19.8.



Examples:





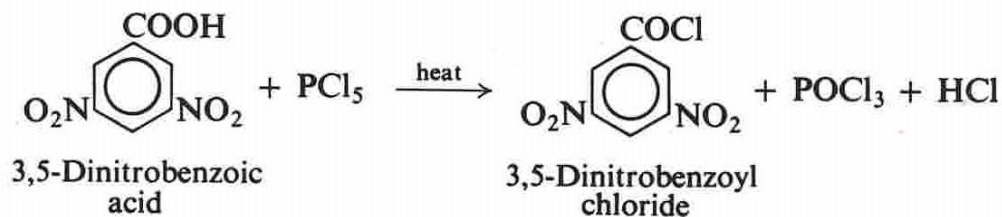
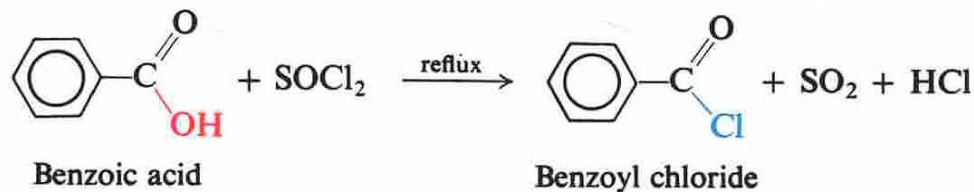
5. **Malonic ester synthesis.** Discussed in Sec. 25.2.

6. **Special methods for phenolic acids.** Discussed in Sec. 24.12. ■

Conversion into acid chlorides

A carboxylic acid is perhaps more often converted into the acid chloride than into any other of its functional derivatives. From the highly reactive acid chloride there can then be obtained many other kinds of compounds, including esters and amides (Sec. 20.8).

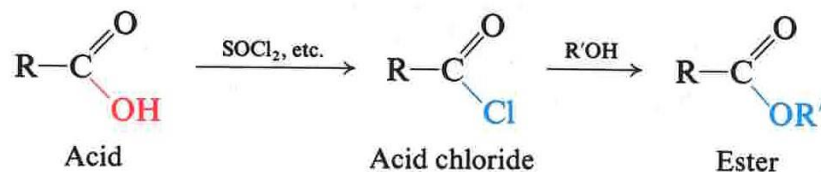
An acid chloride is prepared by substitution of $-\text{Cl}$ for the $-\text{OH}$ of a carboxylic acid. Three reagents are commonly used for this purpose: *thionyl chloride*, SOCl_2 ; *phosphorus trichloride*, PCl_3 ; and *phosphorus pentachloride*, PCl_5 . (Of what inorganic acids might we consider these reagents to be the acid chlorides?) For example:



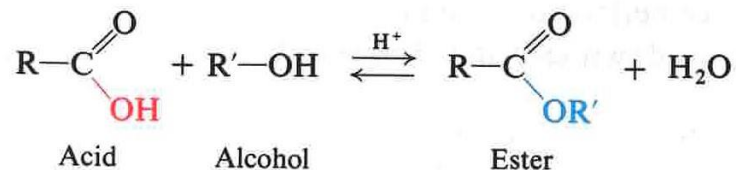
Thionyl chloride is particularly convenient, since the products formed besides the acid chloride are gases and thus easily separated from the acid chloride; any excess of the low-boiling thionyl chloride (79°C) is easily removed by distillation.

Conversion into esters

Acids are frequently converted into their esters via the acid chlorides:



A carboxylic acid is converted directly into an ester when heated with an alcohol in the presence of a little mineral acid, usually concentrated sulfuric acid or dry hydrogen chloride. This reaction is reversible, and generally reaches equilibrium when there are appreciable quantities of both reactants and products present.



For example, when we allow one mole of acetic acid and one mole of ethyl alcohol to react in the presence of a little sulfuric acid until equilibrium is reached (after several hours), we obtain a mixture of about two-thirds mole each of ester and water, and one-third mole each of acid and alcohol. We obtain this same equilibrium

Reactions of Carboxylic Acids

- Determined by their functional group, -COOH (carboxyl group)
- Composed of the carbonyl group (-C=O) and a hydroxyl group (-OH)
- It is the -OH that actually undergoes nearly every reaction –loss of H⁺, or replacement by another group

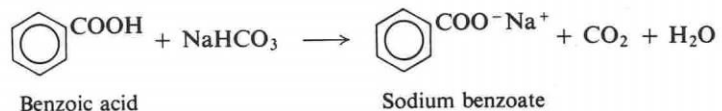
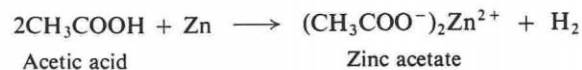
Reactions of Organic Acids

REACTIONS OF CARBOXYLIC ACIDS

1. Acidity. Salt formation. Discussed in Secs. 19.4, 19.10–19.14.



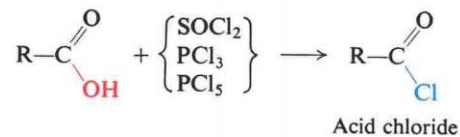
Examples:



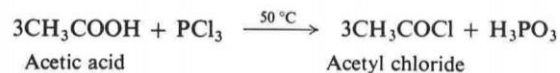
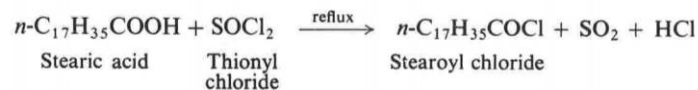
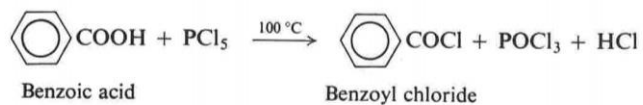
2. Conversion into functional derivatives



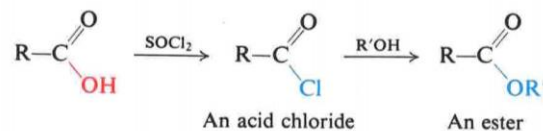
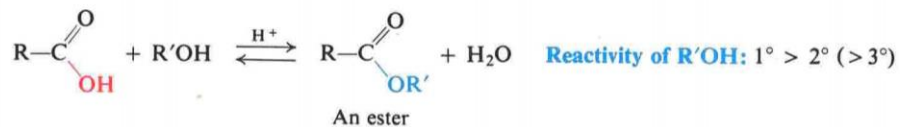
(a) Conversion into acid chlorides. Discussed in Sec. 19.15.



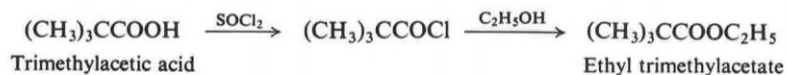
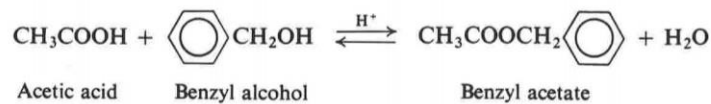
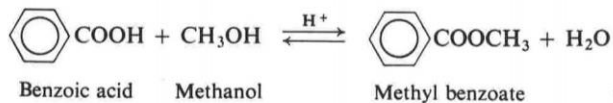
Examples:



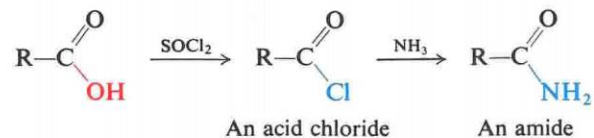
(b) Conversion into esters. Discussed in Secs. 19.16 and 20.15.



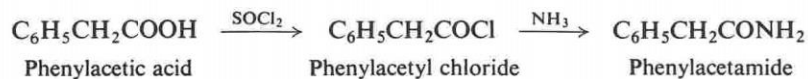
Examples:



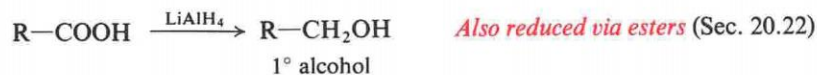
(c) **Conversion into amides.** Discussed in Sec. 19.17.



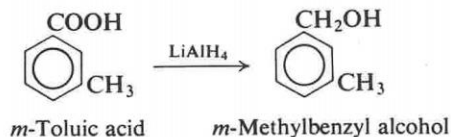
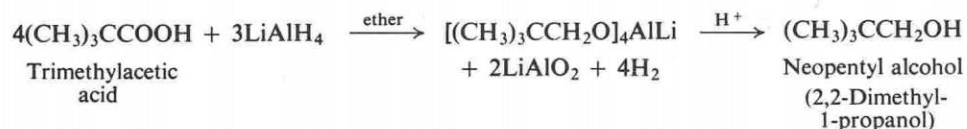
Example:



3. Reduction. Discussed in Sec. 19.18.

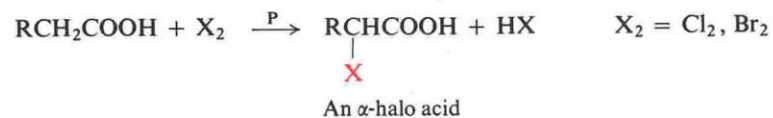


Examples:

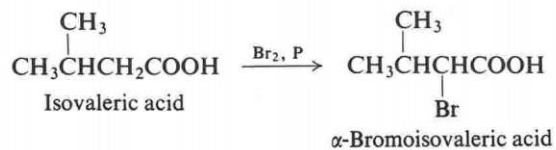
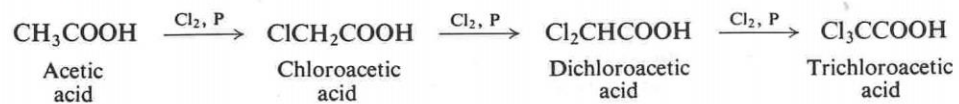


4. Substitution in alkyl or aryl group

(a) **Alpha-halogenation of aliphatic acids. Hell-Volhard-Zelinsky reaction.** Discussed in Sec. 19.19.



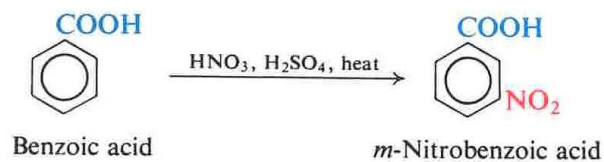
Examples:



(b) Ring substitution in aromatic acids. Discussed in Secs. 15.5 and 15.15.

—COOH: deactivates, and directs *meta* in electrophilic substitution.

Example:



Nomenclature of Diacids



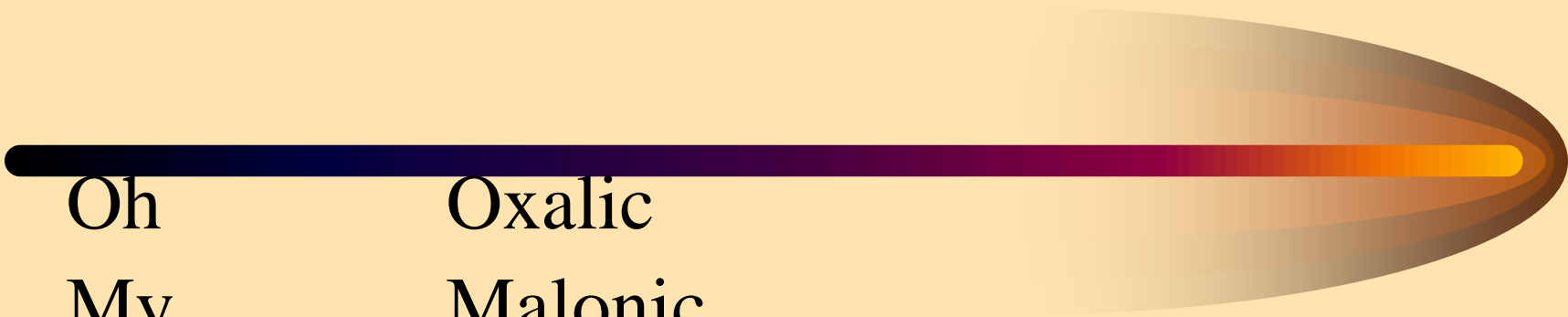
Nomenclature of Diacids

• Common Names	# carbon atoms
Oxalic	2
Malonic	3
Succinic	4
Glutaric	5
Adipic	6
Pimelic	7

Nomenclature of Diacids

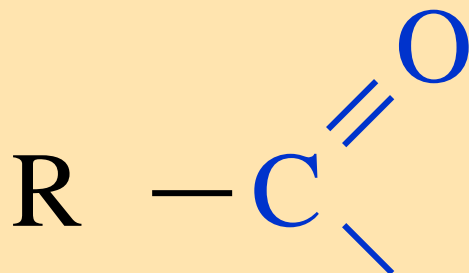


• Common Names	# carbon atoms
Suberic	8
Azelaic	9
Sebacic	10



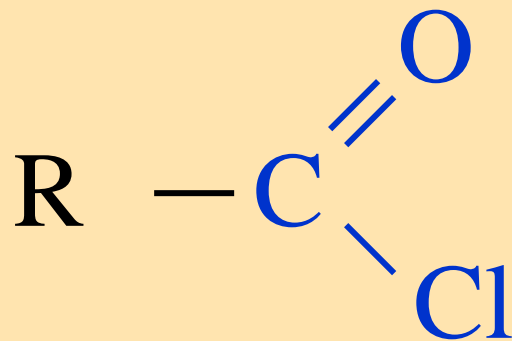
Oh	Oxalic
My	Malonic
Such	Succinic
Good	Glutaric
Apple	Adipic
Pie	Pimelic
Sweet	Suberic
As	Azelaic
Sugar	Sebacic

Functional Derivatives of Carboxylic Acids



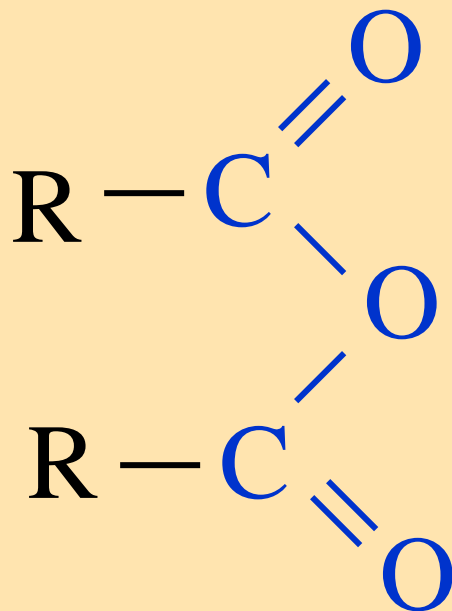
Acyl Group

Functional Derivatives of Carboxylic Acids



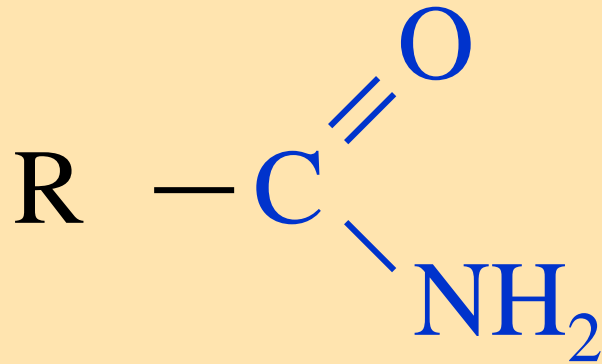
Acid chloride

Functional Derivatives of Carboxylic Acids



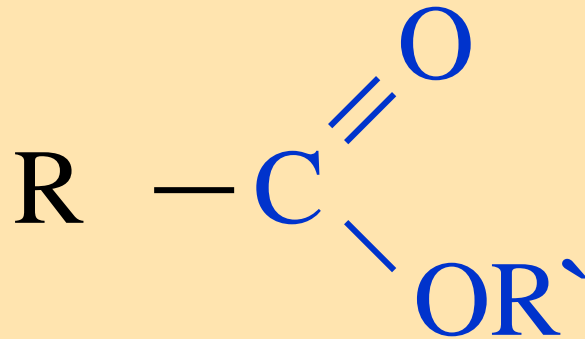
Anhydride

Functional Derivatives of Carboxylic Acids



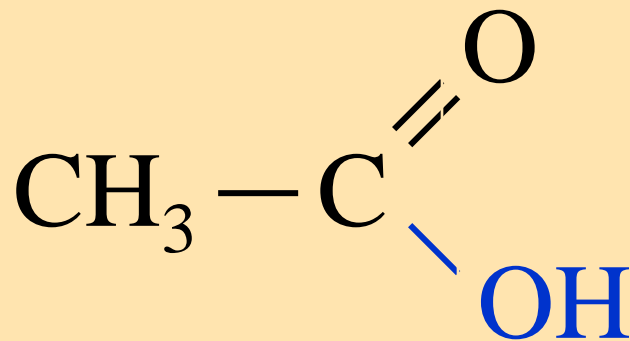
Amide

Functional Derivatives of Carboxylic Acids



Ester

Nomenclature

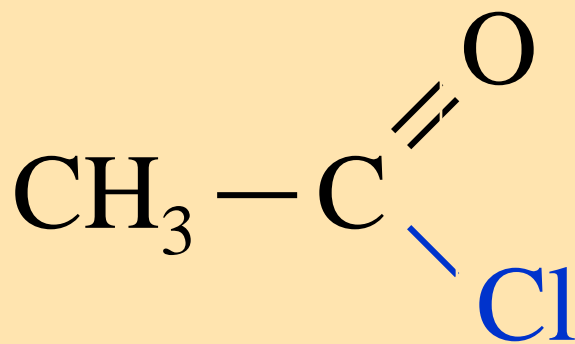


Acetic Acid

or

Ethanoic Acid

Nomenclature

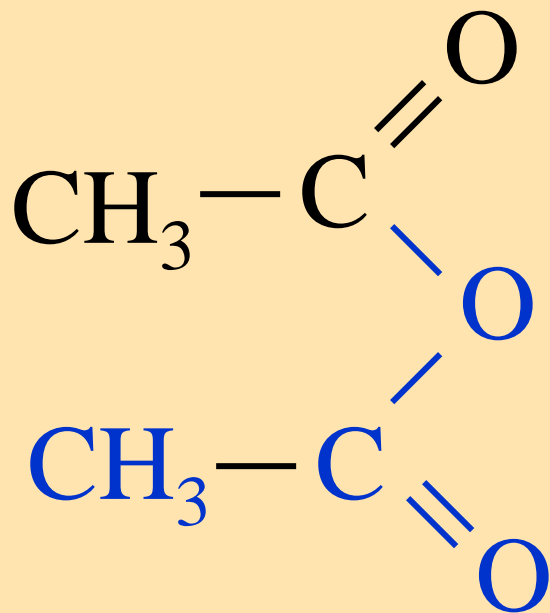


Acetyl chloride

or

Ethanoyl chloride

Nomenclature

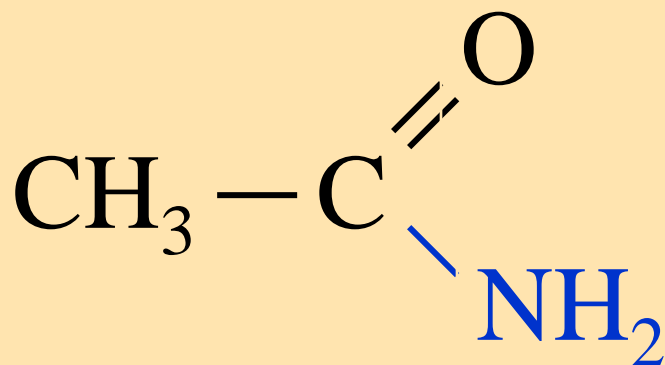


Acetic anhydride

or

Ethanoic anhydride

Nomenclature

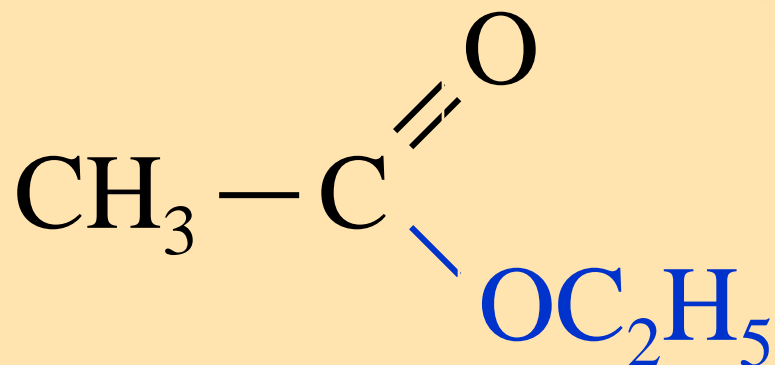


Acetamide

or

Ethanamide

Nomenclature



Ethyl acetate

or

Ethyl ethanoate

