

Chapter 15. Functional Derivatives of Carboxylic Acids

Learning objectives:

1. Recognize the names and structures for the following functional groups: acid halide, acid anhydride, ester, amide, lactone, and lactam.
2. Write the general electron-pushing (arrow-pushing) mechanisms for the nucleophilic acyl substitution of acid halide, acid anhydride, ester, and amide.
3. Explain the order of reactivity toward nucleophilic acyl substitution among acid halide, acid anhydride, ester, and amide based on the pK_a of the conjugate acid of the leaving groups on these four acid derivatives.
4. Provide appropriate reagents and reaction conditions for the feasible interconversions among acid halide, acid anhydride, carboxylic acid, ester, and amide.

Sections to be covered (in the order of delivery):

- 15.1 Introduction[#]
- 15.2 Structure and Nomenclature
- 15.3 Characteristic Reactions^{*}
- 15.4 Reaction with Water – Hydrolysis^{*}
- 15.5 Reaction with Alcohols^{*}
- 15.6 Reaction with Ammonia and Amines^{*}
- 15.7 Interconversion of Functional Derivatives^{*}
- 15.8 Esters with Grignard Reagents^{*}
- 15.9 Reduction

* Sections that will be focused

Sections that will be skipped

Recommended additional problems

15.8 – 15.43

15.2 Structure and Nomenclature

A. Ethanoyl Chloride (Acyl Halides)

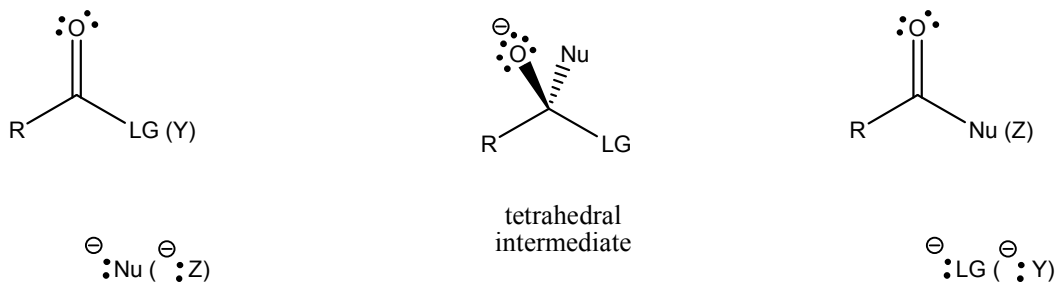
B. Acid Anhydrides

C. Esters and Lactones

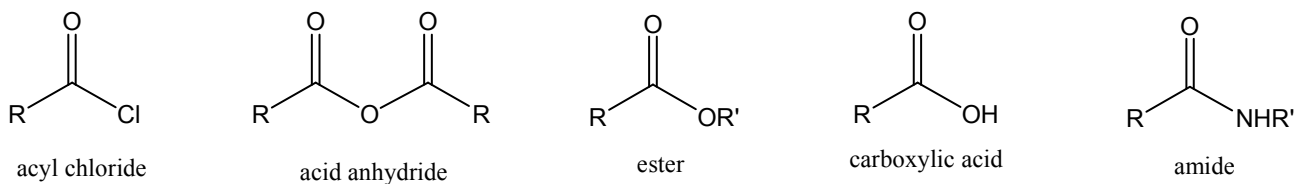
D. Amides and Lactams

15.3 Characteristic Reactions

A. General Reaction



B. Relative Reactivities of Carboxylic Acid Derivatives



(i) Inductive effect vs. resonance effect

(ii) Nucleophilicity, basicity, and pK_a

15.4 Reaction with Water – Hydrolysis

A. Acid Chlorides (Acyl Chlorides)

B. Acid Anhydrides

C. Esters

(i) In Acidic Condition

(i) In Basic Condition

D. Amides

15.5 Reaction with Alcohols

A. Acid Chlorides (Acyl Chlorides)

B. Acid Anhydrides

C. Esters

D. Amides

15.6 Reaction with Ammonia and Amines

A. Acid Chlorides (Acyl Chlorides)

B. Acid Anhydrides

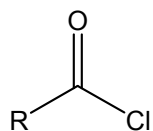
C. Esters

D. Amides

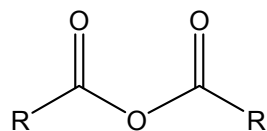
15.7 Interconversion of Functional Derivatives

Important Transformation: $\text{RCO}_2\text{H} \rightarrow \text{RCOCl}$

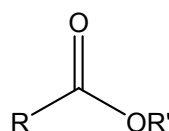
Important Reactivity Tendency:



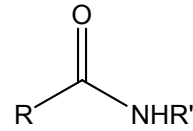
acyl chloride



acid anhydride

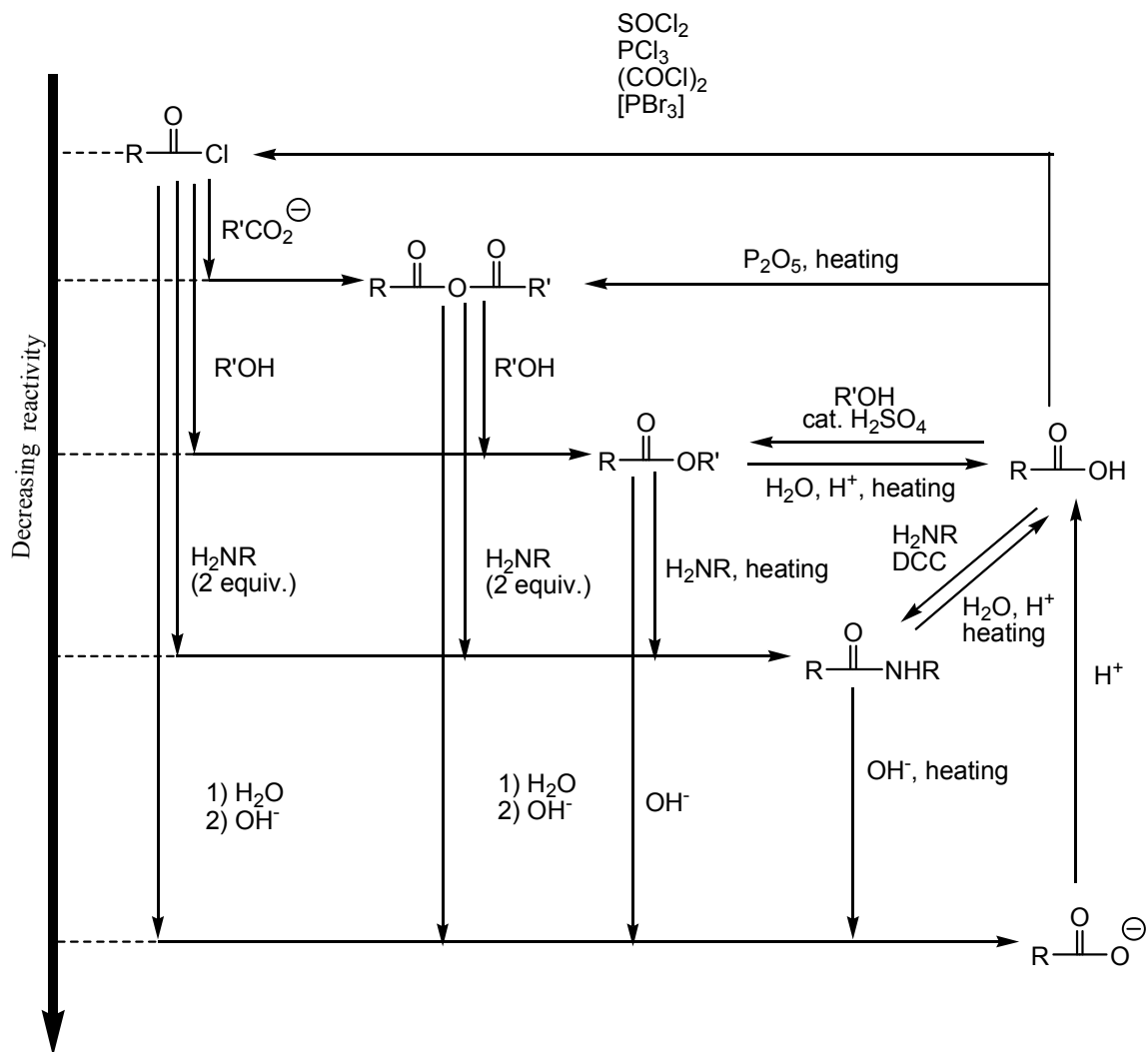


ester



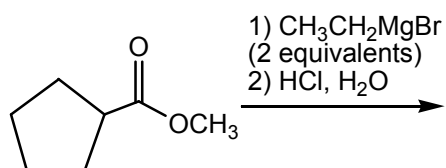
amide

A. Summary of Transformation of Acid Derivatives



15.8 Esters with Grignard Reagents

A. Example



B. Mechanism

15.9 Reduction

A. Esters

B. Amides