What are Carboxylic Acids and Derivatives?

Worksheet

Carboxylic acids contain the -COOH group and are weakly acidic (pKa ~4-5). Their main derivatives (acyl halides, anhydrides, esters, amides) contain the C(=O)- acyl group and react via nucleophilic acyl substitution.

Questions

1. The reaction RCOOH + R'OH RCOOR' + HO is called

A) Saponification
B) Fischer esterification
C) Hydrolysis
D) Condensation

2. Which is most reactive in nucleophilic acyl substitution?

A) Ester
B) Amide
C) Acyl halide
D) Anhydride

3. Acyl halides react with water to form

A) Ester
B) Carboxylic acid
C) Amide
D) Anhydride

4. Amides are stabilized by

A) Hydrogen bonding
B) Resonance
C) Ionic bonding
D) van der Waals

5. Acetic acid (CHCOOH) reacts with ethanol to form an ester. What is the product?

6. Acetyl chloride (CHCOCl) reacts with water. Predict the product.

7. Benzoic anhydride ((CHCO)O) reacts with ammonia. What forms?

8. Define: What is the carboxyl group?

9. Define: What are the five main derivatives of carboxylic acids?

10. Define: Which derivative is most reactive?

Answer Key

1. B) Fischer esterification - Fischer esterification is acid-catalyzed formation of esters from carboxylic acids and alcohols.

2. C) Acyl halide - Acyl halides are most reactive - Cl is the best leaving group.

3. B) Carboxylic acid - RCOCl + HO RCOOH + HCl.

4. B) Resonance - The N lone pair resonates with the C=O, reducing its electrophilicity.

5. This is Fischer esterification: RCOOH + R'OH RCOOR' + HO Reactants: CHCOOH + CHCHOH Product: CHCOOCHCH (ethyl acetate) Conditions: acid catalyst (HSO), heat, equilibrium

6. Acyl halides hydrolyze easily Nucleophile (HO) attacks the acyl carbon Product: acetic acid CHCOOH + HCl The reaction is fast and goes to completion

7. Anhydrides react with nucleophiles (NH) NH attacks the acyl carbon Product: benzamide CHCONH + benzoate Anhydrides are moderately reactive acyl donors

8. COOH: a carbonyl (C=O) bonded to a hydroxyl (OH).

9. Acyl halides (RCOCl), anhydrides ((RCO)O), esters (RCOOR'), amides (RCONH), and the acid itself.

10. Acyl halides (RCOCl) - the chlorine is an excellent leaving group.