Exam # 3 Review Topics – Fall 2010

1) Aldehydes, Ketones, Carboxylic Acids & Acid Derivatives (Chapters 16 & 18)
   • General properties and relative reactivity
   • Nomenclature basics
   • General nucleophilic additions to the carbonyl
   • Acidity of the carboxylic acid group
   • pKa and acid-base reactions

2) Reductions (Chapter 16)

   A) Reduction of carboxylic acids to aldehydes
      • Convert carboxylic acid to the acid chloride.
      • Treat with LiAlH(O-t-Bu)_3 in diethyl ether at low temperature (-78ºC).

   B) Reduction of esters and nitriles to aldehydes
      • Treat ester or nitrile with AlH(i-Bu)_2 in hexanes at low temperature (-78ºC).
      • Note on the Mechanism: Be sure you do know the role of the carbonyl oxygen in activating
        the aluminum hydride species, as well as the protection of the aldehyde by the bulky groups
        on the aluminum.

   REVIEW (Chapter 12) - Also be familiar with NaBH_4, LiAlH_4, and Grignard Organolithium
   Reagent Reductions.

3) Aldehyde Hydrates, Hemiacetals, & Acetals (Chapter 16)
   • Structure
   • Acid-catalyzed & base-catalyzed formation of hemi-acetals
   • Acid-catalyzed formation of acetals
   • Role of acetals as protecting groups:
     • Particular consideration of ethylene glycol in the protection of ketones.
     • Acetals are stable under basic conditions.

4) Carboxylic acids and acid derivatives (Chapter 18)
   • Basic structure, nomenclature, and reactivities of:
     o Carboxylic acids
     o Carboxylate anions
     o Esters
     o Amides
     o Acid Chlorides
     o Anhydrides
     o Nitriles
   • Various nucleophilic reactions at the carboxylate and derivative carbons
     Acid-catalyzed and base-catalyzed reactions
     • Esterification
       o Acid-catalyzed esterification & hydrolysis
       o Saponification (base-promoted hydrolysis)
       o Trans-esterification
• Acid Chlorides
  o Synthesis from carboxylic acids – SOCl₂, PCl₃, PCl₅
  o Conversions to other carboxylate derivatives – conditions and mechanism

• Anhydrides
  o Synthesis from acid chlorides and carboxylic acids.
    ▪ Review base: pyridine
  o Cyclic anhydrides
  o Conversions to esters and amides

• Amides
  o Synthesis from acid chlorides & anhydrides
  o Hydrolysis (acidic or basic conditions)

• Nitriles
  o Cyanide ion as a nucleophile
  o Acidic or basic hydrolysis of a nitrile
  o Grignard Reduction of a nitrile (section 16.5D)

• Intramolecular reactions

5) Enols & Enolates (Chapter 17)
• Acidity of the α hydrogen
  ▪ Resonance-stabilization of the enolate ion
• Keto-enol tautomerization
  ▪ Acid & Base catalysis
  ▪ Racemization

6) Halogenation of Aldehydes and Ketones (Chapter 17)
• General reaction
• Base promotes mechanism
• Acid-catalyzed mechanism
• Haloform Reaction

7) Aldol Reactions (Chapter 17)
• Reaction Process of an aldol condensation:
  ▪ Aldol Addition
  ▪ Dehydration of the Aldol addition product (formation of the α,β unsaturated carbonyl)
• Mechanisms for these reactions with acid or base catalysis
• Crossed Aldol Reactions
  ▪ Challenges
  ▪ Practical Crossed Aldol Reactions
• Claisen-Schmidt Reactions (ketone/aldehyde)