Chapter 12 - Alcohols from Carbonyl Compounds

12.1 - Structure of the Carbonyl Group
- Carbonyl compounds can go through nucleophilic addition where a pair of electrons from the C=O double bond moves up to the oxygen atom to make a negative formal charge and the nucleophile bonds to the carbon atom.
- Hydride ions and carbanions are important nucleophiles in these reactions.
- RedOx reactions also occur with carbonyl compounds.

12.2 - Oxidation-Reduction Reactions in Organic Chemistry
- Reduction to an organic molecule typically involves increasing hydrogen content or decreasing oxygen content.
- Oxidation typically occurs with increasing oxygen content or decreasing hydrogen content.
- The symbol [H] refers to reduction while [O] refers to oxidation.

12.3 - Alcohols by Reduction of Carbonyl Compounds
- Reduction converts a carboxylic acid to a primary alcohol by taking off an oxygen from C=O.
- Reduction converts an ester into two 1° alcohols, one derived from the carbonyl part of the ester group, and the other from the alkoxy part of the ester.
- Reduction converts a ketone to a 2° alcohol and an aldehyde to a 1° alcohol.

- Aldehydes and ketones are easily reduced by NaBH₄.

12.4 - Oxidation of Alcohols
- 1° alcohols can be oxidized to aldehydes and carboxylic acids.
- PCC will convert a 1° alcohol to an aldehyde and oxidize a 2° alcohol to a ketone. NOT 3°.
- KMnO₄ or H₂CrO₄ (Jones Reagen t) can oxidize a 1° alcohol to a carboxylic acid.
- Oxidizing agents based on Cr(VI) can oxidize a 2° alcohol to a ketone. One example is H₂CrO₄.

---

1Sections 12.4D, 12.4E, and 12.4F are skipped.
12.5 - Organometallic Compounds
- Organometallic compounds contain carbon-metal bonds

12.6 - Preparation of Organolithium and Organomagnesium Compounds
- The general reaction to create organolithium compounds is, \( RX + 2 \text{Li} \rightarrow R\text{Li} + \text{LiX} \)
- Grignard reagents are organomagnesium halides and are prepared by, \( RX + \text{Mg} \rightarrow R\text{MgX} \)

12.7 - Reactions of Organolithium and Organomagnesium Compounds
- Grignard Reagents react with any compound that has a hydrogen attached to an atom of high electronegativity (e.g., oxygen, nitrogen, sulfur, etc.)
- Grignard Reagents react well with compounds that have carbonyl groups

12.8 - Alcohols from Grignard Reagents
- When a Grignard reagent adds to the carbonyl group of an ester, the initial product breaks down to a ketone. Then, the ketone reacts with the excess Grignard reagent and then goes through hydrolysis to form a tertiary alcohol with two identical alkyl groups
- It is not possible to prepare a Grignard reagent from a compound that contains any hydrogen more acidic than the hydrogen atoms of an alkane or alkene
- We're essentially limited to alkyl halides or analogous organic halides containing carbon-carbon double bonds, intermolecular triple bonds, ether linkages, and NR₂ groups
- Acetylenic Grignard reagents can be made by allowing terminal alkynes to react with alkyl Grignard reagents (similar to what we did with NaNH₂)
- Organolithium reagents react with carbonyl compounds in the same way as Grignard reagents
- Sodium alkynides react with aldehydes and ketones to yield alcohols

12.9 - Protecting Groups
- Protecting groups can be used to perform a Grignard synthesis with a compound that has a relatively acidic hydrogen by protecting that group and then taking off the protecting group with a fluorine anion