Learning Guide for Chapter 14 - Alcohols (I)

I. Introduction to Alcohols and Thiols II. Acid/base Behavior of Alcohols, Phenols, and Thiols III. Nomenclature of Alcohols IV. Synthesis of Alcohols Previous reactions Reduction of C=O functional groups Organometallic reagents

I. Introduction to Alcohols and Thiols

What does an alcohol functional group look like?

How are alcohols different from carboxylic acids?

What are some common alcohols?

What does a thiol functional group look like?

What other name are they known by?

Why is their reactivity similar to alcohols?

What is the main difference in their reactivity?

What is the most noticeable characteristic of thiols?

What are some examples of this?

Is this always the case?

Classification of Alcohols

How are alcohols in which the carbon is sp³ hybridized classified?







How are alcohols in which the carbon is sp² hybridized classified?





How would the following compounds be classified?



Physical Properties of Alcohols

Match up the following compounds with their boiling points and justify your answers.



Which of the following would you expect to be soluble in water?



IR Spectra of Alcohols

Is IR a good way to identify alcohols?

Label the important bands in the following spectrum.



NMR Spectra of Alcohols

Consider the following compound.

Where should you look for the H's next to the OH?

Where should you look for the OH peak?

What will happen if D_2O is added to this sample?

Label the peaks in the following spectrum.



II. Acid-base Behavior of Alcohols, Phenols, and Thiols

What happens when an alcohol reacts with an acid?

H-base ю́н

What kind of acid would be required for this reaction to have a favorable equilibrium?

What would happen if the protonated alcohol came in contact with a base?

What happens when an alcohol reacts with an base?

What kind of base would be required for this reaction to have a favorable equilibrium?

How can alkali metals be used to form alkoxides?



What would happen if an alkoxide came in contact with an acid?



What would happen if a protonated alcohol and an alkoxide were reacted with each other?

How does the acidity of alcohols vary?



LG Ch 14 p 6

Why are aryl alcohols more acidic than aliphatic alcohols?

Could NaOH be used as the base?

Why won't this work with regular alcohols?

Why are thiols more acidic than alcohols?



Could NaOH be used as the base?

III. Nomenclature of Alcohols

Common names

Based on the common name for the following alkyl halide, deduce the common name of the alcohol shown.



Give the common names of the following alcohols.



IUPAC names

What are the four steps in naming an organic compound?

1.

- 2.
- 3.
- 4.

What are the priorities for choosing the principle chain?



How does the alkane name change for each of the following?



What are the priorities for numbering the principle chain?

1.

- 2.
- 3.
- 4.

Number the following compounds.



If you have to name an alcohol as a substituent, what is it called?



Draw structures for the following names.

2-cyclohexyl-1-butanol

1,3-cyclopentanediol

5-bromo-4-methyl-2-hexanol

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2-cyclopenten-1-ol 2-(1-hydroxyethyl)-1-cyclohexanol 5-methyl-3-hexanol
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Give the names of the following compounds.



юн OH



IV. Synthesis of Alcohols

Reactions from Previous Chapters

What reagents would be required to convert the following compounds to alcohols using the reaction given?



In this chapter, we will learn two more:

reduction of a C=O by adding hydrogen



reduction of a C=O by adding an alkyl group



Reduction of C=O groups to form alcohols

How is oxidation defined in organic chemistry?

How is reduction defined in organic chemistry?

Which of these is occurring in the following reactions, and why?



What type of alcohol can be formed by the reduction of the following compounds?



Which of the following reagents is effective in reducing the functional groups shown?

C=C to C-C ketone, aldehyde COOH, ester C=O to C-OH C=O to C-OH H_2 , Pd/C NaBH₄ LiAlH₄ Raney Ni

Which is more reactive, NaBH₄ or LiAlH₄? Why?

 $NaBH_4 = LiAlH_4 =$

How do they react?



What is Raney Ni? What is the advantage of using it?

What safety hazards exist with these materials?

What reagent(s) could be used to accomplish the following reactions?



Addition of Organometallic Reagents to C=O Groups to form Alcohols

What is the advantage of using an organometallic reagent instead of a reducing agent to convert a C=O group to an alcohol?

What are the two most common kinds of organometallic reagents used in organic chemistry?

Grignard reagents

organolithium reagents

What polarity do these reagents have? How reactive are they, and why?

How are organometallic reagents formed?



Li . l

What other kinds of halides can be used?

What are the two ways in which a Grignard or organolithium reagent can react?



How strong of bases are organometallic reagents? Why is this so?

What would happen if an organometallic reagent came in contact with water?

What other kinds of compounds will react as acids with organometallic reagents?

If this usually a reaction we desire?

Is there any way in which it could be useful?



In the absense of any compounds with acidic H's, organometallic reagents react as nucleophiles.

What type of compound will be formed when a Grignard or organolithium reagent is reacted with an aldehyde or ketone, followed by mild, aqueous acid?



Is there any way to get a primary alcohol?



What type of compound will be formed when a Grignard or organolithium reagent is reacted with an acid chloride, following by mild, aqueous acid?



Why doesn't this happen with aldehydes and ketones?

What will happen to an ester?



What type of compound is formed when a Grignard or organolithium reagent is reacted with ethylene oxide?



What reagents would be needed to complete the following reactions?



How could the following compound be synthesized?



Summary of methods for synthesizing alcohols:

S_N2:

1° alkyl halide + NaOH --> 1° alcohol

Acid-catalyzed hydration:

alkene + H_2SO_4 + H_2O --> 2° or 3° alcohol (more substituted side, rearrangements possible)

Oxymercuration-reduction:

alkene + 1. $Hg(OAc)_2$, H_2O 2. $NaBH_4 \rightarrow 2^\circ$ or 3° alcohol (more substituted side, no rearrangements)

Hydroboration-oxidation:

alkene + 1. BH₃-THF, 2. H_2O_2 , NaOH --> 1° or 2° alcohol (less substituted side, no rearrangements)

Reduction of an aldehyde or ketone:

aldehyde or ketone + NaBH₄, CH₃OH --> 1° or 2° alcohol

Reduction of a carboxylic acid or ester:

carboxylic acid or ester + $\text{LiAlH}_4 \rightarrow 1^{\circ}$ alcohol (ester has a second alcohol)

Addition of an organometallic reagent to an aldehyde or ketone

aldehyde or ketone + Grignard or organolithium reagent, 2. $H_3O^+ -> 2^\circ$ or 3° alcohol

Addition of an organometallic reagent to and acid chloride or ester:

acid chloride or ester + Grignard or organolithium reagent, 2. $H_3O^+ -->$ 3° alcohol with two identical groups

Addition of an organometallic reagent to an epoxide:

ethylene oxide + Grignard or organolithium reagent, 2. H₃O⁺ --> 1° alcohol