

Chapter 8 – Introduction to Alkyl Halides, Alcohols, Ethers, Thiols, and Sulfides (partial)

Introduction

Chapter 8 provides a quick survey of several functional groups:

- Alkyl halides, RX (RF, RCl, RBr, RI)
- Alcohols, ROH
- Ethers, ROR
- Thiols, RSH
- Sulfides, RSR

These groups are *chemically* related in the sense that it might be possible to transform one group into another, e.g., $RBr + R'OH \rightarrow ROR'$, or two different groups might display similar kinds of chemistry, e.g., ROH versus RSH.

Although relationships exist, this chapter does not explore them. Rather, it introduces nomenclature, structure, bonding, physical properties, and some of the commercial uses (and problems) of compounds based on these groups.

Perhaps the best way to think of the material in chapter 8 is to view it as a “base camp” that will be used to climb various functional group “summits” in later chapters.

Read the “key idea” list on p. 372 to gain some notion of what lies inside this unusual chapter *before* you read it.

Checklist

The phrase “functional groups in this chapter” refers to five groups: alkyl halides, alcohols, ethers, thiols, and sulfides. When you have finished studying Chapter 8, you should be able to:

1. Identify and name (using common and substitutive nomenclature) molecules that contain the functional groups in this chapter. Identify and draw molecules using the following special names:
 - a. *methylene*
 - b. *vinyl*
 - c. *allyl*
 - d. *phenyl*
 - e. *benzyl*
2. Identify and name the following special compounds:
 - a. *haloforms*

- b. *glycols*
 - c. *oxiranes* (a.k.a. *epoxides*)
3. Describe and predict the geometric and electronic properties of the functional groups in this chapter. Relevant properties include:
 - a. bond distances
 - b. bond angles
 - c. dipole moments
 - d. electrostatic potentials
4. Identify and describe “noncovalent” interatomic interactions (forces) such as *ion-dipole (charge-dipole)*, *dipole-dipole*, *hydrogen bonding*, *donor-acceptor interactions*, *van der Waals attraction and repulsion*
 - a. Predict the relative strengths of these interactions.
 - b. Rationalize the following phenomena in terms of these interactions:
 - i) intermolecular interactions
 - ii) physical properties (boiling points, solubilities)
 - iii) conformational preferences
 - iv) ability of molecules to penetrate biological membranes
 - v) cation-binding by neutral organic molecules (*crown ethers*, *cryptands*)
 - c. Predict the ideal orientations of hydrogen bond *donors* and *acceptors* in a hydrogen bonded complex
 - i) Identify *hydrogen bond donors* and *acceptors*
 - ii) Predict the relative lengths of covalent X-H and “hydrogen bonded” $X\cdots H$ bonds
5. Classify common solvents. Rationalize this classification. Solvent categories include:
 - a. *protic* vs. *aprotic*
 - b. *polar* vs. *nonpolar* (apolar)
 - c. *donor* vs. *nondonor*
6. Predict and rationalize the acid-base chemistry of the functional groups in this chapter
7. Identify the important commercial uses and health/environmental problems associated with the compounds listed in the supplement
8. Plan and predict the outcomes of the following chemical reactions:
 - a. Formation of Grignard and organolithium reagents
 - b. Protonolysis of Grignard, organolithium, and other “organometallic” reagents
 - c. Free-radical halogenations of alkanes
 - d. Autoxidation of ethers

Top 11 Problems for Chapter 8

All of these problems are drawn from the *Additional Problems* located at the end of the chapter 8.

The top 11 for chapter 8 are **33, 35, 37, 44ACE, 45, 48, 52, 54E, 55, 59A, 62A**

Supplement

Names

Organic chemists love “name” problems. These are always variations on the following: What is the name that goes with this structure? Draw the structure that goes with this name. Because it is quite easy to issue naming problems of nearly “impossible” difficulty, and because I would rather have you spend your time thinking about phenomena and not names, I am going to place several limits on the complexity of potential naming problems.

There are three areas that I expect you to master. These can be described roughly as:

- Learning how to use common names for *simple* compounds
- Learning the names of *special* compounds (and families)
- Learning how to use IUPAC (substitutive) names for compounds of *limited* complexity

Notice that I’m emphasizing “simple”, “special”, and “limited”. I do not expect you to learn how to name everything in sight. Furthermore, I don’t even expect you to learn how to name all of the compounds that Loudon teaches you to name.

So is it possible to say how much you need to learn? Sort of. First, “simple” means compounds with simple alkyl, cycloalkyl, and aryl groups. Also see Checklist item #1. *Isopropyl bromide, cyclohexyl chloride, allyl vinyl ether* are the kinds of names I mean. More complicated names, in which the alkyl group is branched or contains additional substituents, e.g., *3-methylcyclohexyl chloride*, will be handled using IUPAC rules.

Second, special compounds will always be listed in the Checklist. See items #2 and 4.b.v.

Third, “limited” complexity means that a compound will not contain two competing principal groups. You may be

faced with a diol or triol, i.e., multiple principal groups of the *same* type, but you won’t have to learn the relative rankings of alcohols and thiols because these are different types of groups. “Limited” complexity also means not too many carbons overall, not too many branches, and so on. Frankly, my naming skills aren’t all that fantastic so if I have to think three times what a name might be, I’m not going to bother putting that problem on an exam.¹

Using Planar Structures to Analyze Stereochemistry

(More next year...)

¹ Believe it or not, the “think three times” guides the writing of most exam problems. I rarely have to “think twice” about an exam problem (although there have been many times when I wished I had). If the solution of a problem isn’t obvious to me after studying organic chemistry for 30+ years, I’m not going to put the problem on *your* exam.