Chem 343  Summer 2002
Lecture 4

Topics

Isomers
- constitutional isomers
- stereo isomers

Hydrocarbons

Overview of Functional Groups.
- alkyl halides
- alcohols
- ethers
- amines
- aldehydes & ketones
- carboxylic acids
- esters
- amides
- nitriles

Props/Visuals

Large Models
- 2-butanes
- dibromo-cyclopentanes

Announcements

Greater University Tutoring Service
Helen C. White Library
Wed. 4-6 pm
http://guts.studentorg.wisc.edu
VII. Introduction to Isomers

A. Isomers - compounds with same chemical formula, but different structures.

B. Constitutional isomers - different order of connection of atoms.

Examples: pentane $C_5H_{12}$

- [Chemical structure depiction]

- [Chemical structure depiction]

Example: $C_5H_{11}Cl$

- [Chemical structure depiction]

- [Chemical structure depiction]

- [Chemical structure depiction]

- [Chemical structure depiction]

- [Chemical structure depiction]
C. Stereoisomers - same order of connection of atoms, but different geometries.

Example. 2-butene

\[
\begin{align*}
\text{trans} & \quad \text{cis} \\
\text{H} & \quad \text{H} \\
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\text{C} \quad \text{C} \quad \text{C} \quad \text{C} \\
\text{=C} & \quad \text{=C} \\
\text{H} & \quad \text{H} \\
\text{H}_3\text{C} & \quad \text{CH}_3
\end{align*}
\]

Example. 1,3-Dichlorocyclopentane

\[
\begin{align*}
\text{trans} & \quad \text{cis} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl} \\
\text{Cl} & \quad \text{Cl}
\end{align*}
\]
Chem 343 Lecture Notes

Chapter 2 - Representative Organic Compounds - Functional Groups

I. Introduction

A. More than 11 million organic compounds are known and thousands more are reported every year.

B. Systematic classification schemes are critically important to the study of organic chemistry.

C. Classification of Organic Compounds is done by Functional Groups.

Functional Group - a part of a molecule characterized by certain types of atoms, the way they are bonded together, and the way they react.


A. Hydrocarbons

1. Alkanes \( \text{C}_n\text{H}_{2n+2} \)

   a. chains of \( \text{sp}^3 \) carbon atoms with hydrogen completing valence requirement.
6. **all single bonds**

   c. "saturated" = maximum amount of hydrogen for # of carbons.

   **examples:** 
   \[
   \text{CH}_4 \text{ methane} \\
   \text{C}_2\text{H}_6 \text{ ethane} \\
   \text{C}_3\text{H}_8 \text{ propane} \\
   \text{C}_4\text{H}_{10} \text{ butane} \ (2 \ \text{isomers}) \\
   \text{C}_5\text{H}_{12} \text{ pentane} \ (3 \ \text{isomers}) \\
   \text{C}_6\text{H}_{14} \text{ hexane} \ (5 \ \text{isomers})
   \]

2. **Alkenes**

   a. contain 2 or more sp² carbons and one or more C= C double bonds

   b. "unsaturated"

   **examples:** 
   \[
   \text{H}_2\text{C} = \text{CH}_2 \text{ ethene (ethylene)} \\
   \text{H}_2\text{C} = \text{CH}-\text{CH}_3 \text{ propane (propylene)} \\
   \text{H}_2\text{C} = \text{CH}-\text{CH}_2\text{CH}_3 \text{ 1-buten e} \\
   \text{H}_3\text{C} \text{CH} = \text{CH}-\text{CH}_3 \text{ 2-buten e} \\
   \text{H}_2\text{C} = \text{CH} - \text{CH} = \text{CH}_2 \text{ 1,3-buten e} \\
   \text{H}_2\text{C} = \text{C} = \text{CH} \text{ acetylene}
   \]

3. **Alkynes**

   a. contain 2 or more sp carbons and one or more C≡ C triple bonds

   b. "unsaturated"

   **examples:** 
   \[
   \text{H}_2\text{C} \equiv \text{C} = \text{H} \text{ ethyne acetylene} \\
   \text{H}_2\text{C} \equiv \text{C} \text{CH}_3 \text{ propyne} \\
   \text{H}_2\text{C} \equiv \text{C} \text{CH}_2\text{CH}_3 \text{ 1-butyne} \\
   \text{H}_3\text{C} - \text{C} \equiv \text{C} \equiv \text{CH}_3 \text{ 2-butyne}
   \]
4. Cycloalkanes and Cycloalkenes
   Examples: cyclopentane

   cyclopentene

   1,3-cyclohexadiene

5. Aromatic Ring Compounds
   All \( sp^2 \) carbons with alternating single and double bonds

   Example: benzene
B. Alkyl & Aryl Groups

1. Alkyl Groups

**Alkane**
- \( CH_4 \) methane
- \( CH_3CH_3 \) ethane
- \( CH_3CH_2CH_3 \) propane

**Alkyl Group**
- \(-CH_3\) methyl (-Me)
- \(-CH_2CH_3\) ethyl (-Et)
- \(-CH_2CH_2CH_3\) propyl (-Pr)
- \(CH_3-CHCH_3\) isopropyl (-iPr)

\(-R\) = general abbreviation meaning any alkyl group.

2. Phenyl and Benzyl Groups.

\(-C_6H_5\) or \(Ph-\) or \(\phi\)

**Phenyl**

\(-CH_2-\) or \(C_6H_5CH_2-\)

**Benzyl**
C. Alkyl Halides \( R-X \)

1. alkane compound with one or more hydrogens replaced by halogen.

2. can be primary (1\(^{\circ}\)), secondary (2\(^{\circ}\)) or tertiary (3\(^{\circ}\)) depending on type of carbon halogen is bonded to.

Example: consider different ways \( \text{Cl} \) can substitute onto isopentane

\[
\begin{align*}
\text{1}\(^{\circ}\) & \quad \text{2}\(^{\circ}\) & \quad \text{3}\(^{\circ}\) & \quad \text{1}\(^{\circ}\) \\
\text{ClH}_3 - \text{ClH}_2 - \text{ClH} - \text{CH}_3 & \quad \text{CH}_3 - \text{CH}_2 - \text{ClH} - \text{CH}_3 & \quad \text{CH}_3 - \text{CH} - \text{CH}_3 - \text{CH}_3 & \quad \text{Cl} \\
\text{ClH}_3 & \quad \text{ClH}_3 & \quad \text{ClH}_3 & \\
\text{1}\(^{\circ}\) & \quad \text{2}\(^{\circ}\) & \quad \text{3}\(^{\circ}\) & \quad \text{1}\(^{\circ}\) \\
\end{align*}
\]

1\(^{\circ}\) alkyl halide \quad 2\(^{\circ}\) alkyl halide \quad 3\(^{\circ}\) alkyl halide.

(demonstrate) (with model)