5-31-2019

Organic Chemistry I Drill (CHEM2210D) - Module 4 - Nomenclature

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BASIC NOMENCLATURE

A STUDENT SHOULD BE ABLE TO:

1. Give examples of, and recognize when given the structure, representatives of the classes of compounds learned in Module 2. Also be able to classify the following functional groups as 1°, 2°, or 3°: alkyl halides, alcohols, and amines.

2. Classify carbons and hydrogens attached to sp³ carbons as 1°, 2°, 3°, or 4°

3. Give the IUPAC names of open-chain alkanes, alkenes (including cis and trans), alkynes, and alkyl halides having a longest chain of ten carbons or less when given the structure, and draw the structure given the name. The unbranched alkanes whose names are the basis of this are:

   - methane (1 carbon)
   - ethane (2 C’s)
   - propane (3 C’s)
   - butane (4 C’s)
   - pentane (5 C’s)
   - hexane (6 C’s)
   - heptane (7 C’s)
   - octane (8 C’s)
   - nonane (9 C’s)
   - decane (10 C’s)

The names of the groups you must be able to recognize and draw are:

   - methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl (the unbranched groups)
   - isopropyl
   - isobutyl, sec-butyl, tert-butyl
   - neopentyl
   - vinyl, allyl, phenyl, and benzyl

4. Give the IUPAC name when given the structure, and give the structure given the IUPAC name, of monocyclic alkanes, alkenes, alkynes, and alkyl halides having rings containing 3-10 carbons. These compounds may also contain halogen atoms and side chains.

5. Give the common name when given the structure, and give the structure when given the common name, of simple alkyl halides. In the system used here, compounds are named by first naming the alkyl group and then naming the functional group (e. g. neopentyl bromide).

6. Give the common name when given the structure, and draw the structure when given the common name, of unsubstituted monocyclic alkyl halides (e. g. cyclobutyl fluoride).

7. Draw the structure when given any of the following common names: ethylene, propylene, isobutylene, acetylene, and alkylacetylenes including any of the alkyl groups named in #3 above. Also, give the name when given the structure of any of these compounds.
8. Know the priority of various functional groups in nomenclature. Names in bold are covered in this module.

<table>
<thead>
<tr>
<th>HIGHEST priority</th>
<th>If the group is a substituent, it is called:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Carboxylic acid</td>
<td></td>
</tr>
<tr>
<td>2. Ester</td>
<td></td>
</tr>
<tr>
<td>3. Acid halide</td>
<td></td>
</tr>
<tr>
<td>4. Amide</td>
<td></td>
</tr>
<tr>
<td>5. Nitrile</td>
<td>cyano</td>
</tr>
<tr>
<td>6. Aldehyde</td>
<td>formyl, oxo</td>
</tr>
<tr>
<td>7. Ketone</td>
<td>oxo</td>
</tr>
<tr>
<td>8. Alcohol</td>
<td>hydroxy</td>
</tr>
<tr>
<td>9. Amine</td>
<td>amino</td>
</tr>
<tr>
<td><strong>10. Alkyne/alkene</strong></td>
<td>(even priority; priority to alkene over alkyne only if numbering is a tie)</td>
</tr>
<tr>
<td></td>
<td><strong>Alkyl, halo, alkoxy, phenyl/benzyl, nitro</strong></td>
</tr>
</tbody>
</table>
Note: There is no specific chapter on Nomenclature in your textbook as it is introduced in different chapters for particular classes of compounds. Explore on your own appropriate Skill Builder problems in the textbook.

A STUDENT WHO HAS MASTERED THE OBJECTIVES FOR THIS UNIT SHOULD BE ABLE TO SOLVE THE FOLLOWING PROBLEMS AND RELATED ONES:

1.1 Draw an example structure of each of the following classes of compounds. Do not use the symbol R.
   a) 2° amine  
   b) 3° alcohol  
   c) 1° alkyl halide

1.2 Name the functional group(s) present in each of the following molecules. Indicate 1°, 2°, or 3° when appropriate.

   a) CH₃CH₂OH  
   b)  
   c)  
   d) CH₃CHClCH₃  
   e)  
   f)  

2.1 How many 1°, 2°, and 3° hydrogens are present in each of the following molecules?

   a) (CH₃)₂CHCH₂CH₃  
   b)  
   c)  

   1° H _____  
   1° H _____  
   1° H _____  
   2° H _____  
   2° H _____  
   2° H _____  
   3° H _____  
   3° H _____  
   3° H _____
3.1 Give the IUPAC name of each of the compounds shown.

a) \( \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \)  

b) \( \text{CHCl}_3 \)  

c) \( \text{CH}_3\text{CH}_2\text{CHCH}_3\text{F} \)

d) \( \text{CH}_2\text{CHCH}_2\text{CH}_3 \)

e) \( (\text{CH}_3)_2\text{CHCHBrCH}_2\text{CH}_3 \)

f) \( (\text{C}_2\text{H}_5)_2\text{CH(CH}_2)_2\text{CH}_3 \)

g) \( \text{CH}_3\text{CH}_2\text{CHCH}_2\text{CHCHCH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \)

h) \( \text{CH}_3\text{CBr}_2\text{CH}_2\text{CCl}_3 \)

i) \( \text{CH}_3\text{CH}_2\text{CCH}_2\text{CH}_2\text{CH}_3 \)

j) \( (\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{C}==\text{CH}_2 \)

k) \( \text{CH}_3\text{CH}_2\text{C}==\text{C}==\text{C}\text{CH(CH}_3)_2 \)

l) \( \text{H}_3\text{CH}_2\text{C}==\text{Br} \)

m) \( \text{H}_3\text{CH}_2\text{C}==\text{H} \)
3.2  Draw the structure of each of the compounds named below.

a) 2,2-dimethylbutane  
b) 3,3-dimethyl-1-butene

c) 4-ethyl-2,2-dimethylhexane  
d) 1,2-dibromo-2-methylpropane

e) 4-methyl-2-pentyne  
f) *cis*-1-bromo-2-pentene

g) 4-benzylctane  
h) 2,3-dimethyl-6-phenylnonane
4.1  Give the IUPAC name of each of the compounds shown.

a)  

b)  

c)  

d)  

4.2  Draw the structure of each of the compounds named.

a) 1,3-dimethylcyclobutane

b) 4-neopentylcyclooctyne

c) 4-isopropylcyclohexene

5.1  Give the common name of each of the compounds shown.

a) CH₂=CHBr  
b) CH₃CH₂CH₂Cl  
c) (CH₃)₂CCH₂I  
d) FC(CH₃)₃

5.2  Draw the structure of each of the compounds named.

a) allyl iodide  
b) isobutyl chloride

c) isopropyl fluoride  
d) sec-butyl bromide
6.1  Give the common name of each of the following compounds.

[Diagrams of compounds]

6.2  Draw the structures of the following compounds.
a) cyclopropyl chloride     b) cyclohexyl iodide

7.1  Draw the structures of each of the following compounds.
a) propylene      b) acetylene      c) ethylacetylene      d) ethylene

SOLUTIONS TO SAMPLE PROBLEMS:

1.1

[Diagrams of compounds]

1.2  a) 1° alcohol      b) 2° amine      c) 2° alcohol
d) 2° alkyl halide      e) 1° amine; alkene      f) 3° amine

2.1  a) 9 1°H’s, 2 2°H’s, and 1 3°H’s
     b) 6 1° H’s, 10 2° H’s, and 2 3° H’s
     c) 3 1°H’s, 10 2°H’s, and 1 3° H’s

3.1  a) pentane      b) trichloromethane      c) 2-fluorobutane      d) 3-methylpentane
e) 3-bromo-2-methylpentane      f) 3-ethylhexane      g) 5-isopropyl-3-methyloctane
h) 3,3-dibromo-1,1,1-trichlorobutane      i) 2-ethyl-1-pentene or 2-ethylpent-1-ene
j) 2,5-dimethyl-1-hexene or 2,5-dimethylhex-1-ene
k) 2,5,5-trimethyl-3-heptyne or 2,5,5-trimethylhept-3-yne
l) \textit{trans}-3,4-dibromo-3-hexene or \textit{trans}-3,4-dibromohex-3-ene
m) 2-ethyl-1-butene or 2-ethylbut-1-ene
n) \textit{cis}-2,7-dichloro-4-octene or \textit{cis}-2,7-dichlorooct-4-ene
o) 2-methyl-2-hepten-5-yne or 2-methylhept-2-en-5-yne
p) 3-phenylnonane      q) 3-benzylheptane
3.2  a) 2,2-dimethylbutane    b) 3,3-dimethyl-1-butene    c) 4-ethyl-2,2-dimethylhexane  

\[
\begin{align*}
\text{a)} & \quad \text{2,2-dimethylbutane} \\
\text{b)} & \quad \text{3,3-dimethyl-1-butene} \\
\text{c)} & \quad \text{4-ethyl-2,2-dimethylhexane}
\end{align*}
\]

\[
\begin{align*}
d) & \quad \text{1,2-dibromo-2-methylpropane} \\
e) & \quad \text{4-methyl-2-pentyne} \\
f) & \quad \text{cis-1-bromo-2-pentene}
\end{align*}
\]

\[
\begin{align*}
g) & \quad \text{4-benzyldecane} \\
h) & \quad \text{2,3-dimethyl-6-phenylnonane}
\end{align*}
\]

4.1  a) cycloheptane    b) isopropylcyclopentane  

\[
\begin{align*}
c) & \quad \text{1-bromo-2-methylcyclobutane} \\
d) & \quad \text{1,4-dichlorocyclohexene}
\end{align*}
\]

4.2  a) 1,3-dimethylcyclobutane    b) 4-neopentylcyclooctene    c) 4-isopropylcyclohexene

\[
\begin{align*}
a) & \quad \text{1,3-dimethylcyclobutane} \\
b) & \quad \text{4-neopentylcyclooctene} \\
c) & \quad \text{4-isopropylcyclohexene}
\end{align*}
\]

5.1  a) vinyl bromide    b) propyl chloride    c) neopentyl iodide    d) tert-butyl fluoride

\[
\begin{align*}
a) & \quad \text{vinyl bromide} \\
b) & \quad \text{propyl chloride} \\
c) & \quad \text{neopentyl iodide} \\
d) & \quad \text{tert-butyl fluoride}
\end{align*}
\]

5.2  a) allyl iodide    b) isobutyl chloride    c) isopropyl fluoride    d) sec-butyl bromide

\[
\begin{align*}
a) & \quad \text{allyl iodide} \\
b) & \quad \text{isobutyl chloride} \\
c) & \quad \text{isopropyl fluoride} \\
d) & \quad \text{sec-butyl bromide}
\end{align*}
\]

6.1  a) cyclooctyl chloride    b) cycloheptyl fluoride    c) cyclobutyl bromide

\[
\begin{align*}
a) & \quad \text{cyclooctyl chloride} \\
b) & \quad \text{cycloheptyl fluoride} \\
c) & \quad \text{cyclobutyl bromide}
\end{align*}
\]

6.2  a) cyclopropyl chloride    b) cyclohexyl iodide

\[
\begin{align*}
a) & \quad \text{cyclopropyl chloride} \\
b) & \quad \text{cyclohexyl iodide}
\end{align*}
\]

7.1  a) propylene    b) acetylene    c) ethylacetylene    d) ethylene

\[
\begin{align*}
a) & \quad \text{propylene} \\
b) & \quad \text{acetylene} \\
c) & \quad \text{ethylacetylene} \\
d) & \quad \text{ethylened}
\end{align*}
\]

\[
\begin{align*}
\text{CH}_2\text{CH} = \text{CH}_2 & \quad \text{HC} = \text{CH} \\
\text{CH}_3\text{CH}_2\text{C} = \text{CH} & \quad \text{H}_2\text{C} = \text{CH}_2
\end{align*}
\]
1. Name the functional group in each of the following compounds, indicating 1°, 2°, or 3° if appropriate.

   a) CH₃CHOHCH₂CH₃  

   b)  

   c)  

   d)  

2. Give a specific example (do not use R) for each of the following types of compounds.
   a) 3° alcohol  
   b) 2° alkyl iodide  
   c) 3° amine

3. Name: Cl₃CCH₂Cl

4. Name: (CH₃)₂CH(CH₂)₃CH(CH₃)₂

5. Draw: neopentylcyclohexane

6. Draw: 2,4-dibromo-3-ethylhexane

7. Name:  

8. Draw: 3,3-dimethylcyclobutene
9. Name: 
\[
\begin{array}{c}
\text{CH}_3 \\
\text{C(CH}_3\text{)}_3
\end{array}
\]

10. Name: 
\[
\begin{array}{c}
\text{CH}_3 \\
\text{CHCH}_2\text{CH}_3
\end{array}
\]

11. Name: 
\[
\text{C}_8\text{H}_{16}
\]

12. Draw: cyclopentyl fluoride

13. Name: 
\[
\begin{array}{c}
\text{C}_2\text{H}_4 \\
\text{Br}
\end{array}
\]

14. Give a structure for: propylacetylene

15. Name: 
\[
\begin{array}{c}
\text{CH}_3 \\
\text{C}_9\text{H}_{16}\text{Cl}
\end{array}
\]

16. Give a structure for: 
\text{cis-5-ethyl-6-methyl-3-heptene}

17. Give a structure for: allyl bromide
1. Draw the structure of an example (do not use R) of each of the following classes of compounds.
   a) primary alcohol  
   b) amide  
   c) 2° alkyl bromide

2. Name the functional group in each of the following compounds. Be specific by indicating 1°, 2°, or 3° if appropriate.
   a)  
   b) CH₃CH₂C—OH  
   c) CH₃NHCH₃

3. Name:  

4. Give a structure for: 1,3-di-tert-butylcyclohexene

5. Name:  

6. Give a structure for: vinyl chloride

7. Name: BrCH₂CH₂CHBr₂  

8. Give a structure for: 2,3-dimethylpentane
9. Name:

10. Give a structure for:
    1,7-dibromo-4,8-diethyldecane

11. Name:

12. Give a structure for:
    4-tert-butyl-4-ethylcyclohexene

13. Name:

14. Give a structure for:
    3,5-dichloro-4-iodononane

15. Name:

16. Give a structure for: sec-butyl chloride

17. Name: