

Survival Organic Chemistry

Part I: Molecular Models

The goal in this laboratory experience is to get you so you can easily and quickly move between empirical formulas, molecular formulas, condensed formulas, Lewis structural formulas and three dimensional models of relatively simple organic compounds. To accomplish this you will use your experience and chemical intuition combined with molecular models and computer graphics in a guided laboratory exploration into the 3-dimensional structure of organic compounds.

So what??? Many new chemistry students find manipulating molecular models helps their understanding of the spatial relationships of atoms in molecules. Using computer graphics will also provide a new way to view and manipulate molecular models.

Some preliminary stuff:

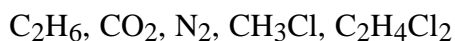
What you need to remember for this experience: Rule of eight, valence electrons, simple electron (Lewis) structures, covalent bond, ionic bond, single, double and triple bonds, and bond angles.

As a way to get a handle on these concepts try the following problems;

1. Write the general rule for determining whether a chemical formula represents an ionic or a covalent compound. For example, which of the following formulas describe ionic and/or covalent compounds?



2. Draw a Lewis electron-dot structure for each of the covalent molecules below. Include all resonance structures if they are needed to adequately represent the bonding in the molecule. Identify those compounds containing double and triple bonds. Indicate whether the compound is polar or nonpolar. In each compound indicate the magnitude of all bond angles.



3. Your textbook will play a helpful role as a reference tool in this laboratory. Chapters and sections which will be important to refer to include;
Chapter 6, page 140 – 153, 158 – 164.
Chapter 9, pages 210 - 228

Exploring structural features of simple organic compounds

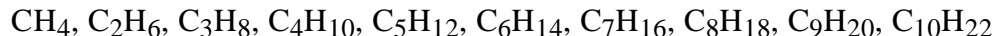
The goal of this part of the experiment is to get you to feel comfortable with moving between molecular formulas, Lewis structural formulas, and condensed formulas. To reach a reasonable level of comfort you will need to checkout a model kit from the freshman chemistry storeroom. Each kit should contain:

Number	Color	Atom
10	black	carbon
6	green	chlorine
6	red	oxygen
2	blue	nitrogen
1	yellow	sulfur
22	white	hydrogen

Each packet should also contain 30 1-inch plastic connectors that represent a pair of electrons, either a lone pair or a bonding pair.

PART I. Alkanes

The hydrocarbon compounds with the following molecular formulas are all classified as alkanes.



Use the molecular model kit to construct several examples of alkane compounds. Use your laboratory book or on separate sheets of paper, write the Lewis structure and condensed structural formulas for those alkanes assigned to you.

Model Building: Using the model kit construct the compounds listed in the group you are assigned

Group A: $\text{CH}_4, \text{C}_3\text{H}_8, \text{C}_6\text{H}_{14}$

Group B: $\text{C}_2\text{H}_6, \text{C}_3\text{H}_8, \text{C}_5\text{H}_{12}$

Group C: $\text{C}_2\text{H}_6, \text{C}_3\text{H}_8, \text{C}_4\text{H}_{10}$

After using the model kit to construct the compounds in your assigned group, answer the following questions;

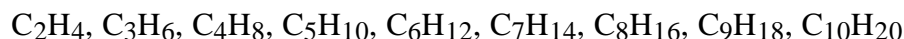
1. What is the general formula for an alkane?
2. A structural isomer is a compound with the same formula but a different arrangement of carbon-carbon bonds. Use the model kit and explore structural isomers by re-arranging the carbon-carbon bonds in each of your compounds. Note: structural isomerism begins with butane. Watch out that you do not make a conformer, which is a different spatial arrangement of a compound but contains the same arrangement of carbon-carbon bonds. Use the space below, and on the next page, to draw the Lewis structure for each of the compounds and any structural isomers they may have.

3. Draw 4 structural isomers of C_8H_{18} . Are there any isomers of C_8H_{18} with a parent chain 4 carbons long?

4. Next to the Lewis structures in 2 and 3 above, name each compound, including structural isomers.
5. List some common physical properties of alkanes. What are some trends?
6. What is a cycloalkane? Give an example.
7. What is a common reaction of alkanes?

PART II. Alkenes

The hydrocarbon compounds with the following molecular formulas are all classified as alkenes.



Use the molecular model kit to construct several examples of alkene compounds. Use your laboratory book or on separate sheets of paper, write the Lewis structure and condensed structural formulas for those alkenes assigned to you.

Model Building: Using the model kit to construct the compounds listed in the group you are assigned

Group A: C_2H_4 , C_4H_8 , C_7H_{14}

Group B: C_3H_6 , C_5H_{10} , C_6H_{12}

Group C: C_4H_8 , C_5H_{10} , C_7H_{14}

After using the model kit to construct the compounds in your assigned group, answer the following questions;

Questions (use your textbook as a reference):

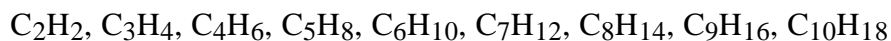
1. What is the general formula for an alkene?
2. Your laboratory instructor will introduce the concept of a geometric isomer. Write the definition of a geometric isomer here.
3. Using the model kit, draw the Lewis structures for each of the three alkenes assigned to you.

4. You'll notice that for alkenes with four or more carbons there is more than one possible position for the double bond. Move the double bond around in each of the alkenes assigned to you. Draw their Lewis structure below and name each compound. For those cases where geometric isomers occur, draw both the *cis* and *trans* isomers.

5. What is a diene? Give some examples.

PART III. Alkynes

The hydrocarbon compounds with the following molecular formulas are all classified as alkanes.



Use the molecular model kit to construct several examples of alkyne compounds. Use your laboratory book or on separate sheets of paper, write the Lewis structure and condensed structural formulas for those alkynes assigned to you.

Model Building: Using the model kit to construct the compounds listed in the group you are assigned

Group A: C_2H_2 , C_4H_6 , C_7H_{12}

Group B: C_3H_4 , C_5H_8 , C_6H_{10}

Group C: C_4H_6 , C_5H_{18} , C_7H_{12}

After using the model kit to construct the compounds in your assigned group, answer the following questions;

Questions (use your textbook as a reference):

1. What is the general formula for an alkyne?

2. Using the model kit, draw the Lewis structures for each of the three alkynes assigned to you.

3. Geometric isomers are not observed in alkynes. Move the triple bond around in each of the alkynes assigned to you. Draw their Lewis structure below and name each compound.

PART IV. Aromatics

The hydrocarbon compound with the following molecular formulas is classified as an aromatic.



Use the molecular model kit to construct benzene. Use your laboratory book to write the Lewis structure and condensed structural formulas of the aromatic listed above.

PART V. Alcohols

The compounds with the following molecular formulas are all classified as alcohols.



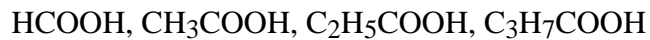
Use the molecular model kit to construct several examples of alcohol compounds. Use your laboratory book to write the Lewis structure and condensed structural formulas for two examples of the alcohols listed above. Use the model kit to help write the Lewis structures and condensed structural formulas.

Questions (use your textbook as a reference):

1. Name the first three alcohols in the list about.
2. What is an ether? How does an ether differ structurally from an alcohol?

PART VI. Carboxylic acids

The compounds with the following molecular formulas are all classified as carboxylic acids.



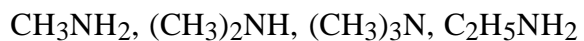
Use the molecular model kit to construct several examples of carboxylic acid compounds. Use your laboratory book to write the Lewis structure and condensed structural formulas for two examples of the carboxylic acids listed above.

Questions (use your textbook as a reference):

1. Name the first two carboxylic acids in the group above.
2. What is an ester? How does an ester structurally differ from a carboxylic acid?

PART VII. Amines

The compounds with the following molecular formulas are all classified as amines.



Use the molecular model kit to construct several examples of amine compounds. Use your laboratory book to write the Lewis structure and condensed structural formulas for two examples of the amines listed above.

Questions (use your textbook as a reference):

1. What is the important functional group in the amines?
2. What are amines derivatives of?