Objectives for Chapter 1

I. Introduction to Organic Chemistry

1. Explain where the term "organic chemistry" originally came from and what it currently means.

2. Explain why there is an entire one-year course devoted to the study of compounds containing carbon.

3. Give examples of areas of study that organic chemistry prepares you for, and industries that depend on knowledge of organic chemistry.

II. Review of Atomic Structure

Elementary Particles

1. List the elementary particles that make up an atom, give their charges, and explain how they are put together to make atoms.

2. Explain why electrons are the part of the atom that participate in chemical reactions.

The Periodic Table of Elements

1. Explain how elements are organized in the Periodic Table of Elements, and why this organization is useful.

2. Explain what atomic number tells you about an element.

3. Locate metals, nonmetals, transition metals, inner transition metals, alkali metals, alkaline earth metals, halogens, and noble gases on the Periodic Table.

4. Explain what periods are and how they are labeled, and what groups are and what they have in common.

5. Draw a Periodic Table containing the most important elements in organic chemistry from memory.

Electronegativity

1. Explain what electronegativity is.

2. Use your knowledge of the Periodic Table to predict which of two elements is more electronegative if they are in the same period or the same family.

3. Determine whether the difference in size or electronegativity will be more important in predicting the relative properties of two atoms in either the same family or the same period.

Atomic Mass and Isotopes

1. Calculate the mass of a specific atom, given the elementary particles that it contains.

2. Explain what isotopes are, and how the are represented.

3. Explain the difference between the atomic mass of an element given in the Periodic Table, and the mass of a specific isotope.

4. State why isotopes can be useful in organic chemistry.

Ions

1. Determine the charge on an atom if it loses or gains a certain number of electrons.

2. Explain why each atom has a charge that is more stable than the others.

Valence electrons

1. Explain what valence electrons are, and why they are important.

2. Draw a Lewis structure showing the valence electrons for any element commonly found in organic compounds (excluding transition metals).

III. Review of Ionic and Covalent Bonds

Overview of Ionic and Covalent Bonds

1. Explain why atoms form chemical bonds.

2. Explain the difference between ionic and covalent bonds, and how to predict which type of bond will form between two given atoms.

Lewis Structures of Covalent Compounds

1. List the steps of the most useful way to construct Lewis structures for organic compounds.

2. Draw Lewis structures for a compound when given the molecular formula.

3. Identify incorrectly drawn Lewis structures.

4. Determine whether two different Lewis structures represent the same compound or different compounds.

Polarity of Covalent Bonds

1. Explain what a polar covalent bond is.

2. Locate the important polar bonds in an organic molecule, predict the partial charges, and label them correctly.

Strength of Covalent Bonds

1. Explain why it is useful to know the strength of a covalent bond.

2. Explain why bond order, size of atoms, and electronegativity influence the strength of bonds.

3. Predict the relative strength of two bonds based on principles of bond order, size of the atoms, and electronegativity.

4. Explain the difference between heterolytic and homolytic bond cleavage, and predict which will occur in a given bond.

Geometry of molecules

1. Explain what is meant by geometry of molecules, and what principle allows us to predict it.

2. Give the five most common shapes found in organic molecules, how many bonds and electron pairs are present in each shape, and what angle the atoms make.

3. Correctly label the geometry of atoms in organic molecules.

Charged atoms in molecules

1. Recognize when a carbon, nitrogen, oxygen, or fluorine atom has a negative charge in a molecule.

2. Rank relative stability and reactivity of ions using principles of electronegativity and full octets.

3. Explain the difference between polar bonds and charged atoms in molecules.

Resonance Structures

1. Explain why resonance structures are needed to correctly describe certain molecules, and how resonance structures are related to the actual compound.

2. State what kinds of compounds most often have resonance structures.

3. Use brackets and arrows to correctly label resonance structures.

4. Explain why compounds with resonance structures are more stable than compounds without resonance structures.

5. Label resonance structures as either equal resonance contributors, or greater and lesser resonance contributors.

6. Explain the difference between resonance structures and equilibria, and recognize when each is occurring.

7. Draw missing resonance structures for simple compounds.

IV. Orbitals and Hydridization

1. Give atomic orbitals and electron configuration for isolated atoms.

2. Explain the difference between atomic and molecular orbitals.

3. Label bonds in a molecule as sigma or pi bonds, and explain why pi bonds are needed in order to form double or triple bonds.

4. Explain where sigma and pi orbitals come from, and what they look like.

5. Explain what antibonding orbitals are, how they are labeled, and why they are usually unoccupied.

6. Explain why hybridization is needed to make the sigma and pi bonds found in most compounds.

7. Explain why lone pairs of electrons go into hybrid orbitals, while empty orbitals are unhybridized.

8. Give the hybridization of atoms in organic compounds.

9. Give the atomic orbitals that go together to form the molecular orbitals of any bond in an organic compound.