Chapter 20 – Organic Chemistry

1) Sec. 20.1 – An Introduction to Organic Chemistry and Hydrocarbon Bonds
   a) Organic Chemistry is the study of the preparation, properties, identifications, and reactions of carbon containing compounds. (Many of theses compounds are produced by living organisms which is where the concept of "organic" came from.)

   b) The Uniqueness of Carbon – Carbon like no other element (except to some extent silicon) can bond to itself (outside of being diatomic) and can do so theoretically in an unlimited extension of one carbon atom after another.

   c) The C – H Bond – The bond between a carbon atom and a hydrogen atom is a strong nonpolar covalent bond. The effect is to render compounds that contain only this type of bond exceptionally resistant to chemical attack. Also, these compounds are soluble only in other nonpolar solvents (not water).

   d) Structural Formula – A formula of a compound that shows how the atoms are bonded together.

   e) Hydrocarbons – Compounds that contain only carbon and hydrogen.

   f) Alkanes – Hydrocarbons that contain only single covalent bonds. Alkanes are also called saturated hydrocarbons since they are full of hydrogens (have no double or triple bonds).

   g) A General Molecular Formula for an alkane is C_nH_{2n+2}.

2) Sec. 20.2 – Continuous Chain Alkanes

Mol. Form.	Name	Structural Formula	Other
CH_4	methane		--
C_2H_6	ethane		--
C_3H_8	propane		--
C_4H_{10}	butane		2 isomers
C_5H_{12}	pentane		3 isomers
C_6H_{14}	hexane		5 isomers
C_7H_{16}	heptane		9 isomers
C_8H_{18}	octane		18 isomers
C_9H_{20}	nonane		35 isomers
$C_{10}H_{22}$	decane		75 isomers

$C_{14}H_{30}$ has 1858 isomers.
$C_{64}H_{130}$ has 1.18×10^{24} isomers!

3) Sec. 20.3 – Structural Formulas and Isomerism

a) An atom or group of atoms, called a substituent, can take the place of a hydrogen atom on a parent hydrocarbon molecule. Sometimes these are referred to as branches.

b) Alkyl Groups – A hydrocarbon substituent group. Alkyl groups cannot exist independently (they exist only as part of larger molecules). They are named as branches in the naming of organic compounds by the I.U.P.A.C. rules of naming.

CH_3– (methyl) CH_3CH_2– or C_2H_5– (ethyl)

c) Sec. 20.4 – Rules for Naming Organic Compounds

1) Find the longest continuous chain of carbons in the molecule. This chain is used as the parent structure.

2) Number the carbons in the main chain in sequence. In doing this, start at the end of the molecule that will give the groups attached to the parent chain the smallest numbers. (The numbers are the numbers of the carbons on the longest chain to which the group is attached.)

3) Add numbers to the names of the substituent groups to identify their positions on the chain. (ex., 3-methyl, 4-ethyl)

4) Use prefixes to indicate the appearance of a group more than once in the structure (di-two, tri-three, tetra-four, penta-five, etc.) (ex., 3,4-dimethyl)

5) Use proper punctuation. Commas are used to separate numbers. Hyphens are used to separate numbers and words. The name of the alkane is written as one word.

Examples – Name the following alkanes: (You might need to write out the structure more fully to see the details.)

1) $CH_3–C(CH_3)_2–CH_2–CH_2–CH_3$

2) $CH_3–C(CH_3)_2–CH(C_2H_5)–CH(CH_3)–CH_2–CH_3$

d) Many organic compounds have the same molecular formula but different structural formulas. Isomers are compounds that have the same molecular formula but different structural formulas.

Example – Give structural formulas and names for all the isomers with the molecular formula C_6H_{14}. (Hint: there are 5 isomers.)

4) Sec 20.7 – Alkenes and Alkynes
   a) Alkenes are hydrocarbons containing a double bond between two of its carbons. To name an alkene, find the longest continuous chain in the molecule that contains the double bond. This is the parent alkene. It gets the root name of the alkane with the same number of carbons plus the ending –ene. ($CH_2=CH_2$ is ethene.) This chain is numbered so that the carbon atoms of the double bond get the lowest possible numbers. The general molecular formula for alkenes is C_nH_{2n}.

      Examples – Give the structural formulas and the names for all the alkenes with the molecular formula C_5H_{10}.

   b) Alkynes are hydrocarbons containing a triple bond between two of its carbons. The rules for naming alkynes is the same as the rules for naming alkenes, except that their name ends in –yne. ($CH{\equiv}CH$ is ethyne.) The general molecular formula for alkynes is C_nH_{2n-2}.

      Example – Give the structural formulas and the names of all the isomers with a molecular formula of C_5H_8 that contain one triple bond.

   c) Unsaturated Hydrocarbons – Compounds that contain double and/or triple bonds are called unsaturated hydrocarbons. (They are not full of hydrogens.)

   d) Polyunsaturated Hydrocarbons – Compounds containing more than one double bond or more than one triple bond. Prefixes are used to indicate the number of multiple bonds.

Examples – Name the following:

1) $CH_2=C(CH3)-CH=CH_2$

2) $CH\equiv C-C\equiv C(CH_3)-CH_3$

5) Sec 20.10 – Functional Groups – A special arrangement of atoms in an organic compound tha is capable of characteristic chemical reactions. The existence of functional groups gives the organic compound properties that are unique to compounds which have that same functional group.

6) Sec. 20.11 - 20.12 – Alcohols are organic compounds with an –OH group. To name continuous chain and substituted alcohols by the I.U.P.A.C. system, drop the –e ending of the parent alkane name and add the ending –ol. The parent alkane is the longest continuous chain of carbons that includes the carbon attached to the -OH group. In numbering the longest continuous chain, the position of the -OH group is given the lowest possible number.

Examples – Names and uses for some common alcohols

1) CH_3-OH
   * methanol
   * methyl alcohol
   * wood alcohol (poisonous)

2) CH_3-CH_2-OH
   * ethanol
   * ethyl alcohol
   * grain alcohol (booze)

3) $CH_3-CH(OH)-CH_3$
   * 2-propanol
   * isopropyl alcohol
   * rubbing alcohol

Examples – Name the following alcohols:

1)
```
        Cl  Cl   CH3 OH
        |   |    |   |
CH3-CH-CH-CH-CH2
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2)
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     OH
     |
CH2-CH=CH2
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3)
```
     OH  OH
     |   |
CH2-CH2
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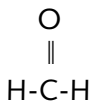
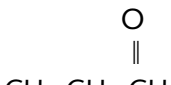
7) Sec. 20.13 – 20.14 – Aldehydes and Ketones

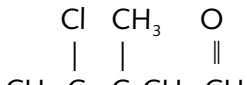
a) A carbonyl group consists of a carbon atom and an oxygen atom joined by a double bond.

b) Aldehydes are organic compounds in which the carbon of the carbonyl group is the first carbon in the chain. One of the other bonds for the carbon is to a hydrogen. The -e ending of the hydrocarbon is replaced by -al to designate an aldehyde. In aldehydes, the number one carbon is always the carbonyl carbon.

Examples – Name the following:

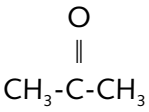
1) 

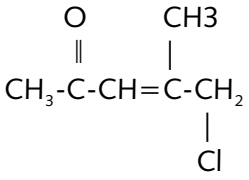
2) 

3) 

c) Ketones are organic compounds in which the carbon of the carbonyl group is joined to two other carbons. Ketones are named by changing the ending of the longest continuous carbon chain that contains the carbonyl group from -e to -one. If the carbonyl group could occur at several places on the chain, then its position is designated by the lowest possible number.

Examples – Name the following:

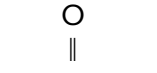
1) 

2) 

12) Sec. 20.15 – Carboxylic Acids and Esters – are compounds that contain a carboxyl group -C-O-H

Carboxylic acids are named by changing the -e ending of the parent alkane to -oic acid. The carboxyl group is always the number one carbon.

Examples – Name the following:

1) 

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