ORGANIC CHEMISTRY - INTRODUCTION

Key Question / Objectives: What makes Organic Chemistry the largest division of Chemistry? What is the importance of Organic Chemistry?

Chemistry
Text Reference

Hebden Workbook Unit X

INTRODUCTION

Organic chemistry is generally defined as the chemistry of carbon compounds. Carbon and carbon chains form the "backbone" or basis of organic compounds. Carbon will generally form 4 covalent bonds (remember Lewis diagrams?) such that each carbon atom can bond with up to 4 other atoms including other carbon atoms. Since carbon atoms can bond to each other, chains of carbon atoms of various lengths can be created and, hence, a great number of organic molecules are possible.

^{14}C
radioactive

Use your text to define these words:

1. Organic - ______________________________.
2. Inorganic - ______________________________.

Organic compounds are found naturally obtained from the following three sources:

1. ______________________
2. ______________________
3. ______________________

The properties of organic compounds are governed by:

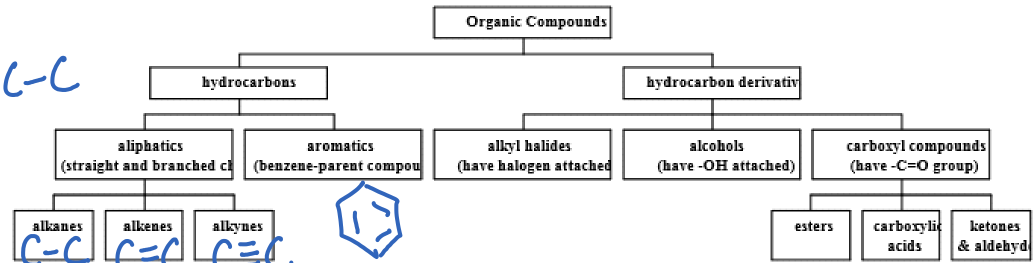
- a series of carbon atoms linked together to form a stable, almost completely unreactive framework or molecular skeleton.
- a series of different reactive functional groups which determine the basic "chemistry" of the molecule that are added on to the carbon skeleton.

These reactive (or functional) groups, when attached to the carbon skeleton, may make the molecule acidic, basic, `fishy smelling', explosive, soluble in water, etc. Use your text to cite several examples of industrial uses or applications of organic compounds such as specific examples of plastics, fuels, pharmaceutical drugs, pesticides, insecticides, solvents, or synthetics.

1. ______________________________.
2. ______________________________.
3. ______________________________.

Before we can discuss the special functional groups that can be attached to the carbon skeleton, we must first be familiar with the possible types of skeletons. These skeletons, called hydrocarbons, consist of carbon and hydrogen (i.e. `hydrogenated carbons`).

C-C-C

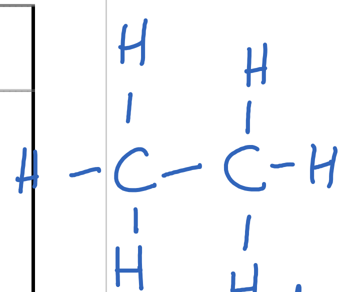


The chart above shows the breakdown of organic compounds. We will discuss a wide variety of organic molecules.

ALKANES – THE MOST BASIC HYDROCARBONS

Chemistry Text Reference	Hebden Workbook Unit X section 1-5

	Teacher Lecture: Alkanes – The Most Basic Hydrocarbons Your teacher will discuss the structure and naming systems of alkanes.
General Information	An alkane is said to be a **SATURATED** hydrocarbon since all the carbon atoms in an alkane are bonded to four other atoms (four bonds is the maximum number possible for carbon) and hence its bonding capacity has been used up, or "saturated".
Chemical Formulas	The general formula for an alkane is $\boxed{C_nH_{2n+2}}$. Examples are: Note: All saturated hydrocarbons have a name ending $\boxed{\text{in -ANE}}$ (and hence the name ALKANE is applied to this type of molecule).
Properties	1. Very unreactive (C-C and C-H bonds are very strong) 2. Boiling & melting points increase with number of carbons



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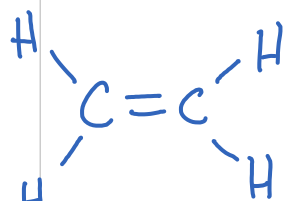
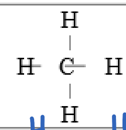
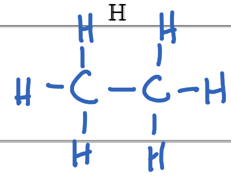


unsaturated

Table 1: Ten Straight Chain Alkanes – Complete the chart.

Name	Formula	Structural Formula	Boiling Point (°C)
methane meth-	CH_4 1C		- 162
eth-	C_2H_6 ethane	2C 	- 89
propane prop-	C_3H_8 3C		- 42
butane but-	C_4H_{10} 4C		0
pentane pent-	C_5H_{12} 5C		39
hexane hex-	C_6H_{14} 6C		69
hept-	C_7H_{16} 7C	heptane	98
oct-	C_8H_{18} 8C	octane	126
nonane non-	C_9H_{20} 9C	nonane	_____°C
decane dec-	$C_{10}H_{22}$ 10C		_____°C

bp incr.
London forces
increases

Page 4

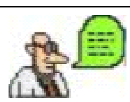
May-26-15 11:13 AM

BRANCHING ALKYL GROUPS "branches"

More complicated hydrocarbons have groups of carbon atoms called **side chains** or "**alkyl groups**" attached to the main string of carbons. Such hydrocarbon side chains are formed by ***removing one hydrogen atom*** from the original or **parent** hydrocarbon.

Table 2: Simple Alkyl Groups

Parent Hydrocarbon:	**Alkyl Group Name**	**Structural Formula**	**Examples:**
methane	meth**yl** meth yl	H H - C -- H	
ethane	ethyl		
propane	propyl		
butane	butyl		



Note from the Teacher: Naming Notes

1. The name of an alkyl group is obtained by substituting **-yl** for the **-ane** ending of the parent (hence, the name "alkyl").
2. A group cannot exist by itself under normal conditions, the group must be attached to some molecule.

IUPAC NOMENCLATURE [NAMING SCHEME]

IUPAC is an acronym for the International Union of Pure and Applied Chemistry, a large group of Chemists worldwide who coordinate and create the basic rules for naming and representing organic molecules. This a large task in organic chemistry since there are well over 3 million known organic molecules, each requiring a unique name. Naming Organic Compounds is like creating a unique address. The following BASIC rules are followed*:

1. Find the **LONGEST continuous chain** of carbon atoms. This chain determines the parent name of the alkane.

"parent" chain

2. **Number the chain** beginning at the end of the chain nearest any branching so that the attached groups are indicated by the lowest possible set of numbers.
3. Use these numbers to designate the location of the substituent groups.
4. If there is more than one group attached:
   a) list the groups alphabetically (by "size" can also be used)
   b) Use the prefixes: di, tri, tetra, penta, hexa, etc. if a group appears more than once
   c) If two or more substituents are present on the same carbon atom, use the number twice.
5. Cyclic Compounds: if the parent chain forms a ring use the prefix "cyclo".
6. Alkenes and Alkynes (in the next section):
   a) Change the -**ane** ending of the parent to -**ene** or -**yne**.
   b) The longest chain containing the double or triple bond determines the parent name.
   c) The position of the double or triple bond is indicated by the number of the lowest numbered carbon involved in the bond. Number the substituents, rank them alphabetically (by "size" can also be used) and assign stereochemistry (E/Z, cis/trans, or R/S etc.) as necessary.
7. If there are more than one functional group, use a group **priority chart**.

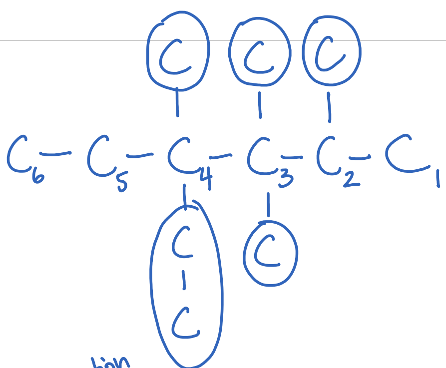
*Note: These are *simplified* rules and will work for the majority of organic molecules encountered at this level.

SUMMARY EXAMPLE:

where
how many
what (usually branching side chain)
2,4-dimethylheptane
main chain
group name
multiplier of group name
position of groups

*Hint: think of the IUPAC naming system like an address system ☺

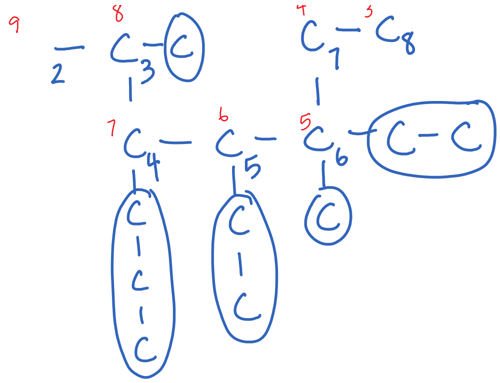
Ex. 1



location how many?

4-ethyl-2,3,3,4-tetramethyl hexane

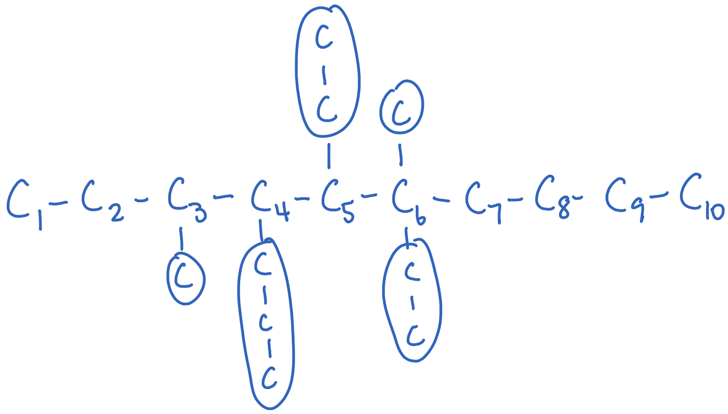
6C C-C



5,6,7,8

3,4,5,6

5,6-diethyl-3,6-dimethyl-4-propyldecane

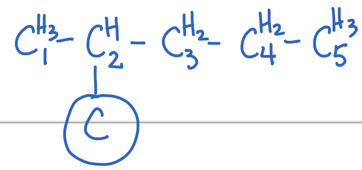
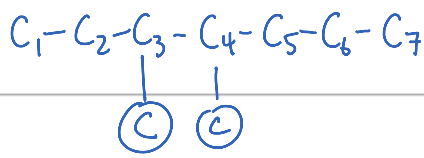


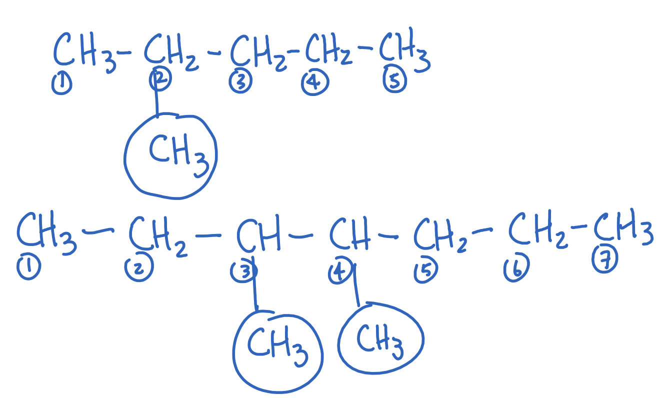
Page 6

May-26-15 11:13 AM

Sample Problems: Naming and Drawing Alkanes

Solve the problems below, by drawing each alkane.

2-methylpentane branch 1C pent ane 5C C-C	
3,4-dimethlyheptane 7C C-C	
3-ethyl-4-propyloctane	
3,4,5-triethyl-4-propyldecane	
cyclopentane	



Page 7

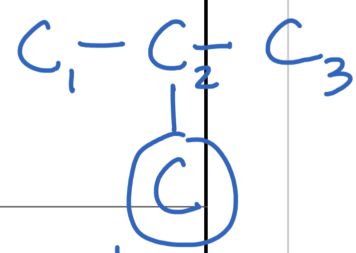
May-26-15 11:13 AM

STRUCTURAL ISOMERISM

Two or more compounds are **structural isomers** if they have the *same* molecular *formula*, but *differently connected* structures.

Sample Problems: **Structural Isomers**

Solve the problems below, by drawing and naming each structural isomer.

C_4H_{10} has two structural isomers	$C_1 - C_2 - C_3 - C_4$ $CH_3 - CH_2 - CH_2 - CH_3$ butane  2-methylpropane
C_5H_{12} has three structural isomers	
Draw and name the 5 different isomers of C_6H_{14}	

Problem Set 7.1: **Alkanes and Cycloalkanes**

Hebden Workbook Unit X #3, 5, 8, 10, 15-16, 17