Organic Chemistry Self-Instructional Unit
Basic IUPAC Nomenclature

Name: _____

1. **Organic** chemistry is the study of **carbon containing** compounds.

2. Not all carbon containing compounds are considered organic. Some notable exceptions are: carbon dioxide (CO_2); carbon monoxide (CO); and hydrogen cyanine ($HCN_{(g)}$). Although these contain carbon, they are classified as *inorganic compounds*.

3. Carbon atoms have four valence electrons and can form four covalent bonds with a variety of other elements. In the box to the right, draw the Lewis Dot Diagram for carbon.

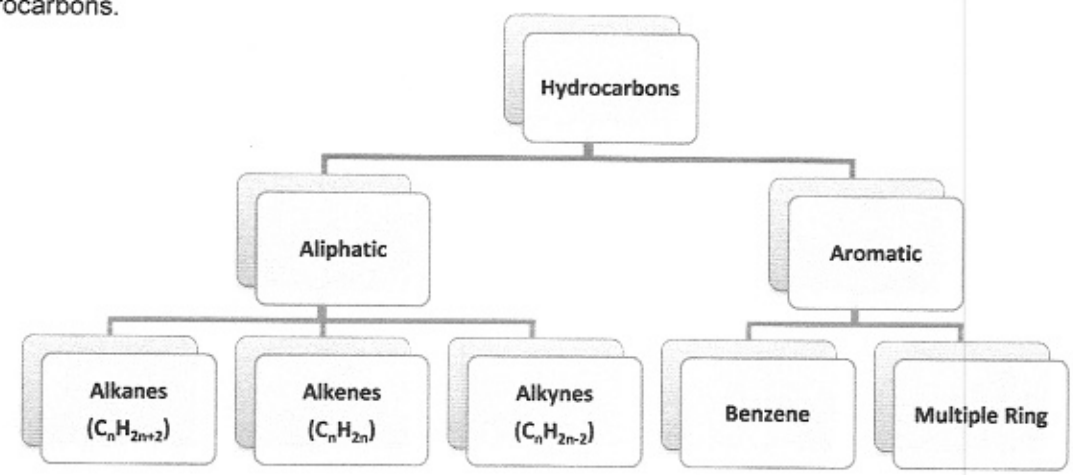
4. Organic compounds composed of *only* **carbon** and **hydrogen** atoms are the simplest of the organic molecules and are called **HYDROCARBONS**. Hydrocarbons, as their name indicates, contain only hydrogen and carbon.

5. Classify the compounds below as either: organic; organic hydrocarbon; or inorganic.

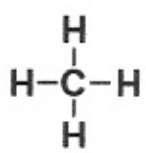
a. CH_3CH_2	e. CH_4
b. CO_2	f. $C_{20}H_{17}N_3Na_2O_9S_3$
c. $MgCl_2$	g. $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3$
d. $C_{14}H_{14}ClN_3S$	h. $C_9H_8O_4$

6. Hydrocarbons are a good source of fuel because the energy contained in the covalent bonds holding carbon-carbon and carbon-hydrogen atoms together is quite high. Hydrocarbon fuels include gasoline, natural gas, oil, and diesel.

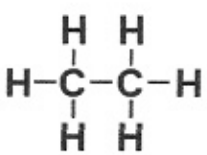
7. Hydrocarbons are subdivided into two groups based on their structure: aliphatic and aromatic. We will begin with the aliphatic hydrocarbons.



8. The simplest of the aliphatic hydrocarbons are the **ALKANES**. Alkanes contain carbon and hydrogen atoms held together by **single** bonds. The simplest alkane is one carbon atom bonded to four hydrogen atoms:



The structural formula below depicts an alkane containing two carbon atoms:



Remember to count the bonds.

Carbon atoms have 4 valence electrons so they can form 4 covalent bonds.

Hydrogen atoms have 1 valence electron so they can form 1 covalent bond.

9. a) To the right, draw the structural formula for an alkane containing three carbons:

   b) the chemical formula for this molecule is: _____

   c) Each carbon has ___ bond(s) and each hydrogen has ___ bond(s).

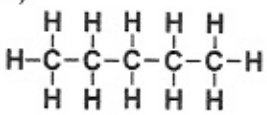
10. Draw the structural formula for an alkane containing four carbons in box A below.

A.

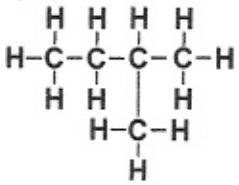
B.

11. Carbon atoms can also form branched structures as illustrated in B and C below. All three diagrams depict an alkane with five carbons. Circle each carbon atom in the compounds below then, write the chemical formula in the box provided.

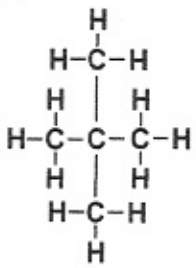
a)



b)



c)



   d) Regardless of the arrangement, each carbon has _____ bond(s) and each hydrogen has _____ bond(s)

   e) In box 10.B. above, draw a second possible structural formula for a four-carbon alkane.

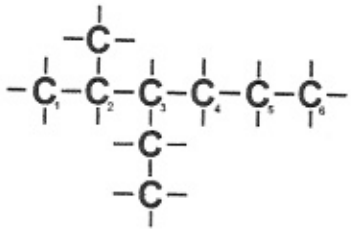
12. For the compounds looked at so far, every carbon atom has made a total of four **single** covalent bonds with atoms of hydrogen or carbon. All the bonds are "full;" there is no room for any additional atoms to be added to the molecule. For this reason, alkanes are considered **SATURATED** hydrocarbons. This makes them very stable and not very reactive.

13. To name alkanes, we first need to identify the **Parent Chain**. The parent chain is the longest continuous chain of carbon atoms. A corresponding prefix is used to communicate the total number of carbon atoms in the parent chain. Examine the table below and complete the second column.

Hydrocarbon Structural Formulas	Number of Carbon Atoms in the Hydrocarbon Chain?	Prefix Used to Denote This Number of Carbon Atoms:	The Name of the Parent Chain is:
–C–		**Meth-**	Methane
–C–C–		**Eth-**	Ethane
–C–C–C–		**Prop-**	Propane
–C–C–C–C–		**But-**	
–C–C–C–C–C–		**Pent-**	
–C–C–C–C–C–C–		**Hex-**	
–C–C–C–C–C–C–C–		**Hept-**	
–C–C–C–C–C–C–C–C–		**Oct-**	
–C–C–C–C–C–C–C–C–C–		**Non-**	
–C–C–C–C–C–C–C–C–C–C–		**Dec-**	

14. The characteristic suffix for alkanes is "**–ANE**." Complete the last column of the table above.

15. Examine the following alkane:



The parent chain (horizontal) contains six carbons. Draw a circle around the parent chain. The name of the alkene will be based on the name of the parent chain, hexane.

All other groups of atoms attached to the parent chain are called **SUBSTITUENTS (or substituent groups)**.

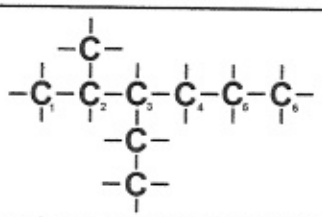
a) The total number of substituent groups attached to the parent chain is _____.

To name substituent groups first count the number of carbon atoms in each. Communicate the number of carbons by choosing the correct prefix and adding the suffix "**–YL**" ("-yl" indicates that one of the hydrogen atoms has been replaced). For example, the substituent group on carbon #2 has one carbon, therefore, it is called a methyl group.

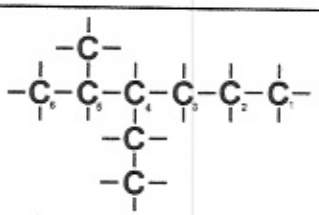
b) The substituent on the second carbon atom has _____carbon(s). It is called: _____.

c) The substituent on the third carbon atom has _____ carbon(s). It is called: _____.

16. Next, communicate the location of substituents on the parent chain. This is done by numbering the carbons on the parent chain. Numbering can begin at either end of the parent chain but, the rule is, the substituent groups must be given the smallest possible numbers. If there is a tie, the substituent that comes first alphabetically gets the smallest number.



a) If the carbon atoms are numbered from **left to right.**



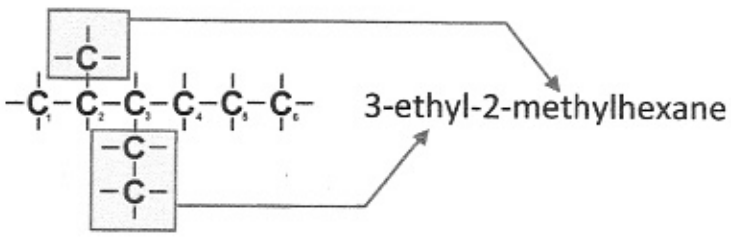
b) If the carbon atoms are numbered from **right to left.**

a) If numbering begins on the left, the substituents will be on carbon number _____ and _____ (a total sum of ___).

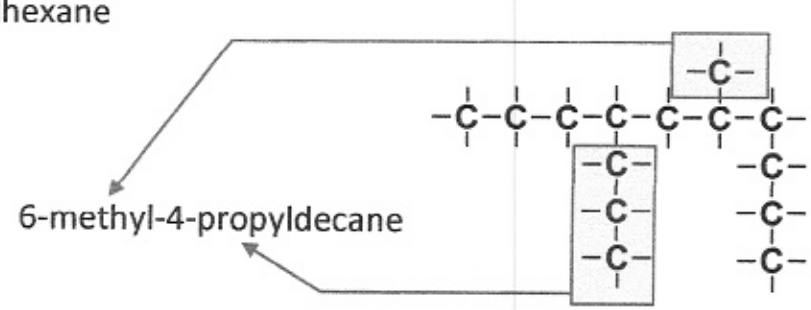
b) If numbering begins on the right, the substituents will be on carbon number _____ and _____ (a total sum of ___).

c) Substituents **must** have the **smallest** possible numbers so the correct numbering is carbon #_____ and #_____.

17. You are now ready to write the final name of the alkane. Write down the name of the parent chain. Precede the name of the parent chain with the names of substituent groups in alphabetical order. Indicate where the substituent is attached to the parent chain by writing the number of the carbon it is attached to in front of the name. Separate numbers from words with hyphens. Separate numbers from numbers with commas.



3-ethyl-2-methylhexane



6-methyl-4-propyldecane