

Name _____ Class _____

Organic Lab 1: Saturated Hydrocarbons (Alkanes)

Introduction

Hydrocarbons are organic molecules composed of only two elements: hydrogen and carbon. The simplest hydrocarbons are called alkanes. In every alkane, carbons share four pairs of electrons with four other carbons and/or hydrogens. We will build a number of simple alkanes, examine their structure, and represent them in two and three dimensions. We will also learn how to name alkanes.

Materials

Each group has a set of molecular models. Notice that the different spheres have different numbers of holes:

White (representing Hydrogen) _____ hole(s)

Black (representing Carbon) _____ hole(s)

The grey sticks represent a pair of shared electrons. The shared pair is also known as a chemical bond, or more specifically, a **covalent bond**. The word "covalent" refers to the **valence electrons**, which are the electrons that are available for making bonds.

How many valence electrons does carbon have? _____

How many valence electrons does hydrogen have? _____

The electrons are the "glue" that holds the molecule together. How are the holes related to the valence electrons?

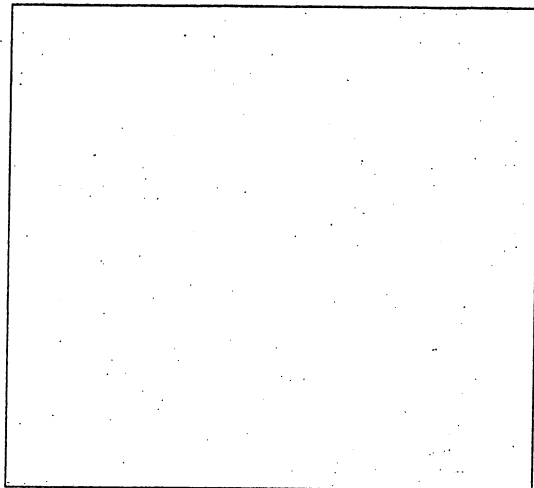
A reference table is provided to help you name the alkanes you create.

Methods

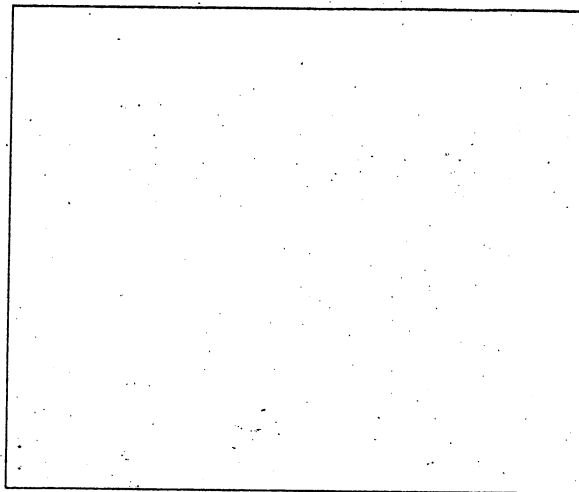
1. Take a carbon atom and connect four hydrogen atoms. Draw a three-dimensional sketch of what you see and a two-dimensional structural formula on the following page using the chemical symbols C and H instead of spheres.

What kind of shape is this molecule? _____

Take a protractor and measure the angle between the carbon and any two hydrogens.
What is it? _____



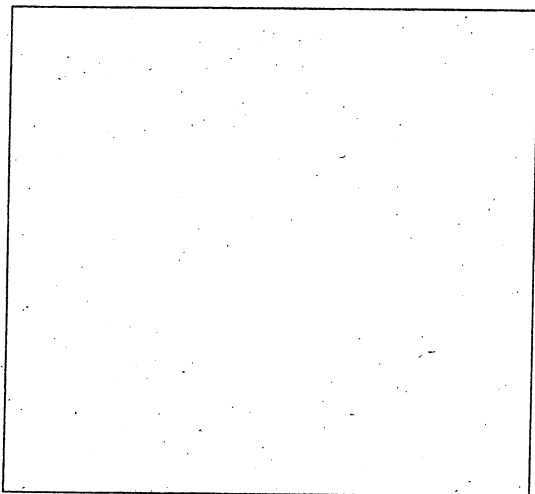
3-D sketch



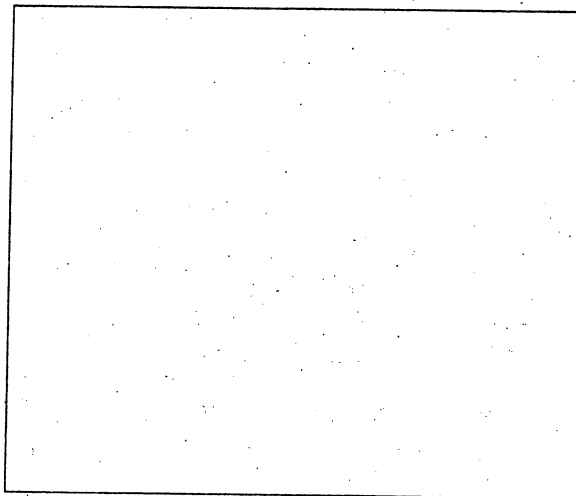
structural formula

Using the prefix chart, name the compound. _____

2. Take a hydrogen off your model and add a -CH_3 group (**methyl group**)
Draw sketches below.



3-D sketch

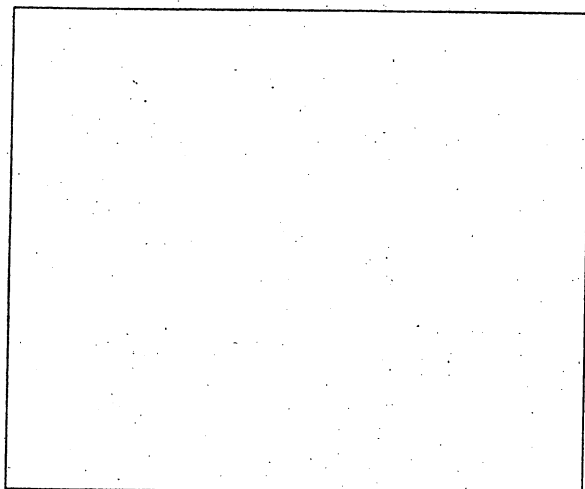


structural formula

What is the name of his compound? _____

What is its chemical formula? _____

3. Pull apart your molecule and add a $\text{-CH}_2\text{-}$ group (**methylene group**). Draw its structural formula, name the compound, and write its chemical formula.

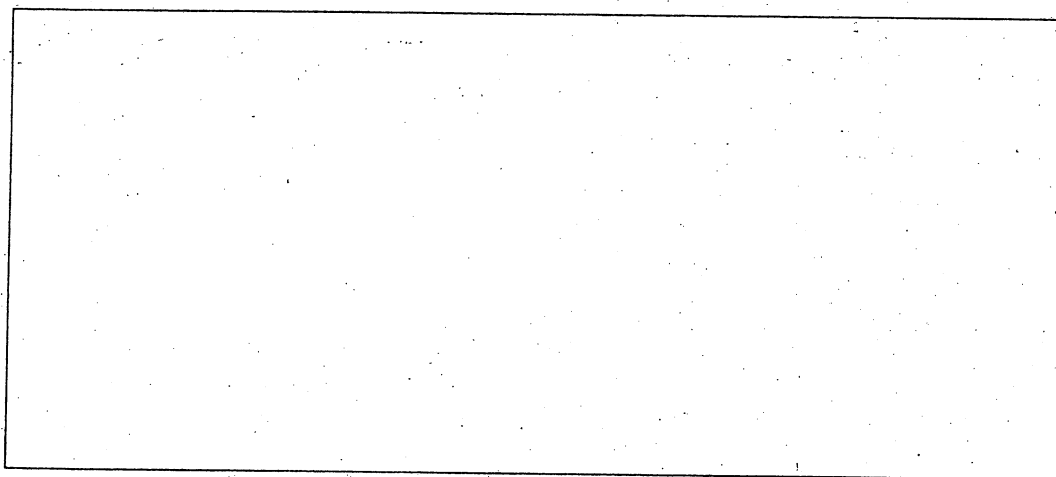


Compound name _____

Chemical Formula _____

Structural Formula

4. Repeat the last procedure by adding a methylene group to your alkane.

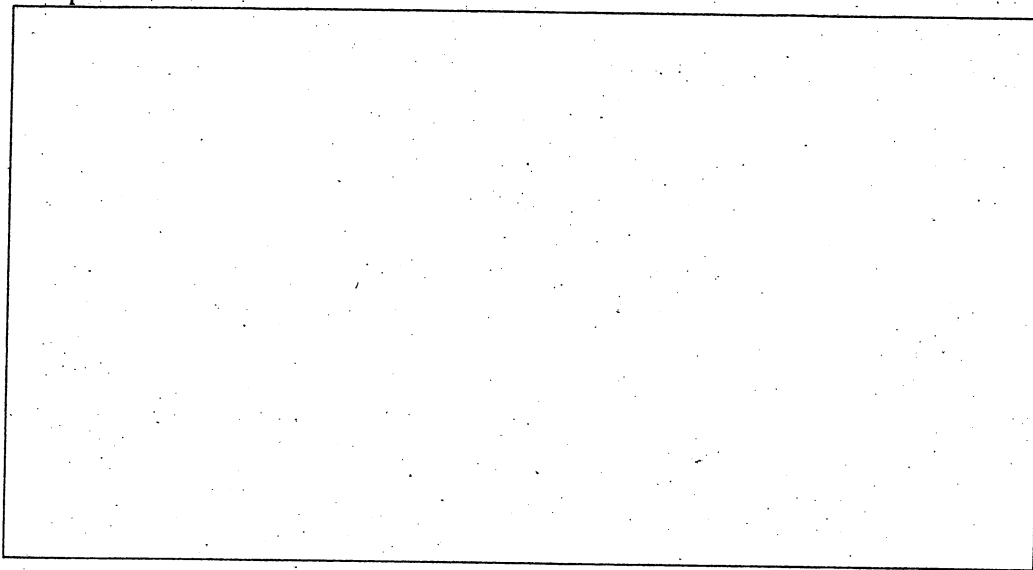


Compound name _____ Formula _____

5. Rearrange the atoms in molecule 4 to make a new molecule with a completely different shape. Draw its structural formula on the following page.

Compounds 4 and 5 are isomers – they have the same chemical formula but different structural formulas. They also have somewhat different chemical and physical properties. For example, compound 4 boils at 0.5°C , while compound 5 has a boiling point of -10.2°C . Which compound has the strongest attractive forces between molecules?

Using the procedure for naming alkanes written on your reference page, name this isomer of compound 4.



Compound Name _____ Formula _____

6. Add another methylene group to compounds 4 or 5. There are three isomers with the same chemical formula; draw their structural formulas and name them below.

7. How many isomers does hexane have? Draw and name them below.

Discussion

1. Consider the following data table of the boiling points of alkanes.

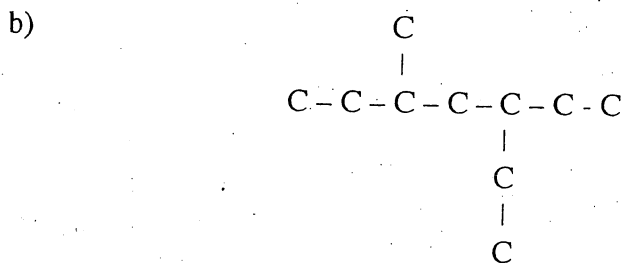
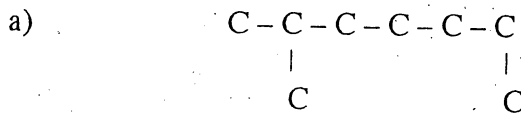
Alkane	Boiling Point (°C)
Heptane	98.5
Propane	-42
Pentane	36
Butane	0.5
Methane	-161
Ethane	-88.5
Hexane	?

On a separate piece of graph paper, make a line graph of this data. Be sure to label the axes and give the graph a title. Based on information contained in the table, predict the approximate boiling point of hexane, and explain why.

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2. At room temperature, what physical state (solid, liquid, or gas) would you predict for $C_{18}H_{38}$? Justify your answer.
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3. Every compound that we have examined today is a member of the alkane homologous series, and has the general formula C_nH_{2n+2} . Draw and name two isomers for an alkane where $n=8$. What is the chemical formula for both compounds?

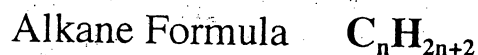
4. Name the following compounds (hydrogens not included) Write the chemical formula for each, including the correct number of hydrogens. Finally, name the straight chain alkane that is an isomer.



Lab 1 Reference Materials

Organic Prefixes

# of Carbons	Prefix
1	Meth-
2	Eth-
3	Prop-
4	But-
5	Pent-
6	Hex-
7	Hept-
8	Oct-
9	Non-
10	Dec-



Alkane Substituents (the branches, otherwise known as alkyl groups)

- CH_3 methyl
- CH_2CH_3 ethyl
- $CH_2CH_2CH_3$ propyl

Rules for Naming Organic Compounds

1. Find the longest continuous chain of carbons (not as easy as it sounds!)
2. Number the carbons in the main chain. Start at the end that gives the substituents the lowest numbers.
3. Add numbers in front of the names of the substituents.
4. If a group appears more than once, add a prefix to the name: di- twice, tri- three, tetra- four, penta- five, and so on.
5. List the names of the substituents in alphabetical order. For example, an ethyl group is listed before a methyl group, even if the methyl group appears on an earlier carbon in the chain.
6. Punctuation – use commas to separate numbers, and dashes to separate numbers and words.

