APES LAB: HYDROCARBON STRUCTURE

This is an informal lab. The data table is all to be submitted.

Objectives

- To learn about hydrocarbon structure
- To see how common hydrocarbons are constructed
- To practice "building" and drawing hydrocarbon structures

Introduction

The study of carbon compounds is called *organic chemistry*. *Hydrocarbons* are compounds which contain carbon and hydrogen. Some hydrocarbon characteristics are summarized below:

- *aliphatic*—made of chains
- *cyclic*—made or rings
- *aromatic*—made of rings with alternating single and double bonds

Prefixes tell how many carbons are in the main structure:

meth = 1	hex = 6
eth = 2	hept = 7
prop = 3	oct = 8
but = 4	non = 9
pent = 5	dec = 10

Carbons in a hydrocarbon are bonded to one another. Hydrogens are always terminal (hanging off the ends). As a hint to drawing the structure, some books write out the formula as it is linked together, as in $CH_3CH_2CH_2CH_2CH_2CH_3$ for hexane, instead of C_6H_{14}.

Carbon can form four chemical bonds. The types of bonds affect the geometry of the molecule. If a bond is coming toward you, use a bold line. For bonds facing away from you, use a dotted line.

4 single = *tetrahedral* (3-D pyramid shape)
1 double, 2 singles = *trigonal* (triangular flat) *planar*
1 triple, 1 single = *linear* (flat)

So single-bonded carbon chains actually "zigzag" in real life.

Hydrocarbons can also be classified according to the types of bonds they contain:

- *alkanes*—chain with single bonds only; C_nH_{2n+2}
- *alkenes*—chain with double bond(s); general formula C_nH_{2n}
- *alkynes*—chain with triple bond(s); general formula C_nH_{2n-2}
- *arenes*—aromatic hydrocarbons; general formula C_nH_n, with alternating single and double bonds

Procedure

1) Set up a data table with four columns. It works better with the paper turned sideways. Use a ruler. Make sure you have plenty of room to draw.

COMPOUND NAME	**COMPOUND FORMULAS**	**"TOOTHPICK"** (symbols connected with lines)	**"BALL-&-STICK"** (draw colored circles with bond angles)
Pentane	C_5H_{12} $CH_3CH_2CH_2CH_2CH_3$		

2) Write each compound *name* in the data table.
3) For compounds #2-9, write each formula in TWO WAYS: *condensed* (like C_5H_{12}) and *expanded* (like $CH_3CH_2CH_2CH_2CH_3$).

4) Draw the "toothpick" structure for the following organic compounds.
5) Build each model as you go. Make sure all group members see each model, and take turns building. Use the kit's color key.
6) Draw the "ball-and-stick" structure for each. Use colors that match the kit, and include a *color key*. Try to get the correct bond angles as described in the introduction.

DATA

PART 1

ALIPHATIC ALKANES: (chains)

1) methane ("swamp gas") = CH_4
2) ethane = C_2H_6
3) propane (main component of "natural gas") = C_3H_8
4) butane (lighter fluid) = C_4H_{10}
5) octane (in gasoline) = C_8H_{18}

CYCLIC ALKANES: (rings)

6) cyclopropane C_3H_6 (*For #6 only, use single springs to connect the carbons.)*
7) cyclopentane C_5H_{10}
8) cyclohexane C_6H_{12}

AROMATIC/ARENES: *(Use two springs for a double bond.)*

9) benzene (C_6H_6 in a ring) ** *DON'T DISASSEMBLE! YOU NEED IT FOR #10 & #11***

COMPOUND NAME	**COMPOUND FORMULA (condensed only)**	**"TOOTHPICK"** (symbols connected with lines)	**"BALL-&-STICK"** (draw colored circles with bond angles)

PART 2

More ARENES and their derivatives: *(Use two springs for a double bond.)*

10) toluene $(C_6H_5)(CH_3)$
11) phenol $(C_6H_5)OH$

ALKENES: *(Use two springs for a double bond.)*

12) ethene (ethylene) C_2H_4
13) 2-pentene $CH_3CHCHCH_2CH_3$

ALKYNES: *(Use three springs for a triple bond.)*

14) ethyne (acetylene) C_2H_2
15) butyne $HCCCH_2CH_3$

ACIDS: *(Use two springs for a double bond.)*

16) formic acid $HCOOH$
17) acetic acid (vinegar acid) CH_3COOH

ALCOHOLS:

18) methanol (wood alcohol) CH_3OH
19) ethanol (drinking alcohol) CH_3CH_2OH

ALDEHYDES: *(Use two springs for a double bond.)*

20) formaldehyde H_2CO
21) acetaldehyde (ethanal) CH_3CHO

ETHERS:

22) dimethyl ether CH_3OCH_3
23) methyl ethyl ether $CH_3OCH_2CH_3$

MISC. POLLUTANTS: *(Use three springs for a triple bond if needed.)*

24) hydrogen cyanide HCN
25) acteonitrile CH_3CN
26) dichloromethane CH_2Cl_2
27) ethylene glycol $HOCH_2CH_2OH$