Name_____Section_____

Date Due_____

Molecular Models

Use the following color codes as you build your models.

Black	Carbon
White	Hydrogen (If you use the school kits; use yellow)
Green	Chlorine
Red	Oxygen

Part I

METHANE Draw a 3-D sketch.

1. Build a model of methane, CH_4.

a. How many atoms are in one plane?

b. How many atoms are out of plane? Which direction to these point to?

c. Can you rotate around a single bond?

d. What is its molecular geometry?

e. What is the hybridization of the C atom?

f. What are the bond angles?

g. Are the C-H bonds polar?

h. Does this molecule have a dipole?

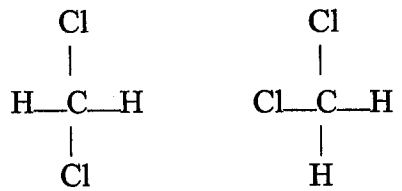
2. Replace one of the hydrogens with a chlorine.

a. Does it matter which hydrogen is replaced with chlorine?

We call these **equivalent** hydrogens.

b. Does this molecule have a dipole?

3. Replace a second hydrogen atom with chlorine to make dichloromethane (methylene chloride) . Convince yourself that the following two formulas represent the same three-dimensional structure.



b. Does this molecule have a dipole?

4. Replace another hydrogen to make $CHCl_3$, trichloromethane (chloroform).

b. Does this molecule have a dipole?

5. Finally, make tetrachloromethane (carbon tetrachloride), CCl_4.

b. Does this molecule have a dipole?

ETHANE

1. Make a model of ethane, C_2H_6, from your model of CH_4 by replacing one of the hydrogens with a $-CH_3$ unit; the **$-CH_3$** unit is called the **methyl** group. Note that the hydrogens of ethane are all equivalent.

2. Replace one of the hydrogens in you ethane model with chlorine to make C_2H_5Cl.

Does it matter which hydrogen you replace?

3. Replace another hydrogen from C_2H_5Cl with a chlorine atom to yield $C_2H_4Cl_2$. You should be able to construct two <u>different</u> molecules. These molecules are called **isomers**. Compounds that have the same molecular formula but different structural formulas are called **isomers.**

a. Name these compounds.

b. Do these molecules have a dipole?

PROPANE

1. From your model of ethane, construct a molecular model of propane, C_3H_8, by replacing one of the hydrogen atoms with a methyl group ($-CH_3$).

2. Replace one of the hydrogens of propane with chlorine. You should be able to construct two isomers. Name these compounds.

3. Replace another hydrogen with chlorine to produce 4 isomers of $C_3H_6Cl_2$. Name these compounds.

BUTANE

1. From your model of propane, C_3H_8, construct two isomers of butane, C_4H_{10}. Name these.

2. Construct all four isomers of C_4H_9Cl by replacing a hydrogen on butane with a chlorine. Name them.

PENTANE

1. Use your model kit to determine how many isomers there are for the formula, C_5H_{12}? Draw their skeletons and name them.

2. Replace one hydrogen from pentane to make $C_5H_{11}Cl$. How many isomers can you construct? Draw and name all isomers.

3. Use a model kit to determine how many isomers there are for C_6H_{14}. Draw and name each.

ALKENES

1. Use two of the longer flexible connectors to make a double bond. (If you are using the school kits, use 2 springs for a double bond). Construct a model of ethene (ethylene), C_2H_4. Note the rigidity of the molecule.

a. Can you rotate around a double bond?

b. How many atoms are in one plane?

c. What is its molecular geometry?

d. What is the hybridization of the C atom?

e. What are the bond angles?

2. How many structures are there corresponding to the formula C_2H_3Cl?

3a. How many isomers are there corresponding to the formula $C_2H_2Cl_2$?

b. Identify which are cis and trans.

c. Identify the constitutional isomers.

d. Which structures have a dipole?

ALKYNES

1. Construct a model of acetylene (ethyne), C_2H_2. (There is a triple bond between the carbons.)

a. Can you rotate around a triple bond?

b. What is the hybridization of the C atom?

c. What is its molecular geometry?

d. What are the bond angles?

2. How many different structures are there if one of the hydrogens is replaced with a chlorine? Are cis-trans isomers possible? Why or why not?

CYCLOALKANES

Cycloalkanes corresponding to the formula, C_nH_{2n} exist. Try to construct (but do not force too much in your attempt) models of: cyclopropane, C_3H_6; cyclobutane, C_4H_8; cyclopentane, C_5H_{10}; and cyclohexane, C_6H_{12}.

a. What does this tell you about the ring strain in these molecules?

b. What are the bond angles?

2. Construct a model of benzene, C_6H_6, using alternating single and double bonds.

a. What is its molecular geometry?

b. What is the hybridization of the C atom?

c. What are the bond angles?

d. Comparing benzene to cyclohexane, which is flat and rigid?

3. Make a model of dichlorocyclohexane, $C_6H_{10}Cl_2$. How many isomers are there?

b. Is cis-trans isomerism possible?

c. Name all structures.

MORE ISOMERS

1. Construct models for two isomers for C_2H_6O. One of these isomers has an (**-OH**) group attached to the second carbon. This isomer is an **alcohol**. The other isomer places the oxygen between the two carbons. This isomer is an **ether**. These isomers have different **functional** groups. Note: The oxygen is bonded to the carbon atom(s) with single bonds.

2. Construct models for two isomers of C_3H_6O. Each will have a double bond between the oxygen atom and a carbon atom.
If the carbon (bonded to the oxygen) is at the end of the molecule, the **functional** group is called an **aldehyde**. If the carbon (bonded to the oxygen) is in within the carbon chain, the **functional** group is called a **ketone**.