Name _____ Chemistry 4X, Sec _____

Molecular Models

Experiment #1 **Pre-Lab Exercise**

1. How many bonds are normally formed to atoms of each of the following elements when they are in most organic molecules.

	No. of Bonds		No. of Bonds		No. of Bonds
H		C		N	
O		Cl		S	
F		Br		I	

2. Molecules can be represented by molecular formulas or by structural formulas. Write the molecular formula for butane below and show all the possible structural formulas for butane.

Molecular Formula for Butane All Possible Structural Formulas for Butane

3. What is the difference between conformational structures of a molecule and different structural isomers? Give an example to illustrate.

4. How would you describe the difference between a saturated hydrocarbon and an unsaturated hydrocarbon? Give examples of each to illustrate.

5. Give two examples of cycloalkanes and one example of a cycloalkene, showing the structural formula for each. Name the structures you have drawn.

6. What is meant by *cis*- and *trans*- isomers of alkenes. Give an example of each, making a structural formula and correctly naming it for each example.

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Molecular Models

Experiment #1 **Data & Report Sheet**

Part A. Simple Hydrocarbons.

1. Make a model of the methane (CH_4) molecule, connecting four H atoms (white balls) to one C atom (black ball), using the light gray, rigid pegs. Place the model on the bench and notice the 3-dimensional structure. Write the structural formula for methane (using chemical symbols, *i.e.*, C and H) on the left below and draw a 3-dimensional diagram of the methane model (ball and stick) you have just made on the right.

2. Remove an H atom and replace it with a C atom forming a C-C bond. Complete the model by adding bonds (light gray, rigid pegs) to H atoms to fill all the holes in the two C atoms.

   What is the name of the molecule you have just formed? _____

   Write the chemical formula for this molecule. _____
   Notice it is possible to rotate the molecule about the C-C bond. Place it on the bench with four H atoms in contact with the bench and two H atoms pointing straight up. Draw a diagram of this model below on the left. Then rotate the molecule about the C-C bond so there are two H atoms from one C in contact with the bench and only one H atom from the other C pointing straight down in contact with the bench. Draw a diagram of this form of the model below on the right.

   Are these different isomers? (yes or no) _____

3. Remove one H atom from the molecule above. What is the name of the C_2H_5 radical (group) you have just formed? _____
   Attach a C atom where the H atom was, and fill in the remaining holes with bonds to H atoms.

   What is the name of this three carbon molecule? _____

   Is it still possible to rotate the molecule about both of the C-C bonds? (yes or no) _____

Remove an H from the central C and remove one -CH_3 group from this C and place it where the H was. Place the H where the -CH_3 group was.

Have you formed a different isomer? (yes or no) _____

Does the molecule look any different? (yes or no) _____
Write the structural formula (using chemical symbols) for this molecule below on the left and draw a diagram of this model (ball and stick) below on the right.

4. Remove an H atom from an end C of the three carbon molecule above and replace it with a -CH_3 group.
What is the name of the molecule you have formed? _____
We will now use numbering to represent the order of the C atoms (*i.e.*, C1, C2, C3, and C4 in this case). Place the molecule on the bench so two H atoms from C2 and two H atoms from C3 are in contact with the bench. Write the structural formula (using chemical symbols) for this molecule (as you see it) in the space below on the left. After drawing that structure, rotate the molecule about the bond connecting C2 and C3 to get two H atoms from C1 in contact with the bench and two H atoms from C3 in contact with the bench. Write the structural formula (using chemical symbols) for this molecule (as you see it) in the space below on the right.

Have you broken any bonds to change the shape? (yes or no) _____
Is this the same molecule or a different molecule after rotating it? (same or different)_____

5. Remove an H atom from C2 and remove C4 (as a -CH_3 group) from C3. Place the -CH_3 group on C2 and place the H atom on C3.
Is this the same molecule or a different molecule than the one you had in step 4? _____

What is the common name for the molecule you have just formed? _____

What is the IUPAC name for this molecule? _____
(See the text book if you need help naming this compound)

Write the structural formula for this molecule
in the space to the right.

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Part B. Unsaturated Hydrocarbons.

6. Make a model of 2-butene using two of the longer, flexible (dark gray) pegs to connect C2 and C3, forming a double bond. The remainder of the molecule should have single bonds (rigid, light gray pegs).
What is the molecular formula for 2-butene? _____
Be sure you have made the correct model for 2-butene.
Can you rotate the molecule about the double bond connecting C2 and C3? (yes or no) _____
Notice the general shape of the molecule and notice that all **atoms** connected to C2 and C3, as well as C2 and C3 are in a plane (*i.e.*, this part of the molecule is planar). Place the model on the bench and write the structural formula (using chemical symbols) for the molecule you have just made in the space below. Is this the *cis*- or *trans*- isomer of 2-butene? _____

7. Now make the other structural isomer (*cis*- or *trans*-) of 2-butene.

Does it look different from the model you made in step 6? (Yes or no) _____
Place the model on the bench and write the structural formula (using chemical symbols) for the molecule in the space below.

Part C. Alkanes vs Cycloalkanes

8. Make a continuous chain (no branching, no double bonds) of six C atoms and make the model of the saturated hydrocarbon by filling all the remaining holes with bonds to H atoms.

What is the name of this molecule? _____
Notice you can now rotate the molecule about all of the C-C bonds to form many different shapes.

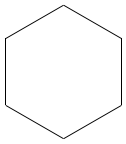
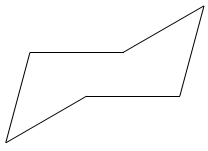
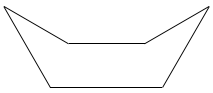
Do the different shapes result in different molecules or different isomers? (yes or no) _____

Have you broken any bonds when you rotate about C-C bonds to give different shapes? _____
Draw structural diagrams for at least four of the possible **structural isomers** of hexane below.

9. Remove one H atom (white ball only) from C1 and remove one H atom (with its bond) from C6 of n-hexane and connect C1 to C6 with a single bond (light gray, rigid peg).

Write the chemical formula for this molecule. _____ Is this an isomer of n-hexane? _____

What is the name of this compound? _____
Is it possible to rotate the molecule about the C-C bonds? _____ Using the diagrams below to represent this cycloalkane, add the appropriate number of H atoms to each of the six points (or angles) in the geometric figures, which represent C atoms.

Note: You should be able to place the model on the bench with three H atoms pointing straight down and three H atoms (on alternating Cs) pointing straight up to get the middle structure. After drawing the H atoms on that diagram, you should be able to get four H atoms (*e.g.*, on C2, C3, C5 and C6) pointing nearly straight down on the bench, and two H atoms (on C1 and C4, the left and right sides) pointing nearly straight up to get the structure on the right above.