Name _____ Class _____
Date _____ Molecular Model Lab
(40 minutes)

INTRODUCTION

The properties of chemical compounds are directly related to the ways in which atoms are bonded together into molecules. In this exercise, you will have the opportunity to apply your knowledge by constructing simple ball-and stick models for some common molecules. The models should help your understanding of electron arrangements in molecules and the resulting shapes of the molecules. You will investigate a number of small molecules containing carbon, nitrogen, oxygen and hydrogen. In the process of doing this exercise you will see how "models" become very useful to chemists in understanding and predicting chemical properties.

BACKGROUND INFORMATION: ELECTRONS AND MOLECULES

The existence of chemical compounds with fixed composition implies that the atoms in compounds must be connected in characteristic patterns. Early models showed the atoms hooked together like links on a chain. Modern representations are a good deal more abstract and often mathematical in nature. Nevertheless, it is possible to represent molecular structures with reasonable accuracy by using relatively simple models. The models serve as a three-dimensional representation of an abstract idea. Molecular model building has proven so useful that it is rare to find a chemist who does not have a model kit close at hand.

The chemical bonds that hold atoms together in molecules generally consist of *pairs of electrons* shared between two atoms. Atoms share outer electrons in such a way that each atom in the union has a share in an *octet of electrons* in its outermost shell. This generalization has come to be known as the **octet rule**. The location of each element in the Periodic Table provides information about the number of electrons in the outermost level of the atoms. Carbon, for example, is in Group 4A and has four outer electrons; thus, it must share four additional electrons from other atoms to achieve a share in eight outer electrons (an octet). Oxygen, in Group 6A, has six outer electrons and shares two electrons from other atoms to achieve an octet

A **single bond** consists of one shared pair of electrons; a **double bond** is two shared pairs (i.e., 4 electrons), and a **triple bond** is three shared pairs (6 electrons). On paper the bonds are represented by single, double, or triple lines, respectively (-, =, ≡). In model kits, straight sticks represent single bonds, while pairs or triplets of curved sticks or springs represent double and triple bonds. Electrons not involved in bonding are termed *unshared electrons*.

MODEL BUILDING BASICS

Molecular model kits vary; therefore, your instructor will explain the particular models that you will use. The kit probably contains balls (used for atoms), sticks (for single bonds), and springs or curved sticks (for double and triple bonds). Each stick or spring represents two electrons.

Color Code for Molecular Model Sets

Atom	Color
Hydrogen	White
Carbon	Black
Nitrogen	Blue
Oxygen	Red
Chlorine	Green

Procedure

1. Get acquainted with the components of the kit. Note the holes in the various colored balls and their positions. If there are two lengths of sticks, the shorter gray ones are for single bonds. The longer, flexible gray ones are for double and triple bonds.
2. Before building your models, complete Data Table I.
3. Build models for each of the molecules listed in Data Table II.
    a. Gather the kind and number of atoms required. (For example, to make the CH_4 molecule you will need one black ball and four white ones.)
    b. Assemble the model by connecting the balls and sticks to match the formula.
4. When you're done assembling then drawing the molecule, dissemble the models and return the pieces to the kit.

Data Table I

Element	Color	Number of Holes

What do the holes represent? _____

_____

Data Table II – Molecular Models

Molecule	Formula	Drawing of Structure	Where is it found in nature?
Methane	**CH_4**		
Ammonia	**NH_3**		
Water	**H_2O**		
Molecular Oxygen	**O_2**		
Molecular Nitrogen	**N_2**		
Carbon Dioxide	**CO_2**		

Analysis Questions

1. List the "big four" elements in living things and how many bonds each requires to fill its valence shell

Element (Symbol & Name)	# of bonds required to fill valence shell

2. Do all of the assigned elements obey the octet rule? If not, how so?

3. The tetrahedral shape (CH_4) is one of the most fundamental shapes in chemical compounds. How would you describe it in words to someone who has not seen it?