Name: **Honors Chemistry**

Section: Molecular Models of Covalent Compounds

Up to this point, we have focused on drawing Lewis structures of molecules, which are two-dimensional models of the actual molecules. While Lewis structures are useful for showing bonding, they are limited when it comes to three-dimensional geometries of molecules. Lewis structures do not necessarily represent the geometry of the molecule! In this lab, we will explore how atoms are arranged in molecules by building simple ball-and-stick models of various covalent compounds. We will use VSEPR theory, a system for predicting molecular shape based on the principle that pairs of electrons orient themselves as far apart as possible. We will also determine the presence of polar bonds and how their three dimensional arrangements are reflected in molecular dipoles.

Problem

Can we predict the three-dimensional geometries of molecules?

Objectives

- To understand how atoms are arranged in molecules
- To visualize the three-dimensional nature of molecules
- To predict the presence of molecular dipoles

Materials

molecular model kit
protractor

For your introduction, research space filling models (sometimes called CPK models). Compare the information given by ball-and-stick models, space filling models (sometimes called CPK representations), and structural formulas. For a molecule of your choice, include illustrations of the structure formula, a ball and stick model, and a CPK model. Under what circumstances is each type of model most appropriate or useful?

Make a chart in your lab book with 8 columns. Label the columns as follows:

- Formula
- Lewis structure
- Sketch of model
- Structural formula (Label the bond angles as much as possible)
- Coordination number of central atom
- Shape of the molecule (Geometry around central atom, or each carbon atom if more than one is present))
- Polar bonds (Y or N? If Y, include → for each polar bond to indicate bond polarity)
- Is the molecule POLAR?

Roles:

Project Manager ___________________________
Materials Manager ___________________________
Quality Control Manager___________________________

For each of the following compounds, first write in the Lewis structure for that compound. Then assemble the molecule and fill in the chart for that compound.

Compounds

1. Cl_2
2. CH_4
3. CH_3Cl
4. CH_2Cl_2
5. C_2H_6
6. C_2H_5OH
7. H_2O
8. NH_3
9. O_2
10. C_2H_4 (double bond)
11. C_2H_2
12. $C_2H_2Cl_2$ (how many isomers—different arrangements of atoms—can you find?)
13. N_2
14. C_3H_8
15. CO_2
16. HCN
17. C_6H_6

Analyze and Apply Questions

1. Distinguish between "lone pairs" and "bonding pairs" of electrons. Which has the greater spatial requirement? What is the effect of lone pairs on molecular shapes?
2. Why does VSEPR theory predict molecular shapes with the largest possible bond angles?
3. Explain how a molecule, such as CCl_4, can have an electronegativity difference ≥ 0.3 and still be considered to be non-polar.
4. Predict the geometries of the chemical species below..

   a) H_3O^+
   b) PCl_3
   c) BCl_3
   d) SiH_4
   e) BH_4^-
   f) H_2S
   g) SCl_2
   h) NH_4^+
   i) BeH_2
   j) BeH_4^{2-}

5. Consider three molecules, all with the general molecular formula AB_4. One is square planar, one is tetrahedral, and one is square planar. How must these molecules be different, with respect to the central atom?