Lab: Models of Molecular Compounds - > VSEPR

Introduction:

Why should people care about the shapes of molecules? Consider that the properties of molecules, including their role in nature, depend not only on their molecular composition and structure, but their shape as well. Molecular shape determines a compound's boiling point, freezing point, viscosity, and the nature of its reactions.

The geometry of a small molecule can be predicted by examining the central atom and identifying the number of atoms bonded to it and the number of unshared electron pairs surrounding it. The shapes of molecules may be predicted using the VSEPR rule, which states that electron pairs around a central atom will position themselves to allow for the maximum amount of space between them.

Covalent bonds can be classified by comparing the difference in electronegativities of the two bonded atoms. If the difference in electronegativities is less than or equal to 0.3, the bond is called a nonpolar covalent bond. If the difference in electronegativities is between 0.4 and 1.7, a polar covalent bond exists. (If the difference in electronegativities is greater than 1.8, an ionic bond results.) In a polar covalent bond, the electrons are more attracted to the atom with the greater electronegativity, resulting in a partial negative charge on the atom. The atom with the smaller electronegativity value acquires a partial positive charge.

Molecules made up of covalently bonded atoms can be either polar or nonpolar. The geometry of the molecule determines whether it is polar or not. For example, if polar bonds are symmetrically arranged around a central atom, their charges may cancel each other out and the molecule would be nonpolar. If, on the other hand, the arrangement of the polar bonds is asymmetrical, the electrons will be attracted more to one end of the molecule and a polar molecule or dipole will result.

Ball-and-stick models can be used to demonstrate the shapes of molecules. In this experiment, you will construct models of covalent molecules and predict the geometry and polarity of each molecule.

Pre-Lab Questions:

Read the entire lab investigation and the relevant pages of your textbook. Then answer the questions that follow.

1. What is a covalent bond? ____
   ____
2. What is a dipole? ____
   ____
3. What two factors determine whether a molecule is polar or not? __________________________
   ____
   ____
4. List the five different molecular geometries that you will be studying in this investigation. _____
   ____
5. Calculate the electronegativity difference and predict the type of bond for the following examples: (Refer to the electronegativity periodic table in your text book for the list of electronegativities.)
   a. Na – Cl ____
   b. C – H ____
   c. S – O ____
   d. N – N ____

Problem:

How can the polarity of the molecules be predicted from their geometry and the types of bonds they contain?

Procedure:

1. Construct ball-and-stick models of the molecules in your data table.
2. For each of the compounds in the data table, be sure to also complete the structural formula, shape and polarity. As an example, the first line of the Data Table has been filled in for you.
3. When you have completed this investigation, take apart your models and return the model set to your teacher. Clean up your work area and wash your hands before leaving the laboratory.

Data Table: **Structure and Polarity of Molecules**

Formula	Electron Dot Structure (Lewis)	Shape of Molecule	Molecular Polarity
HBr			
H_2O			
PH_3			
CH_4			
N_2			
C_2H_2			
CH_3Cl			
HCN			

Critical Thinking: Analysis and Conclusions

1. Explain how you used the molecular shapes to predict molecular polarity. Support your answer with examples from the results of this investigation.

2. Can a molecule with all nonpolar bonds ever be polar? Why or why not?

3. Can a molecule with polar bonds ever be nonpolar? Why or why not?