Lab #5: Molecular Shapes

Objectives:
1. To become familiar with the three-dimensional shapes of molecules and polyatomic ions.
2. To draw electron-dot structures for simple molecules and polyatomic ions.
3. To build molecular models from electron-dot structures drawn and applying VSEPR model.
4. To predict the polarity and the type of intermolecular forces involved in molecules from its shape.

Pre-lab:
Copy the observation table. Draw the electron dot structures for the molecules. Show all your work.

Materials:
Molecular Model Kit

Procedure:
1. From the electron dot structures drawn in the pre-lab section and applying VSEPR model, build the three-dimensional structure of the molecules or polyatomic ions using either the Molecular Model Kit.
2. Draw (using —, ◄, ····, and indicate ***all*** lone pairs) the three-dimensional structures built.
3. Name the three-dimensional structures built.
4. Determine if the molecule is polar or non-polar for each of the molecule along with the types of intermolecular forces involved.

Observations:

	Compounds or Ions	Electron-Dot Structures	Sketch of 3-D Model	Name of Shape	Polar or Non-polar	Type(s) of Intermolecular Force
1.	HCl					
2.	SiH_4					
3.	PH_3					
4.	HCN					
5.	CH_3F					
6.	H_2S					
7.	CH_2O					
8.	O_3					
9.	H_2O_2					
10.	CO_3^{2-}					
11.	NO_2^-					
12.	NO_2					
13.	SO_2					
14.	PF_5					
15.	SCl_6					
16.	PO_4^{3-}					
17.	SO_4^{2-}					

Analysis:

1. Explain the polarity of each molecule from the observation table.
2. Three of the compounds from the observation table have their boiling points listed below. Account for the differences in these boiling points.

Molecule	Boiling Point
CH_3F	–78°C (195 K)
H_2O_2	150°C (423 K)
SiH_4	–107°C (166 K)

Evaluation:

Research on the Internet to answer the following questions.

1. Why is it difficult to draw the Lewis Dot Diagram for NO_2? How does NO_2^- solve this problem? Besides NO_2^-, describe other ways to resolve this difficulty?
2. Can a neutral NO_3 molecule exist? If not, what can be done so that one nitrogen atom and three oxygen atoms can form this molecule?
3. Most of the time, phosphorus and sulfur atoms follow the octet rule. However, there are times where phosphorus follows the ten-electrons rule, and sulfur follows either the ten-electrons or the twelve-electrons rule. Why do they happen and what types of quantum orbitals do they involve? Take a look again at all the molecules that contain sulfur or phosphorus in this lab, explain how some of your initial shapes might be wrong. Correct any wrong assumptions.

   (Internet search phrase: "formal charges of *(name of ion or molecule)*" or go to http://www.chem.plu.edu/pchem/chem342/FormChg.htm as the starting point of your research.)

Conclusion:

Summarize what you have learned from this lab.