Lab #6: Molecular Models

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 or ions. Show all your work.

Materials:

Molecular Model Kit *Website:* molview.org (for Distant-Learning Virtual Molecular Modeling)

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^{1-}					
12.	NO_2					
13.*	SO_2					
14.*	PF_5					
15.*	SCl_6					
16.*	PO_4^{3-}					
17.*	SO_4^{2-}					
18.*	SCl_4					
19.*	IF_2^{1-}					
20.*	BrF_5					
21.*	$XeCl_4$					
22.*	$BrCl_3$					

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:

1. Why is it difficult to draw the Lewis Dot Diagram for NO_2? How does NO_2^{1-} solve this problem? Besides NO_2^{1-}, 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.

*Note:

2. For SiH_4, use a black ball to represent Si.
3. For PH_3, use a blue ball to represent P.
6. For H_2S, use a red ball to represent S.
8. For O_3, use a black ball to represent the central atom.
13. For SO_2, use a black ball to represent S.
14. For PF_5, use a brown ball (or any ball with 5 holes) to represent P.
15. For SCl_6, use a yellow ball (or any ball with 6 holes) to represent S.
16. For PO_4^{3-}, use a black ball to represent P if it follows the octet rule. If P follows $10e^-$ rule, use the brown ball (or any ball with 5 holes) to represent P.
17. For SO_4^{2-}, use a black ball to represent S if it follows the octet rule. If S follows $10e^-$ rule, use the brown ball (or any ball with 5 holes) to represent S. If S follows $12e^-$ rule, use the yellow ball (or any ball with 6 holes) to represent S.
18. For SCl_4, use a black ball to represent S if it follows the octet rule. If S follows $10e^-$ rule, use the brown ball (or any ball with 5 holes) to represent S. If S follows $12e^-$ rule, use the yellow ball (or any ball with 6 holes) to represent S.
19. For IF_2^{1-}, use a black ball to represent I if it follows the octet rule. If I follows $10e^-$ rule, use the brown ball (or any ball with 5 holes) to represent I. If I follows $12e^-$ rule, use the grey ball (or any ball with 6 holes) to represent I.
20. For BrF_5, use the brown ball (or any ball with 5 holes) to represent Br if it follows $10e^-$ rule. If Br follows $12e^-$ rule, use the grey ball (or any ball with 6 holes) to represent Br.
21. For $XeCl_4$, use a black ball to represent Xe if it follows the octet rule. If Xe follows $10e^-$ rule, use the brown ball (or any ball with 5 holes) to represent Xe. If Xe follows $12e^-$ rule, use the grey ball (or any ball with 6 holes) to represent Xe.
22. For $BrCl_3$, use a black ball to represent Br if it follows the octet rule. If Br follows $10e^-$ rule, use the brown ball (or any ball with 5 holes) to represent Br. If Br follows $12e^-$ rule, use the grey ball (or any ball with 6 holes) to represent Br.