EXPERIMENT 2

PREDICTING MOLECULAR SHAPE AND POLARITY USING VSEPR THEORY

Materials Needed

Molecular model kit.

Textbook Reading

Smith, chapter 3.10-3.12

Background

In this lab, you will practice your understanding of Valence Shell Electron Pair Repulsion (VSEPR) theory. You will draw Lewis Structures of several compounds and make models of these structures in order to help you visualize the molecular shape. Finally, you will predict molecular polarity for each compound. Make sure to carefully read chapters 3.10-3.12 prior to doing this lab. It probably will be beneficial for you to also at least attempt to do the corresponding chapter-end problems.

VSEPR Theory. VSEPR theory allows one to predict the electronic and molecular geometries of a molecule from its Lewis structure. These predictions are primarily based on the number of regions of electron density (REDs or VSEPs) around the central atom(s). In order to get correct answers from VSEPR theory, you must first have a correct Lewis structure. Therefore, the procedures for drawing Lewis structures presented in the textbook and lectures need to be mastered. Remember that you must account for all valence electrons and you must show all of these electrons in the Lewis structure.

Electronic Geometry. VSEPR theory merely proposes that the REDs will be arranged around the center atom in such a manner that places them as far apart as possible. (This arrangement may be referred to as the "electronic geometry".) Each of the following is considered to be a single region of electron density:

- A non-bonding pair of electrons or lone pair)
- A covalent bond
- A multiple covalent bond (i.e., a double bond or a triple bond).

The most commonly encountered cases for numbers of REDs and electronic geometries are summarized in the following table.

Number of Regions of Electron Density (REDs)	Electronic Geometry and Angles
2	linear, 180°
3	trigonal planar, 120°
4	tetrahedral, 109.5°

Molecular Geometry. The molecular geometry describes the arrangement of **the atoms** in a molecule. The non-bonding pairs do not figure into this description. Hence, if there are non-bonding pairs present in the molecule they are ignored when describing the molecular geometry. For example, the electronic geometry of H_2O is tetrahedral but two of the REDs are lone pairs, which are ignored. Therefore the molecular geometry of water (the arrangement of the H, O, and H atoms) is best described as "bent". (If there are no non-bonding pairs then the molecular geometry is just the same as the electronic geometry.)

Molecular Polarity. Both the polarity of the bonds present and the molecular geometry must be considered in determining whether a molecule is polar or not. There are three cases:

- There are no polar bonds. The molecule is not polar.
- There are polar bonds but the molecular geometry makes it so they cancel each other out. The molecule is not polar.
- There are polar bonds present and they do not cancel each other out. The molecule is polar.

Procedure

You will be provided with three molecular models:

- A model with a linear central atom and two other atoms attached.
- A model with a trigonal planar central atom and three other atoms attached.
- A model with a tetrahedral central atom and four other atoms attached.

For each compound in the observations/data/report table follow the following steps.

1. Name the compound and draw its Lewis structure. You may want to work on the Lewis structure on a sheet of scratch paper first before filling in the table.

2. Count up the number of REDs in your Lewis structure and predict the electronic geometry.

3. Choose the model that has the correct electronic geometry and remove one attached atom for every non-bonding pair that is present on the central atom of your Lewis structure. (The non-bonding pairs do not count when describing molecular shape – they are "invisible".) You now have a model that shows the shape of the molecule (the molecular geometry).

4. Make a structural drawing that shows the molecular geometry using wedges and dashes as necessary to show bonds that are not in the plane of the paper. (Tetrahedral molecules are not flat and require using the wedged or dashed bond symbolism to properly show their three-dimensional shape. See Bettelheim.)

5. Decide which of the three categories of molecular polarity the molecule fits into.

PRE-LABORATORY QUESTIONS

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Name ____ Section ____________ Date ____________

Draw Lewis structures for each of the following.

BeH_2

PCl_3

BF_3

SO_2

EXPERIMENT 2 - PREDICTING MOLECULAR SHAPE AND POLARITY USING VSEPR (Report/Data/Observations)

Names ____ Date__________________

Formula	Lewis Structure	# of REDs	Electronic Geometry	Drawing of Structure showing Shape	Molecular Geometry and Bond Angles	Molecular Polarity
BeH_2						
BF_3						
CF_4						
PCl_3						

Formula	Lewis Structure	# of REDs	Electronic Geometry	Drawing of Structure showing Shape	Molecular Geometry and Bond Angles	Molecular Polarity
SO_2						
NH_3						
HCN						
CS_2						
H_3O^+						
NO_2^-						

Post Lab Assignment: Do problems 3.89 and 3.90 on page 102 in Smith and attach your work to this report.