Chemistry CP

Name:

Activity: Molecular Models of Covalent Compounds Section:

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 activity, 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.

Problem

Can we predict the three-dimensional geometries of molecules?

Objectives

- To understand how atoms are arranged in molecules
- To assist in visualizing the three-dimensional nature of molecules

Materials

Molecular model kit protractor

Procedure:

Make a chart using legal size paper with 7 columns. Label the columns as follows:

- Formula
- Lewis structure
- Sketch of model (label the bond angles)
- Number of electron domains (around any central atoms, including C atoms)
- Molecular geometry (geometry around central atom, or around the C atoms)
- Does the molecule have polar bonds? (Which ones?)
- Is the molecule polar?

For each of the following compounds, first write in the formula and Lewis structure for that compound. Then assemble the molecule and fill in the chart for that compound. You will turn in one copy of the data table for the group.

The model kits are color coded as follows:

Carbon	Black
Hydrogen	White or yellow (small)
Oxygen	Red
Nitrogen	Blue
Clorine, bromine, iodine	Green, orange, purple

Part I: Compounds with one central atom

1. CH_4
2. CH_3Cl
3. CH_2Cl_2
4. H_2O
5. NH_3
6. CO_2
7. HCN
8. H_2CO

Part II: Molecules with more than one central atom. List the number of electron domains and geometry around each central atom if they vary. As before, complete the table for each compound.

9. C_3H_8
10. C_2H_5OH
11. C_2H_6
12. C_2H_4 (double bond)
13. C_2H_2
14. C_6H_6—the carbons form a ring!

Analyze and Apply Questions

You will individually answer these questions individually in the space below.
Write your answers in complete sentences.

1. Why does VSEPR theory predict molecular shapes with the largest possible bond angles?

2. Explain how the presence of lone pairs affects the bond angles of molecules. Refer to specific examples in your answer.

3. Sketch models of the following geometries: triatomic linear; octahedral; bent; tetrahedral; trigonal planar; trigonal bipyramidal; trigonal pyramidal.

4. Why is it important to be able to predict the geometry of molecules? Describe at least one real-world application—include a reference.

5. Explain how a molecule, such as CCl_4, can have an electronegativity difference ≥ 0.3 and still be considered to be non-polar (i.e., have no molecular dipole).