Lab - Models of Covalent Compounds

Introduction

Why should people care about the shapes of molecules? Consider that the properties of molecules, including their role in nature, depend primarily on molecular structure, or shape. Molecular shape determines a compound's boiling point, freezing point, viscosity, and the amount and type of its reactions.

The geometry of a molecule can be determined 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 occur when atoms share electrons as opposed to transferring electrons from one atom to the other. The sharing of electrons allows both atoms to lay “claim” to the electrons, in order to achieve an octet. Covalent bonds can further be classified by comparing the difference in electronegativities of the two bonded atoms. If the difference in electronegativities is less than 0.5, the bond is called a nonpolar covalent bond. If the difference in electronegativities is between 0.5 and 1.9, a polar covalent bond exists. (If the difference in electronegativities is greater than 1.9, an ionic bond results.) In a polar covalent bond, the electrons are shared, but more attracted to the atom with the greater electronegativity, resulting in a partial negative charge on that 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 cancel each other out and the molecule is 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 (sometimes called a 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 Discussion

Read the introduction above. 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) For the following bonds, calculate the electronegativity difference and determine the polarity of the bond:

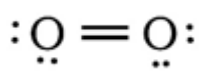
Bond	a) Na — Cl	b) C — H	c) S — O	d) N — N
Electronegativity Difference				
Bond Polarity				

Purpose: To determine the shape and molecule polarity of several covalent compounds.

Procedure

1) Construct ball-and-stick models of the compounds listed in the data table:
2) For each of the following compounds, complete the Data Table in the Observations section. 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.

Data Table: Structure and Polarity of Covalent Molecules

Formula	Lewis Structure	Structural Diagram	Picture	Molecule Shape	Bond Polarity	Molecule Polarity
O_2				linear	nonpolar	nonpolar
HBr						
H_2O						
PH_3						

Formula	Lewis Structure	Structural Diagram	Picture	Molecule Shape	Bond Polarity	Molecule Polarity
CH_4						
HOCl						
N_2						
CH_3NH_2						
CO_2						
H_2CO						
C_2H_2						

Formula	Lewis Structure	Structural Diagram	Picture	Molecule Shape	Bond Polarity	Molecule Polarity
CH_3Cl						
HCOOH						
HCN						
H_2O_2						

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) List the advantages and disadvantages of using ball-and-stick models to construct molecules.

3) The polarity of a substance can have a great effect on its reactivity and solubility. A rough rule of thumb for solubility is "like dissolves like." Knowing this general rule, what can you predict about the polarity of alcohol if you know that alcohol dissolves in water? Why do you think that water is not used to dissolve greasy stains and dirt at dry cleaners?