**MOLECULAR STRUCTURE INVESTIGATION**

**TEKS 7Di and 7E**

**Pre-lab Questions**

Before beginning this experiment in the laboratory, you should be able to answer the following questions.

1. Distinguish among ionic, covalent, and metallic bonding.
2. Which of the following molecules possess polar covalent bonds: H2, N2, HCl, HCN, and CO2?
3. Which of the molecules in question 2 have molecular dipole moments?
4. What are the favored geometrical arrangements for AB*n* molecules for which the A atom has 2, 3, 4, 5, and 6 pairs of electrons in its valence shell?
5. How many equivalent orbitals are involved in each of the following sets of hybrid orbitals: *sp*, *sp*2, *sp*3*d*,and *sp*3*d*2?
6. Define the term *formal charge*.
7. Calculate the formal charges of the atoms in CO, CO2, and CO32- .

**INVESTIGATION EXERCISES**

1. Using an appropriate set of models, make molecular models of the compounds listed below and complete the table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Molecular  Formula | No. of  bond pairs (bp) | No. of lone  pairs on central atom  (bp) | Hybridization of central atoms | Molecular geometry | Bond  angle(s) | Dipole  moment  (yes or no) |
| BeCl2 |  |  |  |  |  |  |
| BF3 |  |  |  |  |  |  |
| SnCl2 |  |  |  |  |  |  |
| CH4 |  |  |  |  |  |  |
| NH3 |  |  |  |  |  |  |
| H2O |  |  |  |  |  |  |
| PCl5 |  |  |  |  |  |  |
| SF4 |  |  |  |  |  |  |
| BrF3 |  |  |  |  |  |  |
| XeF2 |  |  |  |  |  |  |
| SF6 |  |  |  |  |  |  |
| IF5 |  |  |  |  |  |  |
| XeF4 |  |  |  |  |  |  |

1. From your models of SF4, BrF3, and XeF4, deduce whether different atom arrangements, called geometrical isomers, are possible; if so, sketch them below. Indicate the preferred geometry for each case and suggest a reason for your choice. Indicate which structures have dipole moments and show their direction.

*Molecule Dipole moment Preferred geometry Reason*

* 1. SF4

*Molecule Dipole moment Preferred geometry Reason*

* 1. BrF3
  2. XeF4

1. Using the Lewis structure predict the geometrical structures of the following ions and state the hybridization of the central atom.

*Ion Structure Central atom hvbridization*

N3–

CO32–

NO3–

BF4–

1. Because lone pairs are larger than bonding pairs, lone pair–long pair interactions are greater than lone pair–bonding pair interactions, which are in turn larger than bonding pair–bonding pair interactions. Using this notion, suggest how the following species would distort from regular geometries.
   1. OF2
   2. SCl2
   3. PF3
2. There are several families of hydrocarbons, among which are alkanes, alkenes, and alkynes. The parents of each family are CH4 (methane), H2C=CH2 (ethene), and H-C ≡ C-H (ethyne), respectively. Predict the geometries of these molecules, give the hybridization of carbon in each molecule, and suggest whether they are polar or nonpolar molecules.

*Molecule C-hybridization Polar (yes or no)*

* 1. CH4
  2. C2H4
  3. C2H2

1. Calculate the formal charges of all atoms in NH3, NO2–, and NO3–.