19.6: VSEPR Theory

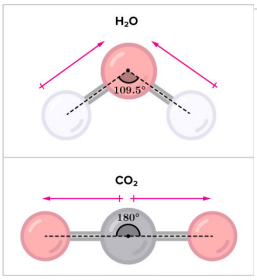

Figure 19.6.1: Copy and Paste Caption here. (CK-12 Curriculum Materials license; CK-12 Foundation via CK-12 Foundation)

Why is the water molecule bent like that?

The characteristic bent shape of the water molecule shown above was a puzzling discovery for scientists at first. The shape allows the molecule to be polar, increasing its boiling point and making it possible for life on earth to exist as we know it. But what makes it bend? The structure is almost the same as carbon dioxide which is known to be a gas at room temperature, why not water too?

Putting atoms together to form compounds can be done on paper or in the lab. However, when the shape of the molecule made in the lab is different from the shape of the molecule drawn on paper, then we need to rethink our ideas and find better explanations.

VSEPR Theory

In 1956, British scientists R.J. Gillespie and R.S. Nyholm recognized that the current model for explaining bond angles did not work well. The theory at that time relied on hybrid orbitals to explain all aspects of bonding. The problem was that this theory gave an incorrect prediction of bond angles for many compounds. They developed a new approach based on earlier work by other scientists that incorporated a consideration of electron pairs in predicting three-dimensional structure.

The **valence shell** is the outermost electron-occupied shell of an atom. The valence shell holds the electrons that are involved in bonding and are the electrons shown in a Lewis structure. The acronym VSEPR stands for the **valence-shell electron pair repulsion** model. The model states that electron pairs will repel each other such that the shape of the molecule will adjust, so that the valence electron-pairs stay as far apart from one another as possible. Molecules can be systematically classified according to the number of bonding pairs of electrons; as well as the number of nonbonding, or lone pairs, around the central atom. For the purposes of the VSEPR model, a double or triple bond is no different in terms of repulsion than a single bond.

Summary

- VSEPR theory allows more accurate predictions of molecular shape.

Review

1. Who did the major work in developing the VSEPR theory?
2. Where are the electrons that are involved in bonding?
3. What is the basic idea behind the VSEPR theory?