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Trash Bag Molecular Geometry

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A personal connection with material being studied helps long-term retention. This is especially true for abstract concepts like molecular geometries obtained by application of valence-shell electron-pair repulsion (VSEPR) theory. Geometric properties of molecules, including respective bond angles, have proven to stump many students who can recall the values of these angles and name their geometries, but fail to understand the molecules in three-dimensional space. We provide here a simple and very inexpensive process for students to visualize and study these geometries. Small trash bags, a resource often thrown away, can be filled with air and held together by hand to represent bonding pairs (smaller bags) and lone pairs (larger bags) in a structure. Held tightly together, the trash bags naturally arrange themselves to represent the geometry at the molecular level. The activity can be done in virtually any situation, with little preparation, and at virtually no cost to the student.

Background

The Peer Lead Team Learning (PLTL) program at the University of Texas at El Paso offers students the opportunity to learn and practice chemistry from their fellow classmates in an environment conducive to their success in the course. In a chemistry class lecture, practice of learned theories and material is usually difficult to arrange due to the sheer number of students in the hall and limited time. However, through PLTL, undergraduate students who have passed and excelled in the course facilitate group learning on a smaller scale in the classroom as an integral part of the students' education (Peer Led Team Learning, n.d.). Students benefit from the group activities and explorations arranged by the course, focused on having students practice material lectured in class as much as possible. Explorations, one-way students are able to exercise chemistry, engage students in hands-on activities that allow students to practice abstract concepts in a physical, realistic capacity for facilitated understanding.

Valence-Shell Electron-Pair Repulsion (VSEPR) theory describes the structure of molecules studied in chemistry 1305 courses. This theory is used most importantly in predicting the geometry of molecules; based on these predicted geometries, the lone electron pairs around the molecule, bonds, and their angles to the central atom, as well as the hybridization of orbitals in the molecule can be defined accordingly. Adjacent electrons present in the molecule repel each other and tend to define the geometry of the molecule and the angles between the atom constituents of the molecule. The VSEPR theory assumes that any molecule will form a geometry that minimizes the amount of repulsion in the molecule ("VSEPR", n.d.).

With this information, the structure for any molecule can be drawn; this is a crucial concept to master and is used heavily in organic chemistry and other chemistry courses, as well. Therefore, students must then be able to identify and arrange the lone pairs and bonds around any molecular structure. Drawing these chemical structures has proven to be a trying section for 1305 students. This is because, while students may be able to memorize the bond angles and hybridizations of molecular structure, they often have difficulty visualizing the structure of these molecules in a three-dimensional space. With this inability to model structures in one's head, VSEPR theory loses its practical application and students suffer in later chemistry courses where a complete understanding of molecular structures is paramount to learning new material.

Materials and Methods

In trash bag molecular geometry, trash bags are used to model molecular structures. In every molecular structure, bond angles are influenced by both bonds and lone pairs. However, lone pairs have a greater repulsion force than bonds between atoms, and thus cannot be described the same as the bond repulsion forces in a model. Therefore, by using smaller trash bags for bonds between atoms and larger trash bags for lone pairs and filling them with air, the molecular structure for a compound can be held in the hand and the trash bags will naturally arrange themselves into the position appropriate for the structures at a molecular level. These steps can be seen in the demonstration section, as well as how this exploration can be used in class (Figures 1-4).

Demonstrations

Figure 1. First, fill the first trash bag with air.

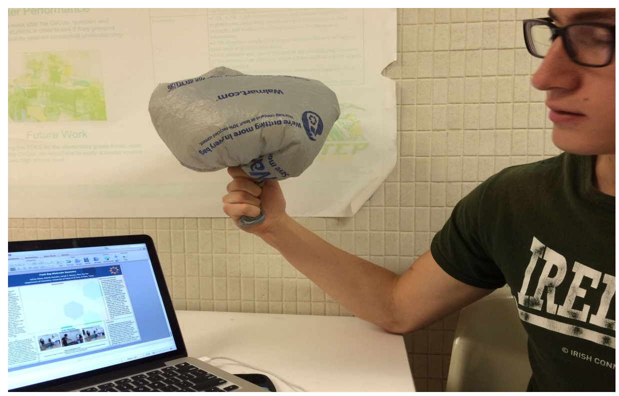

Figure 2. Hold trash bag in one hand, with the hand representing the central atom.

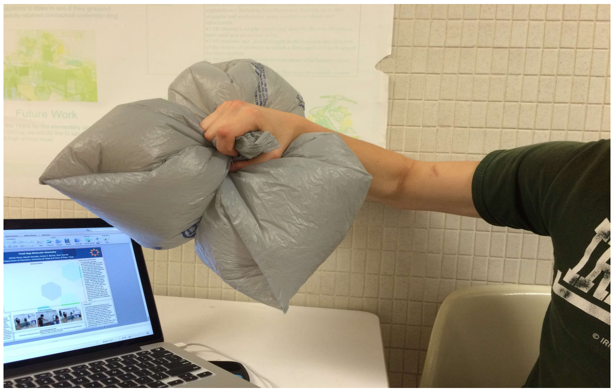

Figure 3. Add more trash bags as atoms bonded to the central atom as needed.

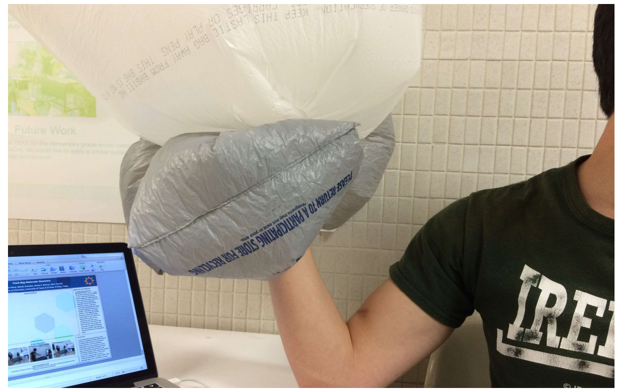

Figure 4. Add larger trash bags as atoms bonded to central atom as needed.

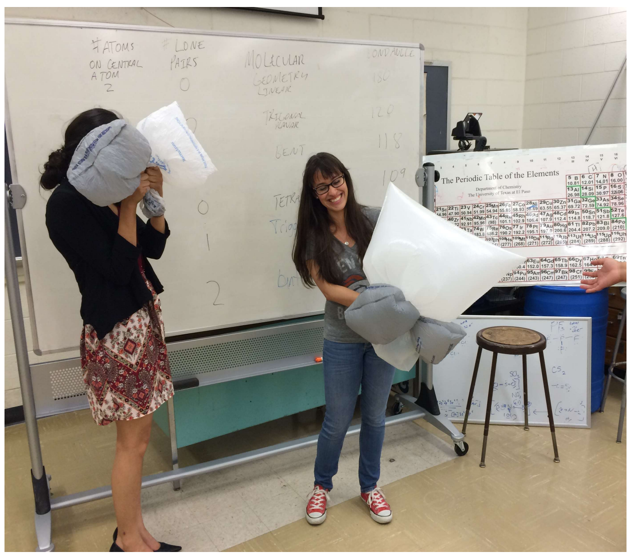

Figure 5. Students learning VSEPR theory in the classroom through the Trash Bag Molecular Geometry Exploration

<u>Conclusion</u>

Trash Bag Molecular Geometry is not meant to redefine the way VSEPR theory is traditionally taught in classrooms. Balloons have previously been used to portray molecular geometries in the past, however, what the Trash Bag Molecular Geometry Exploration does is improve upon the exploration that already exists with balloons. The first improvement upon the preexisting exploration of VSEPR theory is improved accuracy of the molecular structure being modeled. This is accomplished by varying the size of the bags used in the model according to the distinction of whether a lone pair or bond is being represented. Through this more appropriate representation of structures, the molecular geometries should be displayed more accurately and the influence of bond angles and lone pairs are more clearly seen. The other improvement on the exploration is that, by using trash bags instead of balloons, the resources needed to practice molecular geometries, hybridizations, and bond angles can be found virtually anywhere. This, then, makes the opportunity to learn a universal possibility to anyone with a few garbage bags and an ambition to learn.

Acknowledgments

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References

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