Lesson Title	Pauli's Magical Water
Length of Lesson	1 hour 15 min
Created By	Chris Ruhs
Subject	Chemistry
Grade Level	10-12th Grade
State Standards	Chemistry I: 5d,e
DOK Level	DOK 2
DOK Application	Students demonstrate their knowledge of the VSEPR Model by predicting and explaining molecular geometries and their implications.
National Standards	B (Physical Science)
Graduate Research Element	Understanding the VSEPR Model allows chemists to explain certain phenomena in nature, such as the polar nature of water, which is integral to an overwhelming number of natural processes.

Student Learning Goal:
MS 9-12th Grade:
Chemistry I: 5 (d) Draw Lewis electron dot structures and determine the geometric structure of simple molecules. *Students will scaffold the VSEPR Model to their previous mastery of Lewis Dot diagrams.* (e) Identify simple molecules as polar or non-polar on the basis of molecular shape and bond polarity. *Students will learn and apply concepts from the VSEPR Model to predict geometry and polarity.*

National Science Education Standards of Content 9-12:
B: Physical Science: Structure and Properties of matter. *Students will discover how the physical properties of compounds reflect the nature of the geometry of molecules, including the constituent atoms, the atomic distances, and the bonding angles.*

Materials Needed (supplies, hand-outs, resources):
VSEPR Model worksheet, Styrofoam balls, toothpicks, molecular geometry rendering software

Lesson Performance Task/Assessment:
Formative:
1. Review of Lewis Dot diagrams with focus on unbounded electron pairs
2. Review of the Pauli Exclusion Principle with focus on how the principle gives rise to VSEPRs
3. Discussion of the VSEPR model, how it works, and how it acts as a predictive model for molecular geometry
4. Examples of AB_xE_y molecules where A is the central atom, B_x are bonded atoms, and E_y are unbounded electron pairs

5. Discussion of the example geometries that arise from the simple Pauli-based VSEPR model with focus given to bonding angles, electronegativity effects, and multiple bond effects.

Summative:

1. Students will be given a worksheet with the VSEPR theory and a set of rules for predicting geometry
2. Students will be placed in groups, and assigned a molecule, the geometry of which they will be required to predict, including any bond angles that deviate from perfect distribution, using Styrofoam balls and toothpicks
3. Groups will present their models, while the rest of the class draws the model and takes notes
4. A molecular geometry rendering program will allow students to see actual molecule arrangements in 3D on the smartboard, to add accuracy to their notes
5. A Q&A session will be led by the teacher

Lesson Relevance to Performance Task and Students:
Understanding molecular geometries will help students understand crystalline structures and other material properties in higher level courses, for example, the reason water is polar, is because it is non-linear. The understanding of molecular geometries is best achieved through a the use of the VSEPR Model, which is itself underpinned by the Pauli Exclusion Principle.

Anticipatory Set/Capture Interest:
A discussion of how important water is, including how important its polar nature is, will serve to capture student interest. The introductory question, "Why is water polar?" will serve as a guiding and perhaps perplexing anticipatory set.

Guided Practice:
Review, discussion and example problems will serve as guided practice.

Independent Practice:
Students will work in teams to demonstrate correct understanding and application of the VSEPR Model's predictive capability.

Remediation and/or Enrichment:
Remediation:
Individual IEP, focus on one simpler examples and fewer geometries.

Enrichment: harder examples, more geometries, long chain molecules and polymers.

Check(s) for Understanding:

What is a VSEPR?
How do VSEPRs relate to Pauli's Exclusion Principle?
What is the geometry of water? Why?

Closure:
A Q&A session will be led by the teacher will bring closure to the lesson plan.

Possible Alternate Subject Integrations:
Geoscience: crystalline structures
Material Science: crystalline structures

Teacher Notes: