Lesson Plan: Shapes of Covalently Bonded Molecules

Grade/Age Level:
15 – 18 yr olds, 10th – 12th grade

Subject Area:
high school chemistry

Time allotted for the lesson:
several class meetings

Day 1:
• Introduce the covalent molecules
• Review ionic vs covalent molecules

Day 2:
• Identify number of valence electrons on C, O, N, H, and halogens
• Review what makes an atom stable (8 valence electrons)
• Discuss how an atom can have 8 valence electrons if it does not already come with eight.
• Point out the gaps that are available to allow for bonding.

Day 3:
• Teach how to draw Lewis Dot Diagrams/ Lewis Dot Structures

Day 4:
• Practice drawing more dot diagrams
• Redraw the molecules they originally made with marshmallows and toothpicks

Day 5:
• Build molecules using a molecular modeling kit
• Draw these images on the paper

Day 6:
• Bring up the concept of 3 dimensional shapes and having names for the shapes
• Have students name the molecules they have been drawing.
• Pass out copies of the images I made to explain tetrahedral, trigonal pyramidal, and bent.

Day 7:
• With images of larger molecules, identify the shape you’d expect to see at various parts of the molecule.

Short description of lesson
• Students review ionic vs covalent compounds
• Students will be able to identify how many bonds each atom can ordinarily make
• Students will demonstrate using the HONC 1234 rule to draw pictures of covalent molecules
• Students will learn how the lone pair affects the alignment of the other atoms connected to the central atom.
• Students will learn the names of the shapes of molecules.

California Curriculum Standards met in this lesson:

California Science Standards: Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:
• Students know chemical bonds between atoms in molecules such as H2, CH4, NH3, HCC2H2, N2, Cl2, and many large biological molecules are covalent.
• Students know how to draw Lewis dot structures.
• Students know how to predict the shape of simple molecules and their polarity from Lewis dot structures.
• Students know how electronegativity and ionization energy relate to bond formation.

Instructional Objectives:
• Students determine how many valence electrons there are for each non-metal and therefore also figure out how many gaps the atoms have.
• Based on the number of gaps, students figure out how the atoms should bond covalently.
• After figuring out how many bonds need to form or in the process of learning how many bonds need to be made, students draw molecules using Lewis Dot diagram methods.
• After drawing the Lewis Structures, students learn how having a lone pair on the central atom affects the shape of the molecule.

Instructional Procedures:
Lesson Set

- If I am with students in a classroom (not virtual) then we will start with having students make marshmallow and toothpick models of a few small molecules. This is done to tap into prior knowledge and to hopefully pull on misconceptions because they are inherently with us.
- If this is a virtual setting, then I would have images and ask students to identify the pictures of ionic formulas and which ones look like they could be covalently bonded molecules.

Techniques and activities:

- Review how ionic and covalent molecules differ.
- Go through C, O, N, H, and a halogen to identify how many valence electrons they have. This time they are not going to gain or lose any so we need to figure out how many gaps they have. For now, we are going to assume single bonds and only work with small molecules.
- We go through how to combine C, O, N, and a halogen with hydrogen to complete the required valence electrons to be stable: 8.
- We could look at images of covalently bonded molecules to see if there are any patterns. Does there seem to be a regularity to how many times each atom bonds to another atom? If so, what is that pattern?
- Then I look at the number of single bonds each atom needs to make to be stable. This should automatically lead to them seeing H needs one bond, Oxygen needs 2, Nitrogen needs 3, and Carbon needs 4. Use the HONC 1234 image at this point.
- Now we discuss shapes of molecules. If they did the opening exercise where they made molecules with gumdrops and mini-marshmallows, they bring out their drawings to see if there are any changes they would now make. If so, what are these changes? On the paper, draw another column so they can sketch their changes.
- Use real modeling kits so students can build molecules that are forced to be in three dimensions.
- Draw another line down the page so students can redraw their molecules based on what the model kit had them make.
- Pass around models of the molecules made in the organic chemistry kit.
- Talk about where there are lone pairs of electrons on the central atom.
- Does having a lone pair or two on the central atom seem to affect how the other atoms are bonded to it? How?
- Pass out copies of the tetrahedral, trigonal pyramidal, or bent images so students can see how that they have been doing matches with what is on the images.
- Draw another line to make another column. Have students now try to draw the image of their molecules in three dimensions. Draw, not trace.

Lesson Closure:

There are a few ways to draw these days to a close.

- Students do more work on their ionic vs. covalent Venn diagram
• Students are given actual formulas and they have to draw what the molecules would be.
• Have students make images of the molecules in jmol and take snapshots of at least two angles for each image. This means they need to know how to rotate the images. If we can pull it off, I will have students make a website where they upload at least one molecule in jmol so others can come to the website to play with the molecule. An example of what I’m talking about can be found here: http://www.onlineschoolsurveys.com/jmol_stuffs/tetrahedral/tetrahedral.html

Adaptations for special learners:

Exceptional learners:
• Needs auditory support: read the lesson that is on the website out loud to make an audio file to go with the website.
• Hopefully all students will be having hands-on experiences with equipment so they can build their own molecules. This should help students who need kinesthetic modes to acquire information.

Supplemental Activities:

Extension:
Students can figure out how or why some molecules have double or triple bonds
Students can make 3-d models of molecules using their own materials, not a kit

Remediation:
I think I just went over it with the students one on one. Sometimes playing with the jmol software will help them see a three dimensional structure. I may have to make a video that goes over how to upload jmol and how to use it if I cannot find videos of that already online.

Assessment/Evaluation:
• Learner success is seen as they make changes to their diagrams over time.
• Their Venn diagrams will also be examined.
• Students can be given a written assessment where they are given formulas and they need to draw the Lewis Dot diagrams and identify the shape of the molecule.
• Learner Products:
• Students will have their drawings.
• If an advanced activity is done where students make a clay model or a 3-D model of molecules using something other than a model kit, then they will have these models to cherish.
• Pictures of Lewis dot diagrams
• Jmol image and maybe website to accompany it.