TO SHARE OR NOT TO SHARE – HOW DOES IT SHAPE THEE?

EDUCATIONAL OBJECTIVES

The learner will:

- correctly model the valence energy levels of various atoms.
- draw Lewis dot structures for various molecules.
- construct models of several molecules (given in the procedure) with their correct shape and bond angles according to the VSEPR theory.
- state the relative degrees of the angles between valence electron pairs when they are involved in bonding and when they are not.
- identify the geometric shapes of various molecular formulae by name.

PREREQUISITE KNOWLEDGE

The students should know:

- how to find the number of valence electrons in an atom.
- be able to draw Lewis dot structures.
- be able to use the octet rule and explain why electrons repel each other.

PREDICTIONS

Knowing that covalent bonds are composed of electron pairs shared by the nuclei of two atoms, how do you think these bonds would be arranged in space if there were two of atoms? What if there were two atoms sharing electrons around a central atom?

SAFETY

Please do not to poke each other with the toothpicks or **EAT** the Playdoh®.

MATERIALS, PREPARATION, AND DISPOSAL

- At least two colors of Playdoh®, clay, or marshmallows per group (You may want to have baggies for each group to store the individual colors of the Playdoh)
- Enough toothpicks to represent all of the electron pairs for each molecule for each group.

  After completion of the lab:
- Keeping the colors separate, place the Playdoh® in the bags, and return to the instructor.
- Return the toothpicks to the designated area.

PRELAB ENGAGEMENT / BACKGROUND INFORMATION

You have already learned that the interactions of electrons with other electrons and with the nuclei of atoms play an important role in the composition of almost all of the substances found in the world. You also know that electrons are found in their orbitals as pairs most of the time.

The interaction of electron pairs with other electron pairs also plays a key role in the geometric shape of molecules. Since all electrons have a negative charge, they will repel each other. The electrons in the pairs will force other pairs such that the pairs are as far apart as possible. There is a limit on how far apart they may be when they are held in place by the nucleus of an atom, and they are even more limited by the attraction of the two nuclei when they are involved in a covalent bond.

Because shared electron pairs are between two nuclei (which have a positive charge), their repulsive forces are not as strong as compared to unshared electron pairs (lone pairs). As such, the distances between different types of electron pairs can be ranked as follows:

Two unshared pairs > a shared pair and an unshared pair > two shared pairs.

PROCEDURE

Use the separate sheet for drawings and answers. Begin each activity by drawing the molecule's Lewis dot structure.

<u>Activity A</u>

Step 1. Keeping in mind how electrons repel each other, construct a molecule of beryllium fluoride (BeF_2) using the Playdoh® (or marshmallows) as atomic nuclei and the toothpicks as electron pairs.

Step 2. After your model is approved by the instructor, draw and label this molecule.

<u>Activity B</u>

Repeat steps 1 and 2 from Activity A for boron trifluoride.

<u>Activities C - F</u>

Repeat steps 1 and 2 from Activity B with these other molecules: CH_4, NH_3, H_2O, O_3
Do not use a ring for O_3.

EXPLANATION

When chemists discuss bond angles and geometric shapes they refer only to the angles between the atoms, or shared electron pairs, in the molecule and they ignore the unshared pairs of electrons. They do, however, take into account the influence of those pairs on the molecule's geometry. Keep this in mind while interpreting your models, learning more about molecular shapes, and answering the questions.

Look up valence shell electron pair repulsion theory and explain how your models show this theory at work.

Use the table at Wikipedia under "VSEPR" along with your models to answer these questions.

QUESTIONS

1. a) What is the measure of the bond angle in beryllium fluoride?
   b) What is the shape of this molecule?

2. a) What is the measure of the F-B-F bond angle in boron trifluoride?
   b) What is the shape of this molecule?

3. What is the approximate measure of the bond angle in methane? Why isn't this simply 90°?

4. a) What is the measure of the angle in ammonia?
   b) How does this compare to the H-N-H angels in CH_4?

5. What is the measure of the angles in water in relation to the angles between a shared bonded pair and a non-bonded pair, and the angle between the two non-bonded pairs?

6. a) What is the measure of the angle in ozone?
   b) How does this compare to BeF_2?
   c) Why are they different?

7. What is the name for the shape of methane?

8. What is the name for the shape of the ammonia molecule?

9. What is the name for the shape of the water molecule?

10. What is the name for the shape of the ozone molecule?

DISCUSSION

1. Ozone and water have the same name for their shapes, but they are slightly different. Explain.

2. What do H_2O, CH_4, and NH_3 have in common? Why do they have different shapes?

GOING FURTHER

Write the formula, draw the Lewis dot structure, and give the approximate bond angles, and write the name of the shape for each.

sulfur dioxide

sulfur trioxide

REFERENCES

Ozmen, H. (2007). Some student misconceptions in chemistry: A literature review of chemical bonding. *Journal of Science Education and Technology, 13*(2), 147-159.

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Name	Formula	Lewis Dot Structure	3-D Drawing
A: Beryllium difluoride	BeF_2		
B: Beryllium trifluoride	BF_3		
C: Methane	CH_4		
D: Ammonia	NH_3		
E: Water	H_2O		
F: Ozone	O_3		