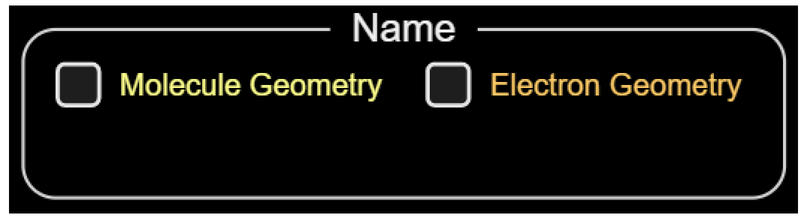
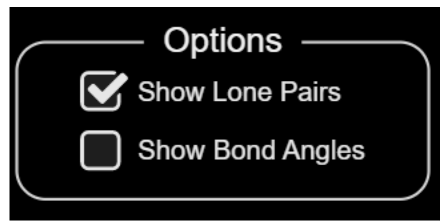
Unit 7: Bonding, Chemical Bonding

#9 Lewis Dot Structures and VSEPR Topic Inquiry

Chemist: ______________________________

Directions:

1. You will begin to explore the V.S.E.P.R. Theory by building simple molecules modeled after drawn lewis dot structures.
   a. Simulation: [Building Molecules]
2. Click on MODEL, explore the tools used in the simulation to get familiar with how to use the simulation.
3. You should see the following in the lower left corner: 

4. You should also see the following in the lower right corner: 

Inquiry Task:

1. Using the simulation, build a simple molecule with the following conditions:

Single Covalent Bonds	Lone Pairs	Molecule Geometry	Electron Geometry
1	3	Linear	Tetrahedral
2	2	Bent	Tetrahedral
3	1	Trigonal Piramidal	Tetrahedral
4	0	Tetrahedral	Tetrahedral

2. According to the identified information, in your own words, how does a molecule geometry differ from an electron geometry?

The molecule geometry only includes the bonded atoms, while the electron geometry includes the bonded atoms and the unshared pairs.

   a. In what way are they similar?

They both account for the bonding spaces around the central atom.

3. Geometry allows you to represent properties and relations between various points within a 3-Dimensional space. The Valence Shell Electron Pair Repulsion (VSEPR) Theory similarly represents molecules within a 3D space by viewing the location and orientation of what two components of a molecule?

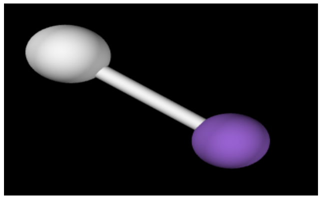
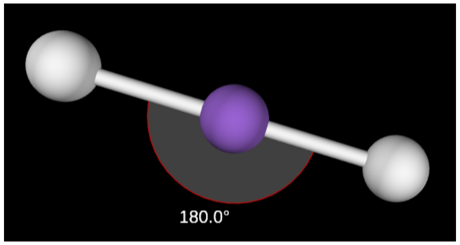
   a. Bonded Atoms
   b. Unshared Pairs

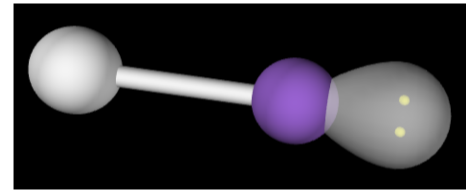
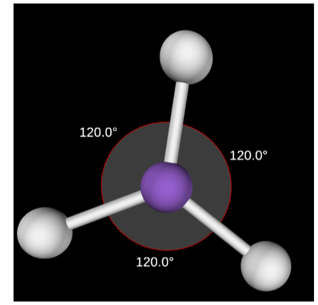
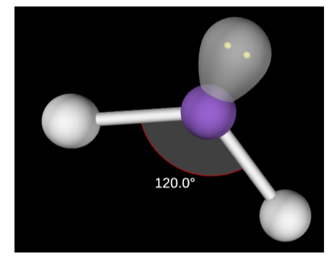
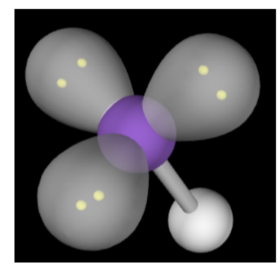
4. Why is this theory called the *Valence Shell Electron Pair Repulsion* Theory? Put this in your own words. To help answer this question, consider building a few more molecules in the MODEL simulation to determine a general reasoning behind the given name of the theory.

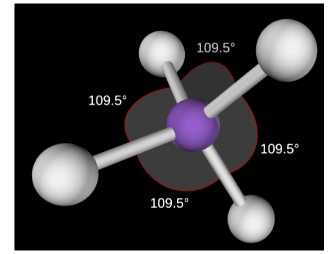
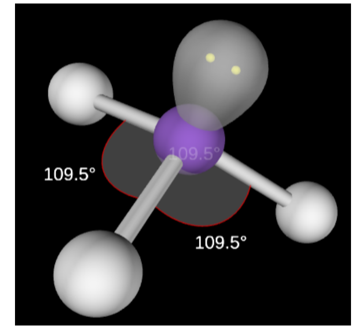
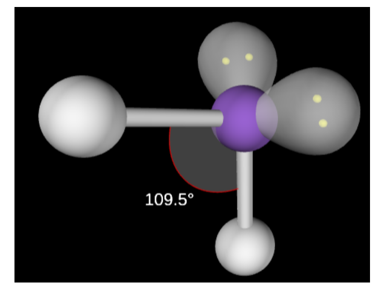
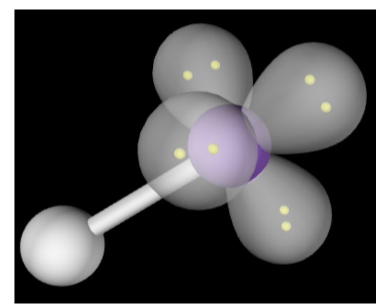
Electrons in the Valence Shell repel each other so that they are as far away from each other as possible. This gives the molecule its 3D shape.

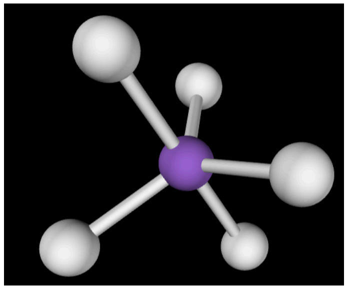
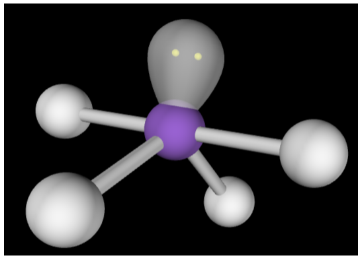
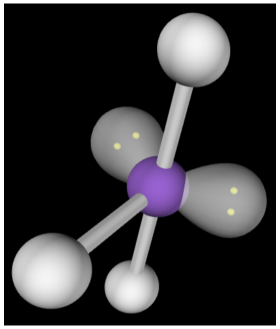
5. To better understand the possible molecular and electron geometries, you will need to complete the following table outlining all potential VSEPR Shapes. Your task is to build molecules with varying numbers of DOMAINS. A DOMAIN is a group of electrons attached to a central atom. Single bonds, double bonds and triple bonds are each considered a single domain. Lone pairs of electrons are also considered a domain under this lens of thinking according to the directions supplied. For each molecule, note its Molecular Geometry, ELECTRON GEOMETRY, and its BOND ANGLE. Also provide a screenshot of the molecule you built in the simulation. The molecule can be rotated for easier viewing. Once you've completed each section, you'll be asked to draw some additional conclusions on this subject.

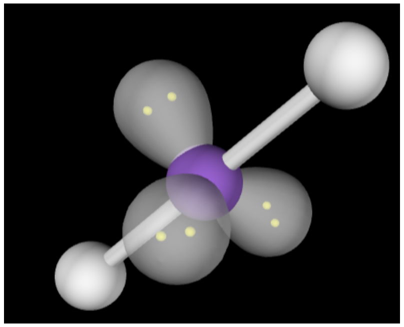
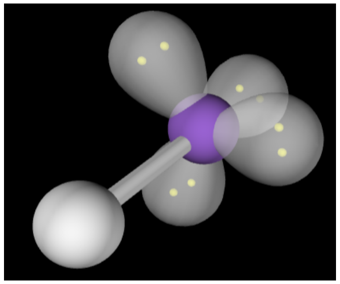
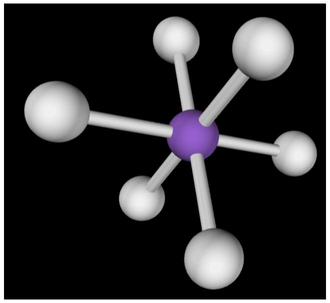
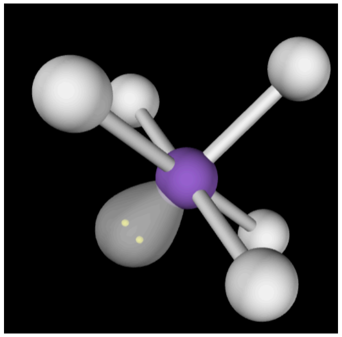
TABLE 1:

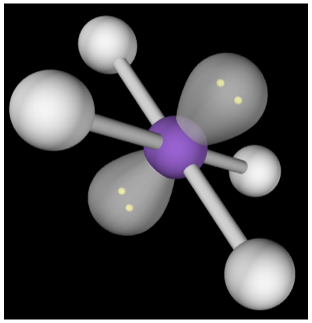
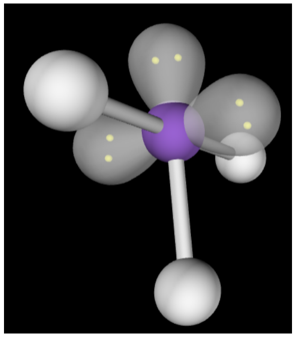
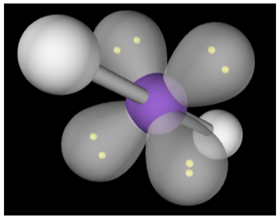
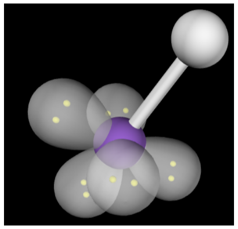
Total Domains	**Bonds on Central Atom**	**Lone Pairs on Central Atom**	**Electron Geometry**	**Molecule Geometry**	**Bond Angle**	**Screenshot of Molecule Built in Simulation**
1	1	0	Linear	Linear	---	
2	2	0	Linear	Linear	180°	

	1	1	Linear	Linear	---	
	3	0	Trigonal Planar	Trigonal Planar	120°	
3	2	1	Trigonal Planar	Bent	120°	
	1	2	Tetrahedral	Linear	---	

4	4	0	Tetrahedral	Tetrahedral	109.5°	
	3	1	Tetrahedral	Trigonal Piramidal	109.5°	
	2	2	Tetrahedral	Bent	109.5°	
	1	4	Trigonal Bipyramidal	Linear	---	

Total Domains	Bonds on Central Atom	Lone Pairs on Central Atom	Electron Geometry	Molecule Geometry	Image or Sketch
5	5	0	Trigonal Bipyramidal	Trigonal Bipyramidal	
	4	1	Trigonal Bipyramidal	See-Saw	
	3	2	Trigonal Bipyramidal	T-shaped	

	2	3	Trigonal Bipyramidal	Linear	
	1	4	Trigonal Bipyramidal	Linear	
6	6	0	Octahedral	Octahedral	
	5	1	Octahedral	Square Pyramidal	

	4	2	Octahedral	Square Planar	
	3	3	Octahedral	T-Shaped	
	2	4	Octahedral	Linear	
	1	5	Octahedral	Linear	

Real Molecules Model

Directions:

1. Click on Real Molecules.
2. Select from the dropdown menu the provided real molecule and note the electron geometry, molecule geometry, and bond angles.

Molecule	Electron Geometry	Molecule Geometry	Bond Angles
H_2O	Tetrahedral	Bent	104.5°
NH_3	Tetrahedral	Trigonal Piramidal	107.8°
CO_2	Linear	Linear	180.0°
SO_2	Trigonal Planar	Bent	119.0°
SF_4	Trigonal Bipyramidal	Seesaw	87.8°
ClF_3	Trigonal Bipyramidal	T-Shaped	87.5°
XeF_2	Trigonal Bipyramidal	Linear	180.0°
PCl_5	Trigonal Bipyramidal	Trigonal Bipyramidal	90.0°
XeF_4	Octahedral	Square Planar	90.0°
BrF_5	Octahedral	Square Pyramidal	84.8°
SF_6	Octahedral	Octahedral	90.0°

1. Which molecules and their associated bond angles differ from the VSEPR Theory predictions in TABLE 1?

2. What does this new information imply about the true nature of electron repulsions between lone pairs of electrons and bonding pairs of electrons?