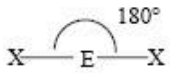
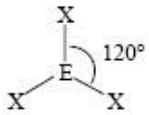
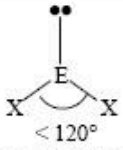
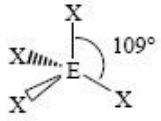
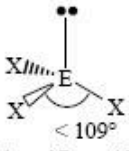
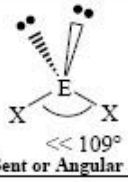
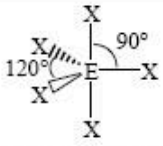
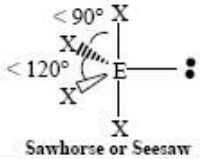
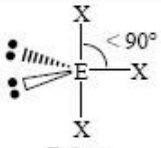
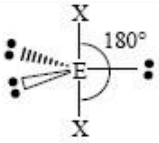
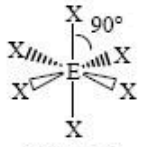
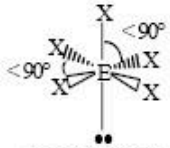
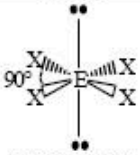
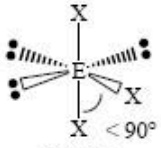
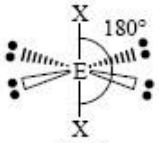
ChemTalk

Unit 9: Molecular Geometry and Bonding Theories
VSEPR Model

This worksheet covers the basics of molecular geometry and VSEPR (Valence Shell Electron Pair Repulsion) Theory. VSEPR is a model used to determine the geometry of molecules based on the number of lone electron pairs and bonds that surround a central atom. Lone pairs exist around the central atom and do not partake in bonding. Bonded pairs of electrons are found in between the central atom and another atom as the pair forms the covalent bond that satisfies each atom's octet. Lone and bonding electrons repel one another, which influences the molecular geometry to minimize these repulsive forces. Using the chart below, you can determine a molecule's geometry:

VSEPR Geometries

Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 Linear				
3	 Trigonal Planar	 Bent or Angular			
4	 Tetrahedral	 Trigonal Pyramid	 Bent or Angular		
5	 Trigonal Bipyramid	 Sawhorse or Seesaw	 T-shape	 Linear	
6	 Octahedral	 Square Pyramid	 Square Planar	 T-shape	 Linear

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Unit 9: Molecular Geometry and Bonding Theories

1. What is the effect of lone pairs on the central atom of a molecule?

2. Determine the molecular geometry of Methane (CH_4) and its bond angle.

3. In water (H_2O), how many lone pairs are on the oxygen atom? What is its molecular geometry?

4. What information is required to apply the VSEPR model to determine molecular geometry?

5. What is the molecular geometry and bond angle of Carbon Dioxide (CO_2)?

6. How is the central atom of a molecule determined?

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Unit 9: Molecular Geometry and Bonding Theories

Answer Key:

1. What is the effect of lone pairs on the central atom of a molecule?

When lone pairs are present around the central atom of a molecule, they tend to repel other electron pairs which causes the molecule to arrange itself into its most stable geometric form.

2. Determine the molecular geometry of Methane (CH_4) and its bond angle.

Methane is Carbon with four Hydrogen atoms bonded to it. This means that there are no lone pairs and that the molecular geometry is Tetrahedral and the bond angle is 109.5 degrees.

3. In water (H_2O), how many lone pairs are on the Oxygen atom? What is its molecular geometry?

The Oxygen in water has 2 pairs of lone electrons. This causes repulsion which makes the molecular geometry of Oxygen bent and its bond angle 109 degrees.

4. What information is required to apply the VSEPR model to determine molecular geometry?

The VSEPR model relies on knowledge of the number of electron densities on the central atom and the number of lone electron pairs on the central atom.

5. What is the molecular geometry and bond angle of Carbon Dioxide (CO_2)?

There are no lone electron pairs present in Carbon dioxide since all atoms have a full octet. Therefore, the molecular geometry of Carbon Dioxide is linear with a bond angle of 180 degrees.

6. How is the central atom of a molecule determined?

When looking at a molecular formula, the central atom of a molecule is generally the atom with the least electronegativity. Note: there are exceptions. For instance, when a molecule is composed of an electronegative atom and many hydrogens (CH_4, NH_3, H_2O, etc.).