

# Lab Investigation 8 - What shapes do molecules form?

Lewis dot structures help us predict covalent bonding patterns as well as locate non-bonding pairs of electrons on a molecule. Given a correct Lewis dot structure we can predict the shape of a molecule using Valence Shell Electron Pair Repulsion theory. Predicting the shape of a molecule is important for understanding how that molecule interacts with other molecules such as enzymes or antibiotics. Finally, knowing the bonding and the shape of a molecule enables us to predict polarity. Polarity is vital to understanding how molecules interact with each other.

In this laboratory exercise you will have the opportunity to use models to build molecules of all shapes and bonding. You will predict the shape of molecules using your model.

## Question 1

First, we will become familiar with the model kit by constructing the 5 basic shapes for compounds in which all electrons are involved in bonds. Construct each of the models below. A is the central atom in each case.

Formula	Model Pieces	Electron Pair Geometry
AB <sub>2</sub>	1 silver, 2 white	Linear
AB <sub>3</sub>	1 brown, 3 white	Trigonal Planar
AB <sub>4</sub>	1 black, 4 white	Tetrahedral
AB <sub>5</sub>	1 brown, 5 white	Trigonal Bipyramidal
AB <sub>6</sub>	1 silver, 6 white	Octahedral

## Question 2

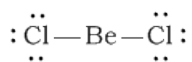
The electron pairs around a central atom will always have one of the five basic shapes you made models of in question 1. If one or more of the electron pairs is non-bonding, we describe the shape of the molecule based on the relative position of the bonding groups. This is called the **molecular shape** as opposed to the **electron pair geometry**. We will systematically look at the effect of a lone pair of electrons on each type of geometry. The letter E indicates a non-bonding pair of electrons. Construct a model for each formula; you can just use an empty bond for the lone pair. Fill in the name for the molecular shape.

Formula	Central Atom Color	Bonding Atoms	Nonbonding Electron Pairs	Electron Pair Geometry	Molecular Shape
AB <sub>2</sub>	Silver	2	0	Linear	
AB <sub>3</sub>	Brown	3	0	Trigonal Planar	
AB <sub>2</sub> E		2	1		
AB <sub>4</sub>	Black	4	0		Tetrahedral
AB <sub>3</sub> E		3	1		
AB <sub>2</sub> E <sub>2</sub>		2	2		
AB <sub>5</sub>	Brown	5	0	Trigonal Bipyramidal	
AB <sub>4</sub> E		4	1		
AB <sub>3</sub> E <sub>2</sub>		3	2		
AB <sub>2</sub> E <sub>3</sub>		2	3		
AB <sub>6</sub>	Silver	6	0	Octahedral	
AB <sub>5</sub> E		5	1		
AB <sub>4</sub> E <sub>2</sub>		4	2		

### Question 3

Use the set of molecular models to construct each of the following molecules. Identify each of the items listed.

a BeCl<sub>2</sub>



Bonding Atoms \_\_\_\_\_

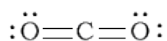
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

b CO<sub>2</sub>



Bonding Atoms \_\_\_\_\_

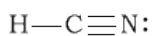
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

c HCN



Bonding Atoms \_\_\_\_\_

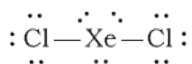
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

d XeCl<sub>2</sub>



Bonding Atoms \_\_\_\_\_

Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

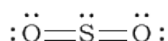
Explain the difference in polarity for HCN and CO<sub>2</sub>.

There are two types of linear molecules. How are they different?

#### Question 4

Use the set of molecular models to construct each of the following molecules. Identify each of the items listed.

a SO<sub>2</sub>



Bonding Atoms \_\_\_\_\_

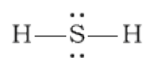
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

**b** H<sub>2</sub>S



Bonding Atoms \_\_\_\_\_

Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

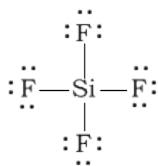
Polarity \_\_\_\_\_

There are two types of bent molecules. How are they different?

### Question 5

Use the set of molecular models to construct each of the following molecules. Identify each of the items listed.

**a** SiF<sub>4</sub>



Bonding Atoms \_\_\_\_\_

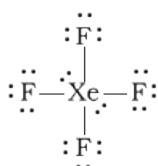
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

**b** XeF<sub>4</sub>



Bonding Atoms \_\_\_\_\_

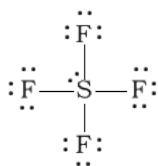
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

**c** SF<sub>4</sub>



Bonding Atoms \_\_\_\_\_

Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

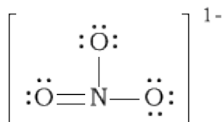
Polarity \_\_\_\_\_

Why are two molecules nonpolar and one molecule polar?

### Question 6

Use the set of molecular models to construct each of the following molecules. Identify each of the items listed.

**a**  $\text{NO}_3^{-1}$



Bonding Atoms \_\_\_\_\_

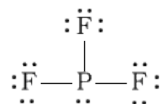
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

**b**  $\text{PF}_3$



Bonding Atoms \_\_\_\_\_

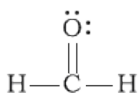
Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

**c**  $\text{CH}_2\text{O}$



Bonding Atoms \_\_\_\_\_

Non-bonding Electron Pairs \_\_\_\_\_

Electron Pair Geometry \_\_\_\_\_

Molecular Shape \_\_\_\_\_

Polarity \_\_\_\_\_

What makes trigonal pyramidal and trigonal planar molecules different?

Why are two molecules polar and one molecule nonpolar?