Determining the molecular shape, bond angles and polarity from a Lewis dot structure

A. Draw a correct **Lewis dot structure** of the molecule or ion

1. Count the total number of **valence** electrons in the molecule or ion. Any charge on an ion will either add (if a negative ion) or subtract (if a positive ion) the number on the charge to/from the total number of valence electrons.

2. Arrange the atoms in the molecule or ion in such a way that the basic **connectivity** is shown. For most simple Lewis dot structures, there is a single central atom flanked by the other atoms.

3. Start by drawing **single bonds** between the central atom and all the other atoms. Recall that a single bond counts as two electrons.

4. Continue by adding **lone pairs** as necessary to fulfill the octet rule on those atoms that follow the octet rule (for instance, hydrogen follows the duet rule, so by drawing a single bond to a hydrogen, you have already fulfilled the duet rule for that hydrogen).

5. Count the total number of valence electrons in the structure you've drawn. If this number matches the number in step 1, then you are done. If this number is greater than the number in step 1, replace a single bond with a **double bond**, and remove a lone pair from each of the atoms connected by the new double bond. Continue this replacement of single bonds by double bonds until the number of valence electrons in the structure matches the number of valence electrons found in step 1.

6. If the structure is that of an ion, put large brackets around the ion's structure, then add the charge of the ion as a superscript.

B. Determining the **molecular shape** and **bond angles**.

1. Identify the **central atom** in the Lewis dot structure.

2. Count the number of atoms that the central atom connects to.

3. Count the number of lone pairs on the central atom.

4. Use the following table (find the appropriate row) to determine the molecular shape and the bond angles:

Total number of atoms and lone pairs around the central atom	Electron pair arrangement around the central atom	Number of atoms connected to the central atom	Number of lone pairs on the central atom	Molecular shape	Bond angle of atoms connected to the central atom
4	Tetrahedral	4	0	Tetrahedral	109°
4	Tetrahedral	3	1	Pyramidal	109°
4	Tetrahedral	2	2	Bent	109°
4	Tetrahedral	1	3	linear	N/A
3	Trigonal planar	3	0	Trigonal planar	120°
3	Trigonal planar	2	1	Bent	120°
3	Trigonal planar	1	2	Linear	N/A
2	Linear	2	0	Linear	180°
2	linear	1	1	Linear	N/A

C. Determining a **molecule's polarity** and the direction of its **dipole moment.**

1. All **ions** are **polar** by definition. However, they do not have a dipole moment that is easily drawn.

2. If the molecule is **symmetric**, that is, if the molecule is either linear, trigonal planar or tetrahedral, *and* all the atoms that connect to the central atom are the same, then the molecule is non-polar. There is no dipole moment to draw.

3. If steps 1 and 2 do not apply to the molecule, then the molecule is polar. Draw the individual bond dipole moments for each bond in the molecule by looking up the **electronegativities** of each pair of bonded atoms in the molecule. A electronegativity difference of greater than 0.5 implies that a **bond dipole moment** should be drawn for that bond; draw this as an arrow along the bond, with the head of the arrow pointing towards the more electronegative atom.

4. After all the bond dipole moments are drawn, sum all of the arrows. The resultant arrow is the direction of the dipole moment for the molecule.