

Molecular Geometry Lab

In this lab you will write out Lewis structures for a number of molecules. You will classify these structures as to VSEPR type. You will then construct ball and stick models, sketch the models and show the direction of polarity, if any. A molecule has polarity if it has polar bonds and if it is non-symmetrical.

You must sketch from the models.

To build the models, pay attention to the following directions for the proper parts of the model kit to use depending on the VSEPR designation of the central atom. The holes in the plastic balls are drilled at the proper angles according to the chart below.

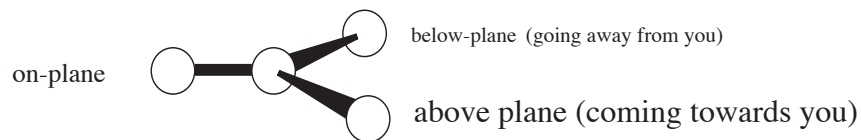
- **To use the model kit:** Use the white pegs to represent non-bonding electron pairs on central atoms. Use the shorter grey pegs for bonding pairs (remember, a double bond is considered as a single bond for VSEPR purposes). Use the following colored balls to represent central atoms with varying numbers of attached electron pairs:

Note: If you use the wrong ball, you will have to remake the model and re-draw

# of pairs (bonding + lone total)	color of ball
2	brown, polar holes
3	brown, equatorial holes
4	black, blue or yellow
5	brown, all holes
6	silver

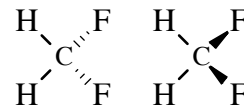
For H, F or Cl in a terminal atom position, use white or green balls. An atom with only one bond is said to be in a terminal position.

To sketch the model: Use any artistic skills at your disposal. Have the model constructed and in view. Show atoms positioned on the plane of paper, above the plane and below the plane as follows:



Notice how the bond lines are drawn. Two atoms, each on the plane, are connected with a simple line touching each atom's edge. An atom above the plane has the broad part of a line touching its edge going down to a narrow part of the line within the edge of the "lower" atom. Note the shape and positioning of the bond between the on-plane and below-plane atom.

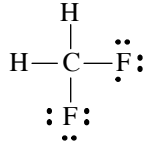
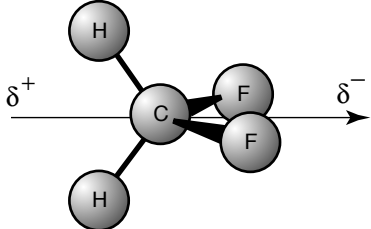
Another method of showing 3-dimensional drawings uses parallel dashes reducing in size to show an atom below the plane, and increasing in size to show an atom above the plane, or wedges going into or out of the plane:

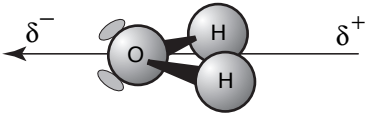


This same molecule is shown on the next page with the more elaborate sketching system mentioned at the top of this page.

One further note on sketching: if there are polar and equatorial bonds, as is the case with the AX_5 series of molecules, show the molecule with the polar bonds north and south. In the example drawn at the top of the page, an atom straight up and another straight down from the central atom would give this orientation. This usually makes the sketch easier to visualize.

To show polarity: If the molecule has polar bonds, and as a whole is non-symmetrical, then show an arrow pointing from the (+) side to the (-) side of the molecule. The convention is to use a small delta with a + or -, δ^+ or δ^- , placed on each side of the arrow. See the example on the next page.

Formula	Lewis Structure	VSEPR type	Sketch (show polarity arrow as needed)
Example: CH_2F_2		AX_4	
BeF_2			
BF_3			
CH_4			
CH_2Cl_2			

Formula	Lewis Structure	VSEPR type	Sketch (show polarity arrow as needed)
H ₂ O			<p>(note how lone pairs are shown)</p>  <p>(Polarity is in the direction of the more electronegative atom, not because of the lone pairs)</p>
H ₃ O ⁺			
NH ₃			
PCl ₅			
SF ₄			

Formula	Lewis Structure	VSEPR type	Sketch (show polarity arrow as needed)
ClF ₃			
SF ₆			
IF ₅			
XeF ₄			
CO ₂			

(Although counting double bonds as single bonds works well in predicting geometry, bond lengths are not considered. Another approach will be used for bond lengths.)

Formula	Lewis Structure	VSEPR type	Sketch
<p>(The following two molecules show resonance. Draw each resonance form under the Lewis structure column. Use the VSEPR column as well if you need more room. Will the models differ for each resonance form?)</p>			
SO ₂			
SO ₄ ²⁻			
<p>(The following two molecules have more than one central atom. Describe the VSEPR geometry around each central atom.)</p>			
CH ₃ OH			
H ₂ O ₂			

For the following molecules, use black balls for the carbon atoms. Show double and triple bonds by using 2 or 3 of the long flexible grey pegs, with two or three holes connected together. Hold one carbon in each hand and gently try to rotate the carbons in opposite directions. Because they do not rotate, the carbons and atoms bonded to them are said to be "fixed in space" relative to one another. This causes 3 isomers to be possible in $C_2H_2Cl_2$, since the positions of the H's and Cl's relative to one another are fixed in the model. Show each one. Do not classify as to VSEPR type. Show direction of polarity if any. The models accurately portray the geometry and hindered rotation of the actual molecules.

Formula	Lewis Structure	Sketch
C_2H_2		
$C_2H_2Cl_2$	1	
	2	
	3	