

Molecules and Polyatomic Ions Containing Atoms that Follow the Octet Rule

Teacher's Guide

1. The following parts are needed by each group for this lab.

ATOM CENTERS		
Qty	Element	Color/holes
4	Hydrogen	White/1
1	Carbon	Black/4
2	Chlorine	Green/4
3	Oxygen	Red/4
2	Nitrogen	Blue/4
1	Sulfur	Yellow/4

BONDS	
Qty	Type
8	single
8	double or triple
10	lone pair

2. Before doing the lab, please read the student instructions. Each student will be asked to complete the lab table and turn it in, but only one student table per group is checked by you during the lab. Staple the papers from each group together.
3. Read the instructions with students to make sure they understand the procedure. You may want to review (or teach) the following topics: Lewis structures and VSEPR shapes, and clarify the difference between CN and SN, using the demonstrations with straws shown above. Extra holes are where lone pairs of electrons are located. Additional topics are resonance, bond polarity, and molecular polarity.
4. FOR ANSWERS IN COLUMN 6, YOU WILL HAVE TO DECIDE WHAT YOU WANT THE STUDENTS TO REPORT: SN (THE COORDINATION NUMBER, PLUS THE NUMBER LONE PAIRS); OR CN (THE NUMBER OF ATOMS BONDED TO THE CENTRAL ATOM, IGNORING THE ACTUAL NUMBER OF BONDS); OR THE ACTUAL NUMBER OF BONDS.
5. The lab table, with blanks to be filled in, is supplied with the student instructions.
6. The answer key is on the next page.

Molecular Formula	Lewis Structure	Shape	Bond Angle	# of Lone pairs	# of Bonds	Resonance?	Bonds Polar?	Molecule Polar?	Model
H ₂	H:H	linear	180	0	1	No	No	No	
Cl ₂	:Cl:Cl:	linear	180	6	1	No	No	No	
H ₂ O	H:Ö:H	bent	105	2	2	No	Yes	Yes	
HCl	H:Cl:	linear	180	3	1	No	Yes	Yes	
O ₂	:Ö::Ö:	linear	180	4	1	No	No	No	
CO ₂	Ö::C::Ö	linear	180	4	2	No	Yes	No	
NH ₃	$\begin{array}{c} \text{H}:\text{N}:\text{H} \\ \\ \text{H} \end{array}$	trigonal pyramidal	107	1	3	No	Yes	Yes	
NH ₄ ⁺	$\begin{array}{c} \text{H} \\ \\ \text{H}:\text{N}:\text{H} \\ \\ \text{H} \end{array}$	tetrahedral	109.5	0	4	No	Yes	No	
O ₃	:O::Ö:O:	bent	117	6	2	Yes	No	Yes	
CH ₄	$\begin{array}{c} \text{H} \\ \\ \text{H}:\text{C}:\text{H} \\ \\ \text{H} \end{array}$	tetrahedral	109.5	0	4	No	Yes	No	
NO ₂ ¹⁻	:Ö::N::Ö:	bent	117	6	2	Yes	Yes	Yes	
NO ₃ ¹⁻	$\begin{array}{c} :\text{O}:\text{N}::\text{O}: \\ \\ :\text{O}: \end{array}$	trigonal planar	120	8	3	Yes	Yes	No	
N ₂	:N::N:	linear	180	2	1	No	No	No	
SO ₂	:Ö::S::Ö:	bent	117	6	2	Yes	Yes	Yes	

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Student Procedure

1. Your teacher will provide your group with atoms and bonds for this activity.
2. Make one copy of the lab the Master copy and have the teacher check that one sheet. Each student should fill out a sheet, but only the Master copy will be used for the final grade.
3. Use a pencil to fill in all blank boxes except the Model Checked (COLUMN 10). This is where your instructor initials that the models are correct. You will fill in the entire first horizontal row and bring the model to the instructor for verification.

Doing the lab

1. Draw the Lewis structure in COLUMN 2, and then use it to determine molecular structure. Rules for making Lewis structures will be supplied by your teacher.
2. In COLUMN 3, labeled Shape, and in COLUMN 4, labeled Bond Angles $^{\circ}$, write the shape name such as linear, bent, etc., and the angles between all atoms. The shape is determined by the position of the atoms, not the electrons.
3. The purple paddles represent lone pairs of electrons. Enter that number in COLUMN 5, #Lone pairs.
4. In COLUMN 6, SN/CN/# Bonds, your teacher will tell you how to report the appropriate answer.
5. In COLUMN 7, Resonance, insert a yes or no. Your teacher will explain the meaning of the term.
6. In COLUMN 8, Bonds, Polar/Non, write either yes or no in the blank to describe individual bonds in the molecule. Your teacher will explain the meaning of the term, polar, as it applies to a bond.
7. In COLUMN 9, Molecule Polar/Non?, write either yes or no in the blank to describe the whole molecule. Your teacher will explain the meaning of the term, polar, as it applies to a molecule.

