Unit 6: Molecular Geometry

Name: ______________________ Block: ____

Learning Targets
1. *Review: I CAN draw the Lewis Dot Structure of an atom, ionic compound and a covalent molecule, indicating valence electrons and bonds*
2. I CAN describe VSEPR theory and explain how it affects lone pairs and bonded pairs in a molecule.
3. I CAN state and model the basic shapes of a covalent molecule (both 2D and 3D) using diagrams and molecular modeling kits
4. I CAN predict the shape of a molecule based on the formula
5. I CAN state the bond angle between two given atoms in a molecule
6. I CAN classify a bond as nonpolar covalent, polar covalent, or ionic using an electronegativity chart
7. I CAN define a polar bond, explain why they form and compare its characteristics with a nonpolar bond
8. I CAN predict the polarity of a molecule based on the formula
9. I CAN define and explain polymers (formation and composition) and describe how polymers are useful in the real-world.

Chemistry Important Dates!

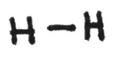
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
March 6	7	8	9	10	11	12
13	14	15 Early Dismissal	16	17	18	19
20	21	22	23	24 NO SCHOOL	25	26

Review of Bonding: Lewis Dot Structures

Draw a Lewis Dot Structure for each of the following atoms:

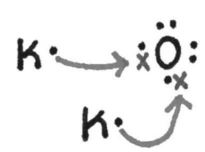
Draw a Lewis Dot Structure for the following compounds *and* name them. Identify the types of bonds (ionic or covalent) in each compound.

H_2



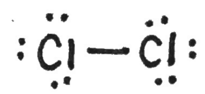
covalent
hydrogen gas

K_2O



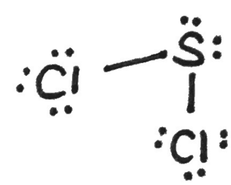
ionic
potassium oxide

Cl_2



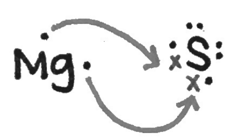
covalent
chlorine gas

SCl_2



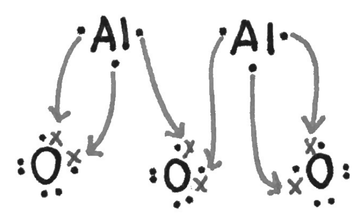
covalent
sulfur dichloride

MgS



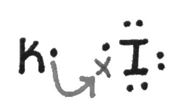
ionic
magnesium sulfide

Al_2O_3



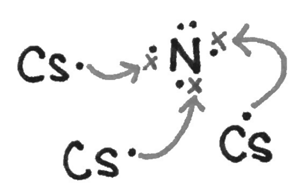
ionic
Aluminum oxide

KI



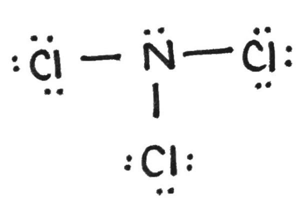
ionic
potassium iodide

Cs_3N



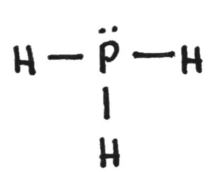
ionic
cesium nitride

NCl_3



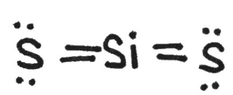
covalent
nitrogen trichloride

PH_3



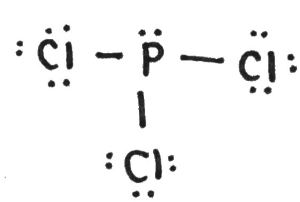
covalent
phosphorous trihydride

SiS_2



covalent
silicon disulfide

PCl_3



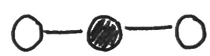
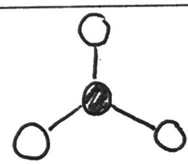
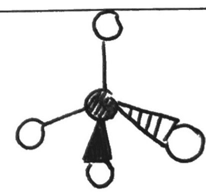
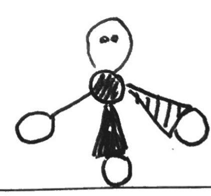
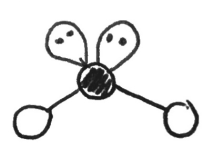
covalent
phosphorous trichloride

Molecular Shapes Simulation

Instructions:

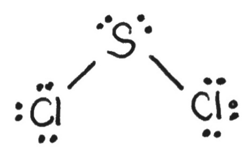
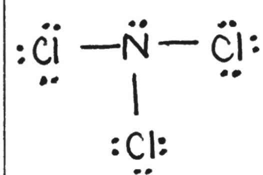
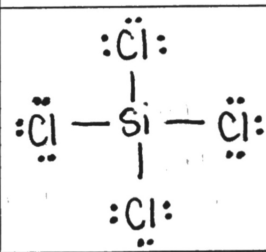
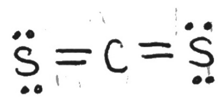
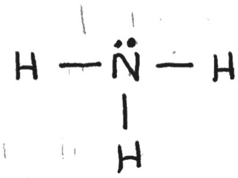
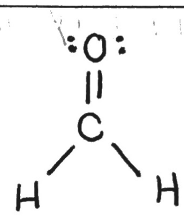
- Go to http://phet.colorado.edu and click play with simulations
- On the left-hand side, click by device and then Chromebook
- Scroll down and click Molecule Shapes, then start the simulation by pressing play
- Click Model, then click the yellow "remove all" button on the right-hand side
- Check the box for molecular geometry (bottom) and the box for show bond angles (right)

Modeling: Using the simulation, complete the chart below. Feel free to rotate the molecule by clicking and dragging it.

# of Bonds Attached to Central Atom	# of Lone Pairs on Central Atom	Molecular Geometry	Bond Angles	3-D Drawing	Examples
1	0	linear	180°		
2	0	linear	180°		CO_2
3	0	trigonal planar	120°		BF_3
4	0	tetrahedral	109.5°		CH_4
~~4~~ 3	1	trigonal pyramidal	109.5° (107.3°)		NH_3
~~4~~ 2	2	bent	109.5° (104.5°)		H_2O

Real Molecules: Click the real molecules button at the bottom of the page. Using the molecule drop down menu, go through and find real molecule examples to add to the above chart.

Molecular Shapes Practice

Formula	Name of Molecule	Lewis Dot Structures	Molecular Geometry	Bond Angle
H_2S	Hydrosulfuric Acid		bent	109.5° (104.5°)
SCl_2	sulfur dichloride		bent	109.5° (104.5°)
NCl_3	nitrogen trichloride		trigonal pyramidal	109.5° (107.3°)
$SiCl_4$	silicon tetrachloride		tetrahedral	109.5°
CS_2	carbon disulfide		linear	180°
NH_3	nitrogen trihydride		trigonal pyramidal	109.5° (107.3°)
CH_2O	* formaldehyde you DO NOT need to know this name		trigonal planar	120°

tes on Bond Polarity

Draw ALL of the examples!

Bond Polarity Practice

1. What is the difference between a polar covalent bond and a nonpolar covalent bond in terms of how they share their electrons? In a nonpolar covalent bond, the electrons are shared ~~between~~ atoms evenly (because of similar electronegativity). In a polar covalent bond, the electrons are shared unevenly.

2. What is the difference between a polar covalent bond and a nonpolar covalent bond in terms of electronegativity values?
   Nonpolar covalent bond $\Delta EN = 0.0 - 0.4$
   Polar covalent bond $\Delta EN = 0.5 - 1.6$
   Ionic Bond $\Delta EN = 1.7 - 4.0$

3. What is a partial charge called? Draw an example below.
   A partial charge is called a dipole. The fluorine is negatively charged because it has more of the e^- in the bond.
   δ^+ H — F: δ^-
   dipole

4. What is the difference between a polar covalent bond and an ionic bond?
   A polar covalent bond has partial charges, not full charges because the electrons are still shared. Ionic bonds involve the transfer of electrons completely and so there are full charges.

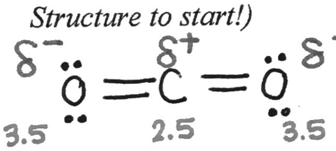
5. Describe the following bonds as nonpolar covalent, polar covalent, or ionic:
   a. CH_4 Nonpolar covalent
   b. HF Polar covalent
   c. Na_2O ionic

Notes on Molecular Polarity

Draw ALL of the examples!

Molecular Polarity Practice

1. Explain why carbon dioxide is a nonpolar molecule even though its bonds are polar. *(Hint: draw a Lewis Dot Structure to start!)*



The bonds in carbon dioxide are polar because carbon has an electronegativity of 2.5 and oxygen has a value of 3.5. This creates <u>TWO</u> dipoles that are in opposite directions due to CO_2's linear shape. This makes the molecule symmetrical and therefore, nonpolar.

2. Divide the following molecules into two categories: polar covalent bonds and nonpolar covalent bonds *(Hint: use an electronegativity chart)*

N_2 HF F_2 NO FCl

Polar Covalent Bonds	Nonpolar Covalent Bonds
HF NO FCl	N_2 F_2

3. Divide the following molecules into two categories: polar and nonpolar molecules.

N_2 HF F_2 NO FCl

Polar Molecule	Nonpolar Molecule
HF NO FCl	N_2 F_2

Molecular Polarity Simulation

Search Google for "PhET". Click on the link and search for the Polarity Lab. Open the simulation by clicking the "Run Now" Icon.

__Introduction:__ In this atomic-level simulation, you will investigate how atoms' ***electronegativity*** value affects the bonds they produce. When two nonmetals bond, a pair of more of electrons are shared between atoms. Electronegativity is a measure of a single atom's ability to pull electrons shared in a bond with another atom.

1) From what you've already learned about trends of the periodic table, what would cause an atom to have a **high electronegativity value**?

A large nuclear pull on an energy level that is close to full.

2) How do additional energy levels affect an atoms' electronegativity value?

More energy levels decrease nuclear pull and therefore decrease an atom's electronegativity.

Procedure: Two Atoms

1) Turn on (check) all view options on the right. In the surface category, click Electrostatic Potential

Create the following situations by dragging the slider above each atom changing the electronegativity values: Describe in detail the bond character, charges, dipoles, and any other characteristics of the situations following:

2) Atom A: High electronegativity, Atom B: Low electronegativity:

a) Specifically, where are the charges found in this molecule? (Electrostatic Potential– who is +? and who is -?)

Atom A: ~~pos~~ negative partial charge, negative EP
Atom B: positive partial charge, positive EP

b) Where does the dipole point to?

Atom A

c) Describe the polarity of the bond: (Polar Covalent/Nonpolar Covalent/Ionic)

Polar covalent

3) Atom A: Low electronegativity, Atom B with an average (middle position) electronegativity:

a) Specifically, where are the charges found in this molecule? (Electrostatic Potential– who is +? and who is -?)

Atom A: positive partial charge, positive EP
Atom B: negative partial charge, negative EP

b) Where does the dipole point to?

Atom B

c) Describe the polarity of the bond: (Polar Covalent/Nonpolar Covalent/Ionic)

polar covalent

4) Atom A: High electronegativity, Atom B: High electronegativity:

a) Specifically, where are the charges found in this molecule? (Electrostatic Potential– who is +? and who is -?)

There are no charges in this molecule.

b) Where does the dipole point to?

There is no dipole

c) Describe the polarity of the bond: (Polar Covalent/Nonpolar Covalent/Ionic)

Nonpolar covalent

7) Describe (in your own words) what is meant by each the dipoles, **δ-** and **δ+**.

The dipole δ^+ means that atom carries a partial charge, it holds less of the e^- in the bond.

The dipole δ^- means that atom carries a partial negative charge, it holds more of the e^- in the bond.

In the surface box to the right, switch the view to electron density: Experiment with different situations.

8) Describe the density of electrons around positively charged atoms compared to the density of electrons around negatively charged atoms.

The electron density is more around negatively charged atoms than around positively charged atoms.

9) A bond is characterized as ionic or covalent by comparing the differences between two atoms' electronegativities. Describe an ionic bond in terms of the atoms' electronegativity values. (Don't write numbers)

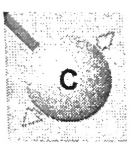
An ionic bond must have two atoms with extremely different electronegativity values, so much that the nonmetal is able to remove the metal's electron(s).

10) Describe a covalent bond in terms of the atoms' electronegativity values. (Don't write numbers)

A covalent bond must have similar (if not the same) electronegativity values, so that the atoms share their electrons.

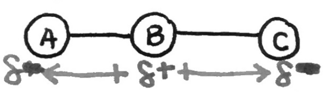
11) Additionally, we further separate covalent bonds into *polar covalent* and ***nonpolar** covalent*. What is true about the electronegativity difference for a *nonpolar covalent bond*? (Don't write numbers)

The electronegativity values for a nonpolar bond must be very similiar if not the same (0.0-0.4 difference).



Three Atoms Switch the tab at the top to three atoms: **In the view category, click on all items!** In this simulation realize that in addition to changing the electonegativities, **you may also move individual atoms by dragging them with the mouse.**

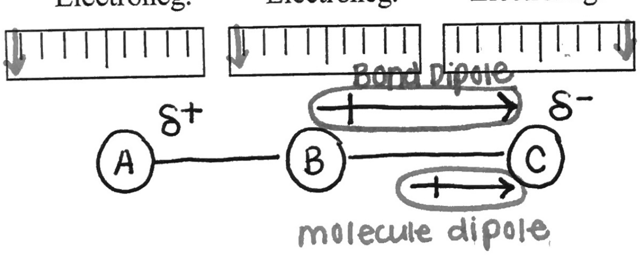
12) Describe how a molecule with strong polar bonds could have no molecular dipole at all?



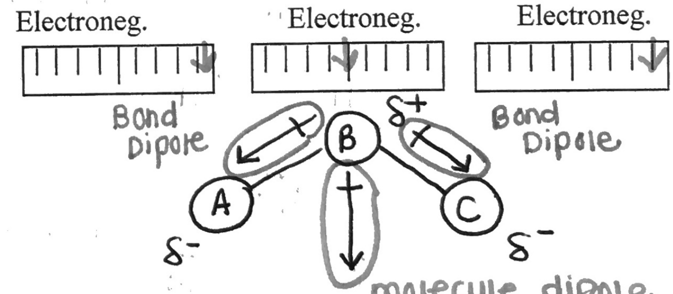
Even if an atom has strong polar bonds, if the dipoles are in opposite directions then the arrangement is symmetrical resulting in a NONPOLAR molecule.

13) Experiment with the three atoms simulation. Choose **two** situations where the atoms have different electronegativites, and different angles between each atom. Illustrate those situations below including each atom's electronegativity, draw the bond polarities (bond dipoles), and draw the molecule's polarity (molecular dipole).

Atom A Electroneg.	Atom B Electroneg.	Atom C Electroneg.



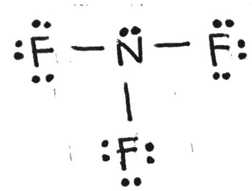
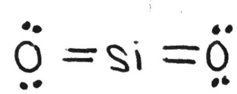
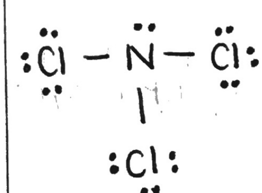
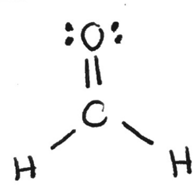
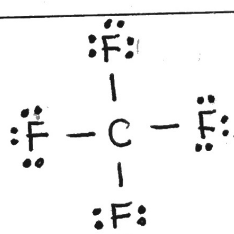
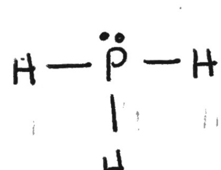
Atom A Electroneg.	Atom B Electroneg.	Atom C Electroneg.



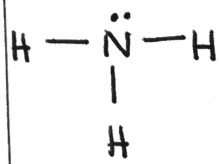
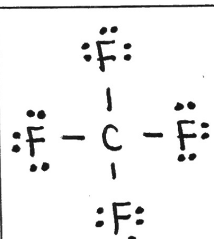
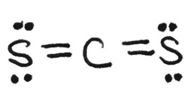
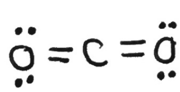
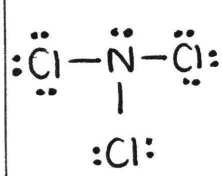
Real Molecules Switch tabs to Real Molecules: View all items and switch surface to Electrostatic Potential. ***Using the simulation***, examine each molecule and indicate **P for Polar and NP for nonpolar** in the table below: ******Notice that some molecules have been omitted and you will need to skip them!!!********

Molecule	H_2	N_2	O_2	F_2	HF	H_2O	CO_2	HCN	O_3	NH_3	CH_2O	CH_4	CH_3F	CH_2F_2	CHF_3	CF_4	$CHCl_3$
Bond Polarity (Between Atoms)	NP	NP	NP	NP	P	P	P	P	NP	P	P	P	P	P	P	P	P
Molecule Polarity (Symmetry)	NP	NP	NP	NP	P	P	NP	P	P	P	P	NP	P	P	P	NP	P

Molecular Polarity Practice

Formula	Lewis Dot Structures	Molecular Shape and Bond Angle	Bond Polarity	Molecule Polarity
NF_3		trigonal pyramidal 107.3°	polar	polar
SiO_2		linear 180°	polar	nonpolar
NCl_3		trigonal pyramidal 107.3°	nonpolar	polar
CH_2O		trigonal planar 120°	C–H nonpolar C=O polar	polar
CF_4		tetrahedral 109.5°	polar	nonpolar
H_2O		bent 104.5°	polar	polar
PH_3		trigonal pyramidal 107.3°	nonpolar	polar

Unit 6 Review: Molecular Geometry and Polymers

Compound	Lewis Dot Structure	Molecular Shape	Bond Angle	Bond Polarity	Molecular Polarity
NH_3		trigonal pyramidal	107.3°	polar	polar
SH_2		bent	104.5°	nonpolar	polar
CF_4		tetrahedral	109.5°	polar	nonpolar
CS_2		linear	180°	polar	nonpolar
CO_2		linear	180°	polar	nonpolar
NCl_3		trigonal pyramidal	107.3°	nonpolar	polar
Li_2S		technically, ionic crystal		ionic	ionic