Bonding Lab

name

We will use ball and peg models to help us see the shapes of molecules and relate that to their valence electrons. You must make ball and peg models before you draw anything. If you draw any diagrams incorrectly (bent vs. straight, guess wrong it will be obviously wrong) There are no shortcuts. You are MAKING MODELS OF MOLECULES, *then you will draw what you see*.

Molecules that are correct will NOT have any open holes, or sticks with no balls attached. Bonding is perfect,

With models in hand, determine if the molecule is polar or nonpolar. With table S, determine if each bond is polar or nonpolar. No guessing. Put your fingers in the right boxes.

Background: Ionic bonds form between metal cations and non-metal anions. These are "polar" because there is a positive (cation) side, and a negative (anion) side. Ionic bonds transfer electrons from cations to anions. Electrons are not shared by ions.

Covalent bonds form between nonmetal atoms (like CO_2 or H_2O). Covalent bonds share electrons between the atoms. The electrons can be shared evenly in a nonpolar bond, or unevenly in a polar bond. Bond polarity is measured by the difference in the electronegativity values of the two atoms. You can find these in Table S. The greater their electronegativity differences, the greater the polarity of the bond.

Covalent bonds can share one pair of electrons in a single bond or share two pairs of electrons in a double bond, or share three pairs of electrons in a triple bond. These all can be polar or nonpolar.

Molecular Polarity is different; it's based upon shape of the molecule. If the molecular shape has radial symmetry, the molecule is nonpolar (or balanced). A round pizza pie exhibits radial symmetry. If the molecule DOES NOT have radial symmetry the molecule is polar.

Radical symmetry is incorrect. Radicals want to change the world.

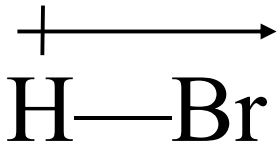
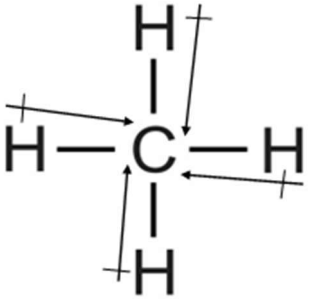
Each of the colored wooden balls are models of atoms. Since each atom has a certain number of valence electrons, and "needs" to borrow enough electrons to get a full shell, they have the "right number" of holes drilled, at the correct angles, to create proper molecules, in their proper shapes (bent, or straight lines). Double and Triple bonds require springs, no springs for single bonds.

Blue balls can be N, P, or As	Red balls can be O, S, Se, or Te	Green balls can be F, Cl, Br, or I	Yellow balls are hydrogen	Black balls can be C or Si
3 holes mean these atoms have 5 valence electrons; they need to make 3 bonds to get an octet.	2 holes mean these atoms have 6 valence electrons; they need to make 2 bonds to get an octet.	1 hole means these atoms have 7 valence electrons; they need to make 1 bond to get an octet.	1 hole means these atoms have 1 valence electron; they need to make 1 bond to get an octet.	4 holes mean these atoms have 4 valence electrons; they need to make 4 bonds to get an octet.

You can show bond polarity in structural diagrams by using a "dipole arrow". The dipole arrow does not replace the bond dash. The arrow has a positive sign "tail" (the side of the bond with lower electronegativity. The arrowhead points towards the atom that has the higher electronegativity value, towards the atom that will pull electrons "harder" in the bond, making that atom "more negative" most of the time.

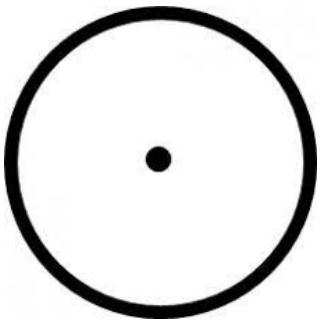
A "+" sign, on the side of the bond that "loses" an electron because of lower electronegativity.

The arrowhead points to where the electron goes most of the time, the atom with the higher electronegativity.

	Examples of dipole arrows properly placed in HBr and CH_4	

Draw 4 molecules with dipole arrows going in the right direction.	
1. CCl_4	2. CO_2
3. OF_2	4. $AsBr_3$

5. Define RADIAL SYMMETRY: Cut the "pizza" to show you understand.



6. Draw structural diagram of H_2O

Does this molecule have radial symmetry? Yes No

Based upon shape H_2O is a polar molecule.

7. Draw structural diagram of CH_4

Does this molecule have radial symmetry? Yes No

Based upon shape CH_4 is a nonpolar molecule.

<u>Memorize this</u> (to be the best you of all time)

Molecules that have radial symmetry are NON-POLAR molecules,
Molecules that do not have radial symmetry POLAR molecules (they have no balance).
Ionic bonds are technically always polar (cation/anion).
Some covalent bonds are polar; they have a difference in electronegativity values.
Some covalent bonds are nonpolar; they have no difference in electronegativity values.
Covalent bonds can be single, double or triple,
because they SHARE a single pair, or a double pair, or a triple pair of electrons.
Ionic bonds are "just" ionic – these are never single double or triple. They do not share pairs of electrons.
Ionic bonds are always polar, it is implied. There is a positive and negative side, the bond is obviously polar.

There are no shortcuts, just do the chem.

You must make a model of each compound BEFORE you draw it.
It is always obvious when you try to fake this, make the models first.

compound name	formula	DRAW the LEWIS DOT diagram	DRAW the structural diagram	Does this molecule have radial symmetry?	Is this a polar or nonpolar molecule?
	NH_3				
				Name the bonds	
	H_2O				
				Name the bonds	
	HCl				
				Name the bonds	
	NBr_3				
				Name the bonds	
ethane	C_2H_6				
				Name the bonds	

compound name	formula	DRAW the LEWIS DOT diagram	DRAW the structural diagram	Does this molecule have radial symmetry?	Is this a polar or nonpolar molecule?
	C_2H_4				
				Name the bonds	
	C_2H_2				
				Name the bonds	
	CCl_4				
				Name the bonds	
	CH_4				
				Name the bonds	
Trichloro methane (chloroform)	$CHCl_3$				
				Name the bonds	

compound name	formula	DRAW the LEWIS DOT diagram	DRAW the structural diagram	Does this molecule have radial symmetry?	Is this a polar or nonpolar molecule?
Tribromo methane	$CHBr_3$				
				Name the bonds	
Difluoro methane	CH_2F_2				
				Name the bonds	
	SCl_2				
				Name the bonds	
Chlorine mono-fluoride	ClF				
				Name the bonds	
	PCl_3				
				Name the bonds	

compound name	formula	DRAW the LEWIS DOT diagram	DRAW the structural diagram	Does this molecule have radial symmetry?	Is this a polar or nonpolar molecule?
	F_2				
				Name the bonds	
	O_2				
				Name the bonds	
	N_2				
				Name the bonds	
Hydrogen cyanide	HCN				
				Name the bonds	
	$AsCl_3$				
				Name the bonds	

compound name	formula	DRAW the LEWIS DOT diagram	DRAW the structural diagram	Does this molecule have radial symmetry?	Is this a polar or nonpolar molecule?
	AsF_3				
				Name the bonds	
	CS_2				
				Name the bonds	
	CO_2				
				Name the bonds	
	SiO_2				
				Name the bonds	
	H_2				
				Name the bonds	

compound name	formula	DRAW the LEWIS DOT diagram	DRAW the structural diagram	Does this molecule have radial symmetry?	Is this a polar or nonpolar molecule?
	HI				
				Name the bonds	
	Br_2				
				Name the bonds	

A really hard one…

Acetic Acid
CH_3COOH

See table K,
acetic acid = ethanoic acid

Acetic is the "inorganic" name. Ethanoic is the "organic" name.

There are 2 names for the exact same molecule, just different styles!

Make
CH_3COOH
with 4 yellows,
2 blacks,
2 reds,
6 pegs and 2 springs.

Draw the structural diagram first

Draw the dot diagram if you can (you can)

Part C. Recognize the bonding…

Decide which bonds are present in each compound. Some substances have more than one bond.

A. Single Polar Covalent B. Double Polar Covalent C. Coordinate Covalent
D. Single Nonpolar Covalent E. Double Nonpolar Covalent F. Triple Polar Covalent
G. Triple Nonpolar Covalent H. Resonating I. Ionic

Number of Bonds Present	Types of bonds (use letters)	Chemical Formula	Proper compound name
2	A A	H_2O	Dihydrogen monoxide
4		CH_4	
		F_2	Fluorine (or diatomic fluorine)
		PCl_3	
Does Not Apply		KCl	
Does Not Apply		Fe_2O_3	
Does Not Apply		$TiCl_4$	
		C_2H_2	From lab
		C_2H_4	From lab
		H_2S	
		AsF_3	
		CO	
		CO_2	
		HCN	
Does Not Apply		Rb_2S	
		SiO_2	

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G. Triple Nonpolar Covalent H. Resonating I. Ionic

Number of Bonds Present	Types of bonds (use letters)	Chemical Formula	Proper compound name
3	A A A	NH_3	Dihydrogen monoxide
Does Not Apply	I	MgO	
		SF_2	
Does not apply		O_3	
		CCl_4	
		I_2	
		HF	
		BF_3	
		O_2	
Does Not Apply		Li_2O	
		CS_2	
		N_2	
Does Not Apply		$AuCl_3$	
		H_2	
		NBr_3	
		CH_2F_2	From lab

Bonding Lab Rubric	Do this...	Points
Cover page	Include one sentence explaining why we did this lab. Draw three structural diagrams for H_2, O_2 and N_2	2 + 3
Lab part A	Lab Handout Questions 1– 7	7
23 molecules (boxes)	Dots, structural, radial symmetry, and molecular polarity	23
Part C	Naming compounds, determining bond types	14
Conclusion	See below. A list conclusion is fine, an essay is not expected.	26
Due on	total	75

Your long, illustrated, very wordy conclusion, = 26 points, includes…

1. What kinds of atoms form ionic bonds? Which kinds form covalent bonds?
   Write the formulas of two of each, NOT FROM this lab.

2. How is electronegativity difference used to determine bond polarity? Using 3 real molecules, compare their bonds as very polar, less polar and non-polar. Show some simple math.
   Show the electronegativity math that makes you know how to rank the polarity of these bonds.

3. Why do all the HONClBrIF twins exhibit non-polar bonds?

4. Draw small structural diagrams for all 7 of the HONClBrIF twins. H_2, O_2, etc.

5. Describe the coordinate covalent bond in $CO_{(G)}$. Draw it too using two different colors for C and O.

6. Describe the resonating bond found in O_3. Draw it two ways: show it "resonating from one structure to another" and then more properly showing both sides of the molecule with "1½" bond.

7. What is the "octet rule"? What atoms or ions adhere (nice word, what's that mean?) to it?
   Name 2 compounds that break this rule

8. Explain how to determine if molecules are polar or nonpolar.
   Draw 2 molecules that are polar, with at least one line showing how they don't have radial symmetry.
   Draw 2 molecules that are nonpolar, with at least 2 lines showing how they have radial symmetry

9. Explain why ionic bonds are not classified as single, double or triple. In your explanation NaCl, MgO, and AlP.

10. Name the 3 kinds of intermolecular bonding. Give an example for each one.

11. How do scientists describe metallic bonding poetically? Name 2 elements that exhibit these metallic bonds.

12 Draw a Lewis dot diagram for each of these: a polar molecule with polar bonds, a polar molecule with nonpolar bonds, a nonpolar molecule with polar bonds, and finally, a nonpolar molecule with nonpolar bonds.

12⅓ Draw the Lewis Dot Diagram for NaCl and MgF_2