Name: _____ Per: ____

Covalent Bonding Puzzle

Lewis Structures for Covalent Molecules

Background Information:

A **single covalent bond** is formed when two atoms share a pair of electrons. Traditionally each atom provides one of the electrons to be shared in the bond. If the two atoms are alike the bond is a **non-polar bond;** if the two atoms are different (one atom exerting a greater attraction for electrons) it is a **polar bond.** Combinations of elements can also share more than one pair of electrons which explains the existence of **double and triple covalent bonds** such as those that exist in Oxygen (O_2) and Nitrogen (N_2). Any group of atoms held together by a covalent bond is called a **molecule.**

The polarity of a compound can tell us a lot about the properties of a certain compound, so learning how to determine the polarity will be helpful. However, we must first learn how to draw the compounds in order to determine bond polarity. In addition, we can take the structural formula of the compound and determine the 3-D shape of the compound.

What is a covalent bond?

_____

_____

What is a molecule?

_____

_____

Complete the electron dot (Lewis dot) symbols for the following elements:

a)	b)	c)	d)
C	O	N	F

Circle the electrons that are shared as bonds in the following drawings:

a)	b)
H : F :	H : O : H

Circle the double and triple bonds in the following molecules:

a)	b)
:O: ‖ H—C—O—H	H—C≡C—H

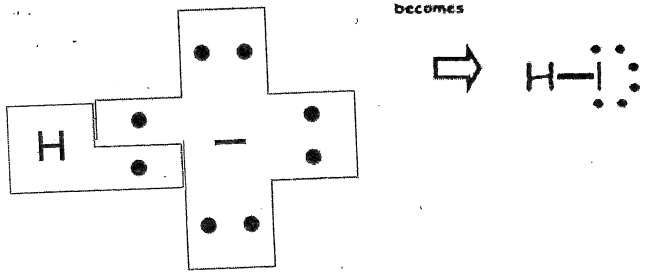
Activity questions and observations

Part A: Lewis dot structures (for molecules with single bonds)

Instructions: Working in groups, use the cut-out puzzle pieces to build, one at a time, the Lewis dot structures for the covalent molecules below. In each of these compounds only one pair of electrons is shared by any two atoms. This is called a "*single bond*". The remaining electrons are called "*nonbonding lone pairs*" or "*unpaired electrons*".

From your completed puzzle, draw what each molecule looks like by replacing each pair of shared electrons with a line (bond). Use the HF example below as a guide.

Ex: HI



NH_3	H_2O
Ammonia: a source of usable nitrogen in fertilizers and for making nylon and some pharmaceuticals.	Many molecules are usually gasses at room temperature, but the strong attraction between water molecules makes it a liquid.
CH_4	CH_2Cl_2
Also called Methane, it is the main component of natural gas (up to 95%); it burns to produce CO_2 and H_2O.	

Use your results from Part A to help answer the following questions:

1) How many bonds does C typically form? _____
2) Does this behavior make sense based on the number of valence electrons that C needs to share to obtain a full valence shell? Explain.

3) How many bonds does N typically form? _____

4) How many bonds does O typically form? _____

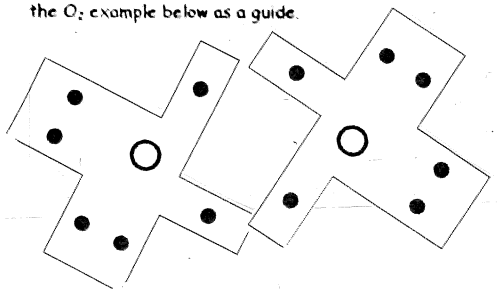
5) How many bonds does H, F, Cl and Br typically form? _____

6) Based on your answer to question 5, explain why H, F, Cl and Br are most likely to be end (terminal) atoms rather than central (bridging) atoms in a molecule.

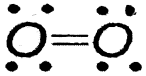
Part B: Lewis dot structures (for molecules with double and triple bonds)

Instructions: Use the puzzle pieces, one at a time, to build the Lewis dot structures for the covalent molecules below. In each of these compounds, two pairs (a "*double bond*") or even three pairs (a "*triple bond*") of electrons may be shared between any two atoms.

From your completed puzzle, draw what each molecule looks like by replacing each pair of shared electrons with a line (bond). If two atoms share four electrons, then draw two lines (double bond). Use the O_2 example below as a guide.



becomes:



HCN An almond-smelling, colorless, poisonous gas. It interferes with the transport of oxygen by the red blood cells.	N_2 Molecular nitrogen: the most abundant gas in the atmosphere accounting for over ¾ of every breath we take. It is a very stable and unreactive molecule.
CO_2	H_2CCH_2 (usually written C_2H_4) Ethylene: Not found much in nature, it is formed during the refining of crude oil in a process called "cracking". It is the starting material of most polymers.

1) If a "double bond" counts as two bonds and a "triple bond" counts as three bonds, do these compounds all follow the rules you determined in questions (1-5) of Part A? Explain.

_____

_____

_____

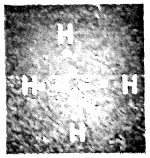
Part C: Follow these steps to draw the Lewis Dot Diagram of a Covalent Molecule:

1. Gather information
   a. Draw the Lewis structures for the elements in the compound
   b. Count the number of valence electrons (you can't end up with more or less than that!)
   c. Determine the central atom

   Example: CH_4

   *How many total valence electrons are represented between the carbon and hydrogens?

2. Arrange the atoms to show how the atoms bond in the molecule
   a. How do you know what atom is the central atom?
      i. If carbon is in the compound, it will be in the center since it has the most **bonding sites** or single electrons.
      ii. If carbon is not in the compound, the less electronegative element is the central atom
      iii. Hydrogen and halogens only have one bonding site so they are never the central atom
      iv. Match single electrons up between atoms
         1. **Lone pairs** (doubled up electrons in Lewis structures) do not participate in bonding. They will stay as a lone pair, only single electrons bond.



3. Draw the Bonds
   a. Replace each pair of dots that represents a shared pair of electrons with a dash.
   b. **How many electrons does each dash represent?** _____

4. Verify the Structure
   a. Count the number of valence electrons surrounding each atom
   b. All atoms should have 8 valence electrons except H, Be, & B
   c. # of valence e- should be the same as step 1

Draw the Lewis Structure for the Following Compounds:

PH_3	CH_3OH
CO	C_2H_2

1) Look back at the molecules you built and drew in Parts A and C of this Activity and answer the following question:
Why do both nitrogen and phosphorus form compounds with hydrogen in a 1:3 ratio (i.e. NH_3 and PH_3)? What formula would you predict for the molecule formed from arsenic (As) and hydrogen?

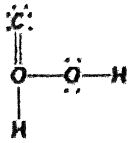
_____

_____

2) Based on your reasoning to the question above, which structure from Part A would resemble the structure for the molecule H_2S, if you were to draw it?

_____

3) List <u>two</u> things that are incorrect about the Lewis Dot structure drawn by a student for a molecule made of 2 oxygen, 1 carbon and 2 hydrogen atoms.

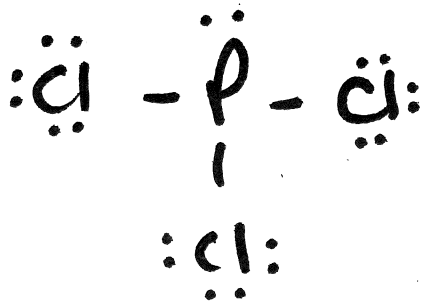


a. _____

b. _____

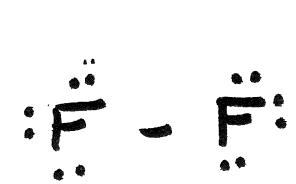
* Class Copy - DO NOT Write on this sheet

PCl_3



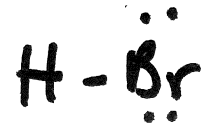
Name: phosphorus trichloride

F_2



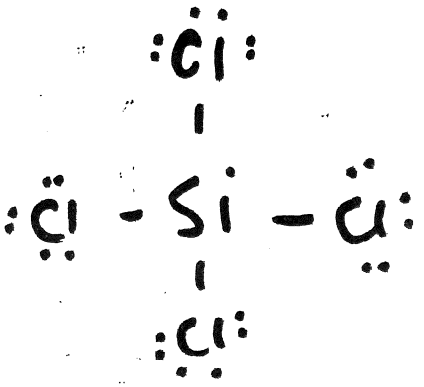
Name: fluorine

HBr



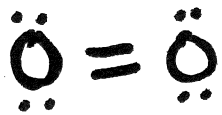
Name: hydrogen bromide

$SiCl_4$



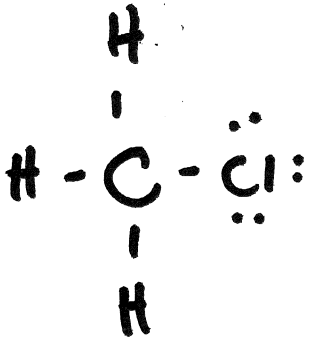
Name: silicon tetrachloride

O_2



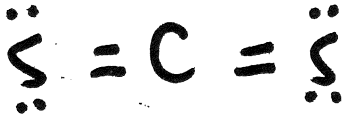
oxygen

CH_3Cl



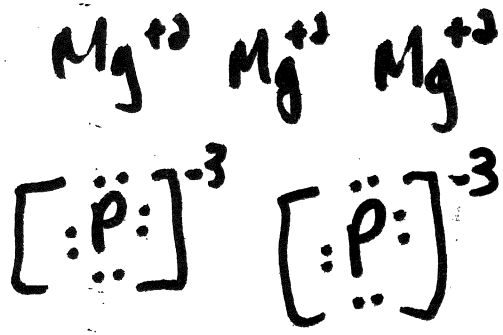
Chloromethane

CS_2



carbon disulfide

Mg_3P_2



Magnesium phosphide