Chemistry

Unit 4: Chemical Reactions

Workbook 2

Name: ________________________________ Period: ______

Workbook 4.2 Date:

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

General rule for drawing simple Lewis structures that contain H, O, N, and C.

- ___________________: H forms 1 bond, O forms 2 bonds, N forms 3 bonds, C forms 4 bonds

__________________________ are diagrams that use dots to show the valence electrons of a single atom.

Ex.

________________________ are diagrams to show how valence electrons are arranged in a molecule.

We can use Lewis dot structures to draw structural formulas. Any electrons that are shared between two nonmentals form a _________________. Any electrons that are not shared remain as dots called ___________________.

Ex.

Response:

Workbook 4.2 Date:

7 Connect the Dots

Lewis Dot Structures

Purpose

To investigate the role of electrons in covalent bonding

Materials

- Lewis dot puzzle pieces

Instructions

The puzzle pieces are called Lewis dot symbols. You can use them to pair up electrons to construct models of molecules.

Lewis dot structure for NH_3

Part 1: Create Molecules

1. Use the puzzle pieces to construct these molecules. Then draw the Lewis dot structure for each molecule, leaving off the outline of each puzzle piece.

PH_3	HOCl	F_2	CH_3Cl

2. Use the puzzle pieces to create more molecules here. Draw the Lewis dot structure of each molecule and write the molecular formula below it.
   a. Use one S atom and as many H atoms as you need
   b. Use one Si atom and as many F atoms as you need
   c. Use two O atoms and as many H atoms as you need
3. Use the puzzle pieces to construct a molecule with the molecular formula C_2H_6. Draw its Lewis dot structure and its structural formula below.

Part 2: Valence Electrons

4. Remove one card of each type of atom. Sort these puzzle pieces according to the periodic table.
5. Record your card sort by copying it into the table. Hydrogen and helium have already been done. Include the symbol for the element and the dots.

H·	He:

6. List two patterns you notice in your table.
7. Draw the Lewis dot structure for the following elements:

Ca	Br	Ge	K

Part 3: Structural formulas

8. Use the puzzle pieces to create the following compounds. See if you can figure out how to draw the structural formula for the compounds using the example:

Formula	Lewis Dot Diagram	Structural Formula
NCl_3		
CH_2Cl_2		
H_2		

Workbook 4.2 Date:

Guiding Question:	
Do Now:	
Important Definitions and Equations:	**Notes:** ________________: nonmetals combine so that each atom has a total of 8 valence electrons by sharing electrons. The only exception is hydrogen, which only needs 2 valence electrons in order to fill the first shell. • Ex. F_2 • Ex. H_2O The HONC 1234 rule and the octet rule both help you figure out Lewis structures and structural formulas. Both of these rules can be satisfied by using double and triple bonds appropriately • Ex. HCN • Ex. N_2 • Ex. CO_2
Response:	

8 Eight is Enough

Octet Rule

Purpose

To apply the octet rule to creating Lewis dot structures and structural formulas

Instructions

1. Fill in the table with the correct Lewis dot structures and structural formulas. Check your drawings against the octet rule. Include lone pairs in the structural formulas.

Molecular formula	Lewis dot structure	Structural formula
H_2		
Cl_2		
O_2		
N_2		
C_2H_4		
C_2H_2		
HCN		

PF_3		
CO_2		
CH_4O		
CH_2O		
NCl_3		

2. Explain how you can tell from the Lewis dot structure when a compound has a double or triple bond.

3. **Making Sense** Describe the process you use to determine the structure of molecules.

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

Drawing structural formulas:

1. Add up the total number of valence electrons
    a. If the compound has an overall charge, it has either lost (+) or gained (-) electrons
2. The atom with 4 (or the closest to 4) valence electrons will be the central atom
3. Attach all other atoms to the central atom with a bond (represents 2 electrons)
4. Subtract the number of electrons used in bonds from the total determined in step 1.
5. Arrange the remaining electrons to satisfy the octet of every atom.
    a. H will never get extra electrons!

Response:

9 Practice Makes Perfect
Lewis Structures

SBr_2 # of electrons: ___________	NCl_3 # of electrons: ___________	CS_2 # of electrons: ___________	NO_3^{-1} # of electrons: ___________
OF_2 # of electrons: ___________	PO_4^{3-} # of electrons: ___________	Cl_2 # of electrons: ___________	CH_2S # of electrons: ___________
PI_3 # of electrons: ___________	CCl_4 # of electrons: ___________	SiF_2Br_2 # of electrons: ___________	$CHCl_3$ # of electrons: ___________
OH^{-1} # of electrons: ___________	CO_2 # of electrons: ___________	NH_4^{+1} # of electrons: ___________	CN^{-1} # of electrons: ___________

Workbook 4.2 Date:

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

________________________________ or (____________________________ for short) states that the electrons involved in bonding, the ____________________ electrons, will repel each other in space.

This includes ____________________ and ______________ ______________ electrons.

This ____________________ causes molecules to form ___________ shapes to give as much room as possible between all electrons.

The shapes are as follows:

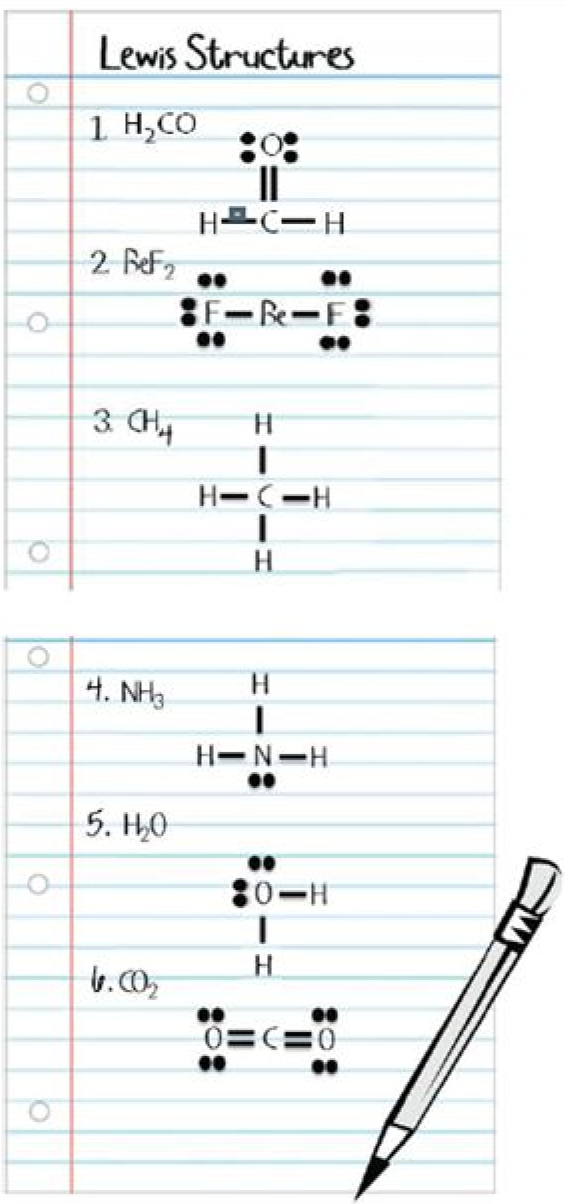
Response:

10 What does it look like?

VSEPR Theory

When you draw a Lewis structure for a molecule on paper, you are making a two-dimensional representation of the atoms. However, molecules are not flat – they are three-dimensional. The true shape of a molecule is important because it determine many physical and chemical properties for the substance. In this activity, you will learn how to predict molecular shapes.

Model 1 – Lewis Structures



Lone pair = ••

H_2CO 3 electron domains (3 bonding, 0 nonbonding)	3-D Molecular Shape
BeF_2 2 electron domains (2 bonding, 0 nonbonding)	
CH_4 4 electron domains (4 bonding, 0 nonbonding)	
NH_3 4 electron domains (3 bonding, 1 nonbonding)	
H_2O 4 electron domains (2 bonding, 2 nonbonding)	
CO_2 2 electron domains (2 bonding, 0 nonbonding)	

1. Examine the drawings in Model 1.
    a. What does a solid line between two elements represent in the drawings of the molecules?
    b. What subatomic particle (protons, neutrons, or electrons) make up these solid lines?
    c. What does a pair of dots represent in the drawings of molecules?
    d. What subatomic particle (protons, neutrons, or electrons) make up each dot?
2. Which molecules in Model 1 have four electron domains? Circle or highlight the four electron domains in the Lewis structure for each molecule that you identified.
3. Which molecules in Model 1 have two electron domains? Circle or highlight the four electron domains in the Lewis structure for each molecule that you identified.
4. Which molecules in Model 1 have three electron domains? Circle or highlight the four electron domains in the Lewis structure for each molecule that you identified.
5. When determining the number of electron domains in a Lewis structure, which of the following should you count? Find evidence from Model 1 to support your answers.
    a. Bonds on the center atom
    b. Total number of atoms in the molecule
    c. Lone pairs on the center atom
    d. Lone pairs on the peripheral atoms

Evidence

6. When determining the number of electron domains in a Lewis structure, do you count double bonds as one domain or two domains? Find evidence to support your answer from Model 1.
7. Explain the difference between a **bonding electron domain** and a **nonbonding electron domain** using the examples in Model 1.
8. Circle the correct word or phrase to complete the sentences:
    a. Pairs of electrons will (attract/repel) each other.
    b. Two bonds on the same atom will try to get as (close to/far from) each other as possible.
    c. A lone pair of electrons and a bonded pair of electrons will (push away from/move toward) each other.

Workbook 4.2 Date:

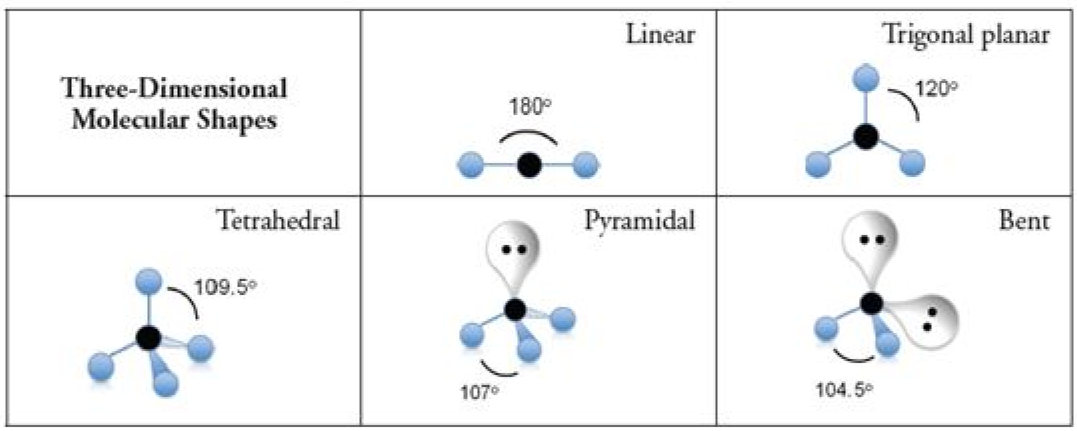
Read This!

The **VSEPR (Valence Shell Electron Pair Repulsion) Theory** helps predict the shapes of molecules and is based on the premise that electrons around a central atom repel each other. **Electron domains** are areas of high electron density such as bonds (single, double, or triple) and lone-pairs of electrons. In simple terms VSEPR means that all electron bonding domains and electron nonbonding domains around a central atom need to be positioned as far apart as possible in three-dimensional space.

9. VSEPR theory specifies "valence shell" electrons. Explain why these are the most critical electrons for determining molecular shape based on your exploration of Model 1.

10. In the VSEPR theory, what is repelling what?

11. Based on the information in the *Read This!* Section, sketch one of the molecular shapes shown below in each of the boxes provided in Model 1.



12. Often we draw Lewis structures with 90˚ bond angles. Do any of the molecular shapes in model 1 have 90˚ bond angles?

13. Are the bond angles shown in the three-dimensional molecules generally larger or smaller than those shown in the Lewis structures drawn on the notebook paper?

14. Identify the three molecules shown in Model 1 that have four electron domains each.

    a. What happens to the size of the bond angle(s) in a molecule as the number of lone pairs on the central atom increases?

15. A student does not "waste" his time drawing a Lewis structure before determine the shape of PF_3. The student thinks that PF_3 must be trigonal planar because there are three fluorine atoms bonded to the central phosphorus atom.
    a. Draw the Lewis structure of PF_3.

    b. Was the student's answer for the shape of the PF_3 molecule correct? Explain.

    c. Why is it important to draw the Lewis structure for a molecule before identifying the shape of the molecule?

16. Complete the following chart:

Molecule	Lewis Structure	3-D Drawing	Name of 3-D Shape	Bond Angle
H_2S				
PH_3				
CCl_4				
CS_2				

Guiding Question:	
Do Now:	
Important Definitions and Equations:	**Notes:** _______________ compounds contain 2 elements that are both nonmetals. · Nonmetals can combine in a variety of ways so we need to indicate how many of each nonmetal are present in a compound using prefixes (see the table on pg. 25 for prefixes) When naming use the following rules: Prefix-first element + prefix-second element-ide ending · Never use the prefix mono on the first element EX:
Response:	

11 Can We Name It?

Molecular Compounds

Purpose

To be able to use prefixes to name molecular covalent compounds

Instructions

1. Complete the following table:

Molecular formula	Number of atoms of first element	Number of atoms of second element	Name of compound
ClF			chlorine monofluoride
ClF_5	1	5	chlorine pentafluoride
CO			carbon monoxide
CO_2			carbon dioxide
Cl_2O			dichlorine monoxide
PCl_5			phosphorus pentachloride
N_2O_5			dinitrogen pentoxide

2. Examine each of the formulas above:
   a. How many different *elements* are present in each compound shown?

   b. Do the compounds combine metals and metals, metals and nonmetals, or nonmetals and nonmetals?

   c. Based on your answer to part b, why type of bonding must be involved in molecular compounds?

3. Find all the compounds that have chlorine and fluorine in them. Explain why the name "chlorine fluoride" is not sufficient to identify a specific compound.

4. Fill in the numerical value that corresponds to each prefix.

Prefix	Numerical Value
mono-	
di-	
tri-	
tetra-	
penta-	
hexa-	
hepta-	
octa-	
nona-	
deca-	

Molecular Formula	Name of Compound
BCl_3	Boron trichloride
SF_6	Sulfur hexafluoride
IF_7	Iodine heptafluoride
NI_3	Nitrogen triiodide
N_2O_4	Dinitrogen tetroxide
Cl_2O	Dichlorine monoxide
P_4O_{10}	Tetraphosphorus decoxide
B_5H_9	Pentaboron nonahydride
Br_3O_8	Tribromine octoxide
ClF	Chlorine monofluoride

5. What suffix (ending) do all the compound names have in common?
6. Carefully examine the names of the compounds above. When is a prefix NOT used in front of the name of an element?
7. Consider the compound NO.
   a. Which element, nitrogen or oxygen, would require a prefix in the molecule name? Explain your answer.
   b. Name the molecule NO.
8. Fill in the following tables:

Molecular Formula	Molecule Name
PBr_3	
SCl_4	
N_2F_2	
SO_3	
BrF	

Molecular Formula	Molecule Name
	Disulfur decafluoride
	Carbon tetrachloride
	Oxygen difluoride
	Dinitrogen trioxide
	Tetraphosphorus heptasulfide