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Name: _____ Section ___

CHEMICAL BONDING

Chapter 20

Chapter 20 – Chemical Bonding Vocabulary Words

Vocabulary Word	Definition
1. Binary Compound	
2. Chemical Bond	
3. Chemical Formula	
4. Covalent Bond	
5. Hydrate	
6. Ion	
7. Ionic Bind	
8. Molecule	
9. Non Polar Molecule	
10. Oxidation Number	
11. Polar Molecule	
12. Polyatomic Ion	

The Lewis Theory:

- **Valence electrons**, or the electrons in the outermost electron shell, have an essential role in chemical bonding.
- **Ionic bo**nds are formed between atoms when electrons are transferred from one atom to another. Ionic bond is a bond between nonmetals and metals .
- **Covalent bonds** are formed between atoms when pairs of electrons are shared between atoms. A covalent bond is between two nonmetals.
- Electrons are transferred/shared so that each atom may reach a more stable electron configuration i.e. the noble gas configuration which contains 8 valence electrons. This is called **octet rule**.

Metals & Non-Metals

Metals

Common characteristics:

- Metallic luster (shine)
- Generally solids at room temperature
- Malleable
- Ductile
- Conduct heat and electricity
- Exist as extended planes of atoms
- Combine with other metals to form alloys which have metallic characteristics
- Form positive ions, e.g. Na^{+}, Mg^{2+}, and Al^{3+}

Nonmetals

Common characteristics:

- Rarely have metallic luster (shine)
- Generally gases at room temperature
- Neither malleable nor ductile
- Poor conductors of heat and electricity
- Usually exist as molecules in their elemental form
- Combine with other nonmetals to form covalent
- Generally form negative ions, e.g. Cl^{-}, SO_4^{2-}, and N^{3-}

The differences in the characteristics of metals and nonmetals can be explained by the following:

1. Metals have relatively few electrons in their valence shells.
2. Metals have lower ionization energies than nonmetals.
3. Metals have smaller electron affinities than nonmetals.
4. Metals have larger atoms than nonmetals.

1) As you move across a **period**, metallic character decreases and nonmetallic character increases.

2) As you move down a **group**, metallic character increases and nonmetallic character decreases.

Semimetals (Metalloids)

- A class of 8 elements that have properties of both metals and nonmetals.

B Si Ge As Sb Te Po At

Common characteristics:

- Generally look metallic but are brittle (not malleable or ductile)
- Neither good conductors nor insulators; instead they are semiconductors.

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Elements and their Symbols

Directions: write the symbols for the following elements.

1. Oxygen _____
2. Hydrogen _____
3. Chlorine _____
4. Sodium _____
5. Fluorine _____
6. Carbon _____
7. Nitrogen _____
8. Helium _____
9. Copper _____
10. Sulfur _____
11. Magnesium _____
12. Manganese _____
13. Neon _____
14. Bromine _____
15. Silver _____
16. Lead _____
17. Iron _____
18. Calcium _____
19. Potassium _____
20. Gold _____
21. Xenon _____
22. Arsenic _____
23. Gallium _____
24. Chromium _____
25. Cobalt _____
26. Krypton _____
27. Vanadium _____
28. Aluminum _____
29. Mercury _____
30. Tin _____
31. Boron _____
32. Nickel _____
33. Cadmium _____
34. Beryllium _____
35. Polonium _____
36. Uranium _____
37. Cesium _____
38. Strontium _____
39. Palladium _____
40. Barium _____

Directions: Write the name of the element that corresponds to each of the following symbols.

41. Cu _____
42. K _____
43. C _____
44. Au _____
45. Zn _____
46. Pb _____
47. At _____
48. Bi _____
49. W _____
50. Y _____
51. Mo _____
52. Rh _____
53. Zr _____
54. Sb _____
55. In _____
56. Ta _____
57. Ce _____
58.Nb _____
59. I _____
60. In _____

How to Count Atoms

Worksheet

1. The **symbol** of an element represents one atom of that element.
   e.g., Ba =

2. A **subscript** is a number written at the **lower right** corner **behind the symbol** of an element. If there is more than one atom of the element, then a subscript is used to indicate the number of atoms.
   e.g., Cl_2 =

3. A **subscript outside a bracket** multiples all the elements inside the brackets.
   e.g., $Ca_3(PO_4)_2$ =

   Ca = _____
   P = _____
   O = _____

3. A **coefficient** is a number written **in front of a chemical symbol** and indicates the number of atoms of that element or number of molecules
   e.g., 3C = ____
   $2NaSO_4$ = _____ _____ _____
   A **subscript** is a number written **after an atom in a formula** and indicates the number of atoms of the kind in the molecule.
   e.g H_2SO_4 The subscript of H = 2 and the subscript of O = ____

Note: a coefficient multiples the number of atoms of each element in the formula

e.g.,
2 H_2O
_____ molecules of H_2O
_____ H (hydrogen)
_____ O (oxygen)

3 Na_2SO_4
_____ molecules of Na_2SO4
_____ Na (copper)
_____ S (sulphur)
_____ O (oxygen)

4 $Pb(NO_3)_2$
_____ molecules of $Pb(NO_3)_2$
_____ Pb (Lead)
_____ N (nitrogen)
_____ O (oxygen)

Counting Atoms

Worksheet

Count the atoms present in the different compounds by using the coefficients and subscripts.

K_2CO_3

Type of Atom	# of Atoms
_____	_____
_____	_____
_____	_____
Total	_____

$Ba_3(PO_4)_2$

Type of Atom	# of Atoms
_____	_____
_____	_____
_____	_____
Total	_____

Na_2CrO_4

Type of Atom	# of Atoms
_____	_____
_____	_____
_____	_____
Total	_____

3 $CaCl_2$

Type of Atom	# of Atoms
_____	_____
_____	_____
Total	_____

$NH_4C_2H_3O_2$

Type of Atom	# of Atoms
_____	_____
_____	_____
_____	_____
_____	_____
Total	_____

4 $Al_2(CO_3)_3$

Type of Atom	# of Atoms
_____	_____
_____	_____
_____	_____
Total	_____

$Pb(NO_3)_2$

Type of Atoms	# of Atoms
_____	_____
_____	_____
_____	_____
Total	_____

2 $(NH_4)_2Cr_2O_7$

Type of Atom	# of Atoms
_____	_____
_____	_____
_____	_____
_____	_____
Total	_____

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Number of Atoms in a Formula

Directions: Determine the number of atoms in the following chemical formulas.

1. NaCl _____
2. H_2SO_4 _____
3. KNO_3 _____
4. $CaCl_2$ _____
5. C_2H_6 _____
6. $Ba(OH)_2$ _____
7. NH_4Br _____
8. $Ca_3(PO_4)_2$ _____
9. $Al_2(SO_4)_3$ _____
10. $Mg(NO_3)_2$ _____
11. $Cu(NO_3)_2$ _____
12. $KMnO_4$ _____
13. H_2O_2 _____
14. H_3PO_4 _____
15. $(NH_4)_3PO_4$ _____
16. Fe_2O_3 _____
17. $NaC_2H_3O_2$ _____
18. $Mg(C_2H_3O_2)_2$ _____
19. Hg_2Cl_2 _____
20. K_2SO_3 _____

Hint:

Coefficients:

Coefficients apply to the entire compound. You multiply the coefficients and the subscripts.

Example: 2 H_2S

Atoms of Hydrogen = (2 X 2) = 4

Atoms of Sulfur = (2 X 1) = 2

Total Atoms equals = 6 atoms

If there isn't a subscript behind an element, there is only one atom of that element.

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Practice Counting Atoms Worksheet

Directions for each problem

1. Write down the different elements in each compound.
2. Write down how many of that particular atom there are
3. How many atoms are there total in the compound.

Examples:

A) $MgCl_2$ Mg – 1
Cl – 2
3 total

B) 5 ZnSO4 Zn – 5
S – 5
O – 20
30 total

1) NaOH _____ 2) 4 HNO_3 _____ 3) $MgCl_2$ _____

4) 4 Li_2O _____ 5) 2 NaOH _____ 6) Li_2SO_4 _____

7) 3 H_2O _____ 8) $NaC_2H_3O_2$ _____ 9) 3 Al_2O_3 _____

10) NH_4Cl _____ 11) 5 $ZnSO_4$ _____ 12) 7 C_2S_2 _____


SUPER STAR CHALLENGE!

13) 2 $Sr_3(PO_4)_2$ _____ 14) 4 $Al(OH)_3$ _____ 15) Ca $(C_2H_3O_2)_2$ _____

16) 4 $Al_2(SO_3)_3$ _____ 17) 2 $(NH_4)_3PO_4$_____ 18) 4 $Mg(OH)_2$ _____

Counting Atoms

The formula for a compound indicates the elements that make up the compound and the number of atoms of each element present in the compound. These numbers of atoms are indicated by the use of small numbers called subscripts. Sometimes groups of atoms act as a single atom. Such a group of atoms is called *a polyatomic ion.* If a polyatomic ion is used in a formula more than once, it is put in parentheses and the subscript appears outside the parentheses. When a subscript appears out side the parentheses, it indicates that *all* the elements inside the parentheses should be multiplied by that subscript. For example, the formula $Fe(OH)_3$ indicates the combination of one atom of iron, Fe. three atoms of oxygen, O, and three atoms of hydrogen, H.

In the following examples, list each element in the compound and the number of atoms of each element present. The first example has been done for you. You may already be familiar with some it the compounds.

NAME	USE	FORMULA	ATOMS IN FORMULA
Calcium carbonate	limestone	$CaCO_3$	Ca = calcium 1 C = carbon 1 O = oxygen 3
Aspirin	Pain reliever	$C_9H_8O_4$	
Magnesium hydroxide	found in milk of magnesia	$Mg(OH)_2$	
Paradichlorobenzene	Moth Crystals	$C_6H_4Cl_2$	
Acetic acid	found in vinegar	$C_2H_4O_2$	
Trinitrotoluene (TNT)	explosive	$C_7H_5(NO_2)_3$	
Calcium dihydrogen Phosphate	fertilizer	$Ca(H_2PO_4)_2$	
Pyrite	fools gold	FeS_2	

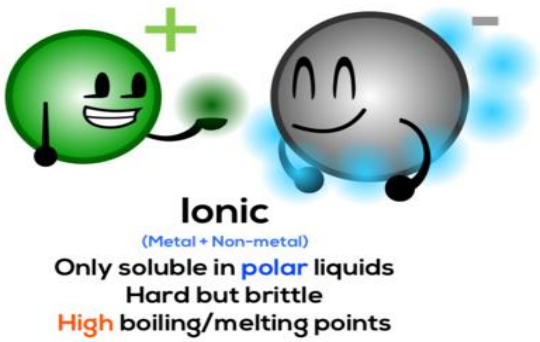
Types of Chemical Bonds

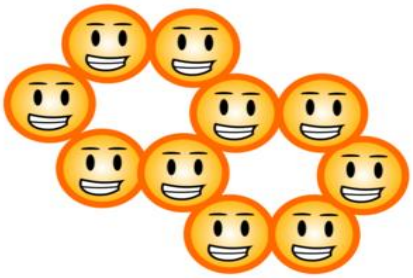
Ionic Bonds

The ionic bond is formed by the attraction between oppositely charged ions. Ionic bonds are formed between metals and nonmetals. Remember that metal atoms lose one or more valence electrons in order to achieve a stable electron arrangement. When a metal atom loses electrons it forms a positive ion or cation. When nonmetals react they gain one or more electrons to reach a stable electron arrangement. When a nonmetal atom gains one or more electrons it forms a negative ion or anion. The metal cations donate electrons to the nonmetal anions so they stick together in an ionic compound. This means that ionic bonds are formed by the complete transfer of one or more electrons.

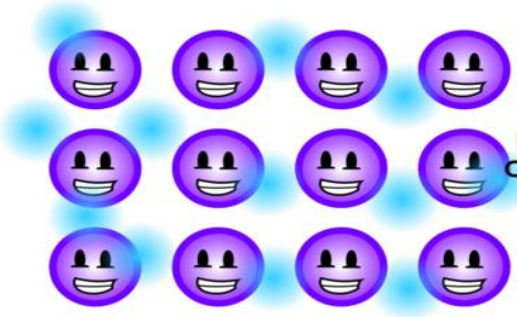
Covalent Bond

A covalent bond is formed between nonmetal atoms. The nonmetals are connected by a shared pair of valence electrons. Remember, nonmetals want to gain valence electrons to reach a stable arrangement. If there are no metal atoms around to give them electrons, nonmetal atoms share their valence electrons with other nonmetal atoms. Since the two atoms are using the same electrons they are stuck to each other in a neutral particle called a molecule. A molecule is a neutral particle of two or more atoms bonded to each other. Molecules may contain atoms of the same element such as N_2, O_2, and Cl_2 or they may contain atoms of different elements like H_2O, NH_3, or $C_6H_{12}O_6$. Therefore, covalent bonding is found in nonmetallic elements and in nonmetallic compounds. Covalent bonds are intramolecular forces; that is, they are inside the molecule and hold the atoms together to make the molecule. Covalent bonds are strong bonds and it is difficult and requires a lot of energy to break a molecule apart into its atoms. However, since molecules are neutral one molecule does not have a strong electrical attraction for another molecule. The attractions between molecules are called intermolecular forces and these are weak forces. Covalent substances have low melting points and boiling points compared to ionic compounds or metals. At room temperature, covalent substances are gases, liquids or low melting point solids. They do not conduct electricity as solids or when molten and usually do not conduct when dissolved in water.





Giant Molecular
(Non-metal + Non-metal)
Not soluble at all
Very hard and strong
Very high melting/boiling points
Insulator (except Graphite)



Metallic
(Metal + Metal)
Not soluble at all
Hard and strong
High melting/boiling points
Conduct electricity as liquids and soilds

COVALENT BONDING

Name _____

Covalent bonding occurs when two or more nonmetals share electrons, attempting to attain a stable octet of electrons at least part of the time. For example:

Show how covalent bonding occurs in each of the following pairs of atoms. Atoms may share one, two or three pairs of electrons.

1. H + H (H_2)

2. F + F (F_2)

3. O + O (O_2)

4. N + N (N_2)

5. C + O (CO_2)

6. H + O (H_2O)

Steps for drawing a covalent bond

1. Determine the number of valence electrons for each element.
2. Decide which one needs more bonds (more electrons to become full). Draw the Lewis dot structure for this element (Element #1) in the center.
3. Create a bond for each unpaired electron in Element #1 by:
   a. Drawing the Lewis dot Structure for the other element (Element #2) next to the unpaired electron
   b. Remember to include all electrons (dots) that the element had originally.
   c. Circle Element #2 if it now has a full outer shell.
4. Continue adding bonds until Element #1 has a full outer shell and circle Element #1.

Practice:

1. Hydrogen and hydrogen

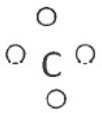
Chemical formula:_____

2. Silicon and hydrogen

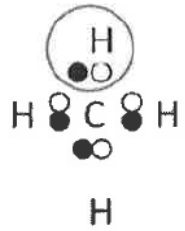
Chemical formula:_____

Example (Carbon and Hydrogen)

1. Carbon = 4 valence electrons
   Hydrogen = 1 valence electron
2. Carbon needs 4 more and hydrogen needs only 1 more.



3.



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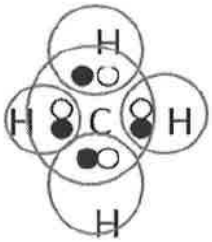


3. Carbon and Fluorine

Chemical formula:_____

4. Sulfur and Chlorine

Chemical formula:_____

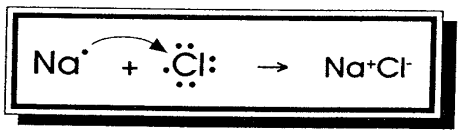
5. Bromine and Iodine

Chemical formula:_____

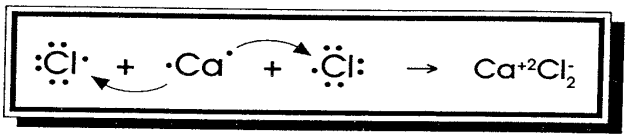
IONIC BONDING

Name _____

Ionic bonding occurs when a metal transfers one or more electrons to a nonmetal in an effort to attain a stable octet of electrons. For example, the transfer of an electron from sodium to chlorine can be depicted by a Lewis dot diagram.



Calcium would need two chlorine atoms to get rid of its two valence electrons.



Show the transfer of electrons in the following combinations.

1. K + F

2. Mg + I

3. Be + S

4. Na + O

5. Al + Br

CO

Cova
attair

Show
share

1.

2.

3.

4.

5.

6.

Chem

Chemical Bonding Worksheet

Ionic Bond	between a Metal and Non-Metal	(M + NM)
Covalent Bond	between a Non-Metal and Non-Metal	(NM + NM)
Metallic Bond	between a Metal and Metal	(M+ M)

Directions:

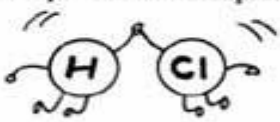
1. Determine if the elements in the following compounds are metals or non-metals
2. Describe the type of bonding that occurs in the compound.

Compound	Element 1 (Metal or non-metal?)	Element 2 (Metal or non-metal?)	Bond Type
NO_2	N = non-metal	O = non-metal	covalent
NaCl			
SO_2			
PO_4^{3-}			
$MgBr_2$			
CaO			
H_2O			
K_2O			
Cu-Zn alloy			
O_2			
$CuCl_2$			
NO_2^-			
TiO_2			
HF			
Rb_2S			
Au-Ag mixture			
Fe_2O_3			
$C_6H_{12}O_{22}$			

HANGING TOGETHER

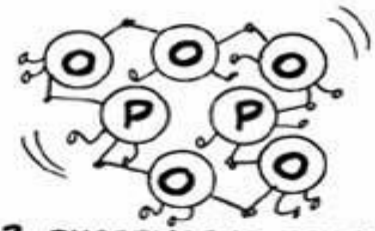
The microscope seemed like a good tool for Robo Rat to find out more about matter. He overheard Dr. Sparks talking about how matter is made up of small particles called **atoms,** which combine together to make different substances called **compounds.** When Robo looked in the microscope, he saw some atoms hanging around together in groups (called **molecules**). For any compound, a formula can be written to show what atoms combine to make the molecules of the compound.

Read the compound names below. Then try to write the formula for each molecule that Robo saw. Number 3 is done for you as an example!



1. HYDROGEN CHLORIDE

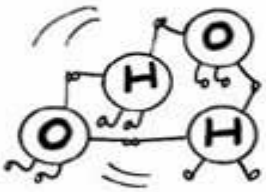
2. CARBON DIOXIDE



3. PHOSPHORUS PENTOXIDE

P_2O_5

4. WATER



5. HYDROGEN PEROXIDE

6. SILICON DIOXIDE

Symbols

Bromine	Br
Calcium	Ca
Carbon	C
Chlorine	Cl
Fluorine	F
Hydrogen	H
Lead	Pb
Nitrogen	N
Oxygen	O
Phosphorus	P
Silicon	Si
Silver	Ag
Sodium	Na

Color the molecules. Use the same color for an element every time you use it.

Use with page 27.

Bond Types

- Metallic (metal – metal)
- Ionic (metal – nonmetal)
- Covalent (nonmetal- nonmetal)

Key difference between the bonds is in the nature of the "positive/negative" attraction

Elements and Bonding Worksheet

1) Classify each of the following elements as an alkali metal, an alkaline-earth metal, transition metal, metalloid, halogen, or noble gas based on its position in the periodic table:

- boron _____
- gold _____
- krypton _____
- calcium _____

2) How many valence electrons do each of the following elements have?

- carbon _____
- selenium _____
- xenon _____
- potassium _____

3) Which of the following ions are likely to be formed?

- N^{+5} _____
- He^{+} _____
- F^{-1} _____
- Al^{+2} _____
- P^{-3} _____
- Mg^{+2} _____

4) Explain why oxygen is a fairly reactive element while neon is not.

5) Explain why beryllium loses electrons when forming ionic bonds, while sulfur gains electrons.

6) Explain why fluorine and chlorine have similar reactivities (the word "valence" should be somewhere in your answer!)

Name _____ Date _____

Identifying Ionic & Covalent Bonds

Directions:

1. ***Use your periodic table & notes to complete this assignment***
2. ***Identify the elements in each formula***
3. ***Categorize them as either "metals" or "non-metals"***
4. ***Determine the type of bond each compound has.***

Formula	Metals	Non-Metals	Type of Bond
1. HF		Hydrogen Fluorine	Covalent
2. NaCl	Sodium	Chlorine	Ionic
3. C_4H_{10}			
4. Al_2O_3			
5. CBr_4			
6. Na_2S			
7. Sr_3N_2			
8. H_2S			
9. BaF_2			
10. C_2H_6			
11. NO_2			
12. $MgCl_2$			

TYPES OF CHEMICAL BONDS

Name _____

Classify the following compounds as ionic (metal + nonmetal), covalent (nonmetal + nonmetal) or both (compound containing a polyatomic ion).

1. $CaCl_2$ _____
2. CO_2 _____
3. H_2O _____
4. $BaSO_4$ _____
5. K_2O _____
6. NaF _____
7. Na_2CO_3 _____
8. CH_4 _____
9. SO_3 _____
10. LiBr _____
11. MgO _____
12. NH_4Cl _____
13. HCl _____
14. KI _____
15. NaOH _____
16. NO_2 _____
17. $AlPO_4$ _____
18. $FeCl_3$ _____
19. P_2O_5 _____
20. N_2O_3 _____

COME TOGETHER
Chemical Bonding

Name_____

Block_____ Date _____

Introduction to Bonding

Write your own definition of a chemical bond and explain why most atoms form chemical bonds.
Use your own words!

_____

_____

_____

Bonding Comparison Chart

	IONIC	COVALENT	METALLIC
Types of Atoms Involved			
Method of Bond Formation			
Type of Structure			
Physical State			
Melting Point			
Solubility in Water			
Electrical Conductivity			
Other Properties			
Image			

Questions: Answer- in complete sentences- the following four questions on a separate sheet of paper.

1. Why do most atoms form chemical bonds?
2. How are the ionic bonds formed? The covalent bonds? The metallic bonds?
3. What are the typical properties of an ionic bond? A covalent bond? A metallic bond?
4. Identify two compounds that are the result of an ionic bond. A covalent bond. A metallic bond.

Application: Complete <u>one</u> of the following.

- **STORY** - Choose one type of bonding and write "A Day in the Life of an Atom" story describing what it's like to be an atom that forms your chosen bond type. The story should incorporate at least 5 properties from your Bonding Comparison Chart.
- **COMIC STRIP** - Choose one type of bonding and write a comic strip with 3+ frames. The comic should incorporate at least 3 properties from your Bonding Comparison Chart.
- **SINGLE-FRAME CARTOON** - Draw a single-frame cartoon for each type of bonding. Each cartoon should incorporate at least one key property from your Bonding Comparison Chart.

http://www.nisd.net/communicationsarts/pages/chem/come_together/index.html

Dot Diagrams

You have learned that atoms are composed of protons, neutrons, and electrons. The electrons occupy energy levels that surround the nucleus in the form of an "electron cloud." The electrons that are involved in forming chemical bonds are called **valence electrons**. Atoms can have up to eight valence electrons. These electrons exist in the outermost region of the electron cloud often called the "valence shell."

The most stable atoms have eight valence electrons. When an atom has eight valence electrons, it is said to have a complete octet. Atoms will gain or lose electrons in order to complete their octet. In the process of gaining or losing electrons, atoms will form chemical bonds with other atoms. The method we use to visually represent an atom's valence state is called a *dot diagram,* and you will practice drawing these in the following exercise.

What is a dot diagram?

Dot diagrams are composed of two parts—the chemical symbol for the element and dots surrounding the chemical symbol. Each dot represents one valence electron.

- If an element, such as oxygen (O), has six valence electrons, then six dots will surround the chemical symbol as shown to the right.

- Boron (B) has three valence electrons, so three dots surround the chemical symbol for boron as shown to the right.

There can be up to eight dots around a symbol, depending on the number of valence electrons the atom has. The first four dots are single, and then as more dots are added, they fill in as pairs.

PRACTICE 1

Using a periodic table, complete the following chart. With this information, draw a dot diagram for each element in the chart. Remember, only the valence electrons are represented in the diagram, not the total number of electrons.

Element	Chemical symbol	Total number of electrons	Number of valence electrons	Dot diagram
Potassium	K			
Nitrogen	N			
Carbon	C			
Beryllium	Be			
Neon	Ne			
Sulfur	S			

Dot Diagrams

9.2

READ

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The most stable atoms have eight valence electrons. When an atom has eight valence electrons, it is said to have a complete octet. Atoms will gain or lose electrons in order to complete their octet. In the process of gaining or losing electrons, atoms will form chemical bonds with other atoms. The method we use to visually represent an atom's valence state is called a *dot diagram,* and you will practice drawing these in the following exercise.

What is a dot diagram?

Dot diagrams are composed of two parts—the chemical symbol for the element and dots surrounding the chemical symbol. Each dot represents one valence electron.

- If an element, such as oxygen (O), has six valence electrons, then six dots will surround the chemical symbol as shown to the right.

- Boron (B) has three valence electrons, so three dots surround the chemical symbol for boron as shown to the right.

There can be up to eight dots around a symbol, depending on the number of valence electrons the atom has. The first four dots are single, and then as more dots are added, they fill in as pairs.

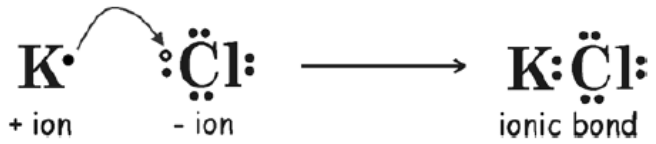
PRACTICE 1

Using a periodic table, complete the following chart. With this information, draw a dot diagram for each element in the chart. Remember, only the valence electrons are represented in the diagram, not the total number of electrons.

Element	Chemical symbol	Total number of electrons	Number of valence electrons	Dot diagram
Potassium	K			
Nitrogen	N			
Carbon	C			
Beryllium	Be			
Neon	Ne			
Sulfur	S			

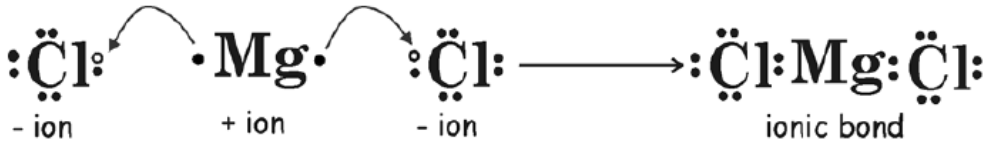
Using dot diagrams to represent chemical reactivity

Once you have a dot diagram for an element, you can predict how an atom will achieve a full valence shell. For instance, it is easy to see that chlorine has one empty space in its valence shell. It is likely that chlorine will try to gain one electron to fill this empty space rather than lose the remaining seven. However, potassium has a single dot or electron in its dot diagram. This diagram shows how much easier it is to lose this lone electron than to find seven to fill the seven empty spaces. When the potassium loses its electron, it becomes *positively* charged. When chlorine gains the electron, it becomes *negatively* charged. Opposite charges attract, and this attraction draws the atoms together to form what is termed an **ionic bond**, a bond between two charged atoms or ions.



Because chlorine needs one electron, and potassium needs to lose one electron, these two elements can achieve a complete set of eight valence electrons by forming a chemical bond. We can use dot diagrams to represent the chemical bond between chlorine and potassium as shown above.

For magnesium and chlorine, however, the situation is a bit different. By examining the electron or Lewis dot diagrams for these atoms, we see why magnesium requires two atoms of chlorine to produce the compound, magnesium chloride, when these two elements chemically combine.



Magnesium can easily donate one of its valence electrons to the chlorine to fill chlorine's valence shell, but this still leaves magnesium unstable; it still has one lone electron in its valence shell. However, if it donates that electron to another chlorine atom, the second chlorine atom has a full shell, and now so does the magnesium.

The chemical formula for potassium chloride is KCl. This means that one unit of the compound is made of one potassium atom and one chlorine atom.

The formula for magnesium chloride is $MgCl_2$. This means that a one unit of the compound is made of one magnesium atom and two chlorine atoms.

PRACTICE 2

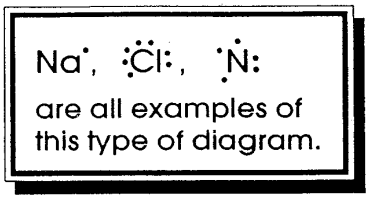
Now try using dot diagrams to predict chemical formulas. Fill in the table below:

Elements	Dot diagram for each element	Dot diagram for compound formed	Chemical formula
Na and F			
Br and Br			
Mg and O			

LEWIS DOT DIAGRAMS

Name _____ A1

Lewis diagrams are a way to indicate the number of valence electrons around an atom.



Draw Lewis dot diagrams of the following atoms.

1. calcium
2. potassium
3. argon
4. aluminum
5. bromine
6. carbon
7. helium
8. oxygen
9. phosphorus
10. hydrogen

DOT DIAGRAM WORKSHEET

Using a periodic table or electron configuration, place dots around the following element symbols to represent the number of electrons in the outer shell.

1.	Li	11.	Ar
2.	C	12.	K
3.	O	13.	C
4.	F	14.	Ti
5.	Ne	15.	Ni
6.	Na	16.	As
7.	Al	17.	Br
8.	P	18.	Kr
9.	S	19.	Rb
10.	Cl	20.	Sr

Rules for Drawing Lewis Dot Diagrams of Covalent Compounds:

1. Calculate the number of valence electrons for each atom and the total for the molecule or ion. For ions, add or subtract electrons as necessary to obtain the correct charge.
2. Write the skeletal structure; place correct number of electrons around each atom.
3. Replace pairs of electrons with a bond
4. Make certain each atom has a complete octet. Use multiple bonds if necessary to complete octet. Double check total number of electrons.

Additional Hints:

H is always an end (terminal) atom. It has one electron and thus is only able to bond covalently with one other atom.

Halogens and Oxygen are often terminal atoms.

In binary compounds, the central atom has the lowest subscript and is usually listed first.

Carbon has four bonds in most compounds.

Formula	CH_4	NH_3	H_2O	SO_3	SO_2	CO_2
Lewis Diagram						

Practice Problems

2. Draw the Lewis dot structures for each of the following molecules:

a. **H_2S**

c. **SO_3**

b. **CH_2Br_2**

d. **HCN**

3. Draw the Lewis dot structure for each of the following polyatomic ions:

a. **NH_4^+**

c. **PO_4^{-3}**

b. **NO_3^-**

d. **CO_3^{2-}**

4. For the following molecules or ions (where the central atom is underlined):
   i. Draw the Electron dot structure.
   ii. Determine the shape of the molecule.
   iii. Determine the approximate bond angles.

a. CH_2F_2

b. OF_2

Nomenclature - (Naming Compounds)

Section A: Binary Compounds

Metals and Non-Metals

- Name the 1st Element
- Change the root of the 2nd element with **–ide** ending

Name the Following Binary Compounds:

1. NaF _____
2. K_2O _____
3. LiBr _____
4. $CaCl_2$ _____
5. BaS _____
6. BaF_2 _____
7. Na_2S _____
8. MgI_2 _____
9. K_3N _____
10. BeSe _____
11. CO _____
12. SO_2 _____
13. N_2O _____

Write Formulas for the following

14. Aluminum chloride _____
15. Lithium sulfide _____
16. Calcium phosphide _____
17. Barium fluoride _____
18. Potassium oxide _____
19. Sodium bromide _____
20. Barium nitride _____
21. Lithium oxide _____
22. Aluminum oxide _____
23. Rubidium iodide _____
24. Carbon dioxide _____
25. Nitrogen dioxide _____
26. Sulfur trioxide _____

Formulas and Nomenclature Binary Molecular Worksheet

Name the following compounds.

1. N_2O_4
2. N_2O
3. P_2O_5
4. Cl_2O_7
5. CO_2
6. OF_2

Write formulas.

1. phosphorus pentachloride
2. carbon monoxide
3. carbon tetrachloride
4. nitrogen trifluoride
5. sulfur hexafluoride
6. dinitrogen trioxide

Formulas and Nomenclature Binary Ionic Compounds Worksheet

Name the following compounds.

1. KCl
2. Li_2O
3. $CaBr_2$
4. LiH
5. $MgBr_2$
6. K_2O
7. ZnO
8. SrS
9. CaS
10. Ag_2S
11. ZnF_2
12. Ag_3N
13. NaF
14. BaO
15. Na_2S
16. $AlBr_3$
17. Li_3N
18. KF
19. SrI_2
20. MgO
21. Al_2O_3
22. CaH_2

Write formulas.

1. sodium bromide
2. calcium oxide
3. silver chloride
4. silver oxide
5. aluminum nitride
6. zinc iodide
7. magnesium nitride
8. calcium hydride
9. potassium phosphide
10. calcium fluoride
11. sodium nitride
12. magnesium chloride
13. calcium chloride
14. potassium iodide
15. aluminum chloride
16. barium chloride
17. sodium chloride
18. silver bromide
19. magnesium hydride
20. zinc chloride
21. zinc sulfide

Name_____ Date_____ Period _____

Naming Binary Covalent Compounds

COVALENT MOLECULAR COMPOUNDS- COMPOSED OF NONMETALS ONLY.

1. Name of the "more metallic" element is written first. Since both are nonmetals, choose the element closest to the bottom or left of the periodic table.
2. The ending of the second nonmetal is changed to -ide.
3. Prefixes are added to indicate the number of atoms present. Mono is not used on the first element just write the name if there is only one.

1	MONO	2	DI	3	TRI		
4	TETRA	5	PENTA	6	HEXA		
7	HEPTA	8	OCTA	9	NONA	10	DECA

EXAMPLES;

CO is **carbon monoxide** CO_2 is **carbon dioxide**

SF_6 is **sulfur hexafluoride** P_2O_3 is **diphosphorus trioxide**

1. **CO** _____
2. **CO_2** _____
3. **H_2O** _____
4. **NH_3** _____
5. **CH_4** _____
6. **NO** _____
7. **N_2O** _____
8. **N_2O_5** _____
9. **N_2O_3** _____
10. **PCl_3** _____
11. **PF_5** _____
12. **P_2O_5** _____
13. **SO_2** _____
14. **S_2O_7** _____
15. **$SiCl_4$** _____
16. **B_4C** _____
17. **BN** _____
18. **CS_2** _____
19. **SeF_6** _____
20. **H_2O_2** _____
21. **Cl_2O** _____
22. **N_2O_4** _____
23. **NI_3** _____
24. **$AsCl_3$** _____
25. **CCl_4** _____
26. **SeF_2** _____
27. **SiO_2** _____
28. **H_2S** _____
29. **SF_4** _____
30. **SO_3** _____
31. **XeF_4** _____
32. **TeF_6** _____
33. **BBr_3** _____
34. **XeF_2** _____
35. **Se_2Cl_2** _____
36. **N_2** _____
37. **ClF_5** _____
38. **BrF_3** _____
39. **SCl_2** _____
40. **S_2F_{10}** _____

Section B: Transition Compounds

Transition Metals and Non-Metals

1- Name the Transition Metal with a Roman Numeral
2- Change the root of the 2nd Non-Metal with **–ide** ending

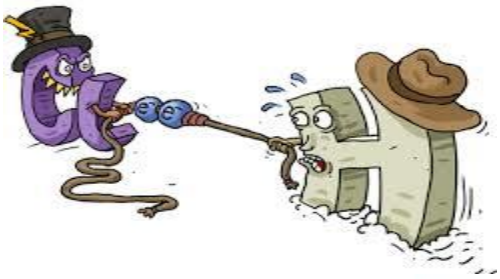
Name the Following Binary Compounds:

1. $CuCl$ _____
2. $CuCl_2$ _____
3. FeO _____
4. MnS _____
5. Cr_2O_3 _____
6. NiF_2 _____
7. $SnCl_4$ _____
8. Ag_3P _____
9. ZnS _____
10. Hg_2Cl_2 _____

Write Formulas for the following

11. Mercury (II) sulfide _____
12. Copper (I) nitride _____
13. Iron (III) bromide _____
14. Mercury (I) oxide _____
15. Silver fluoride _____
16. Copper (II) oxide _____
17. Chromium (III) iodide _____
18. Nickel (II) bromide _____
19. Tin (IV) sulfide _____
20. Zinc oxide _____

Polar Covalent Bond



Non-Polar Covalent Bond

Representative Ions Only

1. LiF Lithium Fluoride
2. $LiCl$ _____ _____
3. Li_2O _____ _____
4. Li_2S _____ _____
5. Li_3N _____ _____
6. $BeCl_2$ _____ _____
7. $BeBr_2$ _____ _____
8. BeI_2 _____ _____
9. BeO _____ _____
10. Be_3P_2 _____ _____
11. BF_3 _____ _____
12. BCl_3 _____ _____
13. BBr_3 _____ _____
14. Na_2O _____ _____
15. Na_2S _____ _____
16. Na_3N _____ _____
17. Na_3P _____ _____
18. KF _____ _____
19. K_2S _____ _____
20. Ca_3N_2 _____ _____

Mix of Representative Ions & Polyatomic Ions

21. NH_4OH Ammonium Hydroxide
22. $NH_4C_2H_3O_2$ _____ _____
23. NH_4NO_3 _____ _____
24. $(NH_4)_2CO_3$ _____ _____
25. $(NH_4)_3PO_4$ _____ _____
26. $LiOH$ Lithium Hydroxide
27. $LiC_2H_3O_2$ _____ _____
28. Li_2CO_3 _____ _____
29. Li_2SO_4 _____ _____
30. Li_3PO_4 _____ _____
31. $Be(OH)_2$ _____ _____
32. $Be(ClO_3)_2$ _____ _____
33. $Be(NO_3)_2$ _____ _____
34. $Be(C_2H_3O_2)_2$ _____ _____
35. $BeSO_4$ _____ _____
36. $Be_3(PO_4)_2$ _____ _____
37. $B(OH)_3$ _____ _____
38. $B(C_2H_3O_2)_3$ _____ _____
39. $B_2(SO_4)_3$ _____ _____
40. BPO_4 _____ _____

Section C: Non-Metal & Non-Metal Compounds

1. Non-Metals and Non-Metals
2. Name the 1st element (with prefix if more than one atom)
3. Change the root of the 2nd Non-Metal with **–ide** ending

Prefixes			
1. – (Mono)	2. (Di)	3. (Tri)	4. (Terta)

Name the Following Binary Compounds:

1- SO_3 _____
2- $AsCl_3$ _____
3- N_2O_3 _____
4- P_2O_5 _____
5- $GeCl_4$ _____
6- XeF_6 _____
7- SF_4 _____
8- NO_3 _____
9- SiO2 _____
10- CO _____

Write Formulas for the following

11. Sulfur dioxide _____
12. Phosphorus trichloride _____
13. Nitrogen monoxide _____
14. Carbon tertafluoride _____
15. Dinitorgen pentoxide _____
16. Sulfur trioxide _____
17. Carbon monoxide _____
18. Phosphorus pentachloride _____
19. Arsenic tribromide _____
20. Nirtogen triiodide _____

Section D: Compounds with Polyatomic Ions

Non-Metals and Non-Metals
Name the 2 parts (ion names)

Name the Following Binary Compounds:

1- BaSO4 _____
2- $(NH_4)_2CO_3$ _____
3- Li_2SO_3 _____
4- $CrPO_4$ _____
5- $NaC_2H_3O_2$ _____
6- BaOH _____
7- $Fe(NO_3)_3$ _____
8- KCN _____
9- $SrCrO_4$ _____
10- $CaCrO_7$ _____
11- $Al(OH)_3$ _____
12- $BaCO_3$ _____
13- K_2SO_4 _____
14- ZNF_2 _____
15- $Ca_3(PO_4)_2$ _____
16- Ag_2S _____
17- Na_3N _____
18- $ZNBr_2$ _____
19- $Fe(NO_3)_3$ _____
20- H_2SO_4 _____
21- Cu_2S _____
22- KBr _____
23- Fe_2O_3 _____
24- $Cu(OH)_2$ _____
25- $NiBr_2$ _____
26- $MgSO_4$ _____
27- NH_4Cl _____
28- FeO _____
29- FeI_3 _____
30- $Ba(ClO_3)_2$ _____

Write Formulas for the following

31. Aluminum sulfate _____
32. Zinc nitrite _____
33. Magnesium chlorate _____
34. Sodium bicarbonate _____
35. Calcium hydroxide _____
36. Copper (II) carbonate _____
37. Ammonium sulfide _____
38. Iron (III) acetate _____
39. Lithium bisulfate _____
40. Strontium phosphate _____
41. Ammonium nitrate _____
42. Iron (II) chlorate _____
43. Sodium carbonate _____
44. Copper (II) chloride _____
45. Silver phosphate _____
46. Barium acetate _____
47. Lithium hydroxide _____
48. Zinc hydroxide _____
49. Iron (II) iodide _____
50. Potassium carbonate _____
51. Silver nitrate _____
52. Copper(II) oxide _____
53. Aluminum hydroxide _____
54. Calcium sulfide _____
55. Ammonium carbonate _____
56. Sodium acetate _____
57. Silver hydroxide _____
58. Iron(III) bromide _____
59. Copper (I) nitrate _____
60. Lithium Fluoride _____

Name:_____ Date: _____Period:_____

Naming WS #3: Ionic Compounds with Transition Metals

Part A Write the formula for each ionic compound.

	Name	Formula
1.	Tin (II) Hydroxide	
2.	Iron (III) oxalate	
3.	Colbalt (II) bromide	
4.	Chromium (III) Chloride	
5.	Iron (II) Oxide	
6.	Mercury (II) Chloride	
7.	Tin (IV) Sulfide	
8.	Silver (I) Phosphide	
9.	Lead (IV) Iodide	

Part B Write the Name for each formula Be sure to include the roman numeral.

	Formula	Name
1.	$Fe(NO_3)_3$	
2.	$Mn(OH)_2$	
3.	$Ti(NO_3)_4$	
4.	PbS_2	
5.	$CuCl$	
6.	$PbSO_4$	
7.	$ZnCl_2$	
8.	Hg_2O	
9.	Cr_2O_3	

Part C: Fill in the following table. Polyatomic ions and transition metals are mixed up.

	Ionic Formula	Ionic Compound Name	Balanced Ion Pairs
1.		Sodium Chromate	
2.	$CuCl$		
3.		Sodium Nitrate	
4.	$ZnSO_4$		
5.		Potassium cyanide	
6.	Al_2O_3		
7.		Copper(II) nitrate	
8.	$FePO_4$		
9.		Lead(II) sulfide	
10.	$NaClO$		
11.		Sodium Carbonate	
12.	Na_2SeO_4		
13.		Ammonium Bromate	
14.	$Au(ClO_4)_3$		
15.		Iron(III) Sulfate	

Naming Ionic Compounds Practice Worksheet

Name the following ionic compounds:

1) NH_4Cl _____

2) $Fe(NO_3)_3$ _____

3) $TiBr_3$ _____

4) Cu_3P _____

5) $SnSe_2$ _____

6) GaAs _____

7) $Pb(SO_4)_2$ _____

8) $Be(HCO_3)_2$ _____

9) $Mn_2(SO_3)_3$ _____

10) $Al(CN)_3$ _____

Write the formulas for the following compounds:

11) chromium (VI) phosphate _____

12) vanadium (IV) carbonate _____

13) tin (II) nitrite _____

14) cobalt (III) oxide _____

15) titanium (II) acetate _____

16) vanadium (V) sulfide _____

17) chromium (III) hydroxide _____

18) lithium iodide_____

19) lead (II) nitride _____

20 silver bromide _____

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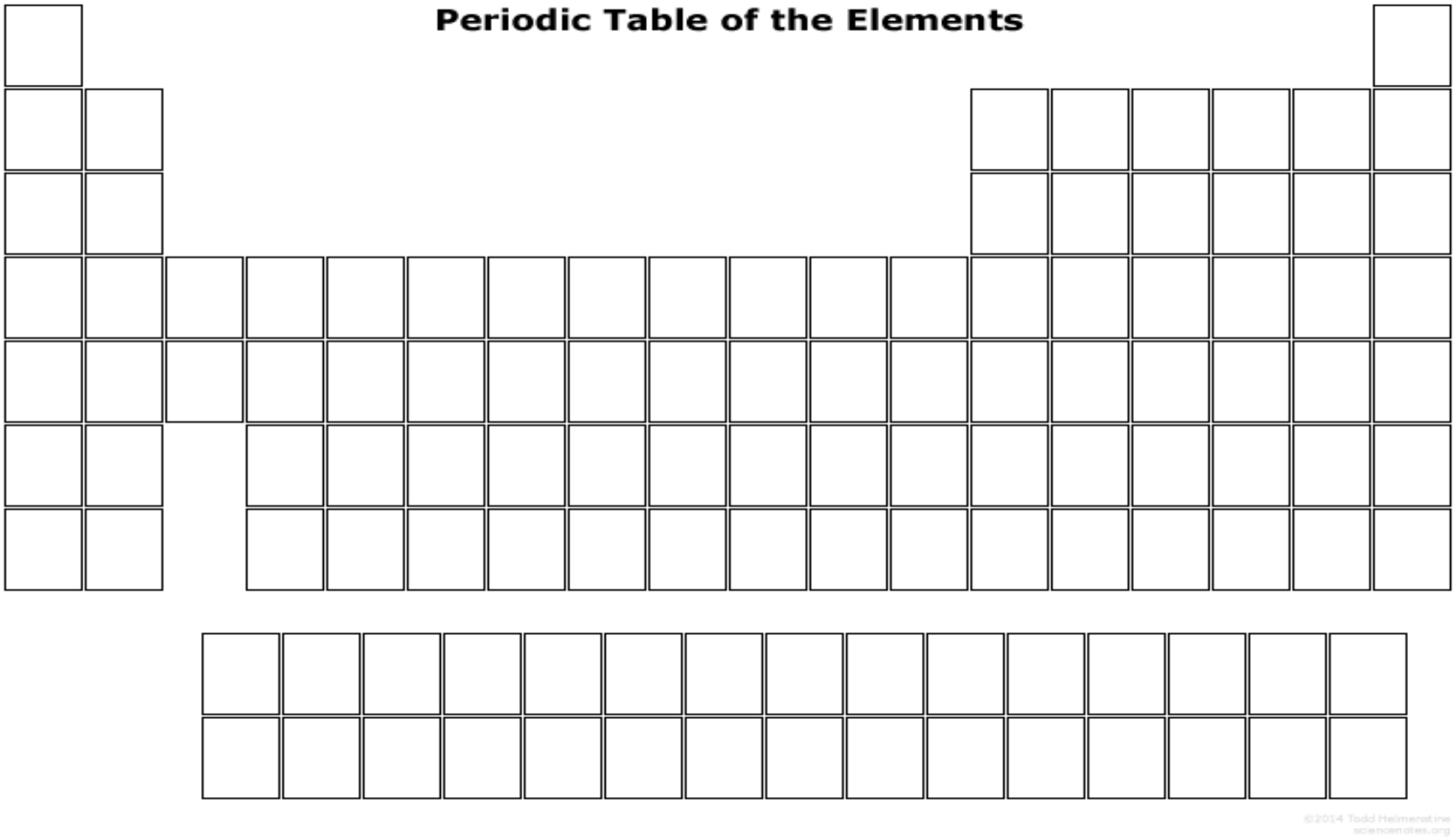
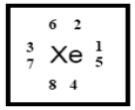
Color the elements on the Periodic Table



Lewis Dot Structures Name Period Date

Lewis dot structures are a simplified way to show how valence electrons are arranged in the outer shell of an element. This is where chemical bonding takes place. Atoms of elements can either *share* or *give up* electrons in order to obtain a full outer shell of 8 electrons or, in the case of hydrogen or helium, a full outer shell of 2 electrons. Lewis dot structures are created by the element symbol of the atom which is surrounded by dots which represent the appropriate number of valence electrons of that atom. Fill in the modified periodic table below, which shows Groups 1A through 8A (not the transition metals), with the appropriate Lewis dot structure. Use the following pattern below by starting with position number 1.



Examples:

1A							8A
H	2A	3A	4A	5A	6A	7A	He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Ga	Ge	As	Se	Br	Kr
Rb	Sr	In	Sn	Sb	Te	I	Xe
Cs	Ba	Tl	Pb	Bi	Po	At	Rn

_____(element name)_____ USES:

This page should include introductory information. With the elements name stated above.

- Include a title for this page called "**(element name)** Uses."
- Describe several uses of your element (more than three; be specific).
- Draw or provide a color picture (if available) of your element. (You may need to be creative here. Show a picture of its use if you can't draw how the element occurs in nature.) A black and white photo is OK if a color one is not available. The periodic table box is not a drawing of your element and neither is an atomic diagram.
- On this page, make sure you cite the picture source.
- Make sure you label/identify the picture.

5

On the back cover, include:

- **Your full name, class, date completed and due date.**
- **The name of the printer/publisher (Use your imagination. Make up a Publishing Company that will print your brochure. Use Co. or Inc.)**
- **List References & Web Sites used (Required). Google can't be a reference!**
- **Use Work Cited (BFA Media Center Format) for references and web sites used. Use WORK CITED as the title and put references in Alphabetical Order.**
- **You must use a MINIMUM of TWO BOOKS and TWO WEB SITES. [Each is worth 5 points.]**

Helpful Hints: *Remember to check over your brochure after you have finished it. Check for the following:*

* Is it neat and readable? Fold the brochure correctly.
* Is all the required information there? Used Bullets?
* Are spelling, punctuation and grammar correct?
* Is the brochure attractive and colorful (color not required)? Will the reader want to pick up your brochure and read it?
* Do not use pencil, crayon or colored pencils. Use ink or markers for final product. [If you use pencil, automatic –5]
* Be sure your margins are adequate so that text isn't cut off.
* Do not staple or use tape — glue pictures; glue separate sheets or print on both sides.
* Computer generated is good, but not required.
* List specific books and Web Sites used.
* Make this for a person who does not know this element.
* Do not attach BFA work cited colored slips to this brochure. Type or write the information on the brochure.
* Ask yourself—What finishing touches can I add to my brochure to improve it?

+ Do you know the meanings of the words you used?

6

Physical Science

Chemistry Assignment

ELEMENT BROCHURE

For this assignment, you will be creating a brochure about an element that is assigned to you.

Your element is

_____.

Use your textbook and resources from the Library/ Media Center, such as books and the internet, to locate information about your element.

Refer to this sample brochure for the information you need to include. USE BULLETS WHEN POSSIBLE!

Set up your brochure in the format described.

The assignment is worth **100 points**, so include all the required information and do your very best! Your brochure should be fun and interesting to read.

The assignment is due _____.

The Brochure Cover should include: [Keep it simple.]

- The element name
- The element symbol
- The Periodic Table "box" and the information usually found inside/around the box like Group and Period Number. [CitePicture Source here]

1

ATOMIC DIAGRAMS FOR _____:
(Use this as the page title.)

On this page, include the following:

- IDENTIFY EACH PART OF THIS PAGE-WITH A NAME.
- Electron Cloud, Shell, Energy Level or Ring Diagram. [Cite Picture Source here?]
- The number of electrons that are in each energy level around the nucleus (Electron Configuration).
- Show the number of Protons and Neutrons in the nucleus and the number of Electrons in the cloud region.
- Draw the Lewis Dot Diagram.
- State the number of Valence Electrons. [Outer orbit e-] Valence Electrons = _____
- Oxidation States (Valences). Be sure to include the charge (- or +). Oxidation States = _____

PLEASE REMEMBER—NO PENCIL Including Colored Pencils—USE INK, MARKERS, OR A COMPUTER PRINTER. [Automatic –5 if you use pencil]

ELEMENT FACTS: (page title)

The Element is: [Put Element Name and Symbol here.]

[Use this order of facts. On the middle and right-hand pages, include information about your element. Use bullets and identify what the information represents. Use units where necessary.]

- The atomic number =
- The average atomic mass (atomic weight) =
- The mass number =
- Who discovered the element? Nationality?
- When was it discovered? In what Country?
- How was the element named?
- What is its natural state/phase of matter? [solid, liquid, gas or plasma/]
- Its melting point in C?
- Its boiling point in C?
- The group it belongs to in the periodic table (Noble gas, metal, nonmetal, Alkali metals, and so forth)?
- Some of its characteristics/properties, such as color, odor, whether it is dangerous—explosive, radioactive, noxious, poisonous, etc.
- Its number of isotopes and the most important isotopes. Use the symbol-mass designation like C-14.]
- Periodic Table—Group Number =
- Periodic Table—Period Number =
- Density in g/mL or g/cm^3=
- Where is it found? [Location or place on Earth]
- Atomic Radius (include units) =
- The most common compounds formed. [formulas]

ADDITIONAL ELEMENT FACTS:

- What is its crystal shape?
- If known, what does it cost?
- Any other interesting facts about the element?

Remember to check all your facts.

Is there anything you can add to improve your brochure?

Be creative…..Have fun!