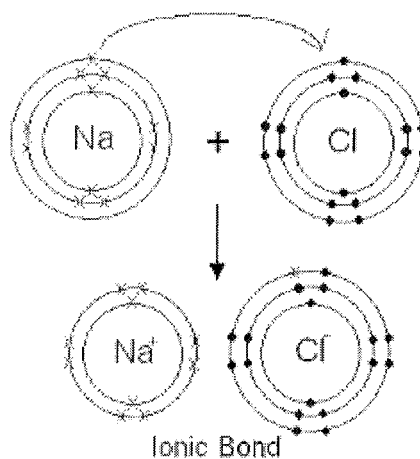
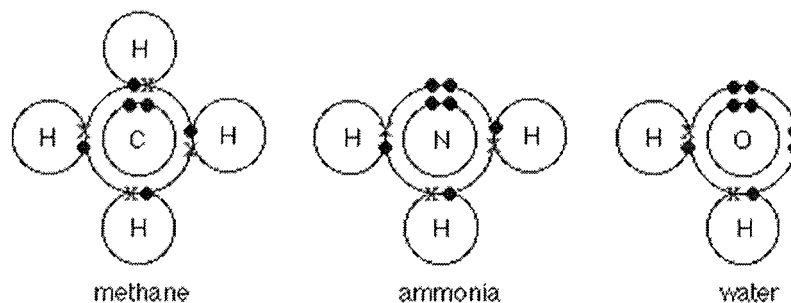
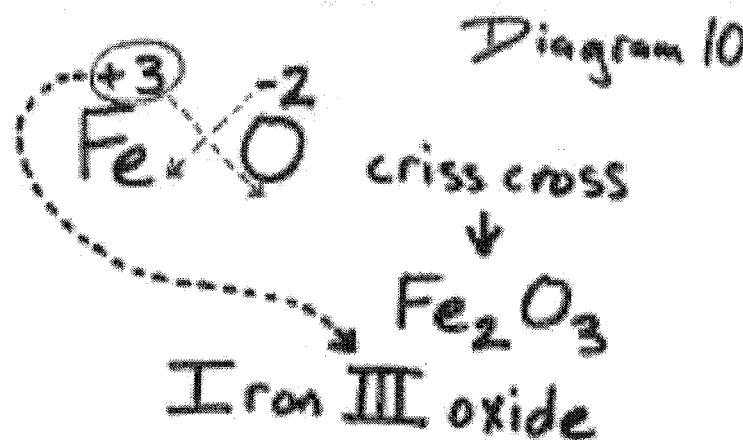


## Unit #5: Bonding



## Formula Writing and Nomenclature



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- P 3. Bonding notes
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- P 11. Bonding quizzes and practice problems
- P 20. Formula Writing and Nomenclature Notes
- P 23. Select Polyatomic Ions (TABLE E)
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## Key Objectives

- Explain how energy and stability are related to chemical bond formation
- Distinguish between ionic and covalent bonds
- Predict whether an interatomic bond is ionic or covalent
- Distinguish between polar and nonpolar bonds
- Describe coordinate covalent bonding
- Draw Lewis structures for covalently bonded molecules and ions
- Use VSEPR to predict the shape of a covalently bonded molecule or ion
- Describe how orbital overlap leads to formation of a covalent bond
- Describe network and metallic bonding
- Define terms polar, nonpolar and dipole as they apply to molecules
- Describe how the polarity of a molecule is related to its symmetry
- Define the term intermolecular force
- Define and apply the following terms as they apply to intermolecular attractions: dipole forces, hydrogen bonding, London dispersion forces and van der Waals forces
- Describe how molecule-ion attractions occur
- Relate chemical bond types to the properties of substances

1

Vocabulary

- asymmetrical molecule** a molecule that lacks identical atomic structure on each side of an axis
- atomic radius** half the distance between two adjacent atoms in a crystal or half the distance between nuclei of identical atoms bonded together
- covalent bond** a bond formed by the sharing of electrons between two nuclei
- double covalent bond** the sharing of two pairs of electrons between two nuclei
- ductility** property of a metal that enables it to be drawn into a wire
- electronegativity** a measure of the attraction of a nucleus for a bonded electron
- endothermic** a chemical reaction that absorbs heat, producing products with more potential energy than the reactants
- exothermic** a chemical reaction that releases heat, producing products with less potential energy than the reactants
- hydrogen bond** the attraction of a hydrogen atom in one molecule for an oxygen, nitrogen, or fluorine atom in another molecule
- hydronium ion**  $\text{H}_3\text{O}^+$ , formed by the combination of water with a hydrogen ion
- ionic bond** a bond formed by the transfer of electrons from one atom to another
- ionic radius** the distance from the nucleus to the outer energy level of the ion
- ionization energy** the amount of energy needed to remove the most loosely bound electron from a neutral gaseous atom
- Lewis dot diagram** a diagram that depicts valence electrons as dots around the atomic symbol (representing the nucleus and non-valence electrons) of the element
- malleability** the property of metals that allows them to be hammered into shapes
- metal** element whose atoms lose electrons in chemical reactions to become positive ions
- metallic bond** the attraction of valence electrons for the positive kernels of metallic atoms
- metalloid** an element that has both metallic and nonmetallic properties
- multiple covalent bond** a double or triple covalent bond
- noble gas** a nonreactive element that is in group 18 on the periodic table
- nonmetal** element whose atoms will gain or share electrons in chemical reactions
- nonpolar covalent bond** a bond formed by the equal sharing of a pair of electrons between two nuclei
- octet of electrons** the stable valence electron configuration of eight electrons
- polar covalent bond** a bond formed by the unequal sharing of electrons between two nuclei
- symmetrical molecule** a molecule with identical atomic structure on each side of an axis
- triple bond** the sharing of three pairs of electrons between two nuclei

1  **Bonding**

Chapter 7 &amp; 8

2  **Endothermic vs. Exothermic**

- Energy is required to break a bond:
  - Endothermic where Heat or E is a reactant and absorbed into system
- Energy is released when a bond is formed:
  - Exothermic where Heat or E is a product and is released from the system
    - When a bond forms, the new compound has less potential energy than the reactants (E released)
    - The more E released, the more stable the compound

3  **Ionic vs. Covalent**

- Ionic Bonding: atoms will gain/lose e<sup>-</sup> to other atoms
  - +/- ions form and attract to one another
- Covalent Bonding: atoms share e<sup>-</sup> pairs equally
- A bond is never purely Ionic or Covalent, but is a combination depending on electronegativity differences (Table S)
- If difference between atoms is roughly
  - 0.0 = Non polar covalent (0.0-0.3)
  - 0.1-1.7 = Polar covalent (0.3-1.7)
  - 1.7-3.3 = Ionic

4  **Ionic vs. Covalent continued**

- Ionic Bonding: occurs between a metal and non-metal
  - Electronegativity differences 1.7 or greater
  - Ex. NaCl, LiBr
- Covalent Bonding: occurs between two, or more, non-metals
  - Electronegativity differences 1.7 or less
  - Ex. CO<sub>2</sub>, CH<sub>4</sub>

5  **Ionic Compounds:**

- Most exist as crystalline solid (lattice structure)
- Chemical formula shows the ratio of ions present that give electrical neutrality (NaCl)
- Formation of 3D arrangement will decrease the potential energy of the structure (becomes more stable)
  - (+) ion = cation      (-) ion = anion

6  **Characteristics of Ionic Bonds:**

- Solid
  - Crystal structure
  - Very strong bonds
  - High melting and boiling points

3

- Hard and brittle
    - Non conductors of electricity
  - Liquid (typically molten)
    - Broken bonds allow for mobility of ions
    - Better conductor of electricity (than solid)
  - Solution (dissolved in water)
    - Crystal completely destroyed
    - Ions become mobile and are good conductors of electricity
- 7  **Characteristics of Covalent Bonds:**
- Molecular structure
  - Weaker bonds (smaller differences in electronegativity compared to ionic bonds)
  - Low melting points
  - Non conductors of electricity
  - Soft as solids
- 8  **Electron Sharing**
- Single Covalent Bond: sharing of 1 pair or 2e-
  - 
  - 
  - 
  - Double Covalent Bond: sharing of 2 pair or 4e-
  - 
  - 
  - 
  - Triple Covalent Bond: sharing of 3 pair or 6e-
- 9  **Non-Polar vs. Polar Molecules**
- Non-polar covalent: equal sharing of e- and balanced electrical charge
  - 
  - Polar covalent: e- is attracted more towards the greater electronegative atom, therefore creating an unequal distribution of charge. Ex. Water is a polar molecule
- 10  **Polar molecules continued**
- Delta ( $\delta$ ) is used to represent partial charges
  - $\delta^-$  such as in Oxygen of a water molecule
    - O pulls e- more so it is a partially (-) end
  - $\delta^+$  such as in Hydrogen of a water molecule
    - H has e- pulled away so it is a partially (+) end
- 11  **Molecular Geometry: Based on VSEPR**
- Valence Shell Electron Pair Repulsion
  - Shape of molecule depends on the # of bonds and non-bonding electron pairs (lone pairs)

4

- Shape will help determine polarity of molecule
  - Ex. Water is a polar molecule because of its bent shape (asymmetrical)
  - 
  - 
  - 
  - Oxygen is non-polar because of its linear and symmetrical shape

12  **Molecular Geometry continued**

- Molecules with symmetry are usually non-polar
- 
- 
- Molecules without symmetry are usually polar

13  **Coordinate Covalent Bonds**

- One atom provides both electrons that are shared in a bond
  - Ex. Hydronium ion  $\text{H}_3\text{O}^+$  (found in water and acids)
    - H = 1 valence electron
    - $\text{H}^+$  = 0 valence electrons (same as Proton)
      - $\text{H}^+$  will attract to  $\delta^-$  end of  $\text{H}_2\text{O}$
      - (+) ion results
      - 
      - 
      - This is also the case with the ammonium ion  $(\text{NH}_4)^+$

14  **Network solids:**

- Covalent bonding with millions of atoms in a crystalline network
- Macromolecules (large)
- Very strong bonds
- High melting points
- Non-conductors of electricity
  - Ex. diamond/graphite/asbestos/silicon dioxide

15  **Metallic Bonding:**

- Bonding between metal atoms in a pure substance
- Consists of an arrangement of positive ions in a 'sea' of mobile electrons (A in diagram below)
- Mobile electrons give the metals:
  - Strength
  - Malleability (D)
  - Ability to conduct electricity/heat (B/C)

16  **Intermolecular Forces Between Molecules:**

- Are not true bonds and can be separated relatively easy
- Dipole Attraction

5

- Exists between polar molecules
- Opposite partial charges attract
- Are weak forces

17  **Intermolecular Forces continued**

- Hydrogen Bonding
  - Between polar molecules containing Hydrogen with O, N and F
  - Hydrogen bonds are strongest with H  $\delta^+$  and an atom with a small atomic radius and high electronegativity

18  **Intermolecular Forces continued**

- Vander waals Forces
  - Between nonpolar molecules due to a momentary imbalance in electron sharing
  - Weak force-but helps geckos defy gravity
  - Seen in noble gases and diatomics
    - $H_2, O_2, F_2, Br_2, I_2, N_2, Cl_2,$
  - Force increases as:
    - Distance between molecules decreases
    - Size of molecule increases
- Ex. Iodine ( $I_2$ )  $\rightarrow$
- Which will be strongest?  $Br_2(l), I_2(s), Cl_2(g)$ 
  - $\rightarrow I_2$ , as it has the largest radius and thus closer molecules due to being a solid

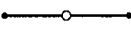
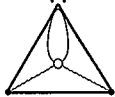
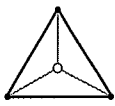
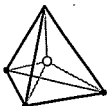
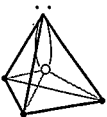
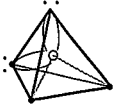
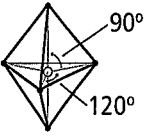
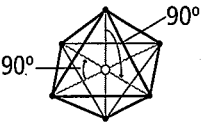
19  **Ion-Molecule Attractions:**

- Ex. When dissolving substances in water
  - $\delta^+$  side of the molecule will attack (-) ion
  - $\delta^-$  side of the molecule will attack (+) ion

20  **Resonance:**

- More than one Lewis structure may represent a molecule (average between the two is considered as either could exist)
- Designated by a double arrow
- Ex. Benzene ( $C_6H_6$ ) and Ozone ( $O_3$ )



	Molecular shape	Atoms bonded to central atom	Lone pairs of electrons	Formula example	Lewis structure
Linear		2	0	BeF <sub>2</sub>	$\text{:}\ddot{\text{F}}\text{--Be--}\ddot{\text{F}}\text{:}$
Bent		2	1	SnCl <sub>2</sub>	$\text{:}\ddot{\text{Cl}}\text{:}\text{Sn}\text{:}\ddot{\text{Cl}}\text{:}$
Trigonal-planar		3	0	BF <sub>3</sub>	$\text{:}\ddot{\text{F}}\text{:}\text{B}\text{:}\ddot{\text{F}}\text{:}$ $\text{:}\ddot{\text{F}}\text{:}$
Tetrahedral		4	0	CH <sub>4</sub>	$\begin{array}{c} \text{H} \\   \\ \text{H--C--H} \\   \\ \text{H} \end{array}$
Trigonal-pyramidal		3	1	NH <sub>3</sub>	$\begin{array}{c} \text{:}\ddot{\text{N}}\text{:} \\   \\ \text{H H H} \end{array}$
Bent		2	2	H <sub>2</sub> O	$\begin{array}{c} \text{:}\ddot{\text{O}}\text{:} \\   \\ \text{H H} \end{array}$
Trigonal-bipyramidal		5	0	PCl <sub>5</sub>	$\begin{array}{c} \text{:}\ddot{\text{Cl}}\text{:}\text{Cl}\text{:} \\   \\ \text{:}\ddot{\text{Cl}}\text{:}\text{P}\text{:}\ddot{\text{Cl}}\text{:} \\   \\ \text{:}\ddot{\text{Cl}}\text{:}\text{Cl}\text{:} \end{array}$
Octahedral		6	0	SF <sub>6</sub>	$\begin{array}{c} \text{:}\ddot{\text{F}}\text{:}\text{F}\text{:}\text{F}\text{:} \\   \\ \text{:}\ddot{\text{F}}\text{:}\text{S}\text{:}\ddot{\text{F}}\text{:} \\   \\ \text{:}\ddot{\text{F}}\text{:}\text{F}\text{:}\text{F}\text{:} \end{array}$

7

**STUDENT VIEWING GUIDE**

Bonding

**Write the answer in the space provided.**

\_\_\_\_\_ 1. Atoms tend to lose, gain, or \_\_\_\_\_ electrons to complete their valence shells.

\_\_\_\_\_ 2. When a chlorine atom gains an electron, it fills its valence shell forming a negative chloride \_\_\_\_\_.

\_\_\_\_\_ 3. Whenever ionic solids are formed, \_\_\_\_\_ is involved.

\_\_\_\_\_ 4. An ionic material is composed of positive ions bonded to \_\_\_\_\_ ions.

\_\_\_\_\_ 5. The famous Hope diamond is an example of a nearly perfect \_\_\_\_\_ crystal.

\_\_\_\_\_ 6. A covalent bond forms as electron clouds overlap and the electrons are \_\_\_\_\_.

\_\_\_\_\_ 7. Weak attractive forces between water molecules cause them to arrange in the orderly pattern of a \_\_\_\_\_ solid.

\_\_\_\_\_ 8. The covalent bonds in  $N_2$  are very strong and require a lot of \_\_\_\_\_ to break.

\_\_\_\_\_ 9. Lightening and bacteria in legumes have the ability to break the strong covalent bonds in \_\_\_\_\_ gas.

\_\_\_\_\_ 10. The energy released by the nitrogen triiodide explosion occurs because of the strong tendency of nitrogen atoms to form \_\_\_\_\_ bonds with each other.

\_\_\_\_\_ 11. The covalent bonds in quartz produce a three-dimensional \_\_\_\_\_ solid.

8

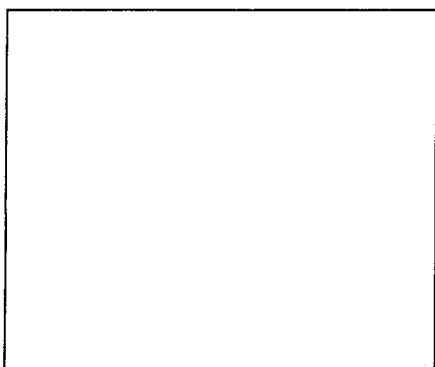
Name \_\_\_\_\_

Draw the following Lewis structures: Be sure to indicate whether it is ionic or covalent

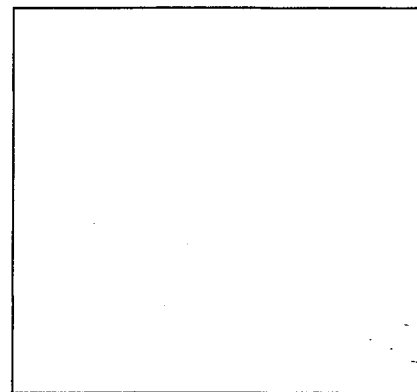
A) If Ionic, be sure to list charges where appropriate

B) If Covalent, be sure to tell if the molecule is polar or non polar

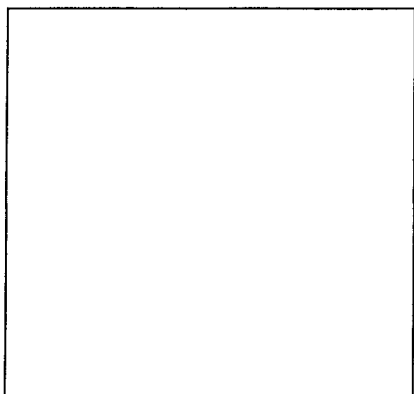
1) LiI



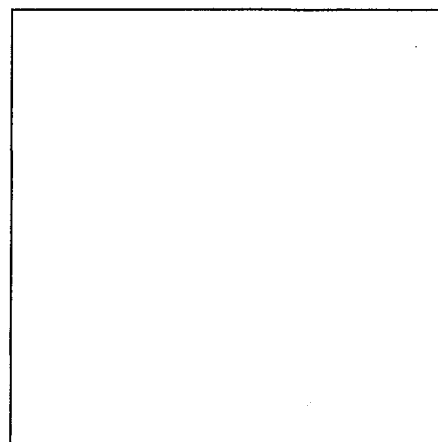
4) PBr<sub>3</sub>



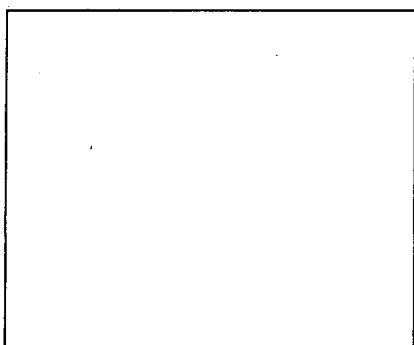
2) AlCl<sub>3</sub>



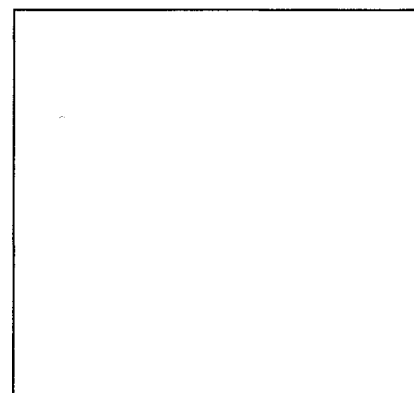
5) Br<sub>2</sub>



3) HF



6) CH<sub>2</sub>BrCl



9

Name \_\_\_\_\_ Lewis Electron-Dot Structures

Ionic Bonds

For the following ionic compounds, draw the Lewis electron-dot structures showing the transfer of electron(s).

1. LiI

2. PbS

3. MgBr<sub>2</sub>

4. AlCl<sub>3</sub>

Covalent Bonds

For the following covalent compounds, draw the Lewis electron-dot structures showing the sharing of electron(s).

5. H<sub>2</sub>

6. F<sub>2</sub>

7. HF

8. CF<sub>4</sub>

9. H<sub>2</sub>O

10. PCl<sub>3</sub>

10

Name \_\_\_\_\_  
Chemistry Bonding Quiz

February 5, 2004

Show all work for each question in the space provided

- 1) What type of bond would exist between Beryllium and Phosphorous
  
- 2) Draw bonding between Tin and Chlorine
  - a. Be sure to show charges as needed
  - b. List the type of bond occurring
  - c. List the type of molecule based on its symmetry
  - d. Show all electrons as necessary

- 3) Which element has the highest Electronegativity?
  
- 4) Which element has the highest Ionization Energy?
  
- 5) Ionic bonds occur between what two types of atoms?
  
- 6) List 3 properties of Metals.

7) A (+) ion is \_\_\_\_\_ than the neutral atom

8) If energy is put into a system and is required to break a bond, this relates to an \_\_\_\_\_ reaction

11

Name \_\_\_\_\_  
Chemistry Bonding Quiz

February 5, 2004

Show all work for each question in the space provided

1) What type of bond would exist between Scandium and Chlorine

2) Draw bonding between Lead and Iodine

- a. Be sure to show charges as needed
- b. List the type of bond occurring
- c. List the type of molecule based on its symmetry
- d. Show all electrons as necessary

3) Which element has the lowest Electronegativity?

4) Which element has the lowest Ionization Energy?

5) Covalent bonds occur between what two types of atoms?

6) List 3 properties of Non-Metals.

7) A (-) ion is \_\_\_\_\_ than the neutral atom

8) If energy is released from a system when a bond forms, this relates to an \_\_\_\_\_ reaction

12

**Bonding Review Quiz**

**Mr. Gardner**

Name \_\_\_\_\_

May-04

**Directions: Place correct answer in space provided!**

\_\_\_\_\_ 1. Which statement explains why the radius of a lithium atom is larger than the radius of a lithium ion?

- |   |  |
|---|--|
| 1. Metals lose electrons when forming an ion. | 3. Nonmetals lose electrons when forming an ion. |
| 2. Metals gain electrons when forming an ion. | 4. Nonmetals gain electrons when forming an ion. |

\_\_\_\_\_ 2. Which bond is most polar?

- |          |          |
|----------|----------|
| 1. H--F  | 3. H--Br |
| 2. H--Cl | 4. H--I  |

\_\_\_\_\_ 3. When a chemical bond is broken, energy is

- |                   |                                  |
|-------------------|----------------------------------|
| 1. absorbed, only | 3. both absorbed and released    |
| 2. released, only | 4. neither absorbed nor released |

\_\_\_\_\_ 4. As an atom becomes an ion, its mass number

- |              |                     |
|--------------|---------------------|
| 1. decreases | 3. remains the same |
| 2. increases |                     |

\_\_\_\_\_ 5. Which formula represents an ionic compound?

- |                     |                     |
|---------------------|---------------------|
| 1. NaCl             | 3. HCl              |
| 2. N <sub>2</sub> O | 4. H <sub>2</sub> O |

\_\_\_\_\_ 6. Which molecule contains a triple covalent bond?

- |                   |                    |
|-------------------|--------------------|
| 1. H <sub>2</sub> | 3. O <sub>2</sub>  |
| 2. N <sub>2</sub> | 4. Cl <sub>2</sub> |

\_\_\_\_\_ 7. Which electron configuration is correct for a sodium ion?

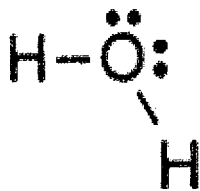
- |        |          |
|--------|----------|
| 1. 2-7 | 3. 2-8-1 |
| 2. 2-8 | 4. 2-8-2 |

\_\_\_\_\_ 8. Which element has atoms that can form single, double, and triple covalent bonds with other atoms of the same element?

- |             |             |
|-------------|-------------|
| 1. hydrogen | 3. fluorine |
| 2. oxygen   | 4. carbon   |

13

9. Which pair of characteristics describes the molecule shown in the accompanying illustration?



- |                             |                              |
|-----------------------------|------------------------------|
| 1. symmetrical and polar    | 3. asymmetrical and polar    |
| 2. symmetrical and nonpolar | 4. asymmetrical and nonpolar |

10. Which statement explains why  $\text{H}_2\text{O}$  has a higher boiling point than  $\text{N}_2$ ?

- |  |  |
|--|--|
| 1. $\text{H}_2\text{O}$ has greater molar mass than $\text{N}_2$ . | 3. $\text{H}_2\text{O}$ has stronger intermolecular forces than $\text{N}_2$ . |
| 2. $\text{H}_2\text{O}$ has less molar mass than $\text{N}_2$ .    | 4. $\text{H}_2\text{O}$ has weaker intermolecular forces than $\text{N}_2$ .   |

11. When  $\text{NaCl}(\text{s})$  is dissolved in  $\text{H}_2\text{O}(\text{l})$ , the sodium ion is attracted to the water molecule's

- |                                    |                                    |
|------------------------------------|------------------------------------|
| 1. negative end, which is hydrogen | 3. positive end, which is hydrogen |
| 2. negative end, which is oxygen   | 4. positive end, which is oxygen   |

12. Which type of attraction results from the formation of weak momentary dipoles?

- |             |                         |
|-------------|-------------------------|
| 1. ionic    | 3. molecule-ion         |
| 2. metallic | 4. van der Waals forces |

13. When ionic bonds are formed, metallic atoms tend to

- |  |  |
|--|--|
| 1. lose electrons and become negative ions | 3. gain electrons and become negative ions |
| 2. lose electrons and become positive ions | 4. gain electrons and become positive ions |

14. A substance that has a melting point of 1074 K, conducts electricity when dissolved in water, but does not conduct electricity in the solid phase. The substance is most likely

- |                    |                      |
|--------------------|----------------------|
| 1. an ionic solid  | 3. a metallic solid  |
| 2. a network solid | 4. a molecular solid |

15. The ability to conduct electricity in the solid state is a characteristic of metallic bonding. This characteristic is best explained by the presence of

- |                             |                     |
|-----------------------------|---------------------|
| 1. high ionization energies | 3. mobile electrons |
| 2. high electronegativities | 4. mobile protons   |

14



Name \_\_\_\_\_

Chemistry Bonding Quiz

Show all work for each question in the space provided

- 1) A. What type of bond would exist between Beryllium and Phosphorous?  
B. What type of bond would exist between Scandium and Chlorine?
- 2) Draw bonding between Tin and Chlorine  
a. Show all electrons as necessary, including overlap with shared electrons and octets as in lab activity  
b. Be sure to show partial charges as needed  
c. List the type of bond occurring within the atom  
d. List the polarity of the molecule based on its symmetry

3) A. Which element has the highest Electronegativity according to table S?

B. Which one has the lowest value?

4) Which element has the highest Ionization Energy?

5) Ionic bonds occur between what two types of atoms?

6) Complete the table with 3 properties of metals and non-metals

<b>Property/Characteristic</b>	<b>Metal</b>	<b>Non Metal</b>
1		
2		
3		

7) (circle the best fit answer) A (+) ion is smaller/larger than the corresponding neutral atom.

8) If energy is put into a system and is required to break a bond, this relates to an \_\_\_\_\_ reaction

15

Name: \_\_\_\_\_

- \_\_\_ 1) Atoms of which of the following elements have the *greatest* tendency to gain electrons?  
 A) O  
 B) Sn  
 C) I  
 D) Cs
- \_\_\_ 2) The nonmetal that is a liquid at STP is  
 A) calcium  
 B) chlorine  
 C) bromine  
 D) mercury
- \_\_\_ 3) Which substance can form a coordinate covalent bond with a hydrogen ion?  
 A)  $H_2$   
 B)  $CH_4$   
 C)  $NH_3$   
 D) He
- \_\_\_ 4) Which electron dot symbol represents the atom in Period 4 with the *highest* first ionization energy?  
 A)  $\cdot X \cdot$   
 B)  $X \cdot$   
 C)  $\cdot X \cdot$   
 D)  $X$
- \_\_\_ 5) A chemical bond results when two nuclei have a simultaneous attraction for  
 A) neutrons  
 B) protons  
 C) electrons  
 D) nucleons
- \_\_\_ 6) *All* of the atoms of the elements in Period 2 have the same number of  
 A) valence electrons  
 B) occupied principal energy levels  
 C) protons  
 D) neutrons
- \_\_\_ 7) Which electron dot formula represents a polar molecule?  
 A)  $\cdot \ddot{F} : \ddot{F} \cdot$   
 B)  $H : H$   
 C)  $H : \ddot{Cl} \cdot$   
 D)  $H : \ddot{C} : H$   
 $\begin{array}{c} H \\ \vdots \\ H \end{array}$
- \_\_\_ 8) Which atom forms an ion with the *largest* radius?  
 A) F  
 B) I  
 C) Cl  
 D) Br
- \_\_\_ 9) As the Group 1 elements of the Periodic Table are considered from top to bottom, the first ionization energy of each successive element decreases. One reason for this is that the  
 A) distance between the valence electron and the nucleus is increasing  
 B) nuclear charge is decreasing  
 C) number of principal energy levels is decreasing  
 D) number of neutrons is increasing
- \_\_\_ 10) Which two atoms will form an ionic bond?  
 A) N and H  
 B) C and H  
 C) K and H  
 D) I and H
- \_\_\_ 11) How does the size of a barium ion compare to the size of a barium atom?  
 A) The ion is larger because it has more electrons.  
 B) The ion is larger because it has fewer electrons.  
 C) The ion is smaller because it has more electrons.  
 D) The ion is smaller because it has fewer electrons.
- \_\_\_ 12) Which electron-dot formula represents a substance that contains a nonpolar covalent bond?  
 A)  $\begin{array}{c} \cdot x \cdot \\ x \cdot Cl \cdot x \cdot \\ \cdot x \cdot \end{array} \begin{array}{c} \cdot x \cdot \\ x \cdot Cl \cdot x \cdot \\ \cdot x \cdot \end{array}$   
 B)  $[Na]^+ [Cl]^-$   
 C)  $\begin{array}{c} \cdot \cdot \\ \cdot \cdot \\ \cdot O \cdot H \\ \cdot x \cdot \\ H \end{array}$   
 D)  $\begin{array}{c} \cdot x \cdot \\ H \cdot Cl \cdot \\ \cdot x \cdot \end{array}$
- \_\_\_ 13) As the elements in Group 15 are considered in order of increasing atomic number, which sequence in properties occurs?  
 A) nonmetal  $\rightarrow$  metalloid  $\rightarrow$  metal  
 B) metalloid  $\rightarrow$  metal  $\rightarrow$  nonmetal  
 C) metal  $\rightarrow$  nonmetal  $\rightarrow$  metalloid  
 D) metal  $\rightarrow$  metalloid  $\rightarrow$  nonmetal
- \_\_\_ 14) Which of these metals loses electrons *most* readily?  
 A) potassium  
 B) calcium  
 C) sodium  
 D) magnesium
- \_\_\_ 15) The shape and bonding in a diatomic bromine molecule are *best* described as  
 A) asymmetrical and polar  
 B) asymmetrical and nonpolar  
 C) symmetrical and nonpolar  
 D) symmetrical and polar
- \_\_\_ 16) Which element is malleable and ductile?  
 A) Si  
 B) S  
 C) Ge  
 D) Au
- \_\_\_ 17) The symmetrical structure of the  $CH_4$  molecule is due to the fact that the four single bonds between carbon and hydrogen atoms are directed toward the corners of a  
 A) triangle  
 B) rectangle  
 C) tetrahedron  
 D) square

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- \_\_\_ 18) In which area of the Periodic Table are the elements with the *strongest* nonmetallic properties located?
- A) upper left                      C) lower left  
B) upper right                     D) lower right
- \_\_\_ 19) Which element has a crystalline lattice composed of positive ions through which electrons flow freely?
- A) calcium                          C) sulfur  
B) bromine                         D) carbon
- \_\_\_ 20) The properties of silicon are characteristic of
- A) neither a metal nor a nonmetal  
B) a metal, only  
C) both a metal and a nonmetal  
D) a nonmetal, only
- \_\_\_ 21) Which compound has the *greatest* degree of ionic character?
- A) SiF<sub>4</sub>                                C) NaF  
B) MgF<sub>2</sub>                              D) AlF<sub>3</sub>
- \_\_\_ 22) Electronegativity is a measure of an atom's ability to
- A) attract the protons of another atom  
B) repel the protons of another atom  
C) repel the electrons in the bond between the atom and another atom  
D) attract the electrons in the bond between the atom and another atom
- \_\_\_ 23) As a chemical bond forms between two hydrogen atoms in a system, energy is released and the stability of the system
- A) remains the same  
B) increases  
C) decreases
- \_\_\_ 24) Which element is brittle in the solid phase and is a poor conductor of heat and electricity?
- A) strontium                         C) calcium  
B) copper                             D) sulfur
- \_\_\_ 25) The relatively high boiling point of water is primarily due to the presence of
- A) ion-ion attractions  
B) van der Waals forces  
C) hydrogen bonds  
D) molecule-ion attractions
- \_\_\_ 26) The elements calcium and strontium have similar chemical properties because they *both* have the same
- A) number of completely filled sublevels  
B) atomic number  
C) number of valence electrons  
D) mass number
- \_\_\_ 27) Elements in a given period of the Periodic Table contain the same number of
- A) neutrons in the nucleus  
B) electrons in the outermost level  
C) occupied principal energy levels  
D) protons in the nucleus
- \_\_\_ 28) Which terms describe a substance that has a low melting point and poor electrical conductivity?
- A) ionic and metallic  
B) ionic and molecular  
C) covalent and molecular  
D) covalent and metallic
- \_\_\_ 29) An element with an electronegativity of 3.2 is *most* likely classified as a
- A) semimetal (metalloid)  
B) noble gas  
C) nonmetal  
D) metal
- \_\_\_ 30) Which substance contains particles held together by metallic bonds?
- A) Ne(s)                                C) N<sub>2</sub>(s)  
B) I<sub>2</sub>(s)                                D) Ni(s)

31 & 32 complete on the back  
of your Scantron

(31) A) Draw the Lewis structure for Potassium Iodide  
B) What type of bonding occurs

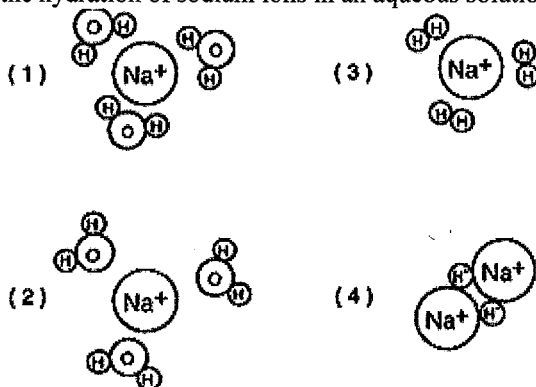
(32) A) Draw Lewis structure for Carbon tetrafluoride  
- show all electrons  
- list polarity of the molecule  
- Designate octets w/ overlapping circles

(17)

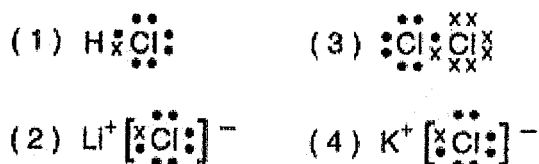
NAME \_\_\_\_\_

**Multiple-Choice Questions: Place proper answer in space provided before each question**

- \_\_\_\_\_ 1. Which kind of compound generally results when metal atoms chemically combine with nonmetal atoms?  
(1) network (2) ionic (3) molecular (4) metallic
- \_\_\_\_\_ 2. Which terms describe a substance that has a low melting point and poor electrical conductivity?  
(1) covalent and metallic (3) ionic and molecular  
(2) ionic and metallic (4) covalent and molecular
- \_\_\_\_\_ 3. Which element has a crystalline lattice composed of positive ions through which electrons flow freely?  
(1) selenium (2) sulfur (3) carbon (4) barium
- \_\_\_\_\_ 4. Metallic bonding occurs between atoms of  
(1) sulfur (2) carbon (3) fluorine (4) zinc
- \_\_\_\_\_ 5. Which molecule contains a double covalent bond?  
(1) H<sub>2</sub> (2) N<sub>2</sub> (3) O<sub>2</sub> (4) Cl<sub>2</sub>
- \_\_\_\_\_ 6. Which diagram best illustrates the hydration of sodium ions in an aqueous solution?



- \_\_\_\_\_ 7. Which molecule has an asymmetrical shape?  
(1) N<sub>2</sub> (2) NH<sub>3</sub> (3) Cl<sub>2</sub> (4) CCl<sub>4</sub>
- \_\_\_\_\_ 8. When KCl(s) is dissolved in H<sub>2</sub>O(l), the chlorine ion is attracted to the water molecule's  
(1) negative end, which is hydrogen (3) positive end, which is hydrogen  
(2) negative end, which is oxygen (4) positive end, which is oxygen
- \_\_\_\_\_ 9. Which Group 16 element when combined with hydrogen forms a compound that would exhibit the strongest hydrogen bonding?  
(1) oxygen (2) tellurium (3) selenium (4) sulfur
- \_\_\_\_\_ 10. Which electron dot diagram represents a compound that has a polar covalent bond?



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Turn Over Please

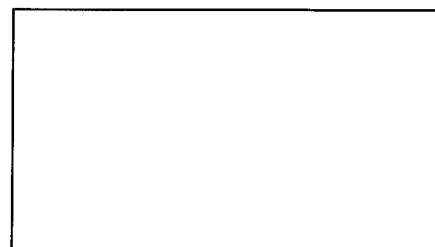
### Free-Response Questions

1. Draw a circle around each particle so that it represents its relative size compared to the other two listed:



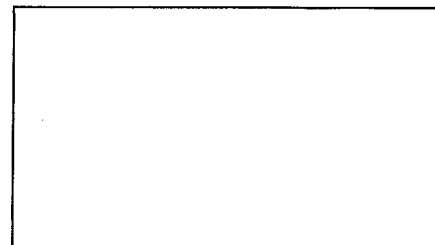
2. Draw the electron-dot diagrams (Lewis structures) of  $Nl_3$  in the box to the right.

3. What kind of bonding is present in the compound in question 2, and why?



4. Draw the electron-dot diagrams (Lewis structures) of  $CaBr_2$  in the box to the right

5. What kind of bonding is present in the compound in question 4 and why?



6. Explain why  $H_2O$  is a polar molecule?

7. Why do noble gases tend not to bond?

**Base your answers, for questions 11-15, on the information below.**

Testing of an unknown solid shows that it has the properties listed below.

- high melting and boiling points
- soluble in water
- nonconductor of electricity
- not malleable

8. State the type of bonding that would be expected in this substance.

9. Explain why this substance does not conduct electricity.

10. What could be done to the unknown substance to make it a conductor?

Bonus: Explain what is so special about an ionic compound such as  $K_3PO_4$  in terms of bonding.

## 1 Formula Writing and Nomenclature:

### (Chemical Names and Formulas)

## 2 Chemical Names and Formulas

- 

- Significance of chemical formulas: they represent the ratio of atoms in the formula
  - Always in a fixed proportion for that material
- Ex. NaCl= 1 sodium : 1 Chlorine
- Ex. H<sub>2</sub>SO<sub>4</sub>= 2 Hydrogen : 1 Sulfur : 4 Oxygen

## 3 Types of Formulas

1. Molecular- two substances held together by chemical bonds (covalent molecules; polar and non-polar bonding)
  - Example: H<sub>2</sub>O, CO<sub>2</sub>
2. Ionic- electrically charged particles held together by opposing charges (ionic compounds)
  - Monatomic ion
    - Ion formed from 1 atom
    - Ex. group 1 loses 1 electron and becomes positively charged (Na → Na<sup>+</sup> by losing 1 e<sup>-</sup>)

## 4 Naming Monoatomic Ions

- Monatomic cations (positively charged ions) are identified by the element's name
- Example: K<sup>+</sup> = Potassium ion
- Monatomic anions (negatively charged ions) ...the element's ending is replaced with "ide"
- Example: F (Fluorine) → F<sup>-</sup> Fluoride ion

## 5 Binary Ionic Compound

- Two ions making up a compound
- Cation (+) always is first in name
- Anion (-) always is second in name
  - Example: Na<sup>+</sup> and Cl<sup>-</sup>
    - Sodium chloride
  - The total number of (+) and (-) charges must equal zero.

## 6 Criss- Cross Method

- When writing/naming the formula use the "criss-cross" method to balance the charges
- 

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- Example:  $\text{Mg}^{+2} \text{Br}^{-1} = \text{MgBr}_2$

-

-

-

- Example:  $\text{K}^{+1} \text{S}^{-2} = \text{K}_2\text{S}$

## 7 Naming a Binary Ionic Compound

- Write name of cation first (+ ion)
- Write name of anion second (- ion)
  - Example: Calcium Bromide
  - When writing the formula use the "criss-cross" method to balance the charges
  - \*If multiple oxidation states (charges) exists, use "stock Nomenclature" (Roman Numerals of oxidation numbers occurring in the material) for naming the compound.
    - Iron (II) Chloride vs. Iron (III) Chloride
    - Lead (II) Oxide vs. Lead (IV) Oxide

## 8 Stock Nomenclature vs. Older System

- Stock Nomenclature with Roman Numerals
  - Iron (II) Chloride  $\rightarrow \text{FeCl}_2$
  - Iron (III) Chloride  $\rightarrow \text{FeCl}_3$
  - Iron (II) Oxide  $\rightarrow \text{FeO}$
  - Iron (III) Oxide  $\rightarrow \text{Fe}_2\text{O}_3$

## 9 Stock Nomenclature vs. Older System (continued)

- Older Naming System
  - Uses Latin names  $\rightarrow$  Iron, Fe (from Ferrum)
  - "ic" ending- use greater oxidation #
    - ex. Ferric chloride (Uses +3)
  - "ous" ending- use lesser/lower oxidation #
    - ex. Ferrous chloride (Uses +2)

## 10 Polyatomic Ions (Table E)

- Two or more elements in one ion
  - grouped together to form a compound with other monatomic or polyatomic ions
  - Examples:
    - $\text{Ca}^{+2} (\text{NO}_3)^{-1} \rightarrow \text{Ca}(\text{NO}_3)_2$
    - $\text{Na}^{+1} (\text{CO}_3)^{-2} \rightarrow \text{Na}_2\text{CO}_3$
    - $(\text{NH}_4)^{+1} (\text{OH})^{-1} \rightarrow \text{NH}_4\text{OH}$

## 11 Naming Covalent Molecules

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- Composed of Covalently bonded units
  - Usually 2 non metals
- When naming, use prefix system for the 1<sup>st</sup> and 2<sup>nd</sup> elements

- 
- 

### 12 Rules for naming

- When writing the formula, the less electronegative element is listed 1<sup>st</sup> (Table S)
  - Use prefix if there are 2 or more atoms of this element
- The 2<sup>nd</sup> element is named by combining the prefix indicating the # of atoms
  - followed with base word of 2nd element
  - add "ide" ending
  - if the prefix ends in an "a", drop the "a"
- Example:
  - P<sub>4</sub>O<sub>10</sub>=tetraphosphorous decoxide
  - As<sub>2</sub>O<sub>5</sub>= diarsenic pentoxide
  - SO<sub>3</sub>= sulfur trioxide
  - ICl<sub>3</sub>= Iodine trichloride

### 13 Balancing Chemical Equations

- Chemical equation or formula tells you the ratio of atoms in the reaction
- Diatomic molecules –(H<sub>2</sub>, O<sub>2</sub>, F<sub>2</sub>, Br<sub>2</sub>, I<sub>2</sub>, N<sub>2</sub>, Cl<sub>2</sub>) atoms that exist in duplicate when not combined with another element
- Law of Conservation of Mass
  - Mass is neither created nor destroyed during a chemical reaction (must have equal numbers of atoms of each element on both sides of reaction)

### 14 Balancing Chemical Equations (continued)

- Use coefficients on both sides of equation to balance
- 1.  $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$
- 2.  $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$
- 3.  $3\text{Fe} + 2\text{O}_2 \rightarrow \text{Fe}_3\text{O}_4$
- 4.  $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$
- 5.  $2\text{NaCl} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{PbCl}_2 + 2\text{NaNO}_3$



**Table E**  
**Selected Polyatomic Ions**

$\text{H}_3\text{O}^+$	hydronium	$\text{CrO}_4^{2-}$	chromate
$\text{Hg}_2^{2+}$	dimercury (I)	$\text{Cr}_2\text{O}_7^{2-}$	dichromate
$\text{NH}_4^+$	ammonium	$\text{MnO}_4^-$	permanganate
$\left. \begin{array}{l} \text{C}_2\text{H}_3\text{O}_2^- \\ \text{CH}_3\text{COO}^- \end{array} \right\}$	acetate	$\text{NO}_2^-$	nitrite
$\text{CN}^-$	cyanide	$\text{NO}_3^-$	nitrate
$\text{CO}_3^{2-}$	carbonate	$\text{O}_2^{2-}$	peroxide
$\text{HCO}_3^-$	hydrogen carbonate	$\text{OH}^-$	hydroxide
$\text{C}_2\text{O}_4^{2-}$	oxalate	$\text{PO}_4^{3-}$	phosphate
$\text{ClO}^-$	hypochlorite	$\text{SCN}^-$	thiocyanate
$\text{ClO}_2^-$	chlorite	$\text{SO}_3^{2-}$	sulfite
$\text{ClO}_3^-$	chlorate	$\text{SO}_4^{2-}$	sulfate
$\text{ClO}_4^-$	perchlorate	$\text{HSO}_4^-$	hydrogen sulfate
		$\text{S}_2\text{O}_3^{2-}$	thiosulfate

Name \_\_\_\_\_

Complete the following chart using oxidation numbers and ionic charges provided.

		acetate $C_2H_3O_2^-$	bromide $Br^-$	carbonate $CO_3^{2-}$	chlorate $ClO_3^-$	chloride $Cl^-$	chromate $CrO_4^{2-}$
aluminum	$Al^{3+}$						
ammonium	$NH_4^+$						
barium	$Ba^{2+}$						
calcium	$Ca^{2+}$						
copper (II)	$Cu^{2+}$						
iron (II)	$Fe^{2+}$						
iron (III)	$Fe^{3+}$						
lead (II)	$Pb^{2+}$						
lead (IV)	$Pb^{4+}$						
magnesium	$Mg^{2+}$						
dimercury (I)	$Hg_2^{2+}$						
mercury (II)	$Hg^{2+}$						
potassium	$K^+$						
silver	$Ag^+$						
sodium	$Na^+$						
zinc	$Zn^{2+}$						

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**Formula Writing**

Write formulas for the following:

Name \_\_\_\_\_

Aluminum

Aluminum sulfate

Ammonia

Ammonium nitrate

Ammonium sulfate

Bromine

Calcium

Calcium carbonate

Calcium hydroxide

Calcium oxide

Calcium phosphate

Carbon

Carbon dioxide

Carbon monoxide

Chlorine

Chromium (VI) oxide

Copper

Copper (II) nitrate

Copper (II) sulfate

Diphosphorus pentoxide

Fluorine

Hydrogen

Hydrogen chloride

Hydrogen sulfide

Iodine

Iron

Iron (III) carbonate

Iron (III) hydroxide

Iron (III) oxide

Lead (II) sulfide

Lead (IV) sulfate

Magnesium

Mercury

Nickel (II) chloride

Nitrogen

Oxygen

Silver

Sodium carbonate

Sodium hydrogen carbonate

Sodium hydrogen sulfate

Sodium hydroxide

Sodium sulfite

Sulfur dioxide

Zinc acetate

Chemistry

FW&N [REDACTED]

Name: \_\_\_\_\_

Date: \_\_\_\_\_

1. sodium fluoride \_\_\_\_\_

2. calcium oxide \_\_\_\_\_

3. iron(III) fluoride \_\_\_\_\_

4. manganese(IV) oxide \_\_\_\_\_

5. magnesium chloride \_\_\_\_\_

6. lithium nitride \_\_\_\_\_

7. oxygen difluoride \_\_\_\_\_

8. dinitrogen monoxide \_\_\_\_\_

9. carbon disulfide \_\_\_\_\_

10. nitrogen(IV) oxide \_\_\_\_\_

11. aluminum chromate \_\_\_\_\_

12. iron(II) phosphate \_\_\_\_\_

13. silver nitrate \_\_\_\_\_

14. ammonium sulfate \_\_\_\_\_

15. lithium perchlorate \_\_\_\_\_

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Chemistry

Name: \_\_\_\_\_

FW&N

Date: \_\_\_\_\_

1. sodium thiocyanate \_\_\_\_\_

2. potassium nitrite \_\_\_\_\_

3. iron(II) acetate \_\_\_\_\_

4. cobalt(II) manganate \_\_\_\_\_

5. potassium permanganate \_\_\_\_\_

6. sodium hydrogen carbonate \_\_\_\_\_

7. calcium hydrogen sulfate \_\_\_\_\_

8. magnesium hydroxide \_\_\_\_\_

9. ammonium sulfite \_\_\_\_\_

10. ammonium dichromate \_\_\_\_\_

11. copper(II) perchlorate \_\_\_\_\_

12. rubidium thiosulfate \_\_\_\_\_

13. cadmium chromate \_\_\_\_\_

14. uranium (IV) sulfate \_\_\_\_\_

15. strontium chlorate \_\_\_\_\_

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\_\_\_\_\_

Name \_\_\_\_\_

For each formula given, state the correct name. Use the stock system unless otherwise directed.

1)  $\text{Na}_2\text{O}$  \_\_\_\_\_

2)  $\text{MgF}_2$  \_\_\_\_\_

3)  $\text{Al}_2\text{O}_3$  \_\_\_\_\_

4)  $\text{Fe}_3\text{S}_2$  \_\_\_\_\_

5)  $\text{PbCl}_4$  \_\_\_\_\_

6)  $\text{CaSO}_4$  \_\_\_\_\_

7)  $\text{KNO}_2$  \_\_\_\_\_

8)  $\text{NaCN}$  \_\_\_\_\_

9)  $\text{Ni}_2(\text{PO}_4)_3$  \_\_\_\_\_

10)  $\text{PbSO}_4$  \_\_\_\_\_

11)  $\text{NaF}$  \_\_\_\_\_

12)  $\text{CaO}$  \_\_\_\_\_

13)  $\text{FeO}$  \_\_\_\_\_

14)  $\text{MgCl}_2$  \_\_\_\_\_

15)  $\text{Li}_3\text{N}$  \_\_\_\_\_

16)  $\text{OF}_2$  \_\_\_\_\_

17)  $\text{MnO}_2$  \_\_\_\_\_

18)  $\text{N}_2\text{O}$  \_\_\_\_\_

19)  $\text{NO}_2$  \_\_\_\_\_

20)  $\text{CS}_2$  (use prefix) \_\_\_\_\_

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Formula Writing: Binary Compounds

1. sodium bromide
2. calcium oxide
3. silver oxide
4. silver chloride
5. aluminum oxide
6. sodium hydride
7. calcium hydride
8. lithium oxide
9. nickel(III) bromide
10. iron(III) oxide
11. nickel(II) nitride
12. zinc iodide
13. iron(II) fluoride
14. mercury(II) nitride
15. tin(II) chloride
16. gold(III) iodide
17. lead(II) sulfide
18. copper(II) iodide
19. mercury(II) chloride
20. arsenic(III) sulfide
21. aluminum carbide
22. mercury(II) oxide
23. calcium chloride
24. cobalt(III) chloride
25. magnesium nitride
26. copper(I) fluoride
27. germanium(II) fluoride
28. manganese(II) bromide
29. magnesium iodide
30. potassium selenide
31. rubidium bromide
32. tellurium(II) chloride
33. tungsten(VI) nitride
34. uranium(IV) fluoride
35. titanium(II) oxide
36. vanadium(II) fluoride
37. sulfur dioxide
38. nitrogen dioxide
39. phosphorus trichloride
40. selenium tetrafluoride
41. boron trifluoride
42. carbon monoxide
43. tribromine octoxide
44. sulfur trioxide
45. dinitrogen tetroxide
46. manganese dioxide
47. silicon dioxide
48. dinitrogen pentoxide
49. dinitrogen monoxide
50. dinitrogen trioxide
51. carbon tetrachloride
52. dichlorine heptoxide
53. diarsenic pentasulfide
54. tetraphosphorus decoxide
55. chlorine trifluoride
56. carbon disulfide
57. dichlorine monoxide
58. xenon tetrafluoride
59. uranium hexafluoride
60. nitrogen(II) oxide
61. nitrogen(IV) oxide
62. sulfur(II) oxide
63. sulfur(IV) oxide
64. manganese(IV) oxide

Formula Writing: Ternary Compounds

1. barium chlorate
2. lithium sulfate
3. iron(II) sulfate
4. iron(III) sulfite
5. potassium permanganate
6. potassium manganate
7. sodium chlorite
8. calcium hypochlorite
9. lithium perchlorate
10. copper(II) sulfate
11. copper(I) nitrite
12. ammonium sulfide
13. nickel(II) hydrogen carbonate
14. aluminum phosphate
15. ammonium carbonate
16. sodium hydrogen sulfate
17. lead(IV) acetate
18. manganese(II) hydroxide
19. lithium phosphate
20. calcium hydrogen carbonate
21. barium dichromate
22. iron(II) chromate
23. sodium hydrogen carbonate
24. ammonium hydroxide
25. potassium hydroxide
26. sodium hydrogen sulfite
27. potassium hydrogen sulfate
28. iron(II) oxalate
29. cobalt(III) hydrogen carbonate
30. manganese(III) oxalate
31. barium hydroxide
32. titanium(II) phosphate
33. ammonium sulfate
34. uranium(IV) carbonate
35. bismuth(III) nitrate
36. silver nitrate
37. calcium phosphite
38. gold(I) dichromate
39. iron(II) hypochlorite
40. mercury(II) chromate
41. platinum(IV) carbonate
42. tin(II) chlorite
43. magnesium carbonate
44. lithium hydroxide
45. cesium chlorite
46. radium nitrate
47. strontium sulfate
48. zinc nitrate
49. beryllium sulfate
50. mercury(II) nitrate
51. manganese(II) oxalate
52. lead(II) sulfite
53. sodium bicarbonate
54. lithium bisulfate
55. potassium bisulfite
56. sodium bisulfite
57. calcium bicarbonate
58. rubidium bisulfate



**Nonmetal/Nonmetal Binary Compounds**

Write the correct formulas for the following compounds using prefixes only.

1. NO
2. ClF<sub>3</sub>
3. N<sub>2</sub>O
4. CS<sub>2</sub>
5. NO<sub>2</sub>
6. SO
7. ClO
8. SO<sub>2</sub>
9. N<sub>2</sub>O<sub>4</sub>
10. CO
11. SiO<sub>2</sub>
12. PF<sub>3</sub>
13. N<sub>2</sub>O<sub>5</sub>
14. XeF<sub>4</sub>
15. CCl<sub>4</sub>
16. BF<sub>3</sub>
17. Cl<sub>2</sub>O<sub>7</sub>
18. Br<sub>3</sub>O<sub>8</sub>
19. CF<sub>4</sub>

**Nonmetal/Nonmetal Binary Compounds:**

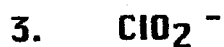
**Designation of Oxidation State With Roman Numeral**

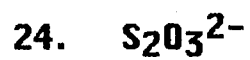
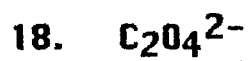
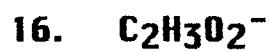
1. NO
2. N<sub>2</sub>O
3. NO<sub>2</sub>
4. SO
5. SO<sub>2</sub>
6. I<sub>2</sub>O<sub>5</sub>
7. ICl<sub>3</sub>
8. XeO<sub>3</sub>
9. SO<sub>3</sub>
10. SF<sub>4</sub>
11. SF<sub>6</sub>

Nomenclature of Ternary Compounds

- |  |  |
|--|--|
| 1. $\text{Ba}_3(\text{PO}_4)_2$        | 26. $\text{KH}_2\text{PO}_4$             |
| 2. $\text{Na}_2\text{SO}_4$            | 27. $\text{NH}_4\text{NO}_3$             |
| 3. $\text{NaHSO}_4$                    | 28. $\text{Zn}(\text{NO}_3)_2$           |
| 4. $\text{Na}_2\text{SO}_3$            | 29. $\text{KHSO}_3$                      |
| 5. $\text{NaHSO}_3$                    | 30. $\text{NaClO}_3$                     |
| 6. $\text{CaCO}_3$                     | 31. $\text{KClO}_2$                      |
| 7. $\text{Ca}(\text{HCO}_3)_2$         | 32. $\text{NaClO}$                       |
| 8. $\text{KOH}$                        | 33. $\text{Au}(\text{OH})_3$             |
| 9. $\text{K}_3\text{PO}_4$             | 34. $\text{Fe}(\text{NO}_3)_2$           |
| 10. $\text{Al}(\text{NO}_3)_3$         | 35. $\text{Fe}(\text{NO}_3)_3$           |
| 11. $\text{KNO}_2$                     | 36. $\text{Hg}(\text{NO}_3)_2$           |
| 12. $\text{NaC}_2\text{H}_3\text{O}_2$ | 37. $\text{CuSO}_4$                      |
| 13. $\text{Na}_3\text{PO}_4$           | 38. $\text{Ba}_3(\text{PO}_4)_2$         |
| 14. $\text{Ca}_3(\text{PO}_4)_2$       | 39. $\text{BeSO}_3$                      |
| 15. $\text{Mg}(\text{HCO}_3)_2$        | 40. $\text{HgSO}_4$                      |
| 16. $\text{NH}_4\text{F}$              | 41. $\text{Fe}_2(\text{SO}_4)_3$         |
| 17. $\text{NH}_4\text{OH}$             | 42. $\text{Pb}(\text{CH}_3\text{COO})_4$ |
| 18. $\text{Ba}(\text{OH})_2$           | 43. $\text{Li}_2\text{Cr}_2\text{O}_7$   |
| 19. $\text{KMnO}_4$                    | 44. $\text{AgNO}_3$                      |
| 20. $\text{K}_2\text{MnO}_4$           | 45. $\text{Co}_2(\text{CO}_3)_3$         |
| 21. $\text{MgSO}_4$                    | 46. $\text{CuNO}_3$                      |
| 22. $(\text{NH}_4)_2\text{CO}_3$       | 47. $(\text{NH}_4)_2\text{S}$            |
| 23. $\text{K}_2\text{Cr}_2\text{O}_7$  | 48. $\text{Mn}_2(\text{SO}_4)_3$         |
| 24. $\text{Na}_2\text{C}_2\text{O}_4$  | 49. $\text{Al}(\text{OH})_3$             |
| 25. $\text{KCH}_3\text{COO}$           | 50. $\text{CsNO}_3$                      |

Determine the oxidation state of each of the elements in the polyatomic ions (radicals) shown below.





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Name \_\_\_\_\_

Chem Formula Writing POP Quiz

Write the FORMULA for the following materials

1) Sulfur dioxide

\_\_\_\_\_

2) Sodium Phosphate

\_\_\_\_\_

3) Ammonium Carbonate

\_\_\_\_\_

4) Copper (II) Fluoride

\_\_\_\_\_

5) Lead (IV) Nitrate

\_\_\_\_\_

Write the NAME for the following materials

6)  $N_2O$  (use prefixes only for #6)

\_\_\_\_\_

7)  $K_2SO_4$

\_\_\_\_\_

8)  $AuCl_3$

\_\_\_\_\_

9)  $AgNO_3$

\_\_\_\_\_

10)  $CaBr_2$

\_\_\_\_\_

**Formula Writing and Nomenclature****Part I: Multiple Choice**

Place the letter of the choice that best completes the statement or answers the question into the space provided..

- \_\_\_\_\_ 1. What type of ions have names ending in *-ide*?  
a. only cations b. only anions c. only metal ions d. only gaseous ions
- \_\_\_\_\_ 2. When Group 2A elements form ions, they \_\_\_\_\_.  
a. lose two protons b. gain two protons c. lose two electrons d. gain two electrons
- \_\_\_\_\_ 3. When naming a transition metal ion that can have more than one common ionic charge, the numerical value of the charge is indicated by a \_\_\_\_\_.  
a. prefix b. suffix c. Roman numeral following the name d. superscript after the name
- \_\_\_\_\_ 4. An *-ate* or *-ite* at the end of a compound name usually indicates that the compound contains \_\_\_\_\_.  
a. fewer electrons than protons b. neutral molecules c. only two elements d. a polyatomic anion
- \_\_\_\_\_ 5. Which of the following compounds contains the  $Mn^{3+}$  ion?  
a.  $MnS$  b.  $MnBr_2$  c.  $Mn_2O_3$  d.  $MnO$
- \_\_\_\_\_ 6. Which of the following is true about the composition of ionic compounds?  
a. They are composed of anions and cations. b. They are composed of anions only. c. They are composed of cations only. d. They are formed from two or more nonmetallic elements.
- \_\_\_\_\_ 7. Which of the following formulas represents an ionic compound?  
a.  $CS_2$  b.  $BaI_2$  c.  $N_2O_4$  d.  $PCl_3$
- \_\_\_\_\_ 8. Which element, when combined with fluorine, would most likely form an ionic compound?  
a. lithium b. carbon c. phosphorus d. chlorine
- \_\_\_\_\_ 9. Which of the following compounds contains the lead(II) ion?  
a.  $PbO$  b.  $PbCl_4$  c.  $Pb_2O$  d.  $Pb_2S$
- \_\_\_\_\_ 10. What is the correct formula for potassium sulfite?  
a.  $KHSO_3$  b.  $KHSO_4$  c.  $K_2SO_3$  d.  $K_2SO_4$
- \_\_\_\_\_ 11. Select the correct formula for sulfur hexafluoride.  
a.  $S_2F_6$  b.  $F_6SO_3$  c.  $F_6S_2$  d.  $SF_6$
- \_\_\_\_\_ 12. What is the correct name for the compound  $CoCl_2$ ?  
a. cobalt(I) chlorate b. cobalt(I) chloride c. cobalt(II) chlorate d. cobalt(II) chloride
- \_\_\_\_\_ 13. What is the correct formula for barium chlorate?  
a.  $Ba(ClO)_2$  b.  $Ba(ClO_2)_2$  c.  $Ba(ClO_3)_2$  d.  $BaCl_2$
- \_\_\_\_\_ 14. Which of the following is the correct name for  $N_2O_5$ ?  
a. nitrous oxide b. dinitrogen pentoxide c. nitrogen dioxide d. nitrate oxide
- \_\_\_\_\_ 15. What is the correct name for  $Sn_3(PO_4)_2$ ?  
a. tritin diphosphate b. tin(II) phosphate c. tin(III) phosphate d. tin(IV) phosphate

NOTE: Be sure you actually do study this year...Each night, put some time in and you will see the exponential growth of your knowledge that will help you on upcoming exams in this class.

Bonding/Formula Writing and Nomenclature

Mr. Gardner