STEM Chemistry
Study Guide – Unit 4 (Bonding and Nomenclature)

Name KEY
Period _____ Date _____

1. Define the octet rule. ATOMS WILL LOSE, GAIN, OR SHARE ELECTRONS IN ORDER TO HAVE A FULL VALENCE SHELL OF ELECTRONS. A FULL VALENCE CONSISTS OF EIGHT ELECTRONS WITH THE EXCEPTION OF HYDROGEN AND HELIUM WHICH ONLY REQUIRE TWO ELECTRONS.
2. Define ionic bond, and describe properties of ionic compounds. What type of elements typically combine to form ionic compounds? AN IONIC BOND IS A CHEMICAL BOND FORMED FROM THE FORCE OF ATTRACTION BETWEEN TWO OPPOSITELY CHARGED IONS. IONIC COMPOUNDS TEND TO HAVE HIGH MELTING POINTS, ARE BRITTLE, AND DO NOT CONDUCT ELECTRICITY IN THE SOLID STATE. IONIC COMPOUNDS TYPICALLY CONSIST OF A METAL AND NONMETAL
3. Define covalent bond, and describe properties of molecular compounds. What type of elements typically combine to form a covalent bond? A COVALENT BOND IS A CHEMICAL BOND FORMED BETWEEN TWO NEUTRAL ATOMS THAT ARE SHARING VALENCE ELECTRONS. MOLECULAR COMPOUNDS TEND TO HAVE LOW MELTING POINTS. COVALENT BONDS TYPICALLY FORM BETWEEN TWO NONMETAL ELEMENTS.
4. Will two different metals combine to form a chemical bond? Explain.
   METAL ATOMS MAY COMBINE TO FORM METALLIC BONDS. HOWEVER, UNLIKE IONIC AND COVALENT BONDS, TWO DIFFERENT METAL ELEMENTS MAY BE COMBINED IN ANY RATIO TECHNICALLY CREATING A MIXTURE NOT A NEW COMPOUND.
5. Define metallic bond, and describe properties of metals.
   METAL ATOMS ARRANGED IN A NETWORK LOSE VALENCE ELECTRONS WHICH FREELY MOVE ABOUT THE METAL. THE METALLIC BOND FORMS FROM THE FORCE OF ATTRACTION BETWEEN THE METAL CATIONS AND THE MOBILE ELECTRONS. METALS ARE GOOD THERMAL & ELECTRIC CONDUCTORS, ARE DUCTILE, MALLEABLE, AND BEND EASILY.
6. Define alloy, and give some examples.
   AN ALLOY IS A MIXTURE OF TWO OR MORE METALS. BRASS = Cu & Zn
   STEEL = Fe, C, & Ni ; STERLING SILVER = Ag & Cu ; AMALGAM = Hg & Ag ; BRONZE = Cu & Sn
7. Explain why a solid metal will conduct electricity, but a solid ionic compound will not. Why will ionic compounds conduct electricity if dissolved or melted to the liquid state?
   ANY ELECTRICAL CONDUCTOR REQUIRES MOBILE CHARGE CARRIERS. THE FREE VALENCE ELECTRONS IN METALS ARE MOBILE CHARGE CARRIERS AND ENABLE THE METAL TO CONDUCT ELECTRICITY. IONIC COMPOUNDS ARE COMPOSED OF IONS, BUT IN THE SOLID STATE, THESE IONS CANNOT FREELY MOVE ABOUT. THEREFORE, THE IONIC SOLID CANNOT CONDUCT ELECTRICITY. HOWEVER, THE IONS CAN MOVE FREELY IN THE LIQUID OR DISSOLVED STATES ENABLING THE IONIC COMPOUND TO CONDUCT IN THESE INSTANCES.
8. Define the following terms regarding molecular compounds:
   a. Molecule: THE SMALLEST UNIT OF A MOLECULAR COMPOUND THAT RETAINS THE PROPERTIES OF THE OVERALL COMPOUND.
   b. Molecular Formula: A CHEMICAL FORMULA INDICATING THE EXACT NUMBER OF ATOMS OF EACH ELEMENT IN A MOLECULE.
   c. Structural Formula: A CHEMICAL FORMULA INDICATING THE EXACT NUMBER AND ARRANGEMENT OF ATOMS OF EACH ELEMENT IN A MOLECULE
   d. Empirical Formula: A CHEMICAL FORMULA INDICATING THE LOWEST WHOLE # RATIO BETWEEN ATOMS OF DIFFERENT ELEMENTS IN A COMPOUND

9. For each element, complete the following table by (a) Determining # of valence electrons; (b) Determining the charge of the most stable ion; (c) Writing the electron configuration of the ion

Element	# of valence electrons	Most likely charge	Electron configuration of ion
Ex: Sodium	*1*	Na^+	$1s^2 2s^2 2p^6$
Phosphorus	5	P^{3-}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
Magnesium	2	Mg^{2+}	$1s^2\ 2s^2\ 2p^6$
Oxygen	6	O^{2-}	$1s^2\ 2s^2\ 2p^6$
Aluminum	3	Al^{3+}	$1s^2\ 2s^2\ 2p^6$
Chlorine	7	Cl^-	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
Potassium	1	K^+	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

10. Write electron configurations for the following transition metal ions

a. Zn^{2+} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

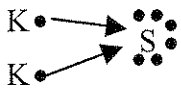
b. Cr^{6+} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

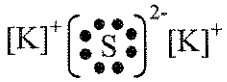
c. Fe^{3+} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

d. Co^{2+} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$

11. For the following pairs of elements, (a) draw the electron dot diagram of the neutral atoms, (b) illustrate transfer of electrons to form ions, (c) draw a Lewis structure of the compound, and (d) write the resulting chemical formula and name.

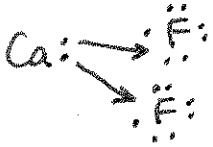
Ex. K and S

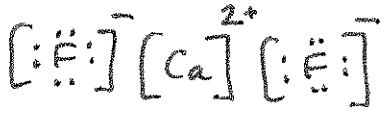




K_2S; Potassium Sulfide

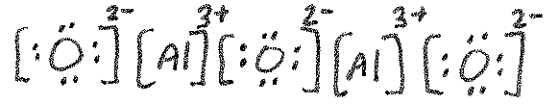
a. Ca and F





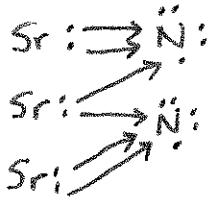
CaF_2; Calcium Fluoride

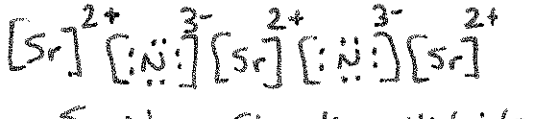
b. Al and O



Al_2O_3; Aluminum Oxide

c. Sr and N





Sr_3N_2; Strontium Nitride

13. Define single covalent bond, double covalent bond, and triple covalent bond. Compare bond lengths and bond strengths between these three types of bonds.

SINGLE COVALENT BOND = SHARING OF TWO ELECTRONS OR ONE ELECTRON PAIR BETWEEN TWO NEUTRAL ATOMS.

DOUBLE COVALENT BOND = SHARING OF FOUR ELECTRONS OR TWO ELECTRON PAIRS BETWEEN TWO NEUTRAL ATOMS.

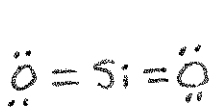
TRIPLE COVALENT BOND = SHARING OF SIX ELECTRONS OR THREE ELECTRON PAIRS BETWEEN TWO NEUTRAL ATOMS.

SINGLE, DOUBLE, TRIPLE → INCREASING STRENGTH AND DECREASING LENGTH

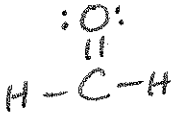
14. Draw valid Lewis diagrams for the following compounds and ions.

a. CF_4 (4+7×4=32)

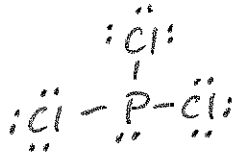
b. SiO_2 (4+6×2=16)



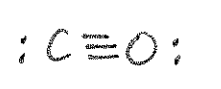
c. H_2CO (1×2+4+6=12)



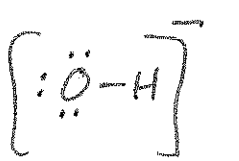
d. PCl_3 (5+7×3=26)



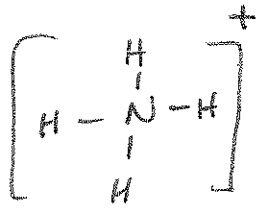
e. CO (4+6=10)



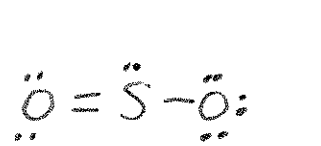
f. OH^- (6+1+1=8)



g. NH_4^+ (5+1×4−1=8)



h. SO_2 (6+6×2=18)



15. Write either the name or the formula of the common acids listed below

(a) carbonic acid H_2CO_3

(b) H_3PO_4 PHOSPHORIC ACID

(c) HNO_3 NITRIC ACID

(d) HBr HYDROBROMIC ACID

(e) hydrocyanic acid HCN

(f) $HC_2H_3O_2$ ACETIC ACID

(g) sulfuric acid H_2SO_4

(h) hydrochloric acid HCl

(i) HNO_2 NITROUS ACID

(j) nitrous acid HNO_2

16. Circle the elements that exist in nature as diatomic molecules

U	Al	(H)	He	(O)	K	(Br)	Fe
(N)	(I)	Te	S	(Cl)	Kr	(F)	C

17. Fill in the blanks in the following table

Question Number	**Compound Formula** [each blank is 1 pt]	**Type of compound (molecular or ionic)** [each blank is 0.5 pt]	**Name of compound** [each blank is 1 pt]
Example	***NaCl***	***ionic***	***Sodium Chloride***
7.	KF	IONIC	Potassium Fluoride
8.	SO_2	MOLECULAR	Sulfur Dioxide
9.	$CaCO_3$	IONIC	Calcium Carbonate
10.	N_2O_7	MOLECULAR	Dinitrogen Heptoxide
11.	$FeCl_3$	IONIC	Iron (III) Chloride
12.	$ZnSO_4$	IONIC	Zinc Sulfate
13.	NH_4Br	IONIC	Ammonium Bromide
14.	PCl_3	MOLECULAR	Phosphorus trichloride
15.	CI_4	MOLECULAR	Carbon tetraiodide
16.	Al_2O_3	IONIC	Aluminum oxide
17.	$Cr_2(SO_3)_3$	IONIC	Chromium (III) sulfite
18.	$AgNO_3$	IONIC	Silver nitrate
19.	S_2Cl_2	MOLECULAR	Disulfur dichloride
20.	PbO_2	IONIC	Lead (IV) oxide
21.	SiO_2	MOLECULAR	Silicon dioxide