Chem 115 POGIL Worksheet - Week 3
Compounds, Naming, Reaction Equations, and Formula Weights
Answers to Key Questions and Exercises

Key Questions & Exercises

1. Do all compounds contain molecules?
   No. Only molecular compounds contain molecules of the compound. (Ionic compounds may contain molecular ions, but these compounds are not composed of molecules corresponding to their empirical formulas.)

2. What is the difference between a molecular and empirical formula?
   A molecular formula represents the composition of molecules in a molecular compound. An empirical formula is the lowest whole-number ratio of elements in the compound.

3. What kinds of compounds (molecular, ionic, network) can be represented with a molecular formula?
   Only molecular compounds

4. What kinds of compounds (molecular, ionic, network) can be represented with an empirical formula?
   All three types. With ionic compounds and network solids, an empirical formula is the only appropriate type of chemical formula.

5. Using the periodic table, predict the chemical formula of the ionic compound formed by the following pairs of elements:

Ga and F	Ca and O	Na and N	Al and O
GaF_3	CaO	Na_3N	Al_2O_3

6. Complete the following table by filling in the formula for the ionic compound formed by each pair of cations and anions, as shown for the first pair.

Ion	K^+	NH_4^+	Mg^{2+}	Fe^{3+}
S^{2-}	K_2S	$(NH_4)_2S$	MgS	Fe_2S_3
NO_3^-	KNO_3	NH_4NO_3	$Mg(NO_3)_2$	$Fe(NO_3)_3$
SO_4^{2-}	K_2SO_4	$(NH_4)_2SO_4$	$MgSO_4$	$Fe_2(SO_4)_3$
PO_4^{3-}	K_3PO_4	$(NH_4)_3PO_4$	$Mg_3(PO_4)_2$	$FePO_4$

7. Predict whether each the following compounds is molecular or ionic: PF_5 - molecular, NaI - ionic, SCl_2 - molecular, B_2H_6 - molecular, $LiNO_3$ - ionic, NOCl - molecular, $CoCO_3$ - ionic, NF_3 - molecular

8. In the chemical formula and name, which element is given first, a metal or nonmetal?
Metals are a named first, then nonmetals.

9. What suffix (ending) is added to the root of the name of the nonmetal in naming an ionic compound?
The suffix -ide is added to the root; e.g., sulfur is named sulfide in an ionic compound.

10. When a metal ion can form more than one kind of cation, how is the charge on the cation indicated in the name of a compound?
The charge on the cation, which can be deduced from the know charge on the anion and the number of anions in the empirical formula, is indicated by Roman numerals in parentheses; e.g., $CrCl_3$ is chromium(III) chloride.

11. Name the following molecular compounds: SCl_2, N_2O_4, P_4O_{10}, PF_5
SCl_2 - sulfur dichloride
N_2O_4 - dinitrogen tetroxide (The "a" of tetra- is dropped before the "o" of oxide.)
P_4O_{10} - tetraphosphorous decoxide (The "a" of deca- is dropped before the "o" of oxide.)
PF_5 - phosphorous pentafluoride

12. Some molecular compounds are not named systematically, but rather retain their traditional names. Name the following compounds that retain their traditional names:
H_2O, NH_3, H_2O_2, H_2S
H_2O - water (not dihydrogen oxide)
NH_3 - ammonia (not nitrogen trihydride)
H_2O_2 - hydrogen peroxide (not dihydrogen dioxide)
H_2S - hydrogen sulfide (not dihygrogen sulfide, because there is no other hydrogen compound of sulfur)

13. Name the following ionic compounds: $AlCl_3$, Li_3PO_4, $Ba(ClO_4)_2$, $Cu(NO_3)_2$, $Fe_2(SO_4)_3$, $Ca(C_2H_3O_2)_2$, $Cr_2(CO_3)_3$, K_2CrO_4, $(NH_4)_2SO_4$
$AlCl_3$ - aluminum chloride
Li_3PO_4 - lithium phosphate
$Ba(ClO_4)_2$ - barium perchlorate
$Cu(NO_3)_2$ - copper(II) nitrate
$Fe_2(SO_4)_3$ - iron(III) sulfate
$Ca(C_2H_3O_2)_2$ - calcium acetate
$Cr_2(CO_3)_3$ - chromium(III) carbonate
K_2CrO_4 - potassium chromate
$(NH_4)_2SO_4$ - ammonium sulfate

14. Give the name or chemical formula, as appropriate, for each of the following acids:
$HClO_4$, HBr, H_3PO_4, hypochlorous acid, iodic acid, sulfurous acid
$HClO_4$ - perchloric acid
HBr - hydrobromic acid
H_3PO_4 - phosphoric acid
hypochlorous acid - HOCl (or HClO)

iodic acid - HIO_3
sulfurous acid - H_2SO_3

15. Name the following simple organic compounds: CH_4 - methane, C_2H_6 - ethane, CH_3OH methanol, C_2H_5OH - ethanol

16. Balance the following skeletal equations, using lowest whole-number coefficients:

$N_2O_5 + H_2O \rightarrow 2\ HNO_3$

$3\ Ca(OH)_2 + 2\ H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ H_2O$

$2\ C_5H_{10}O_2 + 13\ O_2 \rightarrow 10\ CO_2 + 10\ H_2O$

17. Why is it incorrect to talk about the molecular weight of NaCl?
There are no molecules of NaCl. We can only define a formula weight, based on the empirical formula.

18. Would the sum of the masses of all atoms in the chemical formula C_2H_5OH be a molecular weight or a formula weight?
This is a molecular compound, because it is composed entirely of nonmetals. Also, it is an organic compound, which we recognize as an alcohol. The given formula, then, is a molecular formula, so the sum of atomic weights multiplied by the numbers of each element would give a molecular weight.

19. Is there a difference between the molecular weight and formula weight of the molecular compound N_2O_5?
No, because the molecular formula in this case happens to involve a lowest whole-number ratio; viz., 2:5. Thus, the empirical and molecular formulas are identical.

20. Calculate the molecular weight and formula weight of glucose, $C_6H_{12}O_6$.
m.w. = (6)(12.01 u) + (12)(1.008 u) + (6)(16.00 u) = 180.15_6 u = 180.16 u
empirical formula = CH_2O
f.w. = 12.01 u + (2)(1.008 u) + 16.00 u = 30.02_{67} = 30.03 u
Note that in this case m.w. = 6 × f.w. As expected, the molecular weight is a whole number multiple of the formula weight.

21. Calculate the percent composition of glucose.

$$\%\ C = \frac{(6)(12.01)}{180.16} \times 100\% = 40.00\%$$

$$\%\ H = \frac{(12)(1.008)}{180.16} \times 100\% = 6.714\%$$

$$\%\ O = \frac{(6)(16.00)}{180.16} \times 100\% = 53.29\%$$

With possibly slight differences due to rounding, the same numbers will be obtained if the empirical formula is used, instead of the molecular formula.

$$\% \text{ C} = \frac{12.01}{30.02_{67}} \times 100\% = 40.00\%$$

$$\% \text{ H} = \frac{(2)(1.008)}{30.02_{67}} \times 100\% = 6.714\%$$

$$\% \text{ O} = \frac{16.00}{30.02_{67}} \times 100\% = 53.29\%$$