Name: _____   Date: _____

Foundations of Chemistry – Unit Practice Problems

Naming Compounds

1. Name the following ionic compounds:

   a. NH_4Cl
   b. $Fe(NO_3)_3$
   c. $TiBr_3$
   d. MgO
   e. Cu_3P
   f. $SnSe_2$
   g. $GaAs$

   h. $Pb(SO_4)_2$
   i. $Mn_2(SO_3)_3$
   j. $Al(CN)_3$
   k. $NaBr$
   l. $Sc(OH)_3$
   m. $V_2(CO_3)_3$
   n. $Ca(HCO_3)_2$

   o. $NiPO_4$
   p. Zn_3P_2
   q. $Sr(C_2H_3O_2)_2$
   r. Cu_2O
   s. Ag_3PO_4
   t. $KMnO_4$
   u. Pb_3N_2

   v. $CoCO_3$
   w. CdS
   x. $Cu(NO_2)_2$
   y. $LiNO_3$

2. Write the formula for the following ionic compounds:

   a. sodium fluoride
   b. lithium iodide
   c. silver oxide
   d. lead(II) nitride
   e. chromium(VI) phosphate
   f. magnesium carbonate
   g. tin(II) nitrate
   h. cobalt(III) oxide
   i. titanium(II) acetate
   j. zinc hydroxide
   k. iron(II) phosphate

   l. calcium selenide
   m. manganese(VII) arsenide
   n. ammonium sulfate
   o. strontium phosphide
   p. aluminum chloride
   q. copper(I) nitrate
   r. lead(IV) oxide
   s. calcium bromide
   t. aluminum dichromate
   u. silver cyanide
   v. ammonium sulfide

3. Name the following covalent compounds:

   a. CO
   b. P_2O_5
   c. NH_3

   d. SiO_2
   e. N_2
   f. C_2Br_6

   g. IO_2
   h. CCl_4
   i. N_2O_3

4. Write the formula for the following covalent compounds:

   a. tetraphosphorus triselenide
   b. disilicon hexabromide
   c. diselenium diiodide
   d. tetrasulfur dinitride
   e. hydrogen gas

   f. silicon dioxide
   g. diboron tetrabromide
   h. xenon hexafluoride
   i. dinitrogen trioxide
   j. methane

5. Name the following compounds:

   a. CoF_2
   b. PCl_3
   c. Sr_3N_2
   d. Na_2S
   e. $AgCl$

   f. $AlBr_3$
   g. P_2O_5
   h. K_3N
   i. $Al_2(SO_4)_3$
   j. FeO

   k. N_2O_3
   l. Cu_2S
   m. NH_4F
   n. Fe_2O_3
   o. $Ba(NO3)2$

   p. $CuNO_3$
   q. $Zn(C_2H_3O_2)_2$
   r. $PbCrO_4$
   s. $Fe_2(Cr_2O_7)_3$

6. Write the formula for the following compounds:
   a. barium bromide
   b. iron(II) oxide
   c. sodium phosphate
   d. nickel(II) chlorate
   e. dinitrogen tetrachloride
   f. calcium sulfide
   g. copper(II) fluoride
   h. strontium sulfate
   i. cobalt(II) nitrate
   j. lithium iodide

   k. cobalt(II) sulfide
   l. calcium acetate
   m. carbon dioxide
   n. chromium(III) sulfate
   o. phosphorus trichloride
   p. magnesium nitride
   q. dichlorine monoxide
   r. phosphorus pentachloride
   s. manganese(VII) phosphate

Writing and Balancing Equations

7. Use the following equation to answer the questions:

$$Mg\ (s) + 2\ HNO_3\ (aq) \rightarrow Mg(NO_3)_2\ (aq) + H_2\ (g)$$
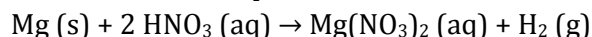
   a. Which compound is a gas?
   b. List the two products in this reaction.
   c. How many atoms of N are on the reactant side?
   d. How many atoms of O are on the product side?

8. What does aqueous mean? How is this different from a liquid? Use an example to explain.

9. For each statement:
   a. Write a word equation.
   b. Write a chemical equation, including states.
   c. Balance the equation.
      i. A solution of lead(II) nitrate is mixed with a solution of sodium iodide, which forms solid lead(II) iodide and a sodium nitrate solution.
      ii. Liquid hydrogen peroxide decomposes to form water and oxygen gas.
      iii. Liquid butane (C_4H_{10}) ignites in oxygen to form carbon dioxide gas and liquid water.

10. Balance the following equations:
   a. ___ Na_3PO_4 + ___ $KOH \rightarrow$ ___ $NaOH$ + ___ K_3PO_4
   b. ___ CF_4 + ___ $Br_2 \rightarrow$ ___ CBr_4 + ___ F_2
   c. ___ HCN + ___ $CuSO_4 \rightarrow$ ___ H_2SO_4 + ___ $Cu(CN)_2$
   d. ___ P_4 + ___ $O_2 \rightarrow$ ___ P_2O_3
   e. ___ CH_4 + ___ $O_2 \rightarrow$ ___ CO_2 + ___ H_2O
   f. ___ Al + ___ $HCl \rightarrow$ ___ H_2 + ___ $AlCl_3$
   g. ___ N_2 + ___ $F_2 \rightarrow$ ___ NF_3
   h. ___ SO_2 + ___ $Li_2Se \rightarrow$ ___ SSe_2 + ___ Li_2O
   i. ___ NH_3 + ___ $H_2SO_4 \rightarrow$ ___ $(NH_4)_2SO_4$

Types of Reactions

11. For each of the following reactions:
   a. Balance the reaction;
   b. State the type of reaction; and,
   c. Write the word equation.

   i. $\_\_ N_2 + \_\_ F_2 \rightarrow \_\_ NF_3$
   ii. $\_\_ C_{12}H_{22}O_{11} + \_\_ O_2 \rightarrow \_\_ CO_2 + \_\_ H_2O$
   iii. $\_\_ MgF_2 + \_\_ Li_2CO_3 \rightarrow \_\_ MgCO_3 + \_\_ LiF$
   iv. $\_\_ CuSO_4 + \_\_ Fe \rightarrow \_\_ Fe_2(SO_4)_3 + \_\_ Cu$
   v. $\_\_ KClO_3 \rightarrow \_\_ KCl + \_\_ O_2$

12. For each of the following reactions:
   a. Write the chemical equation;
   b. Balance the reaction; and,
   c. State the type of reaction.

   i. magnesium + silver nitrate → silver + magnesium nitrate
   ii. lead(II) oxide → lead + oxygen
   iii. aluminum chloride + sodium hydroxide → aluminum hydroxide + sodium chloride
   iv. sodium + oxygen → sodium oxide
   v. ethane + oxygen → carbon dioxide + water

Single Displacement Reactions

13. What is the general formula for a single displacement reaction? How do you know when it will occur?

14. For each reaction, determine if it will occur. If it will, write the correct products. If not, write "NR".

   a. $Ag + KNO_3$
   b. $Zn + AgNO_3$
   c. $Al + H_2SO_4$
   d. $Cl_2 + KI$
   e. $Li + H_2O$
   f. $Cu + FeSO_4$
   g. $Na + H_2O$
   h. $Fe + Pb(NO_3)_2$
   i. $Cu + H_2O$
   j. $Cu + Al_2(SO_4)$
   k. $Al + Pb(NO_3)_2$
   l. $Cl_2 + NaI$
   m. $Fe + AgC_2H_3O_2$
   n. $Al + CuCl_2$
   o. $Br_2 + CaI_2$
   p. $Al + HCl$
   q. $Mg + HCl$
   r. $Zn + H_2SO_4$
   s. $Fe + CuSO_4$
   t. $Cl_2 + MgI_2$

15. Predict the products for each reaction. If the reaction will occur, write the formulas and balance each reaction. Otherwise, write "NR".

   a. zinc + hydrogen chloride
   b. magnesium + hydrogen sulfate
   c. copper(II) chloride + fluorine
   d. silver + sodium hydroxide
   e. potassium iodide + bromine
   f. calcium + hydrogen hydroxide
   g. iron(III) oxide + hydrogen

Double Displacement Reactions

16. What is the general formula for a double displacement reaction? How do you know when it will occur?

17. Visually, how do you know when a double displacement reaction will occur?

18. Indicate whether each substance is soluble.
    a. aluminum hydroxide
    b. potassium hydroxide
    c. sodium sulfate
    d. lead(II) chloride
    e. iron(III) phosphate
    f. barium nitrate
    g. ammonium phosphate
    h. magnesium bromide
    i. tin(IV) nitrate
    j. copper(II) carbonate

19. For each pair of reactants, write the two possible products, then use the solubility rules to determine if a precipitate will form. If a reaction will occur, write the balanced molecular equation, including states.
   a. aluminum iodide + mercury(II) chloride →
    b. silver nitrate + potassium phosphate →
    c. copper(II) bromide + aluminum chloride →
    d. calcium acetate + sodium carbonate →
    e. ammonium chloride + mercury(I) acetate →
    f. calcium nitrate + hydrochloric acid →
    g. iron(II) sulfide + hydrochloric acid →
    h. copper(II) hydroxide + acetic acid ($HC_2H_3O_2$) →

Sources of Error in Measurement

20. Suppose you wanted to find the density of a solid chunk of metal. First, you find the mass of a metal on an electronic balance. Then, you fill a graduated cylinder half full and record the volume. You drop the piece of metal in and determine the volume by measuring the change in the water level. Density is then calculated by dividing mass by volume.
    a. List the sources of error in the procedure that could affect the accuracy of the result.
    b. How could the error be reduced in this procedure?

21. Write down the measurement, including units and uncertainty, for each device.
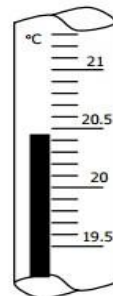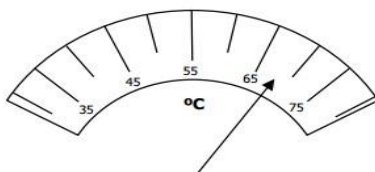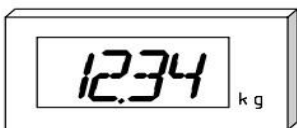
Molar Mass

22. Find the molar mass of each of the following compounds:
    a. Fluoride gas
    b. Potassium hydroxide
    c. Iron (III) chloride
    d. Ammonium sulfate
    e. Magnesium oxide
    f. Silver nitrate
    g. Methane (carbon tetrahydride)
    h. Nitrogen trihydride
    i. Dinitrogen pentoxide
    j. Sodium bromide

23. What is the name for the number of particles in one mole? What is the number?

24. Compounds X, Y and Z have the following molar masses: M_X = 50.00 g/mol, M_Y = 100.00 g/mol, M_Z = 150.00 g/mol. Assume they are covalent compounds.

    a. If you had 50.00 g of X, 100.00 g of Y and 150.00 g of Z in separate containers, what do these samples have in common?

    b. If you had 100.00 g of X and 100.00 g of Y in separate containers, which containers would have the greater number of molecules? How do you know?

    c. An individual molecule of Z has a mass that is _____ times as much as a single molecule of X.

Molar Mass Conversions

25. Determine the molar mass of each of the following:

    a. Na   b. Cu   c. Si

26. Determine the number of moles in each of the following:

    a. 23.5 g of Co   b. 216 g of Ag

27. Determine the mass of each of the following:

    a. 0.0250 mol of Au   b. 1.90×10^{-2} mol of U

28. Determine the molar mass of the following compounds:

a. KF	c. Ca_3N_2	e. $Ca(OH)_2$
b. NaOH	d. $CH_3CO_2CH_2NH_2$	f. $Al_2(SO_4)_3$

29. Determine the number of moles in each of the following:

    a. 506.3 g of C_4H_{10} b. 0.0750 g of $Ca_3(PO_4)_2$

30. Determine the mass of each of the following.

    a. 10.2 mol of KF b. 1.06 mol of $Al_2(SO_4)_3$

31. A 0.500 mol sample of table sugar, $C_{12}H_{22}O_{11}$, weighs how many grams?

32. A solution of zinc chloride, $ZnCl_2$, in water is used to soak the ends of wooden fence posts to preserve them from rotting while they are stuck in the ground. One ratio used is 840 g $ZnCl_2$ to 4 L water. How many moles per lire (mol/L) of $ZnCl_2$ are in this amount of solution?

33. If iodine is not in a person's diet, a thyroid condition called goiter develops. Iodized salt is all that it takes to prevent this disfiguring condition. Calcium iodate, $Ca(IO_3)_2$, is added to table salt to make iodized salt. How many grams of calcium iodate are needed to supply 0.500 moles of $Ca(IO_3)_2$?

34. Why does 100.0 grams of ammonia, NH_3, have so many more moles than 100.0 grams of cholesterol, $C_{27}H_{46}O$?

Concentration

35. A 0.750 L aqueous solution contains 90.0 g of ethanol, C_2H_5OH. Calculate the molar concentration of the solution.

36. What mass of sodium chloride is dissolved in 152 mL of a solution if the concentration of the solution is 0.364 M?

37. What mass of dextrose, $C_6H_{12}O_6$ is dissolved in 325 mL of 0.258 M solution?

38. A mass of 98 g of hydrogen sulfate is dissolved in water to prepare a 0.500 M solution. What is the volume of the solution?

39. A solution of sodium carbonate contains 53.0 g of solute in 215 mL of solution. What is its molarity?

40. What is the molarity of a solution of nitric acid, HNO_3 that contains 12.6 g of solute in 5.00 L of solution?

41. What mass of copper(II) nitrate is present in 50.00 mL of a 4.55×10^{-3} M aqueous solution?

42. What mass of ammonium phosphate is needed for 100.0 mL of a 0.320 M solution?

Mole Ratios and Mole Conversions
43. Given the chemical reaction: $3\ MgCl_2 + 2\ Al \rightarrow 3\ Mg + 2\ AlCl_3$
    a. Write the mole ratio for:
        i. magnesium chloride to aluminum
        ii. magnesium chloride to aluminum chloride
    b. If 8.0 moles of magnesium chloride reacts, how much aluminum chloride is produced?
    c. How many moles of magnesium chloride are needed to react with 10.0 moles of aluminum?

44. Given the chemical reaction: $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$
    a. Write the mole ratio for:
        i. iron to oxygen
        ii. iron(III) oxide to oxygen
    b. How many moles of oxygen are needed to react with 6.50 moles of iron?
    c. How many moles of iron(III) oxide is produced if 0.0746 moles of oxygen reacts?

45. Given the chemical reaction: $6\ Mg + P_4 \rightarrow 2\ Mg_3P_2$
    How many moles of magnesium phosphide is produced if 0.575 moles of phosphorus reacts?

46. Given the chemical reaction: $H_2 + Cl_2 \rightarrow 2\ HCl$
    How many moles of hydrogen and of chlorine are needed to produce 7.90 moles of hydrogen chloride?

47. Methanol reacts with oxygen in a combustion reaction to produce water and carbon dioxide.
    a. Write the chemical reaction and balance it.
    b. How many moles of methanol are needed to produce 12.7 moles of water?

48. Solid sodium reacts with water to produce sodium hydroxide and hydrogen gas.

a. Write the chemical reaction and balance it.
b. How many moles are in 0.589 g of sodium?
c. If 0.589 g of sodium reacts, how many moles of hydrogen gas are produced?
49. Given the chemical reaction: $2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + 2\ CO$ If 2.45 g of $NaHCO_3$ reacts, how many moles of water are produced?

Mass-to-Mass Conversions
50. How many grams of iron are needed to react completely with 32.0 g of sulfur, given the reaction: $Fe + S \rightarrow FeS$

51. Given the equation: $HCl + Na_2SO_4 \rightarrow NaCl + H_2SO_4$
    If 22.3 g of hydrochloric acid reacts, how many grams of sulfuric acid will be produced?

52. Calcium hydroxide reacts with hydrogen bromide to produce calcium bromide and water.
    a. Write and balance the chemical equation for this reaction.
    b. If 9.26 g of calcium hydroxide reacts, how many grams of calcium bromide will be produced?

53. Ethylene (C_2H_4) reacts with oxygen gas to produce carbon dioxide and water. If 45.1 g of ethylene reacts, how many grams of carbon dioxide will be produced?

Percent Yield
54. A test is out of 65 marks. You got 58 marks on the test.
    a. What is the theoretical yield?
    b. What is the actual yield?
    c. What is the percent yield?

55. In a chemical reaction, 4.3 g of precipitate is supposed to be produced. However, only 3.8 g was produced.
    d. What is the theoretical yield?
    e. What is the percent yield?

56. Given the equation: $CaCO_3 + 2\ HCl \rightarrow CaCl_2 + H_2O + CO_2$
    f. How much carbon dioxide will be produced if 0.672 g of calcium carbonate reacts?
    g. If 0.254 g of carbon dioxide is actually produced, what is the percent yield?

57. Given the equation: $2\ NH_3 \rightarrow N_2 + 3\ H_2$
    h. What is the theoretical yield of hydrogen if 0.475 g of ammonia reacts?
    i. How much hydrogen is produced if the percent yield is 63.9%?

58. A reaction occurs between propane (C_3H_8) and oxygen.
    j. What type of reaction is this?
    k. Write and balance the chemical equation for this reaction.
    l. If 5.40 g of propane reacts, what is the theoretical yield of water?
    m. When 5.40 g of propane reacts, the percent yield of carbon dioxide is 76.2%. What mass of carbon dioxide is formed?

59. A reaction occurs between iron(III) phosphate and sodium sulfate.
   n. What type of reaction is this?
   o. Write and balance the chemical equation for this reaction.
   p. If 25.0 g of iron(III) phosphate reacts, what mass of iron(III) sulfate will be formed?
   q. When 25.0 g of iron(III) phosphate is reacted, 18.5 g of iron(III) sulfate is produced. What is the percent yield?
   r. Is the answer from (d) reasonable? Explain.
   s. If 15.0 g of sodium sulfate reacts and the percent yield is 65.0%, how many grams of sodium phosphate is formed?

Limiting Reactants
60. Given the equation: $Al_2(SO_3)_3$ + 6 NaOH $\longrightarrow$ 3 Na_2SO_3 + 2 $Al(OH)_3$
   a. If 10.0 g of $Al_2(SO_3)_2$ is reacted with 10.0 g of NaOH, which reactant is limiting?
   b. Determine the number of moles of $Al(OH)_3$ produced.
   c. Determine the mass of the excess reactant remaining at the end of the reaction.

61. Given the equation: Mg + HCl $\longrightarrow$ H_2 + $MgCl_2$
   a. What is the limiting reactant when 6.00 g of HCl reacts with 5.00 g of Mg?
   b. What is the maximum number of grams of H_2 that can be formed?
   c. Determine the mass of the excess reactant remaining at the end of the reaction.

62. Given the reaction: H_2CO_3 + 2 LiOH $\longrightarrow$ Li_2CO_3 + 2 H_2O
   44.5 grams of carbonic acid is mixed with with 32.3 grams of lithium hydroxide. How many grams of lithium carbonate are produced?

63. 2.33 grams of chlorine gas reacts with 43.0 grams of sodium bromide to produce bromine gas and sodium chloride.
   a. Write and balance the chemical equation for this reaction.
   b. How many grams of bromine gas are produced?

64. A double displacement reaction occurs when 45.3 moles of sodium iodide react with 34.8 grams of lead (II) nitrate. How many grams of solid product are produced?