CHEM 1311
Practice Problems
Stoichiometry

1. (6.44) Calculate the molecular masses of the following substances:
   a. Hg_2Cl_2 b. $C_4H_8O_2$ (butyric acid, responsible for the odor of rancid butter)
   c. CF_2Cl_2

2. (6.45) What are the formulas of the following substances?
   a. $PCl_?$; mol mass = 137.3 b. Nicotine, $C_{10}H_{14}N_?$; mol mass = 162.2

3. (6.46) Determine the molecular masses of the following pharmaceuticals:
   a. $C_{33}H_{35}FN_20_5$ (atorvastatin, lowers blood cholesterol)
   b. $C_{22}H_{27}F_3O_4S$ (fluticasone, anti-inflammatory)
   c. $C_{16}H_{16}ClNO_2S$ (clopidogrel, inhibits blood clots)

4. (6.47) Calculate the molecular masses of the following herbicides:
   a. $C_6H_6Cl_2O_3$ (2,4-dichlorophenpxyacetic acid, effective on broadleaf plants)
   b. $C_{15}H_{22}ClNO_2$ (metolachlor, pre-emergent herbicide)
   c. $C_8H_6Cl_2O_3$ (dicamba, effective on broadleaf plants)

5. (6.48) Find the mass in grams that are in a mole of each of the following substances:
   a. Ti b. Br_2 c. Hg d. H_2O

6. (6.52) Calculate the molecular mass of chloroform if 0.0275 mol has a mass of 3.28 g.

7. (6.53) Obtain the molecular mass of cholesterol if 0.5731 mol has a mass of 221.6 g.

8. (6.54) Iron (II) sulfate, $FeSO_4$, is prescribed for the treatment of anemia. How many moles of $FeSO_4$ are present in a standard 300 mg tablet?

9. (6.55) The “lead” in pencils is almost pure carbon, and the mass of a period mark made by a lead pencil is about 0.0001 g. Determine the number of carbon atoms that are in the period.

10. (6.56) An average cup of coffee contains about 125 mg of caffeine, $C_8H_{10}N_4O_2$. Calculate the number of moles of caffeine that are in a cup. Calculate the number of caffeine molecules that are in a cup.

11. (6.60) Titanium metal is obtained from the mineral rutile, TiO_2. Find how many kilograms of rutile are needed to produce 100.0 Kg of Ti.

12. (6.61) Iron metal can be produced from the mineral hematite, Fe_2O_3, by the reaction with carbon. Calculate the mass in kilograms of iron present in 105 Kg hematite.

13. (6.62) In the preparation of iron from hematite, Fe_2O_3 reacts with carbon according to the following equation: $Fe_2O_3 + C \rightarrow Fe + CO_2$
    a. Balance the equation.
    b. Determine the number moles of carbon needed to react with 525 g of hematite.
    c. Determine the mass in grams of carbon needed to react with 525 g of hematite.

14. (6.64) Magnesium metal burns in oxygen to form magnesium oxide, MgO.
    a. Balance the equation.
    b. Determine the mass in grams of oxygen needed to react with 25.0 g of Mg.
    c. From (b) Determine the mass in grams of MgO produced.
    d. Calculate the mass in grams of Mg that are needed to react with 25.0 g of O_2.
    e. From (d) Determine the mass in grams of MgO produced.

15. (6.65) Ethylene gas, C_2H_4, reacts with water at high temperature to yield ethyl alcohol, C_2H_6O.
    a. Calculate the mass in grams of ethylene needed to react with 0.133 mol of H_2O.
    b. Determine the mass in grams of water needed to react with 0.371 mol of ethylene.

16. (6.66) Pure oxygen was first made by heating mercury (II) oxide: $HgO \xrightarrow{heat} Hg + O_2$
    a. Balance the equation
    b. Determine the mass in grams of mercury and how many grams of oxygen formed from 45.5 g of HgO.
    c. Calculate the mass in grams of HgO would be needed to obtain 33.3 g O_2.

17. (6.67) Titanium dioxide (TiO_2), the substance used as the pigment in white paint, is prepared industrially by the reaction of $TiCl_4$ with O_2 at high temperature.
    $$TiCl_4 + O_2 \xrightarrow{heat} TiO_2 + 2Cl_2$$
    Determine the mass in kilograms of TiO_2 prepared from 5.60 Kg $TiCl_4$.

18. (6.68) Silver metal reacts with chlorine (Cl_2) to yield silver chloride. Providing 2.00 g of Ag reacts with 0.657 g Cl_2, Obtain the empirical formula of silver chloride.

19. (6.69) Aluminum reacts with oxygen to yield aluminum oxide. Providing 5.0 g of Al reacts with 4.45 g of O_2, calculate the empirical formula of aluminum oxide.

20. (6.70) The industrial production of hydriodic acid takes place by the treatment of iodine with hydrazine (N_2H_4) according to the following equation: $2I_2 + N_2H_4 \rightarrow 4HI + N_2$
    a. Determine the mass in grams of I_2 required to react with 36.7 g of N_2H_4.
    b. Determine the mass in grams of HI produced by the reaction of 115.7 g of N_2H_4 with excess iodine.

21. (6.71) An alternative method for production of hydriodic acid is the reaction of iodine with hydrogen sulfide according to the following equation: $H_2S + I_2 \rightarrow 2HI + S$
    a. Determine the mass in grams of I_2 required to react with 49.2 g of H_2S.
    b. Determine the mass in grams of HI produced by the reaction of 95.4 g of H_2S with excess I_2.

22. (6.86) An unknown liquid is composed of 5.57% H, 28% Cl, and 66.42% C. The molecular mass is 126.58. Give the molecular formula of this compound.

23. (6.87) An unknown liquid is composed of 34.31 % C, 5.28% H, and 60.41 % I. The molecular mass is 210.07. Discover the molecular formula.

24. (6.88) Calculate the empirical formula of stannous fluoride, the first fluoride compound added to toothpaste to protect teeth against decay. Its mass percent composition is 24.25% F and 75.75% Sn.

25. (6.89) Determine the empirical formulas of each of the following:

    a. Ibuprofen, a headache remedy: 75.69% C, 15.51% O, 8.80% H
    b. Magnetite, a naturally occurring magnetic mineral: 72.36% Fe, 27.64% O
    c. Zircon, a mineral from which cubic zirconia is made: 34.91% O, 15.32% Si, 49.77% Zr

26. (6.90) Combustion analysis of 45.62 mg of toluene, a commonly used solvent, gives 35.67 mg of H_2O and 152.5 mg CO_2. Calculate the empirical formula for toluene.

27. (6.99) The stimulate amphetamine contains only carbon, hydrogen, and nitrogen. Combustion analysis of a 42.92 g sample of amphetamine gives 37.187 mg H_2O and 125.75 mg CO_2. Providing the molar mass of amphetamine is less than 160 g/mol, determine the molecular formula.

28. (6.72) Assume that you have 1.39 mol of H_2 and 3.44 mol of N_2. How many grams of ammonia (NH_3) can be made, and how many grams of which reactant will be left over?

    $$3H_2 + N_2 \rightarrow 2NH_3$$

29. (6.73) Hydrogen and chlorine react to yield hydrogen chloride: $H_2 + Cl_2 \rightarrow 2HCl$

Determine the mass in grams of HCl formed from reacting 3.56 g H_2 with 8.94 g Cl_2. Determine the limiting reactant.

30. (6.76) Nickel (II) sulfate, used for nickel plating, is prepared by treatment of nickel (II) carbonate with sulfuric acid: $NiCO_3 + H_2SO_4 \rightarrow NiSO_4 + CO_2 + H_2O$
Determine the number of grams $NiSO_4$ needed to react with 14.5 g of $NiCO_3$.

31. (6.77) Hydrazine, N_2H_4, once used as a rocket propellent, with oxygen:
$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$
Calculate the grams of O_2 required to react with 50.0 g of N_2H_4.

32. (6.100) Determine the number of moles of solute present in each of the following solutions:

(a) 35.0 mL of 1.200 M HNO_3

(b) 175 mL of 0.67 M glucose ($C_6H_{12}O_6$)

33. (6.101) In preparing each of the following solutions, find the mass of solute needed:

(a) 250.0 mL of 0.600 M ethyl alcohol (C_2H_6O)

(b) 167 mL of 0.200 M boric acid (H_3BO_3)

34. (6.102) Determine the volume in mL of a 0.350 M KOH solutions containing 0.0171 mol of KOH.

35. (6.105) The concentration of glucose ($C_6H_{12}O_6$) in normal blood is approximately 90 mg per 100 mL. Calculate the molarity of blood glucose.