Summer Assignment for Rising Juniors

On a separate sheet of paper – show all of your work and watch your significant digits and units. Assignment is due on the first day of school.

1. Take the reaction: $NH_3 + O_2 \rightarrow NO + H_2O$. In an experiment, 3.25 g of NH_3 are allowed to react with 3.50 g of O_2.

   a. Which reactant is the limiting reagent?

   b. How many grams of NO are formed?

   c. How much of the excess reactant remains after the reaction?

2. If 4.95 g of ethylene (C_2H_4) are combusted with 3.25 g of oxygen.

   a. What is the limiting reagent?

   b. How many grams of CO_2 are formed?

3. Consider the reaction of $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$

   a. What is the theoretical yield of C_6H_5Br if 42.1 g of C_6H_6 react with 73.0 g of Br_2?

   b. If the actual yield of C_6H_5Br is 63.6 g, what is the percent yield?

4. Use the following reaction: $C_4H_9OH + NaBr + H_2SO_4 \rightarrow C_4H_9Br + NaHSO_4 + H_2O$ If 15.0 g of C_4H_9OH react with 22.4 g of NaBr and 32.7 g of H_2SO_4 to yield 17.1 g of C_4H_9Br, what is the percent yield of this reaction?

5. Silicon nitride (Si_3N_4) is made by a combining Si and nitrogen gas (N_2) at a high temperature. How much (in g) Si is needed to react with an excess of nitrogen gas to prepare 125 g of silicon nitride if the percent yield of the reaction is 95.0%?

6. Souring of wine occurs when ethanol is converted to acetic acid by oxygen by the following reaction: $C_2H_5OH + O_2 \rightarrow CH_3COOH + H_2O$. A 1.00 L bottle of wine, labeled as 8.5% (by volume) ethanol, is found to have a defective seal. Analysis of 1.00 mL showed that there were 0.0274 grams of acetic acid in that 1.00 mL. The density of ethanol is 0.816 g/mL and the density of water is 1.00 g/mL.

   a. What mass of oxygen must have leaked into the bottle?

   b. What is the percent yield for the conversion of ethanol to acetic acid if O_2 is in excess?

7. H_3PO_4, Phosphoric acid, is used in detergents, fertilizers, toothpastes and flavoring in carbonated beverages. Calculate the percent composition by mass to two decimal places of H, P and O in this compound.

8. What is the percent composition by mass of aspartame ($C_{14}H_{18}N_2O_5$), the artificial sweetener NutraSweet?

9. Ascorbic acid (vitamin C) is 40.92% C, 4.58% H and 54.50% O by mass. What is the empirical formula of ascorbic acid?

10. What is the empirical formula of each of the following compounds?

a. Talc by mass composition contains 19.2% Mg, 29.6% Si, 42.2% O and 9.0% H.

b. Saccharin has by mass composition 45.89% C, 2.75% H, 7.65% N, 26.20% O and 17.50% S.

c. Salicylic Acid, used in aspirin, contains 60.87% C, 4.38% H, and 34.75% O by mass composition.

d. L-Dopa, a drug used for the treatment of Parkinson's disease, is 54.82% C, 5.62% H, 7.10% N, and 32.46% O by mass composition.

11. Determine the empirical formula of the following compounds that underwent combustion analysis.

a. Toluene is composed of C and H and yields 5.86 mg of CO_2 and 1.37 mg of H_2O after combustion.

b. 0.1005 g of menthol, which is composed of C, H, and O, yields 0.2829 g CO_2 and 0.1159 g H_2O after combustion.

12. What is the molecular formula of benzoyl peroxide (the empirical formula is $C_7H_5O_2$) if the molecular mass is 242 g/mol?

13. What are the empirical and molecular formulas of the following compounds?

a. Ibuprofen by mass composition is 75.69% C, 8.80% H and 15.51% O and the molecular mass is approximately 206 g/mol.

b. Caffeine contains by mass composition 49.5% C, 5.15% H, 28.9% N and 16.5 % O and the molecular mass is about 195 g/mol.