

# 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:  $\text{NH}_3 + \text{O}_2 \rightarrow \text{NO} + \text{H}_2\text{O}$ . In an experiment, 3.25 g of  $\text{NH}_3$  are allowed to react with 3.50 g of  $\text{O}_2$ .
  - a. Which reactant is the limiting reagent?
  - b. How many grams of  $\text{NO}$  are formed?
  - c. How much of the excess reactant remains after the reaction?
2. If 4.95 g of ethylene ( $\text{C}_2\text{H}_4$ ) are combusted with 3.25 g of oxygen.
  - a. What is the limiting reagent?
  - b. How many grams of  $\text{CO}_2$  are formed?
3. Consider the reaction of  $\text{C}_6\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_6\text{H}_5\text{Br} + \text{HBr}$ 
  - a. What is the theoretical yield of  $\text{C}_6\text{H}_5\text{Br}$  if 42.1 g of  $\text{C}_6\text{H}_6$  react with 73.0 g of  $\text{Br}_2$ ?
  - b. If the actual yield of  $\text{C}_6\text{H}_5\text{Br}$  is 63.6 g, what is the percent yield?
4. Use the following reaction:  $\text{C}_4\text{H}_9\text{OH} + \text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{C}_4\text{H}_9\text{Br} + \text{NaHSO}_4 + \text{H}_2\text{O}$  If 15.0 g of  $\text{C}_4\text{H}_9\text{OH}$  react with 22.4 g of  $\text{NaBr}$  and 32.7 g of  $\text{H}_2\text{SO}_4$  to yield 17.1 g of  $\text{C}_4\text{H}_9\text{Br}$ , what is the percent yield of this reaction?
5. Silicon nitride ( $\text{Si}_3\text{N}_4$ ) is made by a combining Si and nitrogen gas ( $\text{N}_2$ ) 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:  $\text{C}_2\text{H}_5\text{OH} + \text{O}_2 \rightarrow \text{CH}_3\text{COOH} + \text{H}_2\text{O}$ . 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  $\text{O}_2$  is in excess?

7.  $\text{H}_3\text{PO}_4$ , 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 ( $\text{C}_{14}\text{H}_{18}\text{N}_2\text{O}_5$ ), 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  $\text{CO}_2$  and 1.37 mg of  $\text{H}_2\text{O}$  after combustion.
  - b. 0.1005 g of menthol, which is composed of C, H, and O, yields 0.2829 g  $\text{CO}_2$  and 0.1159 g  $\text{H}_2\text{O}$  after combustion.
12. What is the molecular formula of benzoyl peroxide (the empirical formula is  $\text{C}_7\text{H}_5\text{O}_2$ ) 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.