CHE 141 Workshop 2 Problems

Chapter 3: Stoichiometry (Balancing equations and related problems)

1. A student wanted to produce hydrogen gas in the laboratory by combustion of methane gas according to: \(2\text{CH}_4(g) + \text{O}_2(g) = 2\text{CO}(g) + 4\text{H}_2(g)\). To get a source for pure oxygen, the student utilized: \(2\text{KClO}_3(s) = 2\text{KCl}(s) + 3\text{O}_2(g)\).

Assuming that in both the steps we get 100% conversions (something industrialists always wish for in real life), what is the mass of hydrogen produced if 37.26 Kg of solid \(\text{KClO}_3\) was heated?

2. Theobromine is composed of C, H, N and O. Combustion of 1.2 g of theobromine in excess oxygen produces three different gases. By cooling the mixture at 25 °C, a colorless liquid (\(\text{H}_2\text{O}\)) of mass 0.48 g was isolated. By cooling the remaining part of the mixture at 0 °C resulted in isolation of a brown liquid (\(\text{NO}_2\), 1.226 g), and a colorless, odorless gas (\(\text{CO}_2\), 2.053 g). Find out:

   a. What is the molecular formula for theobromine?
   
   b. What is the balanced equation of combustion for theobromine?
   
   c. What is the % composition of the elements in theobromine?

   [DO THIS PROBLEM ON THE PAPER WITH YOUR NAME AND BARCODE TO SUBMIT AT THE END OF THE CLASS]

3. Starting with 1.0 Mg of NaCN and 5.0 Mg of Br\(_2\), cyanogen bromide (CNBr) is produced industrially in a two-step process as follows:

   \(2\text{NaCN}(s) + \text{Br}_2(l) = (\text{CN})_2(g) + 2\text{NaBr}(s)\) \hspace{1cm} \text{yield for (CN)}_2 = 80\% \text{ (by mole)}

   \((\text{CN})_2(g) + \text{Br}_2(l) = 2\text{CNBr}(s)\) \hspace{1cm} \text{yield for CNBr} = 90\% \text{ (by mole)}

   With this information calculate:

   a. Which one is the limiting reagent?
   
   b. What is the overall absolute and percent yield of the reaction?
   
   c. How much excess of the non-limiting reagent remains after the reaction is complete?