**Competency 5: Practice Problems #2**

1. A sample of 1.000 g of a compound containing carbon and hydrogen reacts with oxygen at an elevated temperature to yield 0.692 g of water and 3.381 g carbon dioxide.

a. Calculate the mass of carbon and hydrogen in the sample.
b. Does the compound contain any other elements?
c. What are the mass percentages of carbon and hydrogen in the compound?
d. What is the empirical formula of the compound?

2. The Haber process is given by the following equation:

$$N_{2(g)} + 3H_{2(g)} \text{ -----> } 2NH_{3(g)}$$

a. What mass of ammonia can be obtained by complete reaction of 0.267 mol of nitrogen?
b. What mass of hydrogen is needed to produce 0.275 mol of ammonia?
c. How many moles of hydrogen are required to produce 1.00 kg of ammonia?
d. What mass of ammonia could be produced by complete reaction of 66.6 g of hydrogen?
e. What mass of hydrogen would be required for complete reaction of 88.8 g of nitrogen?
f. If 27.7 g of ammonia was obtained from the reaction of 18.4 g of hydrogen with excess nitrogen, what is the percent yield?

3. a. If 30.0 g of zinc is reacted with 25.0 g of hydrochloric acid, which reactant is in excess?
b. If 35.0 g of zinc chloride was obtained from the above amounts, what is the percentage yield?

4. The reaction of hydrazine, $N_2H_4$, with hydrogen peroxide, $H_2O_2$, has been used to propel rockets:

$$N_2H_{4(l)} + 2H_2O_{2(l)} \text{ -----> } N_{2(g)} + 4H_2O_{(g)}$$

a. How many moles of nitrogen can be obtained from 1.00 kg of hydrazine and exesss hydrogen peroxide?
b. What is the total number of moles of products produced from the reactants in (a) ?
c. What mass of hydrogen peroxide is needed to completely use up the 1.00 kg of hydrazine?
d. If 33.5 g of hydrazine is reacted with 30.3 g of hydrogen peroxide, which is the limiting reactant, and how much of the reactant in excess is left over?
e. If 29.0 g of water are obtained from the amounts in (d) what is the percentage yield?

5. Vanadium and oxygen form a series of compounds that have the following compositions:

| Mass % V | Mass % O |
|---|---|
| 76.10 | 13.90 |
| 67.98 | 32.02 |
| 61.42 | 38.58 |
| 56.02 | 43.98 |

What are the relative numbers of atoms of oxygen in the compounds for a given mass of vanadium?

6. The clay mineral kaolinite, a major component of many ceramics, has the chemical formula $Al_4Si_40_{18}(OH)_8$. Calculate the percentage by mass of each of the four elements in kaolinite.

7. Many of the activities of man introduce sulfur dioxide into the atmosphere. The sulfur dioxide is then converted into sulfuric acid according to the following reaction:

$$\mathbf{2S0_{2(g)} + 0_{2(g)} + 2H_20_{(l)} \rightarrow 2H_2S0_{4(aq)}}$$

a. What mass of sulfuric acid could be formed from 1.00 kg of sulfur dioxide and 325 g of oxygen with excess water?
b. If the percent yield is 88.3%, what mass of sulfur dioxide would have to react with excess water and oxygen to form 35.3 g of sulfuric acid?

8. A sample of $P_4$ is burned in 32.0 g of oxygen according to

$$\mathbf{P4(s) + 502(g) \rightarrow P4010(g)}$$

Enough oxygen is left over to convert 15.0 g of $S_8$ to $SO_2$. How many moles of $P_4$ were burned?

9. An element **X** has a dibromide whose empirical formula is $XBr_2$ and a dichloride whose empirical formula is $XCl_2$. The dibromide is completely converted to the dichloride when it is heated in a stream of chlorine according to the equation

$$\mathbf{XBr_2 + C1_{2(g)} \rightarrow XCl_2 + Br_{2(l)}}$$

When 1.500 g of $XBr_2$ is treated, 0.890 g of $XCl_2$ is produced.

a. Calculate the atomic mass of X.
b. By reference to a periodic table, identify element X.