Name _____ AP Problems Stoichiometry Unit

1. A 10.0 gram sample containing calcium carbonate and an inert material was placed in excess hydrochloric acid. A reaction occurred, producing calcium chloride, water, and carbon dioxide.

   (a) Write the balanced equation for the reaction.

   (b) When the reaction was completed, 900. mL of carbon dioxide gas was collected 740 mmHg and 30°C. How many moles of calcium carbonate were in the reaction?

   (c) If all of the calcium carbonate initially present in the sample was consume in the reaction, what percent by mass of the sample was due to calcium carbonate?

   (d) If the inert material was silicon dioxide, what was the molar ratio of calcium carbonate to silicon dioxide in the original sample?

2. A gaseous hydrocarbon sample is completely burned in air, producing 1.80 liters of carbon dioxide at standard temperature and pressure and 2.16 grams of water. At standard temperature and pressure for only gases, 22.4 L = 1 mole.

   (a) What is the empirical formula for the hydrocarbon?

   (b) What was the mass of the hydrocarbon consumed?

   (c) The hydrocarbon was initially contained in a closed 1.00 L vessel at a temperature of 32°C and a pressure of 760 mm of Hg. What is the molecular formula of the hydrocarbon?

   (d) Write the balanced equation for the combustion of the hydrocarbon.

3. The table below shows three common forms of copper ore.

ORE #	Empirical Formula	Percent by Weight		
		Copper	Sulfur	Iron
1	Cu_2S	?	?	0
2	?	34.6	34.9	30.5
3	?	55.6	28.1	16.3

(a) What is the percent by weight of copper in Cu_2S?

(b) What is the empirical formula of ore #2?

(c) If a sample of ore #3 contains 11.0 grams of iron, how many grams of sulfur does it contain?

(d) Cu can be extracted from Cu_2S by the following process:

$$3\ Cu_2S + 3\ O_2 \rightarrow 3\ SO_2 + 6\ Cu$$

If 3.84 grams of O_2 are consumed in the process, how many grams of Cu are produced?

4. Combustion of 8.652 grams of a compound containing C, H, O, and N yields 11.088 grams of CO_2, 3.780 grams of H_2O and 3.864 grams of NO_2.

   (a) How many moles of C, H, and N are contained in the sample?

   (b) How many grams of oxygen are contained in the sample?

   (c) What is the simplest formula of the compound?

   (d) If the molar mass of the compound is 206 g/mol, what is its molecular formula?

   (e) Write and balance a chemical equation for the combustion of the compound.

5. Answer the following questions relating to gravimetric analysis.

In the first of two experiments, a student is assigned the task of determining the number of moles of water in one mole of $CuSO_4 \cdot n\,H_2O$. The student collects the data shown in the following table.

Mass of the evaporating dish	42.75 g
Initial mass of sample of hydrate and evaporating dish	44.71 g
Mass of hydrate and evaporating dish after first heating	44.86 g
Mass of hydrate and evaporating dish after second heating	43.99 g
Mass of hydrate and evaporating dish after third heating	44.00 g

(a) Explain why the student can correctly conclude that the hydrate was heated a sufficient number of times in the experiment.

(b) Use the data above to

(i) calculate the total number of moles of water lost when the sample was heated, and

(ii) determine the formula of the hydrated compound.

(c) A different student heats the hydrate in an uncovered crucible, and some of the solid spatters out of the crucible. This spattering will have what effect on the calculated mass of the water lost by the hydrate? Justify your answer.

In the second experiment, a student is given 9.21 g of a mixture containing anhydrous $CuSO_4$ and KNO_3 . To determine the percentage by mass of $CuSO_4$ in the mixture, the student uses excess $Na_2CO_3(aq)$ to precipitate the copper ion as $CuCO_3(s)$.

(d) Starting with the 9.21 g sample of the mixture dissolved in water; briefly describe the steps necessary to quantitatively determine the mass of the $CuCO_3$ precipitate.

(e) The student determines the mass of the $CuCO_3$ precipitate to be 6.74 g. On the basis of this information, calculate each of the following.

(i) The number of moles of $CuSO_4$in the original mixture

(ii) The percent by mass of $CuSO_4$ in the original mixture