AP Problems Practice

1. **(2016)**To determine the molar mass of an unknown metal, M, a student reacts iodine with an excess of the metal to form the water-soluble compound MI_2, as represented below. The reaction proceeds until all of the I_2 is consumed. The $MI_2(aq)$ is quantitatively collected and heated to remove the water, and the product is dried and weighed to constant mass. The following data table provides the data collected throughout the experiment.

$$M + I_2 \rightarrow MI_2$$

Data for Unknown Metal Lab	
Mass of beaker	125.457g
Mass of beaker + metal M	126.549g
Mass of beaker + M + I_2	127.576g
Mass of MI_2, first weighing	1.284g
Mass of MI_2, second weighing	1.284g

(a) Given that Metal M is in excess, calculate the number of moles of I_2 that reacted.
(b) Calculate the molar mass of the unknown metal M.
(c) Identify M.
(d) Thinking about the law of multiple proportions, what is another compound that could be made with these two elements?
(e) Write a balanced equation to show this new reaction.

2. (1982) Water is added to 4.267g of UF_6. The only products are 3.730grams of a solid containing only uranium, oxygen, and fluorine and 0.970g of a gas. The gas is 95.0% fluorine, and the remainder is hydrogen.

(a) From these data, determine the empirical formula of the gas.
(b) What fraction of fluorine of the original compound is in the solid and what fraction in the gas after the reaction?
(c) What is the formula of the solid product?
(d) Write a balanced equation for the reaction between UF_6 and H_2O. Assume the empirical formula of the gas is the true formula.

3. (1991) The molecular formula of a hydrocarbon is to be determined by analyzing its combustion products.

(a) The hydrocarbon burns completely, producing 7.2grams of water and 7.2liters of CO_2 at STP. What is the empirical formula of the hydrocarbon?
(b) Calculate the mass of O_2 required for the complete combustion of the sample of hydrocarbon described in (a)
(c) If the molar mass of the hydrocarbon was determined to be 56.16g/mol, what is the molecular formula?

4. (1986) Three volatile compounds X, Y, Z contain element Q. The percent by weight of element Q in each compound was determined. Some of the data obtained are given below:

compound	Percent by weight of element Q	Molecular weight
X	64.8%	?
Y	73.0%	104.
Z	59.3%	64.0

(a) The density of compound X at 27°C and 750. mmHg was determined to be 3.52 g/L. Calculate the molecular weight of compound X.
(b) Determine the mass of element Q contained in 1.00 mole of each of the three compounds.
(c) Calculate the most probable value of the atomic weight of element Q.
(d) Compound Z contains carbon, hydrogen, and element Q. When 1.00 grams of compound Z is oxidized and all of the carbon and hydrogen are converted to oxides, 1.37 grams of CO_2 and 0.281 grams of water are produced. Determine the most probable molecular formula of compound Z.

5. (2003B) Iron (III) oxide can be reduced with carbon monoxide according to the below equation:

$$Fe_2O_3\,(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

(a) Determine how many moles of CO(g) are available to react if 16.2L sample of CO(g) at 1.40atm and 200.°C.
(b) If the amount of CO(g) in (a) is combined with 15.39g of $Fe_2O_3(s)$, determine the limiting reactant.
(c) How many moles of Fe(s) are formed in the reaction?
(d) If you ran this experiment in an open container, how would the mass of reactants compare with the mass of products? Justify your answer.

6. (Kubacki) A sample of soluble metallic chloride (MCl_2) is dissolved in water. An excess of silver nitrate is added and all of the silver chloride is precipitated.

(a) Write a balanced equation to represent the reaction described above.
(b) If the original sample contained 5.00g of MCl_2 and the final precipitate weighed 6.885g, what is the atomic mass of element M?
(c) Identify element M.
(d) What is the percent yield of the precipitate collected?