1) Theobromine (which, despite its name, does not contain any bromine.) is the active stimulant ingredient in chocolate. Analysis of theobromine, which contains only C, H, N, and O, shows that it is 47.73% C, 2.29% H, and 31.81% N. If the $M_m$ of theobromine is 176.135 g, determine both the empirical and molecular formulas of theobromine. (Note I need to see two formulas, even if they work out to be the same!)

2) Hydrogen cyanide, HCN, can be made by a two-step process. First, ammonia is reacted with O$_2$ to give nitric oxide, NO.

$$4\text{NH}_3(g) + 5\text{O}_2(g) \rightarrow 4\text{NO}_2(g) + 6\text{H}_2\text{O}(g)$$

Then nitric oxide is reacted with methane, CH$_4$.

$$2\text{NO}_2(g) + 2\text{CH}_4(g) \rightarrow 2\text{HCN}_2(g) + 2\text{H}_2\text{O}(g) + \text{H}_2(g)$$

When 50.2 g of ammonia and 48.4 g of methane are used, how many grams of hydrogen cyanide can be produced?

3) Cytochrome c, found in the cells of all aerobic organisms, is an iron-containing enzyme. A sample of cytochrome c with mass 35.2 mg gave upon treatment with the proper reagents, yields 0.1939 mg of FeO. What is the percentage of iron in cytochrome c? Given these data, what is the minimum molecular weight of cytochrome c?.

4) 3.16 g M$^+$ ion reacts with 0.158 mole X$^-$ ion to produce a compound, MX$_2$, which is 79.9 % X by mass. What are the identities of M$^+$ and X$^-$?

5) A chemical reaction produces less than the expected amount of product. Is this result a violation of the law of conservation of mass? Explain your answer.