Gravimetric Analysis Problem Set 2

1.) Some rocks are thought to consist of insoluble silica (SiO_2) and calcium carbonate ($CaCO_3$; molar mass 100.1g/mol). The fraction of $CaCO_3$ in an 8.64 g sample of the crushed rock was determined by mixing the sample with excess hydrochloric acid. The acid reacts with $CaCO_3$ according to the following equation.

$$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

The resulting solution was filtered and the SiO_2 that was collected was washed and dried. The mass of SiO_2 was found to be 1.55 g.

A. Calculate the expected percentage of $CaCO_3$ in the original rock sample?

B. To verify the expected percentage calculated in part A, excess ammonium oxalate $(NH_4)_2C_2O_4$ solution was added to the filtered solution. The calcium ions present in the solution precipitate out as $CaC_2O_4 \cdot H_2O$
The $CaC_2O_4 \cdot H_2O$ was collected by filtration, washed and dried. It was then heated to convert it to CaO (molar mass 56.1 g/mol) and a mass of 3.87 g was obtained. Using this mass of CaO, calculate the percentage of $CaCO_3$ in the rock sample. (hint: note that the number of Ca^{2+} is the same in each of the three compounds, thus a mole ratio of 1:1:1).

C. Suppose that the percentage of $CaCO_3$ determined by the chemical analysis with ammonium oxalate was less than the result found in part A above. Provide one possible explanation for the difference.

2.) A soluble fertilizer contains phosphorus in the form of phosphate ions (PO_4^{3-}). To determine the PO_4^{3-} content by gravimetric analysis, 5.97 g of the fertilizer powder was completely dissolved in water to make a volume of 250.0 mL. A 20.00 mL volume of this solution was pipetted into a conical flask and the PO_4^{3-} ions in the solution were precipitated as $MgNH_4PO_4$. The precipitate was filtered, washed with water and then converted by heating into $Mg_2P_2O_7$. The mass of $Mg_2P_2O_7$ was 0.0352 g.

A. How many moles of the precipitate formed?

B. How many moles of phosphorus were in the 20.0 mL sample of the solution? (hint: phosphorus is the limiting reagent)

C. Calculate the amount, in moles, of phosphorus in 5.97 g of fertilizer. (hint: a 250 mL solution was made from the 5.97 g. If you know how many moles are in 20.0 mL can you calculate the number of moles in 250 mL?

D. Calculate the percentage by mass of phosphate ions (PO_4^{3-}) in the original fertilizer powder sample.