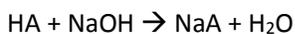**Titration Experiments**
Practice Sheet #41

1. An unknown acid (HA) is titrated with a solution of sodium hydroxide. The balanced equation for the neutralization reaction that takes place is given below.

HA + NaOH → NaA + H_2O

A sample of the unknown acid is weighted and the mass is recorded. The acid is then dissolved in water to make a solution. A few drops of phenolphthalein are added to the solution. The solution is titrated using sodium hydroxide and the volume required for the reaction to be complete is recorded. The data collected for the experiment is shown below.

Concentration of NaOH = 0.100 M
Average volume of NaOH used = 10.50 mL
Mass of Unknown Acid = 0.185 g

a. What observation indicated that the reaction was complete?

b. Determine the moles of sodium hydroxide used in the experiment.

c. How many moles of the unknown acid are required in the experiment?

d. From the moles and the mass of unknown acid, determine the molar mass of the unknown acid.

e. The unknown acid is known to have the following percent composition: 40.91 % carbon, 4.58 % hydrogen, 54.51 % oxygen. Determine the empirical formula for the unknown acid.

f. From the empirical formula and the molar mass of the unknown acid (the molecular weight), determine the molecular formula.

2. The unknown acid is also called "ascorbic acid" and is found in the compound vitamin C. A different titration experiment is carried out to determine the percent content of ascorbic acid found in a vitamin C tablet. The mass of a vitamin C tablet (that contains ascorbic acid as well as a variety of other compounds that do not react in the experiment) is determined and recorded. The tablet is then dissolved in water and a few drops of phenolphthalein are added to the solution. The solution is titrated using sodium hydroxide and the volume required for the reaction to be complete is recorded. The data collected for the experiment is shown below.

Concentration of NaOH = 0.100 M
Average volume of NaOH used = 28.70 mL
Mass of the Vitamin C Tablet = 0.620 g

a. Determine the moles of sodium hydroxide used in the experiment.

b. How many moles of ascorbic acid are required in the experiment?

c. From the moles and the molar mass of ascorbic acid, determine the mass of the ascorbic acid found in the tablet.

d. From the mass of ascorbic acid and the mass of the vitamin C tablet, determine the percent content of ascorbic acid in a tablet.

e. The actual content of ascorbic acid in a vitamin C tablet is 500 mg. Calculate the percent error for the experiment.