Complexometric Titration with EDTA

In this experiment you will use ethylenediaminetetraacetic acid (EDTA) to determine metals in aqueous solution by complexation titration. EDTA is a chelating agent that binds to metals through four carboxylic acids. Its formation constant for complexation is different for each metal, and because the ligands are acids, the formation constants are also strongly dependent on pH. Metals always bind more strongly as pH increases because acidic hydrogens are removed from the EDTA. By controlling pH you can favor complexation of one metal over another.

EDTA is colorless whether or not it is bound to a metal ion. Endpoints for complexation titrations can be observed using metal ion indicators such as Eriochrome Black T. This compound is wine red when complexed with metal ions, and blue in the free form. Addition of the indicator to a solution containing metal ions turns the solution red due to metal ion binding. EDTA binds metals more strongly than the indicators, so when all of the metal ions are bound to EDTA, the indicator is left in its free form, and the solution turns blue.

Preparation of Titrant
EDTA complexes metals, which may be present in tap water and deionized water. Use distilled water for all the following procedures. You should also rinse your equipment with distilled water. Prepare a 0.01 M EDTA solution: Accurately weigh ~0.93 g of previously dried (at 80 °C for 1 hr) Na₂H₂EDTA * 2H₂O (FW = 372.2) and add it to approximately 75 mL distilled water in a clean 250 mL beaker. If the entire solid does not dissolve heat the solution gently until the solid disappears. Quantitatively transfer the solution to a 250 mL volumetric flask and dilute to the mark. Use the experimental mass to calculate the molarity of your titrant.

A. Determination of Zinc
1. Dilute 25 mL of unknown zinc sample to 250 mL with distilled water in a volumetric flask.

2. Transfer 25 mL of the diluted unknown solution to four different Erlenmeyer flasks. To each of the flasks add 6 drops of the indicator and 5 mL of the buffer solution (check that the pH of the solution is ~10 with pH paper). Then titrate the solutions with 0.01 M EDTA solution. At the end point the color changes from deep purple to blue.

3. Record the titration volumes and determine the concentration of zinc in the original unknown solution.
B. Determination of the Hardness of Tap Water

1. Transfer 50 mL of tap water to four different Erlenmeyer flasks. Add 6 drops of indicator and 3 mL of buffer solution. Titrate the solutions with 0.01 M EDTA until the color changes from wine red to blue.

2. Record the titration volumes. You have measured the total concentration of Mg$^{2+}$ and Ca$^{2+}$ with this method. However, water hardness is traditionally expressed as ppm Ca. You are expected to convert the concentration to this value.
Chemistry 3200  
Complexometric Titration with EDTA

Date: __________ Lab Instructor: _______________ Section: _______  
Unknown Number: ________

Part A: Determination of Zinc

Grams of EDTA salt measured: ____________  
Molarity of EDTA solution: ________________  
Volume used to titrate unknown:  
________________  ___________________  __________________  
Average titrant volume: ____________ ± ____________

Molarity of the titrated solution: ________________ ± ____________
Molarity of the unknown: ________________ ± _____________

Part B: Determination of Water Hardness

Volume of titrant: ____________  __________________  __________________  
Average titrant volume: ____________ ± ____________

Concentration of Mg$^{2+}$ and Ca$^{2+}$ combined: ____________ ± ____________

Concentration of Mg$^{2+}$ and Ca$^{2+}$ in ppm Ca: ______________
Calculations for the molarity of the unknown zinc solution:

Calculation for water hardness:

Calculation for error analysis (Include a list of the errors and their sources):