Masking and Demasking

Lead, magnesium, and zinc can be determined on a single sample by two titrations with standard EDTA and one titration with standard Mg$^{2+}$. The sample is first treated with an excess of NaCN, which masks Zn$^{2+}$ and prevents it from reacting with EDTA.

$$\text{Zn}^{2+} + 4\text{CN}^- \leftrightarrow \text{Zn(CN)}_4^{2-}$$

The Pb$^{2+}$ and Mg$^{2+}$ are then titrated with standard EDTA. After equivalence point has been reached, a solution of the complexing agent BAL(2-3-dimercapto-1-propanol, CH$_2$SHCHSHCH$_2$OH), which we will write as R(SH)$_2$, is added to the solution. This bidentate ligand reacts selectively to form a complex with Pb$^{2+}$ that is much more stable than PbY$^2$.

$$\text{PbY}^2- + 2R(SH)_2 \rightarrow \text{Pb(RS)}_2 + 2H^++Y^{4-}$$

The liberated Y$^{4-}$ is then titrated with a standard solution of Mg$^{2+}$. Finally, the zinc is demasked by adding formaldehyde.

$$\text{Zn(CN)}_4^{2-} + 4\text{HCHO} + 4\text{H}_2\text{O} \rightarrow \text{Zn}^{2+} + 4\text{HOCH}_2\text{CN} + 4\text{OH}^-$$

Suppose the initial titration of Mg$^{2+}$ and Pb$^{2+}$ required 42.22 mL of 0.02064 mol/L of EDTA. Titration of the Y$^{4-}$ liberated by the BAL consumed 19.35 mL of 0.007657 mol/L of Mg$^{2+}$. Finally, after addition of formaldehyde, the liberated Zn$^{2+}$ was titrated with 28.63 mL of EDTA. Calculate the percent of the three elements if a 0.4085-g sample was used.

To obtain the percentages, we write

$$\frac{\text{mmol Pb}^{2+} + \text{mmol Mg}^{2+}}{\text{mmol Pb}} \times 100\% = 7.515\% \text{ Pb}$$

$$\frac{\text{mmol Mg}^{2+}}{\text{mmol Mg}} \times 100\% = 4.303\% \text{ Mg}$$

$$\frac{\text{mmol Zn}^{2+}}{\text{mmol Zn}} \times 100\% = 9.459\% \text{ Zn}$$