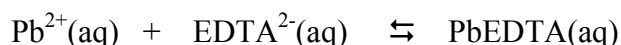


Toxic Metals Challenge Problem

Toxic heavy metal ions, such as lead(II) ions are removed from drinking water by precipitation as the metal carbonate at water treatment plants. The metal carbonate is allowed to settle at the bottom of a settling tank, and the last traces are removed by sand filtration. This is similar to how Nature purifies ground water. Most metal ions are turned into minerals using carbonates, phosphates silicates found in the soil.

Suppose a terrorist group sends a letter to the mayor claiming they have dumped 2 tons of lead(II) nitrate into a 500,000 gallons holding tank at a local reservoir. To verify their claim, a chemist at the water quality assurance lab assays for lead(II) ions using EDTA according to the following reaction:



EDTA is a complexing reagent often used to quantitatively determine many metal ion concentrations in solution. A 10.00 mL sample of the water from the holding tank requires 35.47 mL of 8.193×10^{-4} M EDTA to reach the end point. (A) Based on this titration, what is the concentration of lead(II) ions in the holding tank? (Have the terrorists been “accurate” as to their claim?) (B) Is the concentration above or below the EPA acceptable level of 15 ppb? (C) What will be the molar concentration of lead(II) ions if you added a 10% excess of the stoichiometric amount of potassium carbonate? (D) Is this enough potassium carbonate to “get the lead out” to meet the EPA limit? (E) Which principle is being applied to remove the lead(II) ions from solution?

Comments to the instructor: This problem reinforces a number of concepts, including nomenclature, stoichiometry, unit conversions, significant figures, solubility equilibria and LeChatelier’s principle. If the last question two questions are eliminated and question (C) was reworded to ask how much potassium carbonate is needed to precipitate the lead(II) nitrate, this problem could be used in the first semester course as a stoichiometry problem. You may need to provide hints for writing the precipitation equation and for looking up the K_{sp} of lead(II) carbonate.