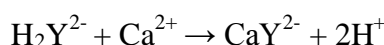


EDTA Titration Calculations

The hardness of water is due in part to the presence of Ca^{2+} ions in water. The concentration of Ca^{2+} ions is usually expressed as ppm CaCO_3 in the water sample. This is equivalent to 1 gram of CaCO_3 in 10^6 grams of sample. In the lab 1 ppm CaCO_3 is expressed as 1 mg CaCO_3 per 1 Liter of sample or ppm is mg CaCO_3 per L of sample.

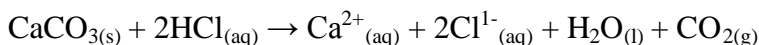
Calcium ions can be analyzed by titration with EDTA using an appropriate indicator. EDTA is ethylene diamine tetraacetic acid or $\text{H}_4\text{C}_{10}\text{H}_{12}\text{N}_2\text{O}_4$. EDTA itself is not very water soluble so the disodium salt is used, $\text{Na}_2\text{H}_2\text{C}_{10}\text{H}_{12}\text{N}_2\text{O}_4$. For the purpose of simplicity, Y will stand for $\text{C}_{10}\text{H}_{12}\text{N}_2\text{O}_4$. The EDTA we use is thus $\text{Na}_2\text{H}_2\text{Y}$. The part that reacts with calcium ions is H_2Y^{2-} according to the following equation.



The procedure is done in 3 steps 1) Preparation of a standard Ca^{2+} solution, 2) Standardization of EDTA with the standard calcium solution and, 3) Analysis of an unknown Ca^{2+} sample with the standardized EDTA solution.

1. Standard calcium solution.

0.405 g of CaCO_3 is dissolved in HCl and diluted to a volume of 250.00 mL. What is the molarity of calcium ions in the solution?



$$(0.405\text{gCaCO}_3) \left(\frac{1\text{molCaCO}_3}{100.09\text{gCaCO}_3} \right) \left(\frac{1\text{molCa}^{+2}}{1\text{molCaCO}_3} \right) = 0.004505 \text{ mol Ca}^{2+} \text{ ions}$$

$$\text{Molarity of Ca}^{2+} = \frac{0.004505\text{molCa}^{2+}}{0.250\text{L}} = 0.01802 \text{ M Ca}^{2+} \text{ ions}$$

2. Standardization of EDTA.

A 25.00 mL aliquot (a portion or part) of the standard calcium solution reacts with 27.25 mL of the EDTA solution. What is the molarity of the EDTA?

$$\left(\frac{0.01802\text{molCa}^{2+}}{\text{L}} \right) \left(\frac{0.02500\text{L}}{1} \right) \left(\frac{1\text{molEDTA}}{1\text{molCa}^{2+}} \right) = 0.0004505 \text{ mol EDTA}$$

$$\text{Molarity of EDTA} = \frac{0.0004505\text{molEDTA}}{0.02725\text{L}} = 0.01653 \text{ M EDTA}$$

3. Ca^{2+} concentration in an unknown solution CaCO_3 reported as ppm CaCO_3 .

A 50.00 mL unknown solution requires 25.55 ml of the standardized EDTA solution for complete reaction. What is the Ca^{2+} concentration in the unknown reported as ppm CaCO_3 ?

$$\left(\frac{0.0149\text{molEDTA}}{L}\right)\left(\frac{0.02555L}{1}\right)\left(\frac{1\text{molCa}^{2+}}{1\text{molEDTA}}\right) = 0.000381\text{mol Ca}^{2+}$$

$$0.000381\text{molCa}^{2+}\left(\frac{1\text{molCaCO}_3}{1\text{molCa}^{2+}}\right)\left(\frac{100.09\text{gCaCO}_3}{1\text{molCaCO}_3}\right) = 0.0381\text{g CaCO}_3$$

$$\text{ppm CaCO}_3 = \frac{\text{mgCaCO}_3}{\text{LSolution}} = 0.0381\text{gCaCO}_3\left(\frac{1000\text{mgCaCO}_3}{1.000\text{gCaCO}_3}\right)\left(\frac{1}{0.05000\text{LSolution}}\right) = 762$$