Eriochrome Black-T Indicator Color Changes

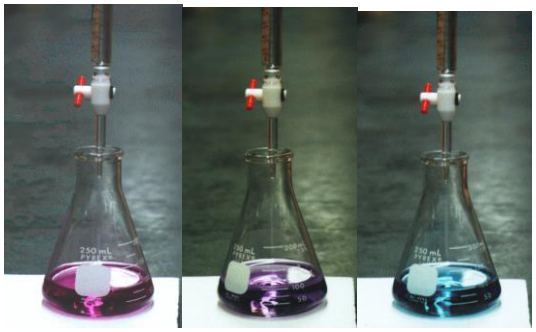
Since the reactants and products in the titration between hard water and EDTA (equation 1) are all colorless, an indicator is needed to allow us to visually see the ***end point*** (or ***equivalence point***) of the titration, i.e. ***the point at which moles of Ca^{2+} = moles of EDTA***. Eriochrome Black-T is the indicator we will use.

Equation 1. $Ca^{+2}_{(aq)} + EDTA^{-2}_{(aq)} \rightarrow CaEDTA_{(aq)}$

How Eriochrome Black-T Works

When Eriochrome Black-T complexes with Mg^{2+} ions, it produces a **PINK-RED** solution. The indicator is **BLUE** when the it is <u>not</u> complexed with Mg^{2+} (equation 2) and the solution is basic.
As EDTA is added to hard water during the titration it reacts with the divalent ions (e.g. Ca^{2+} and Mg^{2+}) present in the hard water. Once all the divalent ions in solution have reacted with EDTA, the EDTA reacts with the Mg^{2+} ions that are complexed with the Eriochrome Black-T indicator, thus causing the solution to turn **BLUE**.

Equation 2. $In\text{-}Mg_{(aq)} \rightarrow In^{2-}_{(aq)} + Mg^{2+}_{(aq)}$
(Pink) **(Blue Endpoint)**



Pink **Violet** **Blue**

Click here for an Animation of EDTA endpoint using Eriochrome Black-T Indicator

The three pictures show the color changes as the end point of the titration is reached. There is only a 1 drop difference of 0.010 M EDTA between the first and second pictures and between the second and third pictures. Two or three seconds were allowed for colors in the second and third pictures to develop after adding the additional drop. In each case the solution was thoroughly mixed. This color change from wine red to violet to blue is due to the color changes of the indicator Eriochrome Black-T.

<u>Sample Problem</u>
Suppose you are using **EDTA with a molarity of 0.008000** for the titration. You titrate **50.00 mL of a water sample** using **10.68 mL of 0.00800 M EDTA**. Calculate the concentration of Ca^{2+} ion in the water sample in *moles per liter* and in parts per million, *ppm $CaCO_3$*.

Answers: 0.001700 M Ca^{2+} or 170.0 ppm $CaCO_3$

<u>Useful information</u>: $Ca^{+2}_{(aq)} + EDTA^{-2}_{(aq)} \rightarrow CaEDTA_{(aq)}$

ppm = mass fraction x 10^6 or $$ppm = \left[\frac{mass_{solute}}{mass_{solution}}\right] x 10^6$$