SUSB-015 – Problem 1

1. (a) The standard recipe used in this exercise uses 3.0 mL of 0.25% phenanthroline solution in 100 mL of final solution to generate the red iron-phenanthroline complex which is determined colorimetrically. What is the initial molarity of phenanthroline in the diluted solution? [0.25% means 2.50 g. of phenanthroline (molar mass 180) per liter of solution.]

Let us represent phenanthroline by oPH

2.5 g of oPH (2500 mg oPH) is:

\[ \frac{2500 \text{ mg oPH}}{180 \text{ mg/mmol oPH}} = 13.9 \text{ mmol which is in 1.0 L of water.} \]

13.9 mmol oPH / 1.0 L = 1.39 \times 10^{-2} \text{ M oPH}

The dilution is made by taking 3.0 mL, which contains:

\[ 1.39 \times 10^{-2} \text{ M oPH} \times 3.0 \text{ mL} = 4.2 \times 10^{-2} \text{ mmol oPH which is diluted to 100 mL} \]

\[ \frac{4.2 \times 10^{-2} \text{ mmol oPH}}{100 \text{ mL}} = 4.2 \times 10^{-4} \text{ M oPH} \]

(b) What is the maximum concentration of iron-phenanthroline complex which can be formed from this amount of phenanthroline, assuming complete complexation?

The stoichiometry is 3 oPH to 1 Fe²⁺. If the limiting agent is oPH, the highest concentration of Fe²⁺ we can have is 1/3 of the oPH concentration:

\[ \frac{4.2 \times 10^{-4} \text{ M oPH}}{3} = 1.4 \times 10^{-4} \text{ M Fe}^{2+} \]

(c) What does this concentration of iron correspond to in mg/L?

\[ (1.4 \times 10^{-4} \text{ mmol Fe}^{2+} / \text{ mL}) \times 56 \text{ mg / mmol} = 7.8 \times 10^{-3} \text{ mg / mL Fe}^{2+} \]

\[ 7.8 \times 10^{-3} \text{ mg / mL Fe}^{2+} \times 10^3 \text{ mL / L} = 7.8 \text{ mg / L Fe}^{2+} \]

(d) Would the 3.0 mL of phenanthroline solution be enough to complex the amounts of iron in the unknowns (between 10 mg/L and 100 mg/L)? (Remember that the unknown is diluted before preparing the complex)

The unknown is diluted from 10 mL to 100 mL – a 10 fold dilution. So, the solution we are adding oPH to and measuring will have between 1 mg/L and 10 mg/L.

The amount will be adequate only for unknowns with a nominal concentration of less than 78 mg/L.

**If you report a number larger than 78 mg/L, you have made some kind of error!**