Part 3. Standard Iron Solution Calculations

Dilution calculations: $M_1V_1 = M_2V_2$,
where M_1 and M_2 are the molarities of the original concentrated and the final dilute solutions and V_1 and V_2 are the volumes of the original concentrated and the final dilute solutions

Calculations:

1. Convert g/L into a mole/L concentration for the standard Fe^{2+} solution
2. Calculate the molarity of the stock $Fe(phen)_3^{2+}$ solution prepared from the standard Fe^{2+} solution using the stoichiometry of the following equation (note that 1,10-phenanthroline is used in excess in this reaction):

   Fe^{2+} (*aq*) + 3 phen (*aq*) $\rightarrow$ $Fe(phen)_3^{2+}$ (*aq*)

3. Calculate the molarities of the five standard $Fe(phen)_3^{2+}$ solutions prepared from the stock $Fe(phen)_3^{2+}$ solution (*dilution calculations*)

Part 4. Iron Content Determination by Visible Spectrophotometry

Beer's law: $A = \varepsilon l c$

Known:

Absorbance of the $Fe(phen)_3^{2+}$ sample, A
Molar absorptivity for $Fe(phen)_3^{2+}$ at 510 nm, ε ($M^{-1}cm^{-1}$)
Dilution factors
Pathlength, l = 1 cm
Mass of the complex iron sample analyzed (g)

To be determined: Moles of Fe^{3+} per gram of sample (mole/g)

Calculations:

1. $M\,(Fe(phen)_3^{2+}) = \dfrac{A}{\varepsilon l}$ (mole/L)
2. Total dilution factor = $5 \times 5 \times X$, where X is your final dilution
3. $M_{original}\,(Fe^{3+}) = M\,(Fe(phen)_3^{2+}) \times$ Total dilution factor
4. In 25 ml of solution: moles $Fe^{3+} = M_{original}\,(Fe^{3+}) \times 0.025\,L$
5. $\text{Moles } Fe^{3+}/\text{g sample} = \dfrac{\text{moles } Fe^{3+}}{\text{mass of sample (g)}}$

$K_xFe_y(C_2O_4)_x \cdot zH_2O$ Molecular Formula Determination

Known:

Moles of $C_2O_4^{2-}$ per gram of sample (mole/g sample)
Moles of K^+ per gram of sample (mole/g sample)
Moles of Fe^{3+} per gram of sample (mole/g sample)
$y = 1$

To be determined: *x* and *z*

Calculations:

1. $\frac{x}{y} = \frac{\text{moles of } C_2O_4^{\;2-} \text{ / g sample}}{\text{moles of } Fe^{3+} \text{ / g sample}} \Rightarrow x - ?$

2. g Fe^{3+}/g sample = moles Fe^{3+}/g sample × MW (Fe)

3. g $C_2O_4^{\;2-}$/g sample = moles $C_2O_4^{\;2-}$/g sample × MW ($C_2O_4^{\;2-}$)

4. g K^+/g sample = moles K^+/g sample × MW (K)

5. g H_2O/g sample = 1.000 g – g Fe^{3+}/g sample – g $C_2O_4^{\;2-}$/g sample – g K^+/g sample

6. $\text{mole } H_2O\text{/g sample} = \frac{\text{g } H_2O\text{/g sample}}{\text{MW } (H_2O)}$

7. $\frac{z}{y} = \frac{\text{moles of } H_2O \text{ / g sample}}{\text{moles of } Fe^{3+} \text{ / g sample}} \Rightarrow z - ?$

Determination of the Theoretical Yield and Percent Yield of $K_xFe_y(C_2O_4)_x{\cdot}zH_2O$

Chemistry involved:

$$Fe(NH_4)_2(SO_4)_2{\cdot}6H_2O + H_2C_2O_4 \rightarrow FeC_2O_4{\cdot}2H_2O + (NH_4)_2SO_4 + H_2SO_4 + 4\,H_2O \qquad (1)$$

$$a\,FeC_2O_4{\cdot}2H_2O + b\,H_2C_2O_4 + c\,H_2O_2 + d\,K_2C_2O_4 \rightarrow e\,K_x[Fe_y(C_2O_4)_x]{\cdot}zH_2O \qquad (2)$$

Note: *Equation (2) has to be balanced before you start working on these calculations.*

Known: Actual yield of the product (g)
Mass of the starting material, $Fe(NH_4)_2(SO_4)_2{\cdot}6H_2O$ (g)
Moles of $FeC_2O_4{\cdot}2H_2O$, produced in reaction (1) and used as a starting material in reaction (2). *See Post-lab 5, question 5 for reference*

Assume $FeC_2O_4{\cdot}2H_2O$ to be the limiting reactant in reaction (2)

To be determined: Theoretical yield (g) and Percent yield (%)

Calculations:

1. Determine moles of $K_x[Fe_y(C_2O_4)_x]{\cdot}zH_2O$ from moles of $FeC_2O_4{\cdot}2H_2O$ using the stoichiometry of equation (2)*

2. Theoretical yield (g) = Moles $K_x[Fe_y(C_2O_4)_x]{\cdot}zH_2O$ × MW ($K_x[Fe_y(C_2O_4)_x]{\cdot}zH_2O$)

3. $\text{Percent yield} = \frac{\text{actual yield (g)}}{\text{theoretical yield (g)}} \times 100\%$

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*If you are unable to balance equation (2) due to the erroneous molecular formula determination, leave equation (2) unbalanced and use a 1-to-1 molar ratio of $FeC_2O_4{\cdot}2H_2O$ to $K_x[Fe_y(C_2O_4)_x]{\cdot}zH_2O$ at this step.