Experiment #21B
Quantitative Redox Reactions Involving Iodine

Name _____

Part 1: Preparation of a Standard Potassium Iodate Solution

Table 1: Preparing Standard KIO_3 Solution

calculated mass of KIO_3 needed to make 250 mL 0f 0.020 M solution	g
actual mass of KIO_3 measured	g

Part 2: Standardization of Sodium Thiosulfate Solution

Table 2: Volume of $Na_2S_2O_3$ Needed to React with Iodine from 25.00 mL of KIO_3

	Trial #1	Trial #2	Trial #3	Trial #4 (if necessary)
Initial buret reading of $Na_2S_2O_3$				
Final buret reading of $Na_2S_2O_3$				
Volume of $Na_2S_2O_3$ required				
Average volume of closest two titrations of $Na_2S_2O_3$				

Part 3: Determination of Unknown [$CuSO_4$]

Table 3: Volume of $Na_2S_2O_3$ Needed to React with Iodine from 25.00 mL of $CuSO_4$

	Trial #1	Trial #2	Trial #3	Trial #4 (if necessary)
Initial buret reading of $Na_2S_2O_3$				
Final buret reading of $Na_2S_2O_3$				
Volume of $Na_2S_2O_3$ required				
Average volume of closest two titrations of $Na_2S_2O_3$				

Part 4: Determination of Amount of Vitamin C in a Sample

Table 4: Volume of $Na_2S_2O_3$ Needed to React with 25.00 mL of I_2 solution

	Trial #1	Trial #2	Trial #3	Trial #4 (if necessary)
Initial buret reading of $Na_2S_2O_3$				
Final buret reading of $Na_2S_2O_3$				
Volume of $Na_2S_2O_3$ required				
Average volume of closest two titrations of $Na_2S_2O_3$				

Table 5: Volume of I_2 Solution Needed to React with Ascorbic Acid (Vitamin C)

	Trial #1	Trial #2	Trial #3	Trial #4 (if necessary)
Initial buret reading of I_2				
Final buret reading of I_2				
Volume of I_2 required				
Average volume of closest two titrations of I_2				

QUESTIONS AND CALCULATIONS

Part I Preparation of a Standard Potassium Iodate Solution

1. Calculate the concentration of KIO_3 solution formed when you dissolved your calculated mass of KIO_3 in water and made the volume up to 250.0 mL.
2. Calculate the number of moles of KIO_3 (and therefore of IO_3^-) in 25.00 mL of this solution.

Part II Standardization of Sodium Thiosulfate Solution

1. Work out the overall redox equation for the reaction of IO_3^-, I^-, and H^+ to give I_2.
2. Work out the overall redox equation for the reaction of $S_2O_3^-$ and I_2 to give $S_4O_6^{2-}$ (tetrathionate ion) and I^-.
3. State the relationship between moles of IO_3^- and moles of $S_2O_3^{2-}$, working through moles of I_2.
4. From this relationship and the number of moles of KIO_3 in 25.00 mL of solution, calculate the number of moles of $S_2O_3^{2-}$ with which the KIO_3 reacts..
5. Knowing the average volume and the number of moles of $S_2O_3^{2-}$ used, calculate the $[S_2O_3^{2-}]$.

Part III Determination of the Concentration of an Unknown Solution of Copper(II) Sulfate

1. Work out the overall redox equation for the reaction $Cu^{2+} + I^- \rightarrow CuI(s) + I_2$.
2. Recalling from Part II the relationship between moles of I_2 and moles of $S_2O_3^{2-}$, and using the equation in item 1 above, state the relationship between moles of Cu^{2+} and moles of $S_2O_3^{2-}$.
3. From the average volume (from Part II) and the known concentration (from Part II) of $S_2O_3^{2-}$ used, calculate the number of moles of $S_2O_3^{2-}$ used.
4. Calculate the number of moles of Cu^{2+} originally present.
5. Calculate $[Cu^{2+}]$ in the original sample from the number of moles and the volume used.

Part IV Determination of Amount of Vitamin C in a Sample

1. Calculate the number of moles of $S_2O_3^{2-}$ used from the average volume used and the molarity from Part II.
2. Calculate the number of moles of I_2 present, using the relationship obtained in Part II.
3. Calculate $[I_2]$ from the number of moles used and the volume in litres.
4. From the average volume of I_2 solution used in the vitamin C titration, calculate the number of moles of I_2 requred to react with the vitamin C.
5. Recalling that it was stated in the Post Lab Discussion that vitamin C and I_2 react in a 1 to 1 mole ratio, and that vitamin C has the formula $C_6H_8O_6$, calculate the mass of vitamin C present, in milligrams.
6. Compare your result with the rated amount of vitamin C for that tablet, and calculate the percentage deviation between your result and the rated amount.
7. In the same manner, calculate the number of milligrams of vitamin C in 100 mL of each juice sample tested.

FOLLOW-UP QUESTIONS

1. Vitamin C was oxidized by iodine in this experiment. By referring to the table of standard reduction potentials in Appendix 5, explain why the vitamin C content of foods is decreased on exposure to air.

2. A chemist who wishes to analyze a sample of hydrated copper(II) nitrate finds that when a sample with a mass of 0.67 g is dissolved in water and excess KI solution is added, 17.7 mL of $0.128M$ $Na_2S_2O_3$ are required to react with the liberated iodine. What is the number of moles of water in the hydrated crystal?

3. A sample of apple juice states on the label "Contains not less than 35 mg/100 mL of ascorbic acid (vitamin C)." A 25 mL sample was titrated with $0.0080M$ I_2 solution and found to require 6.55 mL until the starch indicator turned blue. Does this sample meet the stated concentration?

CONCLUSION

State the results of Objectives 3 and 4.