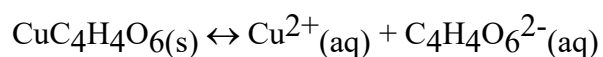


K_{SP} OF COPPER (II) TARTRATE

Introduction:

The solubility product constant, K_{sp} , of a slightly soluble salt provides a simple example of aqueous equilibria. Spectrophotometric determination of this constant can be done quickly and simply. If an ion of a compound is colored or can be made to form a colored complex in solution, the solubility product constant may be determined by visible spectroscopy. The solubility product constant is defined as the product of the concentration of the ions formed by the dissociation of the salt, each raised to the power of the coefficient of the balanced equation. Copper (II) tartrate dissociates according to the equation:



Thus the solubility product constant is represented by the expression:

$$K_{sp} = [\text{Cu}^{2+}] [\text{C}_4\text{H}_4\text{O}_6^{2-}]$$

The copper 2+ ion has a characteristic blue color. A saturated solution of copper (II) tartrate can be prepared by mixing solutions of copper (II) sulfate and sodium tartrate. The concentrations of the solutions to be mixed needs to be great enough to exceed the solubility of copper (II) tartrate. The copper (II) tartrate will then form a precipitate. The solution that remains is then saturated with respect to copper (II) tartrate. It is necessary to keep the tartrate ion in excess so that all the copper (II) ions present in excess of the solubility of copper (II) tartrate will precipitate.

Purpose:

The purpose of this experiment is to determine the solubility product constant of copper (II) tartrate.

Equipment/Materials:

small Erlenmeyer flasks 15-25 mL
spectrophotometer and cuvetts
centrifuge and centrifuge tubes
millipore filter and syringe
volumetric flask (100 mL, 10 mL) (a 10 mL graduated cylinder may be used)
adjustable pipets (0-2 mL)
Beral pipets
copper (II) sulfate (0.100 M)
sodium tartrate (0.100 M)

Safety:

- Always wear goggles and an apron in the lab.

Procedure:**Part I: Preparation of a saturated solution of copper (II) tartrate**

1. Place 4.0 mL of 0.100 M copper (II) sulfate and 5.0 mL of 0.100 M sodium tartrate in a 10.00 mL volumetric flask. Add distilled water to make 10 mL of solution. Mix well.
2. Allow the solution to remain undisturbed for about 15 minutes while other solutions are being prepared. The solution should form a precipitate.
3. Centrifuge to remove the precipitate. Save the clear blue solution. If this solution shows any cloudiness or further precipitates, filter it with a millipore filter.

Part II: Preparation of standard copper (II) tartrate solutions

4. Prepare 10 mL of 0.02 M copper (II) tartrate. Measure 2.00 mL of 0.100 M copper (II) sulfate. Add 5.0 mL of 0.100 M sodium tartrate, and dilute until the total volume is 10.00 mL.
5. Prepare 10 mL of 0.018 M copper (II) tartrate. Measure 1.8 mL of 0.100 M copper (II) sulfate. Add 5.0 mL of 0.100 M sodium tartrate, and dilute until the total volume is 10.00 mL.
6. Prepare 10 mL of 0.015, 0.012, 0.010 M copper (II) tartrate in a similar manner.

Part III: Determination of copper (II) ion concentration in the saturated copper (II) tartrate solution

7. With nothing in the sample compartment of the spectrophotometer, zero the % transmittance. (If using a Spec 21, omit this step.)
8. Set the spectrophotometer to a wavelength of 675 nm. Zero the absorbance using a blank made by diluting 5.0 mL of 0.1 M sodium tartrate to 10 mL with distilled water.
9. Determine the absorbance of each of the five standard copper solutions.
10. Place the saturated copper (II) tartrate solution in a cuvet and record the absorbance of this solution.

Name _____

Name _____

Period _____

Date _____

K_{SP} OF COPPER (II) TARTRATE

Data Table:

| Concentration of Copper (II) Tartrate | Absorbance |
|--|-------------------|
| 0.000 M | |
| 0.010 M | |
| 0.012 M | |
| 0.015 M | |
| 0.018 M | |
| 0.020 M | |
| saturated solution | |

Calculations:

1. Using the Beer's Law plot, determine the concentration of the copper 2+ ion in the saturated copper (II) tartrate solution.
2. Write the equation for the dissociation of copper (II) tartrate in water.
3. Write the equation for the K_{sp} of copper (II) tartrate.
4. Calculate the value for the K_{sp} of copper (II) tartrate.

Questions:

1. Why was the sodium tartrate added to the copper (II) sulfate solution?
2. Why is a K_{sp} value useful?
3. Why was a wavelength of 675 nm used?