SOLUBILITY AND THE COMMON-ION EFFECT

INTRODUCTION

Read and/or review Sections 17.1 and 17.2 in your textbook.

When a saturated, aqueous solution of calcium iodate is prepared, an equilibrium is established between solid calcium iodate and the calcium and iodate ions.

$$Ca(IO_3)_2(s) \iff Ca^{2+}(aq) + 2\ IO_3^-(aq)$$

The equilibrium constant for this reaction is known as the solubility product constant, K_{sp}, and has the form:

$$K_{sp} = [Ca^{2+}]\,[IO_3^-]^2$$

According to Le Chatelier's Principle, if a solution containing either calcium ions or iodate ions is added to a saturated solution of calcium iodate, the solubility of calcium iodate will decrease. The shift in ionic equilibrium (in this case, a decrease in solubility corresponding to a shift to the left) that occurs when a solute containing an ion that takes part in the equilibrium is added to a solution at equilibrium is known as the common-ion effect.

In this lab, the common-ion effect will be studied by determining the solubility of calcium iodate in water and also in an aqueous solution of potassium iodate. A starch-iodine titration will be used to determine the concentration of iodate ion in each solution. The molar solubility and the solubility product constant of calcium iodate in water can be determined from the concentration of iodate ion in solution. The concentration of iodate ion in solution and the concentration of iodate ion that came from the potassium iodate solution are used to determine the molar solubility of calcium iodate in a potassium iodate solution.

NOTE:

In a starch-iodine titration, iodate ions first oxidize iodide ions:

$$IO_3^-(aq) + 5\ I^-(aq) + 6\ H^+(aq) \rightarrow 3\ I_2(aq) + 3\ H_2O(l)$$

The thiosulfate ion in sodium thiosulfate then reacts with the iodine produced in the first reaction:

$$I_2(aq) + 2\ S_2O_3^{2-}(aq) \rightarrow 2\ I^-(aq) + S_4O_6^{2-}(aq)$$

PROCEDURE

Prepare and load a 50 mL buret with the sodium thiosulfate solution.

Part 1. Standardization of the sodium thiosulfate solution.

Pipet 10.0 mL of standard KIO_3 solution into an Erlenmeyer flask. Add 2 g KI and 10 mL of 1 M HCl. (pump dispenser). The solution should turn dark brown.

Titrate the solution until it is "yellow". Add 5 mL of starch solution. Continue the titration until the "blue" starch-iodine complex color disappears. Repeat the titration on fresh samples (at least three trials) until acceptable precision is obtained.

Part 2: Molar solubility of $Ca(IO_3)_2$ in pure water.

A filtered saturated solution of $Ca(IO_3)_2$ will be provided. Pump dispense 10.0 mL of this solution into an Erlenmeyer flask. Add 2 g KI and 10 mL of 1 M HCl. (pump dispenser). The solution should turn dark brown.

Titrate the solution until it is "yellow". Add 5 mL of starch solution. Continue the titration until the "blue" starch-iodine complex color disappears.

Repeat the titration on fresh samples (at least three trials) until acceptable precision is obtained.

Part 3: Molar solubility of $Ca(IO_3)_2$ in standard KIO_3 solution.

A filtered saturated solution of $Ca(IO_3)_2$ in standard KIO_3 will be provided. Pump dispense 10.0 mL of this solution into an Erlenmeyer flask. Add 2 g KI and 10 mL of 1 M HCl. (pump dispenser). The solution should turn dark brown.

Titrate the solution until it is "yellow". Add 5 mL of starch solution. Continue the titration until the "blue" starch-iodine complex color disappears.

Repeat the titration on fresh samples (at least three trials) until acceptable precision is obtained.

DATA AND ANALYSIS SHEET: SOLUBILITY AND THE COMMON ION EFFECT

Name: ____

Date ______________ Lab Partner ______________________________________

Part 1. Standardization of the sodium thiosulfate solution.

Concentration of the standard KIO_3 solution: ________________

Volume of KIO_3 solution used: _____________

Volume of sodium thiosulfate solution used in each trial: ________ ________ ________

Average Volume of sodium thiosulfate used: ___________

Calculate the molar concentration of the sodium thiosulfate solution.

____

Part 2. Solubility of $Ca(IO_3)_2$ in pure water.

Volume of filtrate of saturated calcium iodate solution used: _____________

Volume of standard sodium thiosulfate solution used in each trial: ________ ________ _______

Average Volume used: ___________

Calculate the molar concentration of IO_3^- in the solution.

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Calculate the molar solubility of $Ca(IO_3)_2$.

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Calculate the solubility product constant, K_{sp}, for $Ca(IO_3)_2$ using the data/information from this part of the experiment.

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DATA AND ANALYSIS SHEET: SOLUBILITY AND THE COMMON ION EFFECT

Name: ____

Part 3 Solubility of $Ca(IO_3)_2$ in standard KIO_3.

Volume of filtrate of saturated calcium iodate in standard KIO_3 solution used: _____________

Volume of standard sodium thiosulfate solution used in each trial: ________ ________ _______

Average Volume used: ___________

Calculate the molar concentration of IO_3^- in the solution.

____

Calculate the IO_3^- concentration that came from dissolved $Ca(IO_3)_2$.

$$[IO_3^-]_{\text{from calcium iodate}} = [IO_3^-]_{\text{total}} - [IO_3^-]_{\text{from potassium iodate}}$$

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Using the above result, calculate the molar solubility of $Ca(IO_3)_2$ in standard KIO_3.

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Calculate the solubility product constant, K_{sp}, for $Ca(IO_3)_2$ using the data/information from this part of the experiment.

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