EXPERIMENT 8
Determining $K_{sp}$

Introduction
The solubility product constant, or $K_{sp}$ of a compound is an equilibrium constant that describes the degree to which a solid dissolves in water. The $K_{sp}$ is calculated based on the chemical reaction that describes the equilibrium between the solid salt and the dissolved ions. By convention, the equation is written with the solid salt and water as reactants and the cations and anions produced when the solid dissolves are the products.

$$\text{Sr(IO}_3\text{)}_2(\text{s}) + \text{H}_2\text{O(l)} \leftrightarrow 2\text{IO}_3^{-}(\text{aq}) + \text{Sr}^{2+}(\text{aq})$$

Since solids and pure liquids have a constant concentration, they are not included in the $K_{sp}$ expression, thus the value of the dominator is 1, leaving the $K_{sp}$ dependent purely on the concentrations of the ions produced in the reaction, rather than directly based on the amount of solid added to the water.

$$K_{sp} = [\text{Sr}^{2+}] [\text{IO}_3^{-}]^2$$

Saturated Solutions
Since the $K_{sp}$ is an equilibrium reaction, the concentrations of the reactants must be at a level that with a slight increase of either one, the solid salt will be produced and precipitate out of the solution. Therefore, to measure the $K_{sp}$, a saturated solution must first be prepared. A saturated solution is one in which the maximum concentration of ions has been achieved in the solution. It can be done by adding a salt to water until you see some of the salt sitting on the bottom of the beaker. At this point no more salt will be dissolved and the solution is said to be saturated. A measurement of the saturation of a solution is called the solubility and is usually measured in grams of salt/100 mL of water. For very soluble salts, such as NaCl, the solubility is approximately 38g/100 mL. For the salt used in this experiment, Sr(IO$_3$)$_2$, the solubility is only about 0.05g/100 mL of water. Thus, there is a huge range in solubility of different salts. These solubility differences can be used to create a precipitate from two more soluble salts. This can be done by reacting two solutions prepared from soluble salts that contain ions that result in a product that is less soluble.

In this reaction, you will use strontium nitrate, Sr(NO$_3$)$_2$, and potassium iodate, KIO$_3$, to produce a relatively insoluble salt, strontium iodate, Sr(IO$_3$)$_2$, that will precipitate from the solution.

$$\text{Sr(NO}_3\text{)}_2(\text{aq}) + 2\text{KIO}_3(\text{aq}) \leftrightarrow \text{Sr(IO}_3\text{)}_2(\text{s}) + 2\text{K}^+(\text{aq}) + 2\text{NO}_3^{-}(\text{aq})$$

The potassium ion, $K^+$ and the nitrate ions, NO$_3^-$ do not play a role in this equilibrium as they do not react, leaving the net ionic equation as that of the precipitation. Note that the precipitation reaction is the reverse of the reaction used to calculate $K_{sp}$.

Equilibrium reaction: $\text{Sr}^{2+}(\text{aq}) + 2\text{IO}_3^{-}(\text{aq}) \leftrightarrow \text{Sr(IO}_3\text{)}_2(\text{s})$

Thus, by reversing this reaction, the $K_{sp}$ can be calculated if the concentration of either the cation or anion can be determined since their concentrations are related to each other through the equilibrium reaction.

Using Titration to Determine Reactant Concentration
A titration reaction is a reaction that goes to completion, so that the initial concentration of a reactant can be directly related to the concentration of the product or another reactant based on the stoichiometry of the reaction. In this lab, you will use two reactions to determine the concentration of the iodate in the solution. The first reaction converts the iodate, IO$_3^-$ to iodine, I$_2$. A solution of sodium thiosulfate, Na$_2$S$_2$O$_3$ is then used to titrate the I$_2$ formed from the first reaction.

Reaction: $\text{IO}_3^{-}(\text{aq}) + 5\text{I}^- (\text{s}) + 6\text{H}^+(\text{aq}) \rightarrow 3\text{I}_2(\text{aq}) + 3\text{H}_2\text{O(l)}$

Titration: $\text{I}_2(\text{aq}) + 2\text{S}_2\text{O}_3^{2-}(\text{aq}) \rightarrow 2\text{I}^-(\text{aq}) + \text{S}_4\text{O}_6^{2-}(\text{aq})$

The calculation of the reactant concentration (IO$_3^-$) is found in the following manner.
First, the volume of titrant, (Na$_2$S$_2$O$_3$) is multiplied by the molarity of the titrant to get moles of S$_2$O$_3^{2-}$.

\[
\text{Moles}_{S_2O_3^{2-}} \times \frac{1}{\text{L}_{S_2O_3^{2-}}} = \text{Moles}_{S_2O_3^{2-}}
\]

Next use the mole ratio in the titration reaction to find the moles of I$_2$ in the solution.

\[
I_2(\text{aq}) + 2S_2O_3^{2-} (\text{aq}) \rightarrow 2I^- (\text{aq}) + S_2O_8^{2-} (\text{aq})
\]

\[
\frac{\text{Moles}_{S_2O_3^{2-}}}{1} \times \frac{\text{Moles}_{I^-}}{2\text{Moles}_{S_2O_3^{2-}}} = \text{Moles}_{I^-}
\]

Finally, use the mole ratio of I$_2$ to to IO$_3^{-}$ in the reaction equation to find the moles of IO$_3^{-}$ in the reaction well.

\[
IO_3^{-} (\text{aq}) + 5I^- (\text{s}) + 6H^+ (\text{aq}) \rightarrow 3I_2(\text{aq}) + 3H_2O(l)
\]

\[
\text{Moles}_{I^-} \times \frac{1\text{Moles}_{IO_3^{-}}}{3\text{Moles}_{I^-}} = 1\text{Moles}_{IO_3^{-}}
\]

Once you know how many moles of IO$_3^{-}$ were in the well, you then divide by the volume of IO$_3^{-}$ in the well (in liters) to obtain the molarity of the IO$_3^{-}$ in the saturated solution of Sr(IO$_3$)$_2$.

**Calculation of $K_{sp}$**

Once you have determined the concentration of one of the ions in the saturated solution, you can use the mole ratio of the ions in the solid to find the concentration of all other ions making up the solid. In your experiment, solid Sr(IO$_3$)$_2$ breaks up into 2 moles of IO$_3^{-}$ and 1 mole of Sr$^{2+}$ for every mole of solid that dissolves. Thus, to find the concentration Sr$^{2+}$, just divide the concentration of IO$_3^{-}$ by 2.

\[
\text{Sr(IO}_3)_2 (s) + \text{H}_2\text{O(l)} \leftrightarrow 2\text{IO}_3^{-} (\text{aq}) + \text{Sr}^{2+} (\text{aq})
\]

The solubility product constant, $K_{sp}$, is literally the product of the concentrations of all of the ions produced by the solid dissolving and can be calculated using the following equation.

\[
K_{sp} = [\text{Sr}^{2+}] \times [\text{IO}_3^{-}]^2 = [\text{Sr}^{2+}] \times [\text{IO}_3^{-}]^2
\]
Chemical Hazards

NFPA Health Recommendations For All Chemicals in this Lab

**ORAL EXPOSURE**
If swallowed, wash out mouth with water. Call rescue if large amounts are swallowed.

**DERMAL EXPOSURE**
Wash affected area immediately. Remove contaminated clothing and shoes.

**EYE EXPOSURE**
In case of contact with eyes, flush with water.
Assure adequate flushing by separating the eyelids with fingers.

---

**10% Hydrochloric Acid, HCl**

NFPA RATING: HEALTH: 3 FLAMMABILITY: 0 REACTIVITY: 0

**ORAL EXPOSURE**
If swallowed, wash out mouth with water provided person is conscious. Call rescue. Do not induce vomiting.

**DERMAL EXPOSURE**
In case of skin contact, wash immediately for several minutes. Remove contaminated clothing and shoes.

**EYE EXPOSURE**
In case of contact with eyes, flush with water.
Assure adequate flushing by separating the eyelids with fingers. Rinse at least 15 minutes. Call rescue immediately.

---

**0.40M Potassium Iodate, KIO₃**

NFPA RATING: HEALTH: 2 FLAMMABILITY: 0 REACTIVITY: 0

Potential teratogen if swallowed in large amounts. Call rescue if this occurs.

---

**1.00M Strontium Nitrate, Sr(NO₃)₂**

NFPA RATING: HEALTH: 0 FLAMMABILITY: 0 REACTIVITY: 0

---

**0.050M Sodium Thiosulfate, Na₂S₂O₃**

NFPA RATING: HEALTH: 0 FLAMMABILITY: 0 REACTIVITY: 0

---

**Saturated Starch Solution**

NFPA RATING: HEALTH: 0 FLAMMABILITY: 0 REACTIVITY: 0

---

**Potassium Iodide, KI(s)**

NFPA RATING: HEALTH: 0 FLAMMABILITY: 0 REACTIVITY: 0

---

Experimental Procedure

Your TA must sign your data before leaving lab or you will not receive credit for attending the lab.

Part 1: Equipment Preparation

1. If not already labeled, label wells in the well plate, A1, A2, B1, B2, B3
2. Label five test tubes: “HCl”, KIO₃, Sr(NO₃)₂, Na₂S₂O₃, Starch”.
3. Add 15 mls of each solution to the appropriate test tube.
4. Record the exact concentration of the Na₂S₂O₃ solution in your laboratory notebook.
5. Label four Beral pipets: “HCl”, KIO₃, Sr(NO₃)₂, Starch”. Place the appropriate pipet in each test tube.
6. Label one 150 ml beaker, “H₂O” and fill with approximately 50ml of distilled water.
7. Label two Beral pipets: “Reaction pipet, Titratio pipet”
8. Label one 150 ml beaker “Pipets” and place the pipets in the beaker with their bulbs down.
9. Open the centrifuge and insert the reaction and titration pipets into centrifuge tubes. If the tip of either or the pipets extend past the top of the centrifuge tube, use scissors to shorten the tip of the pipet until it is even with the top of the centrifuge tube.

**Part 2a: Calibrating the reaction pipet**

1. Fill a 10.0 mL graduated cylinder with water exactly to the 2.00ml mark with a wash bottle with distilled water.
2. Draw water into Reaction pipet and position the pipet horizontally over the graduated cylinder.
3. With the tip over the top of the graduated cylinder, press on the bulb to dispense the water dropwise.
4. Count the drops as they are released into the graduated cylinder until you reach exactly 3.00ml.
5. Record the number of drops in your laboratory notebook.
6. Repeat this procedure until 4.00ml and then 5.00ml marks are reached.
7. Discard the water into the waste beaker when finished.

**Part 2b: Calibrating the titration pipet**

1. Fill a 10.0 mL graduated cylinder with Na$_2$S$_2$O$_3$ exactly to the 2.00ml mark.
2. Repeat part 2 using Na$_2$S$_2$O$_3$ and the titration pipet instead of water and the reaction pipet.
3. Discard the solution in the graduated cylinder into the waste beaker.

**Part 3: Preparing a Saturated Sr(IO$_3$)$_2$ Solution**

1. Use your pipets to fill well A1 ¾ full of Sr(NO$_3$)$_2$ and fill well A2 ¾ full of KIO$_3$.
2. Draw up a small amount of KIO$_3$ solution into the Reaction pipet.
3. Swirl to rinse the bulb of the reaction pipet with KIO$_3$ solution and discard the solution into a waste beaker.
4. Refill reaction pipet bulb approximately ½ full with KIO$_3$ from well A2. Add more KIO$_3$ to well if necessary.
5. Invert the Reaction pipet till all of the solution drains into the bulb.
6. Squeeze the bulb to remove all air.
7. Wipe the tip of the bulb off with a kimwipe, but do not release pressure on bulb.
8. Without releasing pressure, put the pipet tip in to the Sr(NO$_3$)$_2$ solution in well A1 and draw up Sr(NO$_3$)$_2$ until the bulb is ¾ full of solution.
   **Note: Do not allow any of the KIO$_3$ solution to go into well A1. If this does happen, you will need to discard your solutions in the well plate and your pipet, rinse both with water and repeat Part 3.**
9. Invert the reaction pipet so the bulb is on the bottom.
10. Hold pipet near the tip and bump the bulb gently with your hand to completely mix the solutions.
11. Once the solid Sr(IO$_3$)$_2$ begins to form, mix for 5 more minutes to finish the precipitation.

**Part 4: Purifying the Saturated Sr(IO$_3$)$_2$ Solution**

1. After mixing for 5 minutes, place the Reaction pipet, bulb down into centrifuge.
2. Make sure centrifuge is balanced and centrifuge 3 minutes.
3. Remove the Reaction pipet from the centrifuge and place it bulb down in a beaker to cool to room temperature.
4. Holding the Reaction pipet horizontally, discard the supernatant liquid into the waste container. Holding the pipet bulb down, squeeze the bulb of Reaction pipet gently to remove the air.
5. Insert the pipet tip into the beaker of H$_2$O and slowly release the pressure on the bulb to fill the bulb with water.
6. Invert the Reaction pipet and thoroughly mix the water and precipitate to remove all traces of the reactants.
7. Centrifuge the Reaction pipet for 3 minutes and set in a beaker to allow the pipet to return to room temperature.
8. Holding the Reaction pipet horizontally, discard wash water into the waste beaker. **Do not disturb precipitate.**
9. Rinse the precipitate twice more with water as done in steps 5-9.
10. Do not discard liquid from last rinse.
11. Let the reaction pipet sit, bulb down, in beaker for 4 minutes.
12. Record the temperature of water in beaker in your laboratory notebook.
14. Wash well plate and rinse with distilled water. Dry with a kimwipe.

**Part 5: Titrating the Saturated Sr(IO₃)₂ Solution**

1. Use your reaction pipet to deliver 25 drops of supernatant liquid into wells A1, A2 and A3. **Do not allow any precipitate to get into the wells.** If you run out of solution before reaching 25 drops, note down the actual number of drops used in well A3.
2. Rinse the reaction pipet with HCl and then rinse the reaction pipet three times with water and discard all rinses.
3. Fill well B1 ¾ full with HCl, B2 with Na₂S₂O₃ and B3 with starch solution.
4. Add 3 crystals of KI to well A1 and A2, mix with your spatula to dissolve.
5. Add 2 drops of HCl from well B1 to well A1, A2 and A3.
6. Fill titration pipet with Na₂S₂O₃ from well B2.
7. Use your titration pipet to add Na₂S₂O₃ dropwise to well A1, until the brownish color begins to disappear, **count the drops as you add them.**
8. When the titration mixture in well A1 turns yellow, add 2 drops of starch solution from well B3 to well A1.
9. Mix with your spatula and solution will turn blue.
10. Continue adding Na₂S₂O₃ dropwise until the blue color is gone.
11. Record total number of drops of Na₂S₂O₃ in your laboratory notebook.
12. Repeat with wells A2 and A3 starting at step 6.
13. Dispose of all chemicals in the waste beaker.
14. Rinse the well plate and all pipets with water before returning them to your drawer. **Do not leave any chemicals in any of the pipets.**
**Laboratory Data**

Create the following data table in your data table before coming to class. Include the correct number of significant figures for each measurement.

Concentration of Na$_2$S$_2$O$_3$ Solution

Temperature of water

---

**Table 1: Pipet Calibrations from Part 2**

<table>
<thead>
<tr>
<th>Pipet drop vol.</th>
<th>Reaction Pipet</th>
<th>Titration Pipet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drops till 3 mL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drops till 4 mL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drops till 5 mL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Drops of Na$_2$S$_2$O$_3$ used in Titrations**

<table>
<thead>
<tr>
<th>Well Number</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drops saturated Sr(IO$_3$)$_2$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drops Na$_2$S$_2$O$_3$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Concentration Data

Table 1

Table 2
Calculations

Remember to show 1 example of each calculation either handwritten or typed on a separate sheet.
Include correct significant figures and units
Include a typed copy of these results in a table with your lab report.

**Average number of drops per mL for Reaction and Titration Pipets**
Average the three trials in Part 2 for each pipet. You may have a different value for each pipet.

**Volume of 1 drop**
Use the inverse button on your calculator or divide 1 by the average number of drops/ml to find the volume of a single drop in milliliters. Calculate the volume of 1 drop for both the reaction pipet and the titration pipet. Then divide by 1000 to convert from milliliters to liters.

**Volume of Saturated Sr(IO₃)₂ Solution in Wells**
Multiply the number of drops (25 if possible) by the volume of 1 drop for the reaction pipet. Find the volume of saturated Sr(IO₃)₂ in each of the three wells, A1-A3.

**Volume of Na₂S₂O₃ solution Used in Titration**
Multiply the number of drops of Na₂S₂O₃ needed for the titration by the volume of 1 drop for the titration pipet. Find the volume of Na₂S₂O₃ needed to titrate the Sr(IO₃)₂ in each of the three wells, A1-A3.

**Moles of S₂O₃²⁻ Needed for Titration**
Multiply the molarity of the Na₂S₂O₃ by the volume of the Na₂S₂O₃ in Liters.

**Moles of I₂ Produced**
The solution was then titrated with Na₂S₂O₃ according to the following equation.

\[
\text{I}_2 (aq) + 2\text{S}_2\text{O}_3^{2-} (aq) \rightarrow 2\text{I}^- (aq) + \text{S}_4\text{O}_6^{2-} (aq)
\]

Since the titration reaction has a mole ratio of 1 mole of I₂ for every 2 moles of S₂O₃²⁻, divide the moles of S₂O₃²⁻ by 2 to find the moles of I₂.

**Moles of IO₃⁻ in the Saturated Sr(IO₃)₂ Solution**
Find the moles of IO₃⁻ present in the equilibrium solution of Sr(IO₃)₂ by using the mole ratio for the reaction with KI.

\[
\text{IO}_3^- (aq) + 5\text{I}^- (s) + 6\text{H}^+ (aq) \rightarrow 3\text{I}_2 (aq) + 3\text{H}_2\text{O}(l)
\]

Since the mole ratio for this reaction is 3 moles of I₂ for each mole of IO₃⁻, divide the moles of I₂ found through the titration by 3 to determine the moles of IO₃⁻ that were present in the equilibrium solution.

**Molarity of IO₃⁻ in the Saturated Sr(IO₃)₂ Solution**
Divide the number of moles of IO₃⁻ by the volume of the saturated Sr(IO₃)₂ solution in each well.

**Molarity of Sr²⁺ in the Saturated Sr(IO₃)₂ Solution**
The solid Sr(IO₃)₂ breaks up according to the following reaction.

\[
\text{Sr(IO}_3\text{)}_2 (s) + \text{H}_2\text{O}(l) \leftrightarrow 2\text{IO}_3^- (aq) + \text{Sr}^{2+} (aq)
\]

Since there are 2 IO₃⁻ ions for every Sr²⁺ ion in the saturated Sr(IO₃)₂ solution, divide the molarity of the IO₃⁻ by 2 to determine the molarity of the Sr²⁺ in the saturated solution.

**K_sp of Sr(IO₃)₂**
Use the following equation to calculate the K_sp for Sr(IO₃)₂ for each of the three trials. Then find the average K_sp for the solution in all three wells.

\[
K_{sp} = [\text{Sr}^{2+}] [\text{IO}_3^-]^2
\]
Results

Include the following results in your lab notebook report. Include the correct number of significant figures and units for each measurement.

### Table 3: Pipet Calibrations from Part 2

<table>
<thead>
<tr>
<th>Pipet drop vol.</th>
<th>Reaction Pipet</th>
<th>Titration Pipet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average drop/mL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of 1 drop</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: $K_{sp}$ Calculations

<table>
<thead>
<tr>
<th>Well Number</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of saturated Sr(IO$_3$)$_2$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of Na$_2$S$_2$O$_3$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moles of S$_2$O$_3^{2-}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moles of I$_2$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moles of IO$_3^-$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molarity of IO$_3^-$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molarity of Sr$^{2+}$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$K_{sp}$

Average $K_{sp}$  __________
Discussion Questions

You must use your data to answer these questions. If the answer you give does not reflect YOUR data and results, you will receive no credit for the question.

1. Using your average $K_{sp}$ as your experimental value, calculate your percent error based on the actual $K_{sp}$ of Sr(IO$_3$)$_2$. The tabulated $K_{sp}$ for Sr(IO$_3$)$_2$ is $3.3 \times 10^{-7}$ at 25°C.

$$% \text{Error} = \left( \frac{\text{Experimental } K_{sp} - \text{Actual } K_{sp}}{\text{Actual } K_{sp}} \right) \times 100$$

2. According to your results, is Sr(IO$_3$)$_2$ more or less soluble in water than you would have predicted based on the actual $K_{sp}$? Give 2 reasons why this could be possible.

3. Explain how your calculation of $K_{sp}$ would have been affected if some of the solid Sr(IO$_3$)$_2$ were transferred into the wells with the saturated Sr(IO$_3$)$_2$ solution before the titration was performed. Do you think this was a source of error in your experiment? Why or why not?

4. After centrifuging, the reaction pipet was put in the beaker for a few minutes after having been in the centrifuge. Why was this done? How could skipping this step have affected your experiment?

5. The pipets were calibrated by holding the pipet horizontally over the top of the graduated cylinder, not vertically. Why was this done? What data would have been affected by holding the pipet vertically during the calibration of each pipet?
Prelab 8 Chem 114

1. Define “titrant” in your own words.

2. How do you know a solution is saturated?

3. What does it mean if we say a salt is “soluble”?

4. Write the $K_c$ for the following reaction: $I_2(aq) + 2S_2O_3^{2-} (aq) \rightleftharpoons 2I^- (aq) + S_4O_6^{2-} (aq)$

5. Write the $K_{sp}$ expression for $Sr(IO_3)_2 (s)$.

6. Calculate the solubility product constant of $Ag_2CrO_4$ if the concentration of silver ion, $Ag^+$, is $3 \times 10^{-4}$ M and the concentration of chromate ion, $CrO_4^{2-}$, is $2 \times 10^{-4}$ M.

7. Why do you hold the pipet horizontally when calibrating and dispensing drops?

8. If your drop/mL rate is 28 drops/mL, what is the volume in liters of 200 drops?

9. Calculate the concentration of the anion if the $K_{sp}$ of $CdS$ is $8 \times 10^{-8}$ and the concentration of the cation is 0.20M.

10. Using the following equation, $Sr(NO_3)_2 (aq) + 2KIO_3(aq) \rightarrow Sr(IO_3)_2 (s) + 2K^+ (aq) + 2NO_3^- (aq)$, how many moles of $Sr(IO_3)_2 (s)$ will be formed from 0.12mL of 0.10M $KIO_3(aq)$?
Experiment Checklist: This sheet must be attached to your lab report

Points:

_____ Format (in order) 5pts Each numbered section should be on separate page(s), unless otherwise noted. Typed in size 10 font, single spaced, headings: size 12 font
(0 / 5) (1) Title page: Title, Name, TA name, Course, section and date
(2) Purpose and procedure: Both should be on 1 single page
(3) Original Data: Must have TA signature, handwritten in lab
(4) Sample Calculations: May be handwritten
(5) Results Table: Typed table
(6) Discussion Questions
(7) Conclusions
(8) Experiment checklist: Last page in each experimental write-up

_____ Purpose 5pts Paragraph of complete sentences summarizing purpose of experiment Must include a clear explanation of what was learned in experiment
(0 / 5)

_____ Procedure 5pts Full procedure not needed, just any changes to experimental procedures
(0 / 5) (1) Give experiment title and page(s) of instructions: ex: Buffers: Pg. 4-5
(2) Heading of each portion of experiment: ex: Part 1: Making a dilution
(3) Under each heading note changes and line of experiment where changed
(4) Note why each change was made, if no changes, state "no changes made"

_____ Data 20pts Original data sheet must have TA signature or 50 point deduction
(0 / 5) (0 / 5) (0 / 5) (0 / 5) (0 / 5) (0 / 5)
(1) All data required in the lab is recorded
(2) Observations are recorded during the experiment
(3) Data is neat and legible
(4) Data is in tables as described in the lab manual

_____ Calculations 15pts Calculations can be hand written. Only 1 sample calculation is required. All calculations listed in experiment are present and correct Calculations must be labeled with the headings given in the calculation section
(0 -15 sliding)

_____ Results 10pts Typed tables with all results. Must match calculations from original data
(0 / 5 / 10) (0 / 5) (0 / 5)
(1) All results are present
(2) Results match calculations
(3) Results must be labeled with the headings given in the calculation section

_____ Discussion Questions 30pts Answers must be correct, typed and in complete sentences for full credit.
(0 / 3 / 6) X 5
Q1 _________ Q2 _________ Q3 _________ Q4 _________ Q5 _________

_____ Conclusions 10pts 5 - 10 complete sentences typed in paragraph form IN YOUR OWN WORDS
(0 / 5 / 10) (0 / 5) (0 / 5) (0 / 5)
(1) Error sources are specific to experiment
(2) Discrepancies between data collected and expected results are explained
(3) Clear final sentence about success in relation to purpose of experiment

Deductions:

_____ Checklist missing: -10 pts
_____ Original data sheet missing -50pts
_____ Significant figures are incorrect in data and/or results -10pts
_____ Units are missing from data and/or results -10pts
_____ Calculations not performed with data from data sheet: -50 pts
_____ Lab report is not typed (original data& calculations can be handwritten) -20pts
_____ Plagiarism (copying from another source): -100 pts
_____ Lab technique points: up to 20pt deduction at your TAs discretion
_____ Late or unprepared
_____ Lab area not clean
_____ Improper waste disposal
_____ Disruptive behavior

_____ Total Score 100pts