Thermochromic **Written Signature Assignment**

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Your lab instructor’s name: Pedro Your lab section:2A

*All work must be* ***very neat*** *and* ***organized****.* *If you need to collect your thoughts, please use a separate sheet of paper. Written Signature Assignments are an* ***individual******effort****. Please submit the completed document to the* ***Thermochromic Written Signature Assignment*** *D2L DropBox folder before the scheduled end of lab.*

1. **Proposal 1 Implementation: Initial Characterization of the Thermochromic Behavior**. In **Table TPSA 1** below, present the **key results** from your Session 2 (**Proposal 1** implementation) characterization of the selected cobalt chloride alcohol volume ratios (CoCl2 in EtOH to CoCl2 in MeOH). There was a minimum of three volume ratios to characterize – a fourth and fifth row is provided if additional (optional) ratios were run.

**Table TPSA 1**: **Proposal 1** Cobalt Chloride Alcohol Volumes and Temperature Observations

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume Ratio** of CoCl2 in EtOH to CoCl2 in MeOH | Volume of **CoCl2(EtOH)2**  (mL) | Volume of  **CoCl2 (MeOH)4**  (mL) | **Total**  **Volume**  (mL) | Color at **Room Temperature** | Kc at **Room Temperature** | Color in the **Ice Bath** | Kc at  **0 oC**  (5 - 7 oC) |
| 1:1 | 2.00 | 2.00 | 4.00 | Pink | 1.285 | Bright Pink | 8.368 |
| 3:1 | 3.00 | 1.00 | 4.00 | Indigo Blue | 0.584 | Lilac | 4.371 |
| 5:1 | 3.33 | 0.67 | 4.00 | Blue af | 1.345 | Light Indigo | 1.252 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

2. **Proposal 1 Implementation: *KC* vs. *T* Graphs**. Paste-in or carefully sketch the *KC* vs. *T* plots for the CoCl2(EtOH)2 **:** CoCl2(MeOH)4 volume ratios of **Table TPSA 1**. Reminder: whenever graphs or plots are presented, you are expected to properly scale, title, and label them using the correct units and appropriate sig figs.

3. **Proposal 2 Implementation: Volume Ratio Optimization**. In **Table TPSA 2** below, present the **key results** from your further **volume ratio** refinements to find the **optimal** cobalt chloride alcohol volume ratio that **most distinctly/sharply changes color at 1 °C**. You were to test at least three (3) additional ratios, but space to record an optional fourth result is provided.

**Table TPSA 2**: **Proposal 2** Optimization of Cobalt Chloride Alcohol Volume Ratios for a Distinct/Sharp Color Change

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Volume Ratio** of CoCl2 in EtOH to CoCl2 in MeOH | Volume of **CoCl2(EtOH)2**  (mL) | Volume of  **CoCl2 (MeOH)4**  (mL) | **Total**  **Volume**  (mL) | Color at **Room Temperature** | Kc at **Room Temperature** | Color in the **Ice Bath** | Kc at  **0 oC**  (5 - 7 oC) |
| 1:1 | 2.00 | 2.00 | 4.00 | Pink | 1.285 | Bright Pink | 8.368 |
| 3:1 | 3.00 | 1.00 | 4.00 | Indigo Blue | 0.584 | Lilac | 4.371 |
| 5:1 | 3.33 | 0.67 | 4.00 | Blue af | 1.345 | Light Indigo | 1.252 |
|  |  |  |  |  |  |  |  |

4. **Proposal 2 Implementation: Thermochromic Thermometer Total Volume Lower Limit**. In **Table TPSA 3** below, present the **key results** from your experimentation to determine the **lower limit** of a **distinct visual color change at 1 °C** for the **optimal** cobalt chloride alcohol volume ratio. You were to prepare and test at least four (4) different total volumes, but space to record up to six is provided.

**Table TPSA 3**: **Proposal 2** Determination of the Total Volume Lower Limit with a Distinct/Sharp Color Change

|  |  |  |  |
| --- | --- | --- | --- |
| **Volume Ratio** of CoCl2 in EtOH to CoCl2 in MeOH | **Total Volume**  (mL) | Color/Intensity at **Room Temperature** | Color/Intensity in the **Ice Bath** |
| 1:1 | 1.00 | Lilac/lavender purple | Bright pink |
| 2.00 | Lilac/lavender purple | Bright pink |
| 3.00 | Lilac/lavender purple | Bright pink |
|  |  |  |
|  |  |  |
|  |  |  |

5. **Claims**.

1. At **high temperatures**, the \_\_\_5:1 volume ratio\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ complex is favored. At **low temperatures**, the \_\_\_\_1:1 volume ratio\_\_\_\_\_\_\_\_\_\_\_\_\_\_ complex is favored.
2. For a cobalt chloride alcohol based thermochromic thermometer that distinctly changes color at 1 °C, the **signs of *ΔHrxn* and *ΔSrxn*** should be \_\_negative\_\_\_\_\_ and \_\_\_negative\_\_\_\_, respectively.
3. The best CoCl2(EtOH)2 : CoCl2(MeOH)4 **volume ratio** for a thermochromic thermometer that **distinctly changes color at 1 °C** is \_the 3:1 volume ratio\_\_\_\_\_\_\_\_\_.
4. The lowest **total volume** of cobalt chloride alcohol solution that **distinctly changes color at 1 °C to the unaided eye** is \_\_\_1mL\_\_\_\_\_\_\_\_.

6. **Justification of the Claims**. In complete, well-written sentences, succinctly explain how and why the data and observations recorded above supports each of your claims. That is, using the ideas and terminology from lecture, the *Thermochromic Guide***,** and the*Kc vs. T Infographic,* give your reasoning that defends your claims using the above experimental evidence.

6a. Justification of Claims in **a)**:

At high temperatures, the 5:1 ratio had the highest K value and since the reaction is Product favored and the 5:1 had 1.345 as its K value, compared to the other two. For the low temperatures, the 1:1 volume ratio is favored as it also had the greatest K value. Since they were all product favored, the one that had the largest K value would be favored the most of them all. This was the 1:1 volume ratio as it had a K value of 8.368.

6b. Justification of Claims in **b)**:

Since the K value at 1 degree Celsius was greater than 1, this indicates that it is Product Favored at low temperatures. This gives us the Delta G value which should be less than 0, or negative. And because the G value is negative at low temperatures, the Delta H and Delta S signs are both going to be negative.

6c. Justification of Claim **c)**:

The 3:1 volume ratio had the most distinct color change out of all the three volume ratios that we chose as it went from a blue color to a purple/pink color. This showed the most distinct color change, visually. K value wise, it went from being reactant favored at room temperature to being product favored at freezing temperature. This would show that there is a huge distinct change between the two temperatures and will allow us to confidently see if there is any temperature changes.

6d. Justification of Claim **d)**:

The total 1 mL volume was the lowest we could go whilst still seeing significant changes in the color. This is because any lower than that and it will be unrecognizable visually to interpret a distinct color change. The volume would just be way too small to effectively conclude that there was a distinct color change.

7. **Reflection 1**. In complete, well-written sentences indicate the important chemical ideals or concepts you learned through this *Project*.

Through the Thermochromic project, I learnt how to observe distinct color changes and how to measure, record, and calculate K values from the data given by the spectrometer. I also learnt how to use the K values and the visual color changes to determine if a ratio would be a good consideration to analyze if a solution has undergone a drastic temperature change, such as from freezing to room temperature.

8. **Reflection 2**. How could you apply what you have learned in this *Project* to other contexts for practical purposes? (That is, discuss how and why what you learned in this *Project* may be important in your life, your studies, or future profession.)

These concepts could be applied when trying to transport certain chemicals and solutions that need to be kept at a certain temperature, such as at 0 degree Celsius, or at freezing. For example, if I needed to move around medical supplies or organs that can only be kept at freezing temperature, I would use the concepts that I have learnt and apply them here. That way, if the temperature were to move away from freezing, I would be alerted as I can see visually this distinct and drastic color change when the solution moves temperature from freezing to room.