Thermochromic **Written Signature Assignment**

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

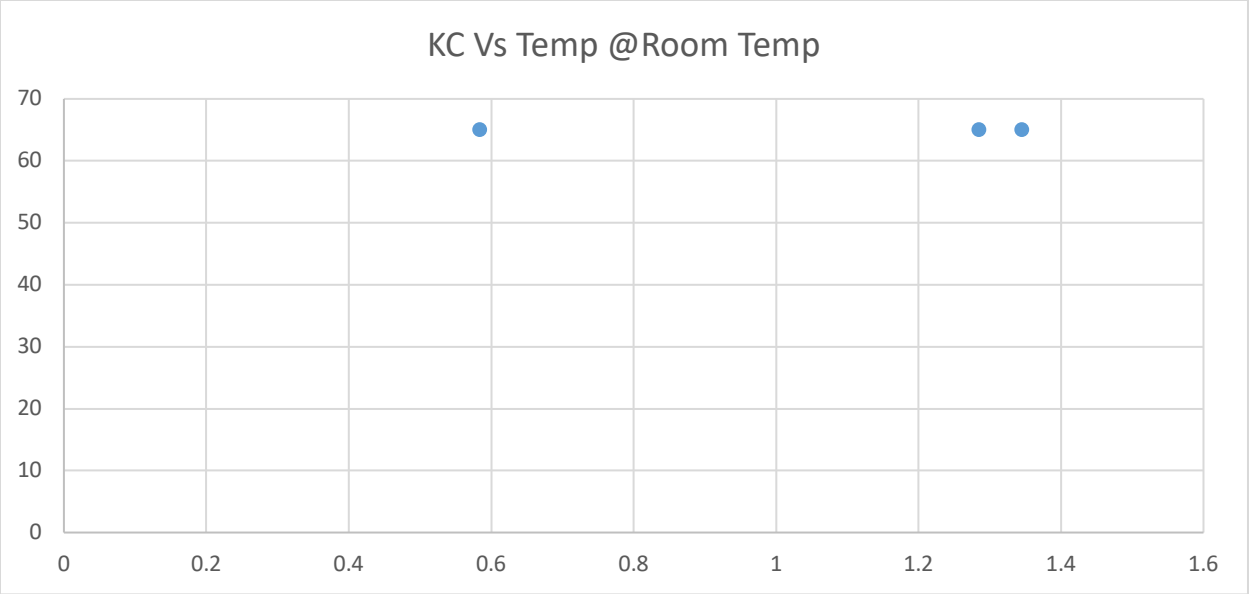
*All work must be **very neat** and **organized**. If you need to collect your thoughts, please use a separate sheet of paper. Written Signature Assignments are an **individual effort**. Please submit the completed document to the **Thermochromic Written Signature Assignment** D2L DropBox folder before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

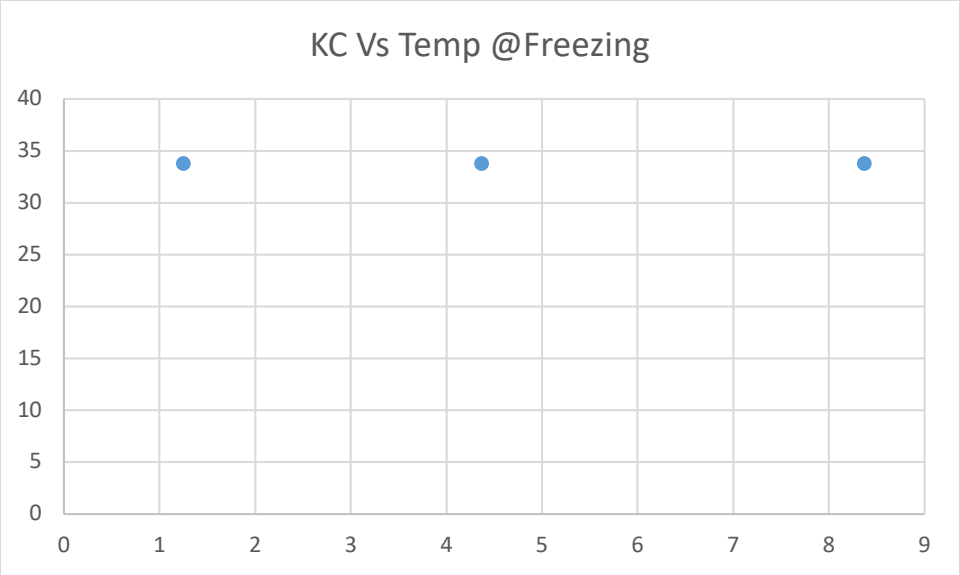
1. **Proposal 1 Implementation: Initial Characterization of the Thermochromic Behavior**. In **Table TPSA 1** below, present the **key results** from your Session 2 (**Proposal 1** implementation) characterization of the selected cobalt chloride alcohol volume ratios ($CoCl_2$ in EtOH to $CoCl_2$ in 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 $CoCl_2$ in EtOH to $CoCl_2$ in MeOH	Volume of **$CoCl_2(EtOH)_2$** (mL)	Volume of **$CoCl_2$ $(MeOH)_4$** (mL)	**Total Volume** (mL)	Color at **Room Temperature**	K_c at **Room Temperature**	Color in the **Ice Bath**	K_c at ≈ **0 °C** (5 - 7 °C)
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: K_C vs. T Graphs**. Paste-in or carefully sketch the K_C vs. T plots for the $CoCl_2(EtOH)_2$ **:** $CoCl_2(MeOH)_4$ 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.


KC Vs Temp @Room Temp
70
60
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6



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 $CoCl_2$ in EtOH to $CoCl_2$ in MeOH	Volume of **$CoCl_2(EtOH)_2$** (mL)	Volume of **$CoCl_2$ $(MeOH)_4$** (mL)	**Total Volume** (mL)	Color at **Room Temperature**	K_c at **Room Temperature**	Color in the **Ice Bath**	K_c at ≈ **0 °C** (5 - 7 °C)
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 $CoCl_2$ in EtOH to $CoCl_2$ 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**.

a) At **high temperatures**, the ___5:1 volume ratio_____ complex is favored. At **low temperatures**, the ____1:1 volume ratio_____ complex is favored.

b) For a cobalt chloride alcohol based thermochromic thermometer that distinctly changes color at 1 °C, the **signs of ΔH_{rxn} and ΔS_{rxn}** should be __negative_____ and ___negative____, respectively.

c) The best $CoCl_2(EtOH)_2$: $CoCl_2(MeOH)_4$ **volume ratio** for a thermochromic thermometer that **distinctly changes color at 1 °C** is _the 3:1 volume ratio_____.

d) 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 *K_c 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.