Experiment 26
The Rate of Bleaching of Food Coloring

Lab Calculation
Pre-Lab 10%
Observations 10%
Report 80%

* We will spend a little time in lab on Tuesday working on graphs so you will either use the data from a week ago, or you can start the graphs for this lab report and fine-tune them while I am around.

Report Details
- This report should be typed, except for the Calculations section.
- The graphs should be done using the Excel program.

- **Objective**: Write a sentence giving the reason for doing this experiment. Do not write "to show how the concepts in lecture relate to a real-world experiment." That's a given. What "main question(s)" are you specifically trying to answer in this experiment? That is your objective. You will find this information in the procedure.
- **Procedure:** The procedure should be in paragraph form, which means complete and correct English sentences. Paraphrase the given procedure (as you did in your pre-labs) only NOT with bullets or steps. Integrate the information. The procedure is as long as you need it to be, to include all of the details.
- **Data**: You have already made your data table. If you think you could improve the presentation, then do so. Data are the direct measurements made in lab, plus any "given" information such as molar masses, or a density obtained from the CRC Handbook (a chemistry reference book). Directly obtained data and reference book values must be listed in their original form. *In general, when you are working with an unknown, always* ***include the unknown # in the data table and in the conclusion.***
- Submit your absorption vs. time data tables. You may photocopy your lab notebook table, but it must be legible!! If it is very messy, you must re-write the tables (on computer or by hand, in pencil or pen). Add this as an appendix.

- **Calculations**

Each calculation must have 3 parts: 1) a header (H) that tells me what you are calculating, 2) a verbal (V) or formula portion, that explains to me where your numbers are coming from, and 3) one sample (S) calculation. The one sample calculation should be the calculation from your first trial, unless you want to discard the information from the first trial because of errors made. If you are excluding your first trial, write a sentence telling me a) why you are not using Trial 1 and b) which trial you are using. Be consistent, if you use data from Trial 1 in the first calculation, use Trial 1 data in all of the calculations. If you work with trial 2, Experiment 2, use that for *all* of the sample calculations. Each sample calculation should be set up as shown below. For the other 7 trials, simply calculate the answers in the same way as shown (on your calculator), and put all of the answers in the Results table(s).

Sample (from the Hydrates experiment in Chem 1A)
H. Mass of Water
V. (Mass of Dish and Hydrate) – (Mass of Dish and Anhydrate)
S. 83.451g – 72.363g = 11.088 g H_2O

- You have 8 sets of data. Hopefully, the temperatures of your reactions were all within 1-3°C of each other. We will call this "constant temperature" , or close enough for us! If they are not within 3°C of each other, this will become a source of error as the rate constant is only constant at a given temperature.

The rate law is : Rate = $k [\text{Red Dye}]^m [\text{NaOCl}]^n$

We need to set up our experiments so that we can solve for m, n, and then k.
Create a table of results (to be placed in the next section) for all 8 experiments that shows the rate of each reaction and the initial concentration of each reactant. This table is similar to some of your homework problems. To do this you need to calculate the initial rate for each experiment:

$$\text{Rate} = \frac{-\Delta[\text{Red Dye}]}{\Delta \text{ time}}$$

We will use the first 15 second interval (or t=0 to whatever time it was when you recorded your first absorbance) as Δt, and the change in concentration of your red dye. You have two things to do here: the initial concentration and initial absorbance are at "full strength", but t=0 occurred the moment that you mixed your dye with the bleach. Using the equation below, (and substituting "before the reaction started" for t), find what the absorbance was at t=0. You have the original concentration of the Dye, and you use the dilution formula to find the concentration of the dye immediately after it has been mixed with the bleach (before the reaction starts reducing the concentrations of both bleach and dye). This will give you your initial absorbance at t=0.

Once you have this, you can determine the concentration of the Dye at t=15 s.

$$\frac{[\text{Dye}]_t}{[\text{Dye}]_0} = \frac{\text{Absorbance (A)}_t}{\text{Absorbance (A)}_0}$$

- After determining the concentrations of the dye at t=0s and t=15s, calculate the Initial Rate. Show one completely detailed calculation (with Header, Brief Verbal or a Formula, and the Sample) for EACH calculation required to lead up to the determination of the Rate for Trial 1 of experiment 1. Then calculate the rest on the calculator and place the answers in the Results Table, described above. If you have reason to believe that the data for one or more of your reactions isn't good, note which ones and briefly explain in the discussion.

- When you have completed the results table, show one complete set of all calculations (H,V,S) leading up to the calculation of the orders for each reactant. For instance, one set of calculations to find "m", but then just show the results for "n".

- This is experimental data. If your results for the orders of reactants are not whole numbers, round the number to the nearest whole number (include that step: show the original calculated value, and state that you are rounding to whatever whole number.)
- Determine the OVERALL order of the reaction (the overall order is simply adding together each reactant order, in this case the rounded numbers for "m+n" = "overall order". Show this calculation: HVS!

Graphs

- In Excel, create 4 graphs, using the integrated rate equation that will yield a straight line (based on the Overall Order of the reaction). If showing the two trials of one reaction on one graph is too time consuming to figure out , make 8 individual graphs. [My Excel directions don't (yet) include directions for graphing two sets of data on one graph.] The graphs should include axes labels with units, a descriptive title (Rxn #, Trial #), and a TRENDLINE to generate a truly straight line and not a connect-the-dots line. Also, once the TRENDLINE is generated, include the Equation of the line directly on the graph and the R^2 value. If you set two sets of data on one graph, label the Series so it is clear which line belongs to Trial 1 and which to Trial 2.
- From the Graphs, you can obtain the rate constant directly from the line equation. Put these values into a Results table, along with appropriate units.

Calculations (again)
These require H,V, S also!

- For the set of reactions that all have close temperatures, (within 3°C) average the rate constants, to come up with one rate constant for the reaction at this temperature.
- Average the temperatures, and give the average rate constant with its average temperature.
- Calculate the Average Deviation for the 8 rate constants from the average.

Average Deviation Formula:

$$\frac{|\bar{x} - x_1| + |\bar{x} - x_2| + |\bar{x} - x_3| + \ldots}{Number\_of\_trials}$$

Where $\bar{x}$ = the average value of k, and x_1, x_2 etc... are the individual values of k, and the denominator is the total number of k values.

Results

- The table for the Rates and Concentrations.
- The table for the rate constants, average rate constant, and average deviation.
- Write the Rate Law with the correct numbers for m, n, and k. Leave the concentration of Dye and Rate as variables.

Discussion and Questions

- *Discussion:* If there was an obvious error or change to your procedure during the course of your experiment, you should mention that here. If there were no obvious mistakes, then simply state that the protocol was followed. If, during your calculations, you notice that something is off (error is too big or the answer to something seems unreasonable

due to its magnitude, for instance) state that you have noticed it, and (if you have one) suggest a reason for it. Sometimes the experiment is at fault, sometimes there is an error in the calculations. Sometimes, the reason won't be clear to you. All of that is acceptable; what isn't acceptable is to "not notice" that the numbers are way off!

- *Questions:*

1. What hypothesis could you make regarding the slowest step in the mechanism for this reaction, based on the rate law? I am looking for a general statement *about* the slowest step in the mechanism, not an actual mechanism.
2. What would you predict the rate would be if the reaction were run at the same temperature with 0.025 M Red dye #40 and 0.050 M NaOCl?

- **Conclusion:** Your concluding sentence(s) should tell me the most important results for each reaction, as stated in your objective. The conclusion should mirror the objective. If you wrote that you are trying to determine something in the objective, what you actually got (and any error analysis that goes with it) should be stated in the conclusion. This is all you need for a conclusion. Statements about possible errors or comments about the procedure belong in the discussion section.

This is the description of what you should do for your lab report. If you have any questions, you can always ask. I won't help with calculations, or tell you if your calculations are correct; I will help clarify what I would like you to do, and I will help if you are unsure about any sort of formatting or graphing questions. If you start your lab before Wednesday night (which is a very good idea), you can show it to me ahead of time to see what I think.