**AP Lab: Determining the rate law for the fading of phenolphthalein in a basic solution.**

**Data**

| | | **0.30M** | **0.20M** | **0.10M** | **0.050M** |
|---|---|---|---|---|---|
| time #1 | minutes | 0.0 | 0.0 | 0.0 | 0.0 |
| | % transmittance | | | | |
| | Absorbance* | | | | |
| | ln absorbance | | | | |
| | | | | | |
| time #2 | minutes | 0.50 | 1 | 2 | 4 |
| | % transmittance | | | | |
| | Absorbance* | | | | |
| | ln absorbance | | | | |
| | | | | | |
| time #3 | minutes | 1.00 | 2 | 4 | 8 |
| | % transmittance | | | | |
| | Absorbance* | | | | |
| | ln absorbance | | | | |
| | | | | | |
| time #4 | minutes | 1.50 | 3 | 6 | 12 |
| | % transmittance | | | | |
| | Absorbance* | | | | |
| | ln absorbance | | | | |
| | | | | | |

*Note: Absorbance = $2-\log_{10}$ %Transmittance

## Data analysis

1. Open the program "Graphical Analysis" from the start menu for the class.
2. In the data table window on the left, double click on the x at the top of the column; change the name to "time" and the unit to "min".
3. Enter the following times: 0.0, 0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 6.0, 8.0, 12.0
4. Double click on the y at the top of the next column and change the name to ln [0.30], with the units blank.
5. Click on the data menu choice along the top of the page, then "new manual column"; change the name to "ln [0.20]" with the units blank.
6. Repeat step 5, creating a column for "ln [0.10]" and "ln [0.050]".
7. Enter your lab data, watching carefully to make sure you match the appropriate "ln data" with the appropriate times.
8. On the graph portion of the screen, click on the "ln [0.30]" on the y axis. Select all the "ln's" by clicking next to it, then click ok. This will plot all four lines on the same graph.
9. Click on the top open portion of your graph. A dialog box will open to allow you to title your graph. Title it as "ln [OH-] vs time" and then skip a few spaces, and include your hour and lab group number in the title.
10. Save your file to your desktop for further reference.
11. Click on the button along the top of the screen that has a red line drawn on a blue curve with "R=" on it. This will draw the best fit straight line to your graphed line. Choose to allow this for all four lines on the graph. Four text boxes will now pop up on your graph. In the boxes, among other information, it will list the slopes of your lines. Click on the graph and drag its window to occupy the whole width of the screen, and move the slope textboxes so they do not cover the lines and it can be clearly seen to which line they are indicating.
12. Print a copy of the graph (using the "print graph" option from the print menu). Print one copy for each group member.

## Results

1. Because different initial [OH-] are used, the shape of the lines indicate the order with respect to phenolphthalein. What does the shape of the lines tell you about the order with respect to phenolphthalein [$H_2P$]?

2. Record the (-) of the slope as "k" for that concentration – do this for each of the concentrations. Calculate the ln of both the concentrations and the measured k's.

| M | k | ln M | ln k |
|---|---|---|---|
| 0.30 | | | |
| 0.20 | | | |
| 0.10 | | | |
| 0.05 | | | |

3. On a new graph, plot the "ln k" values (on the y axis) v " ln [OH-]" as a single line; determine the slope of the best fit line as done above. Title the graph as done above and print a copy for each group member.

4. If the k for each concentration is designated $k_1$, then $\ln k_1 = m \ln[OH^-] + \ln k_{overall}$; therefore, the slope of this line is the order with respect to [OH-]. To a single digit, what is the order with respect to [OH-]?

5. Using the y-intercept of this graph as $\ln k_{overall}$, and taking the antilog, what is $k_{overall}$? Include the appropriate units.

6. Write the complete rate law for the reaction; include the number value for k with the correct units.