Name______________________________ Section _____________________

Partner(s) ________________________ Date _________________________

INVESTIGATING A HYPOTHETICAL INITIAL RATE MODEL OF THE BEHAVIOR OF CRYSTAL VIOLET ION (CV^+) ABSORBANCE

You have had the opportunity to investigate the kinetics of the crystal violet-sodium hydroxide reaction in the laboratory. This activity is an extension of that experience using a computer model that will allow you to change reaction conditions and explore the effects of variable changes on the reaction system.

1. Bring up the STELLA model "CV_absorbance_kinetics_103" on the computer. This model permits variation in five variables that might influence the rate of reaction and/or the overall absorbance measured during a run. The influence can result from changes in Beer's Law parameters or from an error during the experiment that affects the kinetics. The five independent variables in the model are listed below:

   CV^+ concentration   Temperature   Wavelength
   NaOH concentration   Pathlength

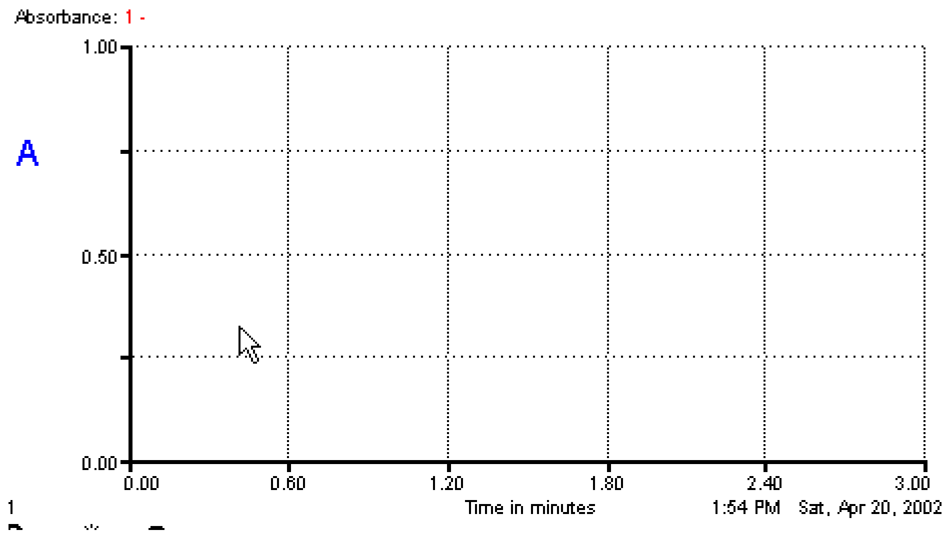
2. Select "RUN" and generate the graph for the model set at the initial conditions. Sketch the graph on the axes below. The variables can be changed by adjusting the sliders or clicking on the box with the numbers in it and typing the value in. To set the model back to the original, click on the U that appears on the slider when it is changed from the original value.

   Assume the rate law for the reaction is given by: Rate = k [CV^+] [OH^-]

   In general, when a variable changes in the above equation, how does the line respond-different slope or intercept? Explain.

   For the absorbance versus time graph, what is the formula for the slope defined in terms of the two variables being measured?

   What does the slope represent in terms of the chemical reaction? Why is the slope negative?



3. What effect on the rate would you predict by changing the concentration of either the CV^+ concentration or NaOH concentration? Why?

Keep NaOH constant and change $[CV^+]$. Sketch the resulting graph on the axes above and label it clearly. Include the change made.

Keep CV^+ constant and change $[OH^-]$. Sketch the resulting graph on the axes above and label it clearly. Include the change made.

Is the response the same for CV^+ and NaOH? Explain why or why not.

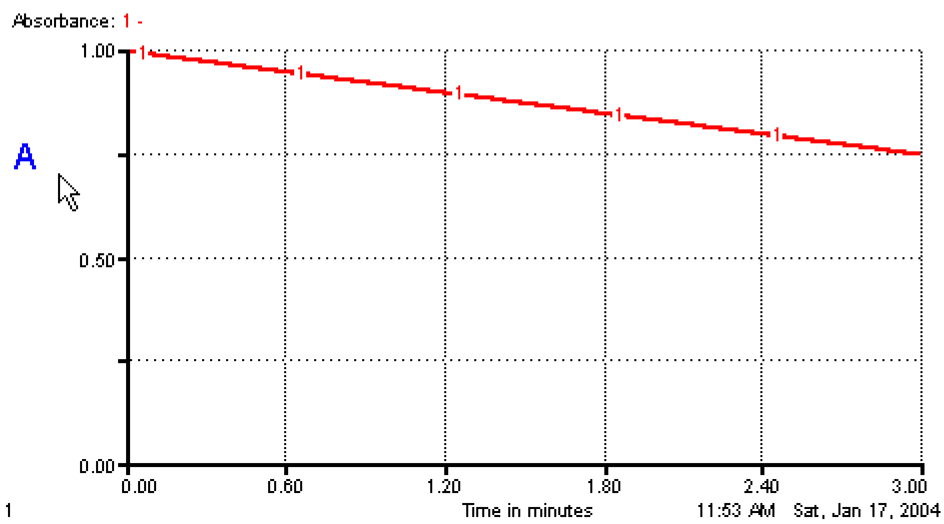
4. Predict how a decrease in temperature might influence the graph. Explain why.

What does temperature influence in the rate law?

Change the temperature and look at the response. Sketch the resulting graph on the axes below and label it clearly. Include the change made.

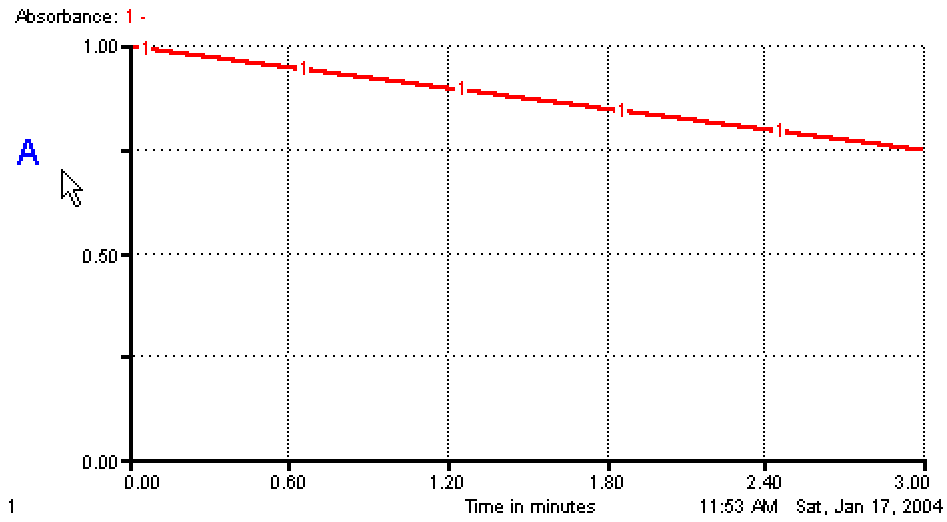
Suppose the cell warmed up from instrument heat about half-way through the run. How would the run be influenced?

See the model for a method to simulate a temperature change mid-run. Sketch the resulting graph on the axes below and label it clearly. Include the change made.



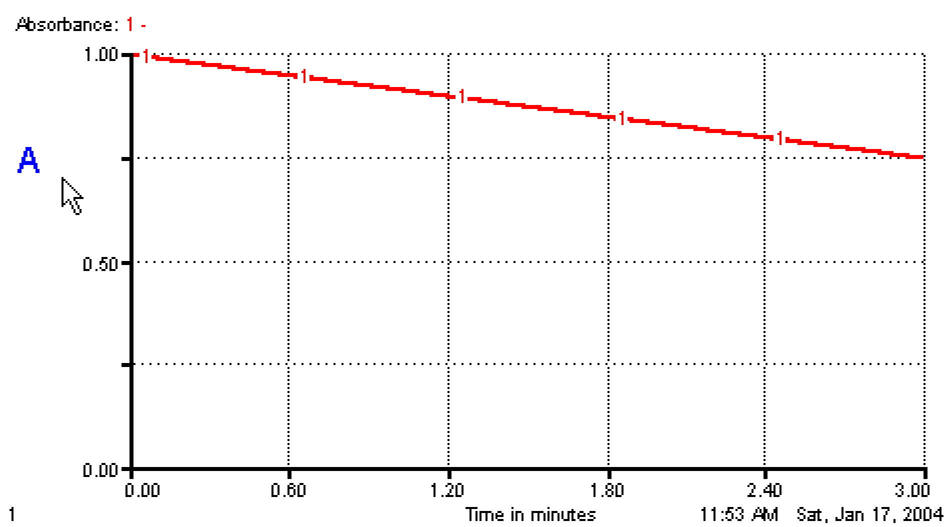
5. How might the system respond to a change in pathlength? Why?

Make an adjustment in the pathlength. Sketch the resulting graph on the axes below and label it clearly. Include the change made.



Explain the results of the graph when the pathlength was changed.

6. How might a run respond to a change in wavelength (where λ_{max} = 500 nm)? Explain your prediction. Sketch the resulting graph on the axes below and label it clearly. Include the change made.

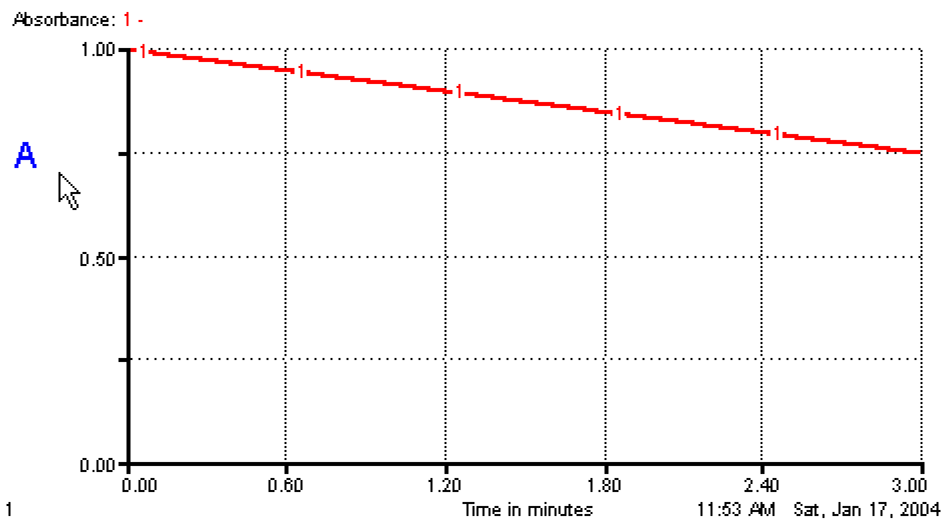


Was your prediction correct? Explain why or why not.

Changing the wavelength, λ, influences the absorbance; yet, λ does not appear in Beer's Law. Explain the variation.

7. For all the runs in this model, the measurements were taken with the normal one minute delay. Suppose that you waited **another** 1.5 minutes to start the measurements, would you get the same rate? Explain.

Suppose you waited 10 minutes, would you get the same rate? For each situation, sketch the predicted graph on the axes below and label it clearly.



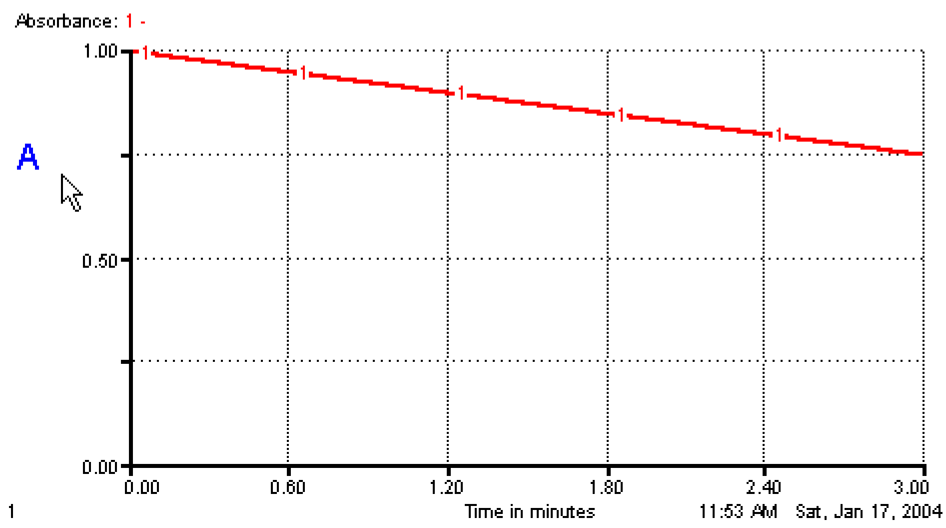
Suppose the reaction in a particular run is slow starting. On the axes above, sketch what the graph would look like with and without time delay.

Does the slow start without time delay effect the regression line? Explain.

8. What happens if a student puts CV^+ in the spectrophotometer tube but forgets to add the NaOH? Sketch and label the result on the axes below.

What happens if a student puts NaOH in the spectrophotometer tube but forgets to add the CV^+? Sketch and label the result on the axes below.

If the (CV^+) is cut in half and the (NaOH) is doubled, does anything change? Explain. Sketch and label this situation on the axes below.



9. Suppose when the CV^+ was made up, it gave an absorbance greater that 1.00 ($A > 1$ has too large an error in measurement). What variable(s), other than diluting the CV^+, could be adjusted to allow the run with a starting absorbance at 1.00 or less?