Determination of Ea Energy of Activation

Short procedure: Wear goggles at all times. Dispose of solutions in the bins placed in the lab.

Lab quest set up:

1. Connect the Colorimeter to LabQuest using the USB cable and choose New from the File menu. Give a file name and save the file.

2. Calibrate the Colorimeter.

   a. Open the Colorimeter lid, insert the blank (cuvette filled with ¾ distilled water is the blank), and close the lid.
   b. Press the < or > button on the Colorimeter to select the wavelength of 565 nm (Green). Press the CAL button on the Colorimeter. When the LED stops flashing, the calibration is complete. Remove the cuvette from the Colorimeter.

3. Set up the data-collection mode.

   a. On the Meter screen of the LabQuest,
   b. Sensor setup > Data Collection > Timebased > Rate > 1 sample/second.
   c. Change the data-collection length to 200 seconds. Select OK.

4. Ice / Water Bath preparation

   a. Prepare an ice bath if ice cubes are available, place ice cubes in a 500 mL beaker or the ice bath prepared for you. if not proceed with the cold tap water and a cold bath.
   b. Prepare a water warm bath using a 1L / 600 / 500 mL beaker (Whichever is available). Fill it $3/4^{th}$ with tap water, place it on a hotplate. When the first bubble starts to appear, turn off the hot plate.

5. Experimental Part
   a. Test tube 1. Accurately measure 10 mL of the CV solution into a test tube using a graduated pipette and place it in the ice / water bath along with a test tube containing accurately measured 0.1 M NaOH solution, when the solutions have attained the temperature of the bath, mix the solutions in a 50 mL beaker and record the temperature, make sure you mix the solutions properly. Fill the cuvette $3/4^{th}$ with the solution. Wipe the outside with paper towels and place it in the colorimeter with the clear side facing the arrow on the colorimeter. Now press the green triangle play button to start data collection. Make sure the colorimeter and Lab quest is set up according to the instructions.
   b. Repeat the steps for the remaining test tubes 2, 3 and test 4 but use the water baths prepared for higher temperatures (Approximately 10 degrees apart)
   c. Every time you start data collection for a different temperature set use the black file cabinet icon to start a new data set collection on your labquest. When all the four values have been collected save your file in your own name and record the labquest number.
   d. When data collection is complete, carefully remove the cuvette from the device. Dispose of the contents of the beaker and cuvette as directed
6. Because the reaction is first order with respect to crystal violet, you can determine the rate constant, *k*, by plotting a graph of ln Absorbance *vs.* time.

a. Tap the Table tab.
b. Choose New Calculated Column from the Table menu.
c. Enter the Name (ln Absorbance) and leave the Units field blank.
d. Select the equation, A ln (X). Use Absorbance as the Column for X, and 1 as the value for A. Select OK. A graph of ln absorbance *vs.* time should now be displayed. Change the scale of the graph, if necessary.

7. To calculate the best-fit line equation for your plotted data, choose Curve Fit from the Analyze menu. Choose Linear as the Fit Equation. The slope, *m*, is equal to the rate constant, *k*. Record this value in your data table. Select OK.
8. Data Table

Trial	Temperature (°C)	Rate constant, *k* (s^{-1})
1		
2		
3		
4		

9. Data Analysis

a. Plot a graph of your data above, using Temperature (°C) as the x-axis, and the rate constant, *k*, as the y-axis. You may use Logger *Pro* to prepare the graph, or plot the data manually on graph paper, as directed by your instructor.

b. Determine the activation energy, E_a, by plotting the natural log of *k vs.* the reciprocal of absolute temperature. You may use Logger *Pro* to prepare the graph, or plot the data manually on graph paper, as directed by your instructor.

c. Calculate the activation energy, E_a, for the reaction. To do this, first calculate the best fit line equation for the data in Step 2. Use the slope, *m*, of the linear fit to calculate the activation energy, E_a, in units of kJ/mol. **Note:** On a plot of ln k *vs.* 1/absolute temperature, $E_a = m \times R$.

d. A well-known approximation in chemistry states that the rate of a reaction often doubles for every 10°C increase in temperature. Use your data to test this rule. (**Note:** It is not necessarily equal to 2.00; this is just an approximate value, and depends on the activation energy for the reaction.)

e. Using the rate constant and precise temperature value for the trial that was done at room temperature (~20°C), as well as the E_a value you obtained in Step 3 above, calculate the value of the rate constant at 40°C.

10. Submit a one page report with graph (Refer to 9a) and show the value of Ea obtained from the slope of the line. Use Arrhenius equation and the rationale for your solution. No lab report needed. 1 page max per group, include all your group members names on the sheet.