Name: _____ Quiz Section: _____

Lab Partner: _____ Student ID#: _____

CHEM 142 Experiment #5: Kinetics I (Integrated Rate Law)

Goals of this lab:

- Create and use a calibration curve for the absorbance/concentration relationship for crystal violet
- Evaluate absorbance versus time measurements to determine the order of a reaction
- Analyze graphs of data to determine best linear fit
- Calculate rate constants from best-fit lines and values
- Assemble a complete kinetic description of the reaction from data gathered

Your lab report will be grade on the following criteria using a poor/good/excellent rating system (see the Self-Assessment on the "Reporting Your Results for Exp #5" page of the lab website for more details):

- Calculations are accurate and complete based on data gathered; proper significant figures and units are used
- Data collected is reasonable; outliers are identified and possible explanations are reasonable
- Interpretations of graphs and data are reasonable
- Reaction orders are determined accurately from data gathered; reasonable conclusions are reached
- All graphs and tables and clearly and accurately labeled; entire report is typed

By signing below, you certify that you have not falsified data, that you have not plagiarized any part of this lab report, and that all calculations and responses other than the reporting of raw data are your own independent work. Failure to sign this declaration will result in 5 points being deducted from your lab score.

Signature: _____

This lab is worth 60 points: 10 points for notebook pages, 50 points for the lab report
(Do NOT include your notebook pages when you scan your report for upload into Gradescope.)

READ THIS BEFORE PROCEEDING WITH THE DATA ANALYSIS FOR THIS EXPERIMENT:

For this lab, you will first evaluate the data for the CV^+ standards to obtain a value for molar absorptivity (ε) that you will then use to convert Absorbance data to [CV^+] (Remember: $A=\varepsilon \ell c$; if the calibration curve does not go through 0,0 then you need to include the y-interecept in your calculation of the concentration). You will then evaluate the concentration data as a function of time using the integrated rate law method of determining the orders with respect to each reactant and the rate contant for the reaction at this temperature.

You will plot all of the data for the calibration curve and for Run 1. However, for the data in Runs 2-4 and the determination of the order with respect to OH^-, INSTEAD OF CREATING ADDITIONAL PLOTS, WE WILL USE A SHORTCUT THAT EMPLOYS FUNCTIONS WITHIN EXCEL TO DETERMINE THE SLOPE AND Y-INTERCEPT FOR A SET OF DATA. For example, to use these functions, click on the cell in which you want the result to appear and enter the following:

=SLOPE(A10:A15,B10:B15)

=INTERCEPT(A10:A15:B10:B15)

In this example, **A10:A15** represent an the cells that contain data for the y-axis and **B10:B15** represent data for the x-axis. This is a shortcut for generating the slope and y-intercept values without actually creating a plot of the data and generating the trendline equation of $y = mx + b$.

You will create three plots on page 4, using the data from Run 1, to determine the order of the reaction with respect to CV^+. Once you know the order of the reaction with respect to CV^+, you will perform the necessary "slope" functions for the other three runs to determine k' for each run. When you get to the section for determining the order of the reaction with respect to OH-, you will also need to use the "intercept" function mentioned above.

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Note: All sections of this report must be typed

Part I. Determining the Molar Absorptivity for Crystal Violet

Concentration of stock solutions

CV^+		M
OH^-		M

Volume of CV^+ stock solution needed to make 25 mL of 1.0 x 10^{-5} M CV^+ is

CV^+		mL

Calibration Curve Data

λ max, CV^+		nm

Dilution Factor	$[CV^+]$ (M)	Absorbance
10.0		
4.0		
2.0		
1.0		

Place your calibration plot here. Make your plot big enough to cover this instruction box so that it is large enought for someone else to read.

This calibration plot is Abs vs. concentration of crystal violet(M) (y-axis vs. x-axis)

Use the online resources if you need help figuring out how to plot a graph in Excel.

Title the graph and label the axis, including the correct units (Absorbance data is unitless). Be sure to double check your units and formatting once you print the report.

Add a Trendline to show the linear fit of your data. Choose a linear line andchoose the options that will "display the equation on the chart", including the R^2 value.

Slope of Absorbance versus concentration graph

_____ M^{-1}

y-intercept of Absorbance versus concentration graph

_____

Detailed calibration equations:

FROM THIS REPORT: _____

FROM THE LQ2 SYSTEM IN LAB: _____

If the slope = $\varepsilon\ell$, what is the molar absorptivity for the CV^+ at this wavelength?

molar absorptivity, ε		$M^{-1}cm^{-1}$

(Note: if you have two different values based on two different calibration curves, use the equation that is based on your data analysis here in the Excel template, not the one from lab.)

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Part II. Determining the Rate Law for the $CV^+ + OH^-$ Reaction

Table of Volumes and Final Concentrations During Solution Preparation for Runs 1-4

Run #	mL of 0.1 M NaOH	mL of DI H_2O	mL of 3.0×10^{-5} M CV^+	mL Total	$[CV^+]_{final}$, M	$[NaOH]_{final}$, M
1	2	0.5	0.5	3	5.00E-06	0.0667
2	1.5	1	0.5	3	5.00E-06	0.0500
3	1	1.5	0.5	3	5.00E-06	0.0333
4	0.5	2	0.5	3	5.00E-06	0.0167

*$[CV+]_{final}$ and $[NaOH]_{final}$ are the final concentrations after all reagents are mixed and the initial concentration for the start of the reactions

	slope	units for slope	y-intercept
Student- specific data from pg 2 used in calculations autofill here:	0	M^{-1}	0.0000

Show your calculation of the $[CV^+]$ at the **first timepoint in Run #1**:

Reaction Order Determination for CV^+

READ THIS BEFORE PROCEEDING

For evaluating the data for Run 1, enter your time and absorbance values, as recorded in your lab notebook during lab, in columns A and B, respectively. In column C, convert the aborbance values to concentration according to the example you provided at the top of this page. In column D, convert the $[CV^+]$ values from column C to ln $[CV^+]$. In column E, convert the $[CV^+]$ values from column C to $1/[CV^+]$. Insert the plots used to determine the order with respect to $[CV^+]$ on the next page, then come back and provide the summary information as requested.

Run 1

Time (s)	Absorbance	$[CV+]_t$	$\ln[CV+]_t$	$1/[CV+]_t$

ORDER WITH RESPECT TO CV^+

Which plot (on the next page) is the most linear?

Based on the plots you created on the next page, what is the order of this reaction with respect to CV^+?

RUN #1

What is the value of the slope for the most linear plot?

What is the psuedo-rate constant (k') for this reaction?

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Place your plot of [CV+] vs time here, making it large enough to cover this box (so that it is easy to read).

FOR FULL CREDIT:

- plot the correct data on each axis

- correctly label each axis and format the axis such that the data being plotted fills the majority of the graph (axes do NOT need to start at 0)

- appropriately title the plot

- use Excel to add a trendline for the data...be sure to choose the trendline options that "display equation on chart" and "display R-squared on chart"

Place your plot of ln[CV+] vs time here, making it large enough to cover this box (so that it is easy to read).

FOR FULL CREDIT:

- plot the correct data on each axis

- correctly label each axis and format the axis such that the data being plotted fills the majority of the graph (axes do NOT need to start at 0)

- appropriately title the plot

- use Excel to add a trendline for the data...be sure to choose the trendline options that "display equation on chart" and "display R-squared on chart"

Place your plot of 1/[CV+] vs time here, making it large enough to cover this box (so that it is easy to read).

FOR FULL CREDIT:

- plot the correct data on each axis

- correctly label each axis and format the axis such that the data being plotted fills the majority of the graph (axes do NOT need to start at 0)

- appropriately title the plot

- use Excel to add a trendline for the data...be sure to choose the trendline options that "display equation on chart" and "display R-squared on chart"
.

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Run 2			
Time (s)	Absorbance	$[CV+]_t$	$\ln([CV^+]_t)$

Run 3			
Time (s)	Absorbance	$[CV+]_t$	$\ln([CV^+]_t)$

RUN #2

What is the value of the slope for the most linear plot?

What is the psuedo-rate constant (k') for this reaction?

RUN #3

What is the value of the slope for the most linear plot?

What is the psuedo-rate constant (k') for this reaction?

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Run 4			
Time (s)	**Absorbance**	**$[CV^+]_t$**	**$f([CV^+]_t)$**

RUN #4

What is the value of the slope for the most linear plot?

What is the psuedo-rate constant (k') for this reaction?

Reaction Order Determination for OH^-

Consult the "Helpful Information" section in the introductory pages for this experiment in the lab manual for help with this last section of data analysis. As explained in the Instruction box on page 1 of the template, for the slope and y-intercept calculations you will use the functions in Excel rather than creating a plot.

Values for $[OH^-]$ and k' autofill from earlier in report

Run #	$[OH^-]$	k'	$\ln[OH^-]$	ln(k')
1	0.0667	0.00E+00		
2	0.0500	0.00E+00		
3	0.0333	0.00E+00		
4	0.0167	0.00E+00		

ln(k') vs. ln($[OH^-]$)

slope

y-int

Show your calculation of the rate constant for the overall reaction.

Order of the reaction with respect to $[OH^-]$:

Rate constant for the overall reaction, k:

Units for k:

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Results from earlier in the report autofill here:

Order wrt CV+	Order wrt OH-	Overall rate constant	Units for overall rate constant
0	0	0.000	0

Results and Discussion

1. Based on your data, write the complete rate law, including the value and units for the rate constant.

2. The literature values of the orders with respect to CV^+ are and OH^- are 1 and 1, respectively. Calculate your % error for the experimental value for the order with respect to $[OH^-]$. Discuss your largest sources of error.

Laboratory Waste Evaluation

Laboratory waste is considered *anything* generated during an experiment that is disposed of down the sewer drain, thrown in the garbage, collected in a container for disposal by the UW Environmental Health & Safety department, or released into the environment. Based on the written lab procedure *and* your actions during the lab, list the identity and approximate amount (mass or volume) of waste that you generated while performing this experiment.