Exploring Rate Laws

The file "Exploring Rate Laws" in the course's workshop folder contains data for the hypothetical reaction $R \rightarrow P$ under zero-order, first-order, and second-order kinetic conditions. The rate constant, k, is the same for all three curves; thus any differences between the curves is due to the effect of concentration on rate. Working together, complete the following tasks:

1. Decide which curve corresponds to which reaction order. Be sure that you clearly state the reasons for your decisions. After reaching a conclusion add a legend to the graph by (i) clicking on the graph to select it; (ii) selecting Options:Graph Options from the main menu; and (iii) checking Legend on the Graph Options tab. Were your assignments correct? If not, then discuss the flaws in your reasoning.

2. Explore how the rates of these three reaction orders vary with time (use the tangent tool to do this). Discuss any trends you see in each case and between the cases.

3. Look at the data on Page 2. Can you unambiguously deduce the reaction's order and, therefore, its rate law? Clearly explain your reasoning. Look at the data on Page 3 and repeat this analysis. Briefly summarize your conclusions about the usefulness of a plot of [R] vs. t as a means for determining a reaction's order.

4. Another way to analyze kinetic data is to look at the reaction's half-life, which is the time it takes for the concentration of R to decrease by 50%. Estimate the first four half-lives for each curve on Page 1 (these are the Δtime for the concentration to change from 100 to 50, from 50 to 25, from 25 to 12.5 and from 12.5 to 6.25. Use the Examine tool to make your measurements, estimating concentrations and time as necessary. You will need to rescale the X-axis, which contains data up to a time of 1001 in order to make some measurements. Use the following table to organize your results:

		Δtime for…		
half-life number	change in [R]	zero-order	first-order	second-order
1	100→50			
2	50→25			
3	25→12.5			
4	12.5→6.25			

What patterns do you observe in these half-lives? Clearly explain how you might use this information to determine if a reaction is zero-order, first-order, or second-order.

5. Return to page 3 and determine the reaction order using half lives. Does your result agree with your earlier prediction? If not, then explain why you were fooled when you originally examined the data.

6. Another way to analyze kinetic data in which the concentration of a reactant is monitored over time, is to use what is called an integrated form of the rate law. Pick up a copy of the handout outlining the integration of the differential rate law and then go to Page 4 for the last assignment.