Matter and Motion Winter 2016
Chemistry Workshop 1

The workshop is intended to be a low-pressure setting where we get to practice problems, ask any questions, and discuss concepts and problem solving methods. Have fun! Work together on whiteboards or scratch paper and then neatly write your solutions in a notebook where you keep chemistry class notes. Your workshop solutions will be included in your portfolio.

1. a) Write the differential rate equation for a 2nd order reaction involving a single reactant A.
b) Use calculus to derive the integrated rate equation for this 2nd order reaction.
c) Derive an expression for the half-life of this 2nd order reaction.

2. Make a graph of a general reactant concentration [A] versus time for zero-, first-, and second-order reactions. Compare the half-lives of the different reactions.

3. Consider the reaction $2I^-$ (aq) + $S_2O_8^{2-}$ (aq) → I_2 (aq) + SO_4^- (aq) at 25°C, with the following experimental results for the initial rates. a) Determine the differential rate law. b) Calculate the value of the rate constant. Is it the same for each experiment?

$[I^-]_0$ (mol/L)	$[S_2O_8]_0$ (mol/L)	Initial rate (mol/L·s)
0.080	0.040	12.5×10^{-6}
0.040	0.040	6.25×10^{-6}
0.080	0.020	6.25×10^{-6}
0.032	0.040	5.00×10^{-6}
0.060	0.030	7.00×10^{-6}

4. Consider the reaction NO_2 (g) + CO (g) → NO (g) + CO_2 (g), where the rate only depends on the concentration of nitrogen dioxide for temperatures under 225°C. Under these conditions, the following data were collected. a) Determine the rate law and the integrated rate law. b) Determine the value of the rate constant c) Calculate $[NO_2]$ at 2.70×10^4 s after the start of the reaction.

Time (s)	$[NO_2]$ (mol/L)
0	0.500
1.20×10^3	0.444
3.00×10^3	0.381
4.50×10^3	0.340
9.00×10^3	0.250
1.80×10^4d	0.174

5. A first-order reaction is 75.0% complete in 320 s. a) What are the first and second half-lives for this reaction? b) How long does it take for 90% completion?

6. A proposed mechanism for the breakdown of hydrogen peroxide is as follows. If the rate law is rate = $k[H_2O_2]$, a) determine the rate limiting step, and b) write the overall balanced reaction for this experiment.

$H_2O_2 \rightarrow 2OH$

$H_2O_2 + OH \rightarrow H_2O + HO_2$

$HO_2 + OH \rightarrow H_2O + O_2$