Diebolt CHM 152/154 Spring '05 **Quiz 1. Take Home Key**

1. Given the following reaction: $8MnO_4^- + 14H^+ + 5S_2O_3^{2-} \rightarrow 8Mn^{2+} + 7H_2O + 10SO_4^{2-}$

   a) Express the general rate of reaction in terms of each of the reactants and products. (2 pt)

Rate = $-\frac{\Delta[MnO_4^-]}{8\Delta t} = -\frac{\Delta[H^+]}{14\Delta t} = -\frac{\Delta[S_2O_3^{2-}]}{5\Delta t} = \frac{\Delta[Mn^{2+}]}{8\Delta t} = \frac{\Delta[H_2O]}{7\Delta t} = \frac{\Delta[SO_4^{2-}]}{10\Delta t}$

   b) If the rate of appearance of H_2O is 0.022 M/s, what is the rate of disappearance of $S_2O_3^{2-}$? (2 pt)

$\frac{0.022\,mol\,H_2O}{L\cdot s} \times \frac{5\,mol\,S_2O_3^{2-}}{7\,mol\,H_2O} =$ **1.6x10^{-2}** $\frac{M}{s}$ **$S_2O_3^{2-}$**

2. Consider rate data obtained for the following reaction:

$2I^- + 4H^+ + 2VO_2^+ \rightarrow I_2 + 2VO^{2+} + 2H_2O$

Trial	$[I^-]$ M	$[H^+]$ M	$[VO_2^+]$ M	Rate $\frac{M}{s}$
1	0.00200	0.0333	0.0100	2.89 x 10^{-9}
2	0.00200	0.100	0.0100	2.60 x 10^{-8}
3	0.00200	0.100	0.0025	6.50 x 10^{-9}
4	0.00600	0.100	0.0100	7.80 x 10^{-8}

   a) What is the rate law for this reaction? (4 pts)

I^-: use 2 → 4, Order I^-= 1; H^+: use 1 → 2; Order H^+ = 2; VO_2^+: use 3 → 2; Order VO_2^+ = 1

Rate = k[I^-][H^+]^2[VO_2^+]

   b) What is the value of the rate constant, k? (Include the appropriate units for k!) (2 pts)

k = $\frac{\text{Rate}}{[I^-][H^+]^2[VO_2^+]} = \frac{2.89x10^{-9}\ M/s}{(0.00200\,M)(0.0333\,M)^2(0.0100\,M)} =$ **1.30x10^{-1} M^{-3}s^{-1}**

   c) What is the rate of reaction if $[I^-]$ is 0.00825 M, $[H^+]$ is 0.0750 M and $[VO_2^+]$ is 0.00425 M? (2 pt)

Rate = k[I^-][H^+]^2[VO_2^+]= 1.30x10^{-1} M^{-3}s^{-1}(0.00825 M) (0.0750 M)^2(0.00425 M) = **2.56x10^{-8} M/s**

3. The first order reaction, A → Products, has a rate constant of 2.81x10^{-4} min^{-1} at 25 °C.

   a) What is the half life for this process? (1 pts)

$t_{1/2}$ = $\frac{0.693}{k} = \frac{0.693}{2.81x10^{-4}\ min^{-1}} =$ **2.47x10^3 min**

   b) How much of a 375 g sample of A will remain after 5 days? (3 pts)

$[A]_0$ = 375 g, k = 2.81x10^{-4} min^{-1}, t = 5 days $\left(\frac{24\,hr}{1\,day}\right)\left(\frac{60\,\text{min}}{1\,hr}\right) =$ 7200 min

$\ln\frac{[A]_t}{[A]_0} = -kt$ $\qquad \ln\left(\frac{[A]_t}{[375\,g]_0}\right) =$ - 2.81x10^{-4} min^{-1} (7200 min) = -2.023

$\left(\frac{[A]_t}{[375\,g]_0}\right) = e^{-2.023} = 1.323x10^{-1}$ $\qquad [A]_t$ = (375 g)(1.323x10^{-1}) = **49.6 g of A**

c) How many minutes will it take for 18.0 % of a sample of A to decompose? (3 pts)

If 18.0% of A has decomposed, 82% will remain: $\mathbf{[A]_t = 0.82[A]_0}$

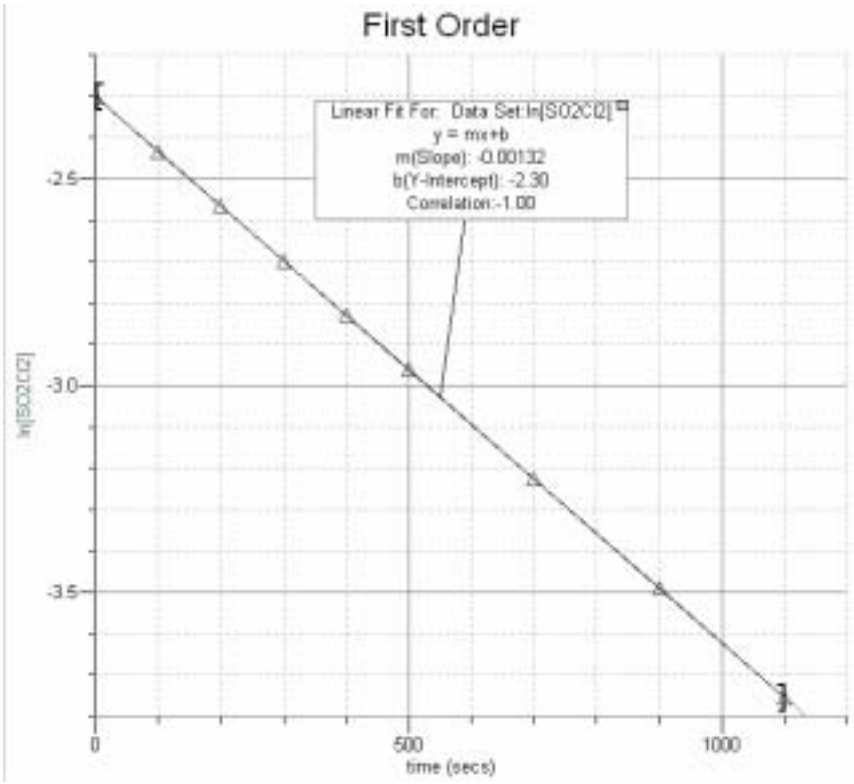
$\ln 0.82 = -(2.81\times10^{-4}\ min^{-1})t$ $\quad\quad$ $-0.1985 = -(2.81\times10^{-4}\ min^{-1})t$

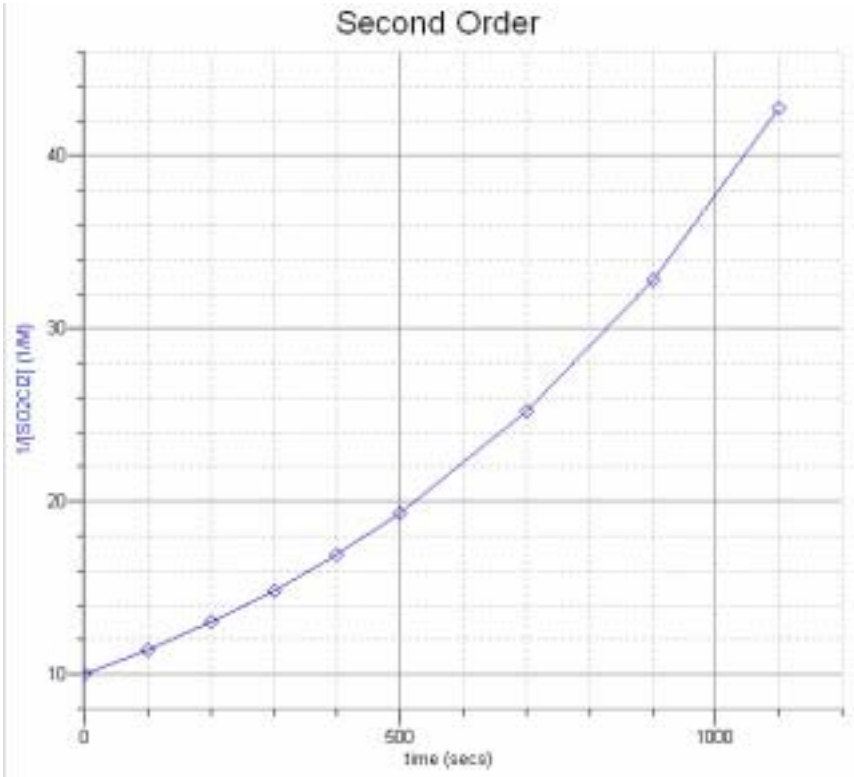
$t = -0.1985/(-2.81\times10^{-4}\ min^{-1}) =$ **7.06×10^{2} min**

4. Kinetic data was obtained for the reaction: $SO_2Cl_2 \rightarrow SO_2 + Cl_2$

	Data Set			
	time (secs)	[SO2Cl2] (M)	ln[SO2Cl2]	1/[SO2Cl2] (1/M)
1	0.0	0.1000	-2.303	10.00
2	100.0	0.0876	-2.435	11.42
3	200.0	0.0768	-2.567	13.02
4	300.0	0.0673	-2.699	14.86
5	400.0	0.0590	-2.830	16.95
6	500.0	0.0517	-2.962	19.34
7	700.0	0.0397	-3.226	25.19
8	900.0	0.0305	-3.490	32.79
9	1100.0	0.0234	-3.755	42.74
10				

a) Make appropriate plots to determine if the reaction is zero, first or second order with respect to SO_2Cl_2 and include original copies **of all 3 plots** (computer-generated preferred or use graph paper). Do **NOT** show all 3 plots on one set of axes – if you do this, it makes it impossible to tell which graph is linear. Use a regression line (straight line) for the linear graph and a "connect-the-points" curve for any non-linear graphs. Make sure the axes are appropriately labeled. (9 pts)





b) Based on your graphs, what is the order of the reaction with respect to SO_2Cl_2? (1 pt)

1st order (This plot is the most linear)

c) What is the value of k based on the graph showing the correct order of SO_2Cl_2? (Include units for k!) (1 pt)

k = -slope = 1.32×10^{-3} s^{-1}