Chem 1515
Problem Set #5
Fall 2001

Name_____

TA Name _____

Lab Section #_____

ALL work must be shown to receive full credit. **Due at the beginning of lecture on Friday, October 5, 2001.**

PS5.1. The following data was collected for the reaction

$$2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$$

Experiment #1		Experiment #2	
time (sec)	Conc.(M)	time (sec)	Conc.(M)
0	1.480	0	0.960
25	1.450	25	0.947
50	1.421	50	0.935
75	1.393	75	0.923
100	1.366	100	0.911
300	1.185	300	0.826
400	1.111	400	0.790
600	0.988	600	0.726
700	0.936	700	0.697
800	0.889	800	0.671
1000	0.808	1000	0.624
1500	0.659	1500	0.531
2000	0.556	2000	0.462
3000	0.424	3000	0.367

a) Plot the data for Exp. #1 and graphically estimate

PS5.1. (Continued)

i) the initial rate

ii) the instantaneous rate at 100 sec? 800 sec? 2000 sec?

iii) the time it takes for half of the N_2O_5 to react

b) Repeat a) for Exp #2

i) the initial rate

ii) the instantaneous rate at 100 sec? 800 sec? 2000 sec?

iii) the time it takes for half of the N_2O_5 to react

c) By what factor did the initial concentration change in going from Exp #1 to Exp #2?

d) By what factor did the initial rate change in going from Exp #1 to Exp #2?

PS5.1. (Continued)

e) What is the order of the reaction with respect to N_2O_5?

f) How did the half-life change for the two experiments?

g) Determine the rate constant for the reaction including units.

h) What would the initial rate be if the initial concentration of N_2O_5 is 1.225 M? 0.475 M?

PS5.2. The following initial rate data were collected for the reaction

$Cr(H_2O)_6^{2+}(aq) + SCN^-(aq) \rightarrow Cr(H_2O)_5SCN^{2+}(aq) + H_2O(l)$

at 25 ˚C.

Exp. #	$[Cr(H_2O)_6^{2+}(aq)]$	$[SCN^-]$	initial rate $\left(\frac{M}{s}\right)$
1	1.85×10^{-4} M	0.25 M	9.25×10^{-11}
2	4.56×10^{-4} M	0.25 M	2.28×10^{-10}
3	4.56×10^{-4} M	0.101 M	9.25×10^{-11}

a) Determine the reaction order for $Cr(H_2O)_6^{2+}(aq)$ and SCN^-.

b) Determine the overall order of the reaction.

c) Write the specific rate law for the reaction.

d) Determine the rate constant for the reaction (include units).

PS5.3. The following initial rate data were collected for the reaction

$$2NO_{2(g)} + O_{3(g)} \rightarrow N_2O_{5(g)} + O_{2(g)}$$

at 100 ˚C.

Exp. #	$[NO_2]$	$[O_3]$	initial rate $\left(\frac{M}{s}\right)$
1	.65 M	.80 M	2.61×10^4
2	1.10 M	.81 M	4.40×10^4
3	1.70 M	1.55 M	1.32×10^5

a) Determine the reaction order for NO_2 and O_3.

b) Determine the overall order of the reaction.

c) Write the specific rate law for the reaction.

d) Determine the rate constant for the reaction (include units).

PS5.4. The reaction

$$SO_2Cl_{2(g)} \rightarrow SO_{2(g)} + Cl_{2(g)}$$

follows simple first order kinetics. If the $[SO_2Cl_2]_0$ is 0.582 M,

a) calculate the rate constant for the reaction if it takes 1.25×10^2 s for the concentration of SO_2Cl_2 to fall to 0.309 M.

b) calculate the half-life for the reaction. (When the $[SO_2Cl_2]_0 = 0.582$ M.)

c) how long will it take for the $[SO_2Cl_2]$ to fall to 0.219 M?

d) what is the $[SO_2Cl_2]$ after 350 s? (When $[SO_2Cl_2]_0 = 0.156$ M.)

e) calculate the fraction of SO_2Cl_2 that remains after 160 s.

PS5.5. The reaction

$$CH_3CHO_{(g)} \rightarrow CH_{4(g)} + CO_{(g)}$$

follows simple second order kinetics. When the $[CH_3CHO]_0 = 0.0120$ M the half-life is 8.75 s.

a) Calculate the rate constant for the reaction.

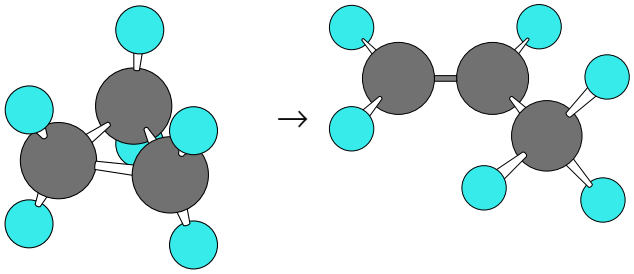
b) How long will it take for the $[CH_3CHO]$ to fall from 0.0120 M to 2.45×10^{-3} M?

c) What is the $[CH_3CHO]$ after 7.0 minutes if $[CH_3CHO]_0 = 0.245$ M?

d) How long will it take for the $[CH_3CHO]$ to decrease by a factor of 6 when the $[CH_3CHO]_0 = 0.245$ M?

PS5.6. C_3H_6 re-arranges from a cyclic structure to a straight chain structure according to the following equation;

$$C_3H_{6(g)} \rightarrow C_3H_{6(g)}$$



the rate constant for the decomposition is $5.5 \times 10^{-4}\ s^{-1}$ at 500 ˚C.

a) What is the order of the reaction?

b) How long would it take for 15.00 % of a sample of C_3H_6 to decompose at 25 ˚C and 1 atm?

c) What is the half-life of the reaction?

d) How long would it take for 15.00 % of a sample of C_3H_6 to decompose at 25 ˚C and 10 atm?

PS5.7. The second-order thermal decomposition of hydrogen bromide, $HBr_{(g)}$, has a half-life of 2.74 s at a given temperature when the initial concentration of HBr is 0.0714 M.

a) What is the concentration of hydrogen bromide after 3.16 s?

b) How long will it take for 20.0 % of the sample to decompose?

PS5.8. The rate constant for the gas phase decomposition of ozone

$$2O_{3(g)} \rightarrow 3O_{2(g)}$$

is 0.0140 $M^{-1} \cdot sec^{-1}$ at 80 ˚C.

a) How long will it take for 90 % of a sample of ozone to decompose given that the initial concentration is 6.00×10^{-3} M?

b) What is the half-life of the reaction for this initial concentration?

PS5.9. In the reaction

$$NO_{2(g)} \rightarrow NO_{(g)} + \frac{1}{2} O_{2(g)}$$

the $[NO_2]$ was followed with time and the data shown below was obtained.

Time(s)	$[NO_2]$(M)
0	0.0831
4.2	0.0666
7.9	0.0567
11.4	0.0497
15	0.0441

Determine the order of the reaction and its half-life. (Include graphs of your data to support your conclusion. Be sure <u>all</u> plots are included.)

PS5.10a. Draw the Lewis structure and name the following compounds;

i) $CH_3CH(CH_3)C(CH_3)_2CH_2CHCH_2$

ii) $CH_3CH(CH_3)CH_2CH_2C(CH_3)_2CH_2CH_2CH(CH_3)CH_3$

PS3.10b. Draw the structure which corresponds with each of the following names.

i) 3-ethyloctane

ii) 2,2,4,4-tetramethylhexane

iii) 2,3-dimethyl-4-propylnonane