General Chemistry with Doc M

Monday Today 11/23 Sect 13.4-13.6
Old exams at CHM 205 website

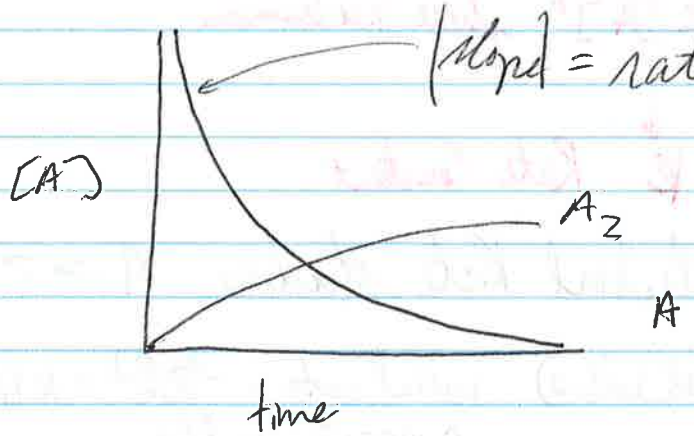
Tuesday 1/24 Review hours moved to 7:30-9 pm
G59 Hixon Tied

Wednesday 1/25 Sect 13.7-13.8 Last content day for first exam

Thursday 1/26 Expt 2 Beer's Law
Lab prep CHM 206 website
* reading volumetric glassware
* Mohr ~~pipette~~ pipet Youtube video
* Weekly lab Quizzes Lab 1

Kinetics - rate of chemical reactions

$$2A_{(g)} \rightarrow A_{2(g)}$$



|slope| = rate $\frac{mol}{L \cdot time}$

[A] = molar concentration of A $\frac{mol\ A}{L}$

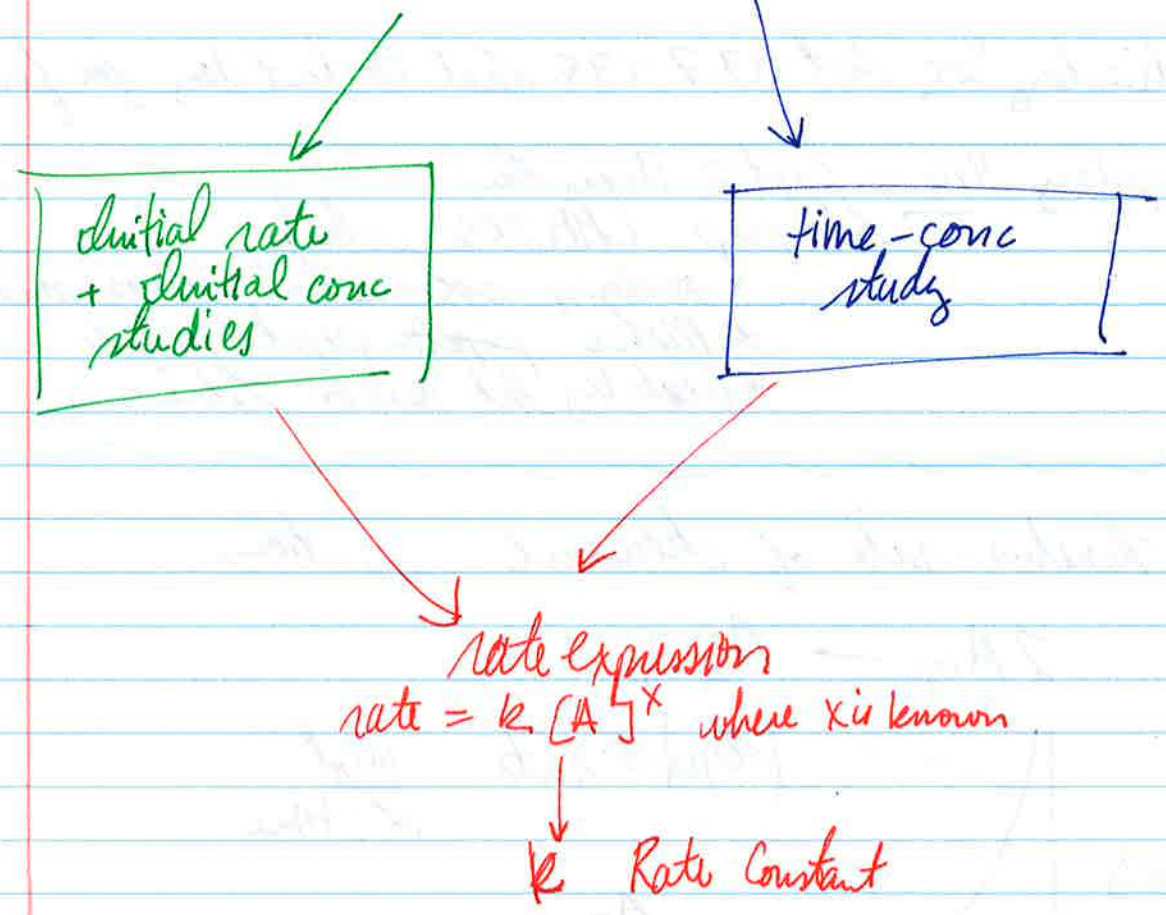
$$\text{rate} = -\frac{\Delta[A]}{\Delta t} = 0.044 \frac{mol\ A}{L\ min}$$

$\frac{mol}{L \cdot time}$

$$\text{rate} = \frac{\Delta[A_2]}{\Delta t} = \frac{0.044 \text{ mol } A}{4 \text{ min}} \left| \frac{1 \text{ mol } A_2}{2 \text{ mol } A} \right. = \frac{0.022 \text{ mol } A_2}{4 \text{ min}}$$

* What is rate law / rate expression? *

$$\text{rate} = k[A]^x \quad x = ???$$



initial [A] and initial Rate studies $A \rightarrow ?$

Expt	$[A]_0$ (initial [ ] at t=0)	initial rate $= -\frac{\Delta[A]}{\Delta t} = k[A]^x$
1	0.050	0.00217 mol/L·min
2	0.068	0.00401
3	0.093	0.00~~75~~

compare Expt 1 + 2

$$\frac{\text{rate}_1 = k[A]_1^x}{\text{rate}_2 = k[A_2]^x}$$

$$\frac{0.00217}{0.00401} = \frac{0.050^x}{0.068^x} = \left(\frac{0.050}{0.68}\right)^x$$

$$0.541 = (.735)^x$$

$$x = 2$$

$$.541 = .541$$

rate $= k[A]^{(2)}$ ← 2nd order reaction

from Expt 3

$$.00751 \frac{\text{mol}}{\text{L} \cdot \text{min}} = k\left(0.093 \frac{\text{mol}}{\text{L}}\right)^2$$

$$k = 0.868 \frac{\text{L}}{\text{mol} \cdot \text{min}}$$

to figure out units on k

$$\text{rate}\ \frac{\text{mol}}{\text{L} \cdot \text{min}} = \left(\frac{\text{L}}{\text{mol} \cdot \text{min}}\right)\left(\frac{\text{mol}^2}{\text{L}^2}\right)$$

↳ units on 2nd order rxn

What is rate if [A] = 0.105 M?

rate $= k[A]^2$

$= 0.868\ \text{L/mol} \cdot \text{min}\ (0.105\ \text{mol/L})^2 = 0.00957 \frac{\text{mol}}{\text{L} \cdot \text{min}}$

Example 2

Expt		[Reactant]$_0$	Initial Rate
	1	0.400	0.00411 mol/L·min
	2	0.600	0.00411 " "
	3	0.800	0.00411 " "

$$\frac{\text{rate}_1}{\text{rate}_2} = \frac{0.00411}{0.00411} = \frac{k(0.400)^x}{k(0.600)^x}$$

$$1 = (2/3)^x$$

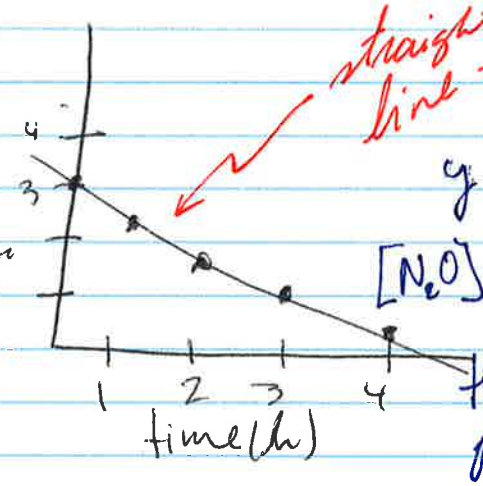
$x = 0 \Rightarrow$ Zero order reaction

$$\boxed{\text{rate} = k}$$

Time Concentration study

$$2N_2O_{(s)} \rightarrow 2N_{2(s)} + O_{2(g)}$$

time	$[N_2O]$
0 hr	3.00 mol/L
1.0 hr	2.37 "
2.0 hr	1.74 "
3.0 hr	1.11 "
4.0 hr	0.48 "



straight line = ∅ zero order reaction

$y = mx + b$

$[N_2O] = -kt + [N_2O]_0$

↓

time-conc expression for zero order rxn

Use time-conc to determine k

at 2.00 hr mark.

$1.74\ \text{mol/L} = 2\text{hr}\times(k) + 3.00\ \text{mol/L}$

$k = 0.63\ \frac{M}{L\cdot hr}$

* what is the rate when $[N_2O] = 2.00\ M$?

rate = k = 0.63 mol/L·hr because it's zero order

* What is the $[N_2O]$ after 3.5 hrs?

$[N_2O]_t = -kt + [N_2O]_0$

$= -0.63\ \frac{mol}{L\cdot hr} \times 3.50\ hr + 3.00\ mol/L = 0.795\ mol/L$

* How long does it take until $[N_2O] = 2.00$ mol/L?

$2.00\ \frac{mol}{L} = -0.63\ \frac{mol}{L\cdot hr} \times t + 3.00$

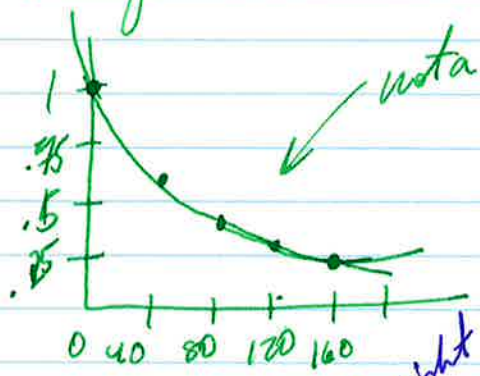
$t = 1.59\ hr.$

Time conc studies : 1st order rxns

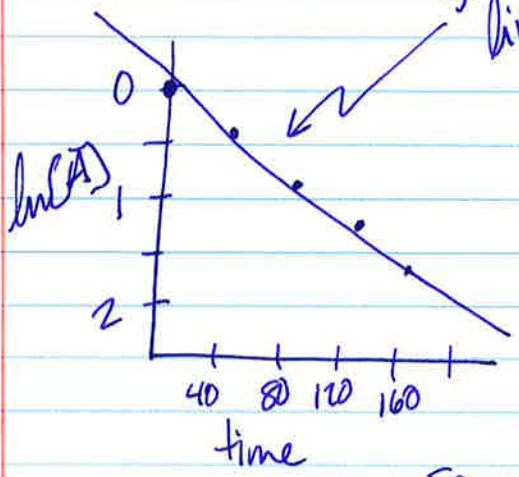
$A \rightarrow ?$

time	[A]
0 hr	1.00 mol/L
40 hr	0.66 mol/L
80 hr	0.43 mol/L
120 hr	0.28 mol/L
160 hr	0.18 mol/L

Test for Zero Order



not a straight line ⇒ not Zero order



time	[A]	ln [A]
0	1.00 mol/L	0
40	0.60	−0.416
80	0.43	−0.844
120	0.28	−1.273
160	0.19	−1.661

So we have a 1st order rate law

$$\text{rate} = k[A]^1$$

time-conc expression for 1st order

$$\ln[A]_t = -kt + \ln[A]_0$$

$$kt = \ln[A]_0 - \ln[A]_t = \ln\left([A]_0/[A]_t\right)$$

$$kt = \ln\left(\frac{[A]_0}{[A]_t}\right)$$

Find k

$$\ln\left(\frac{1.00}{0.43}\right) = k * 80\,hr$$

$$k = 0.0105\ hr^{-1}$$

What is the rate if [A] = 2.00 mol/L?

~~$\ln(1.00)$~~ $\quad rate = k[A] = 0.0105\,\frac{1}{hr} * 2\,\frac{mol}{L}$

$$= 0.021\,\frac{mol}{L \cdot hr}$$

How long does it take until [A] = 0.50 mol/L

$$\ln\left(\frac{1.00}{.50}\right) = \frac{0.0105}{0.0105\,\frac{1}{hr}} * t \Rightarrow t = 66.0\,hrs$$

What is [A] after 100 hr?

$$\ln\left(\frac{1.00}{[A]}\right) = 0.0105 * 100$$

$$\ln\left(\frac{1.00}{[A]}\right) = 1.05$$

$$\frac{1.00}{[A]} = 2.85_{77}$$

$$[A] = \frac{1.00}{2.85_{77}} = 0.349_{9}\ mol/L$$