#5 worksheet 13-4

January 27th

→ sections 14.1-14.6
  ↳ rxn rate laws
→ Tues: problem club w/ Kendall
→ Wed: 14.7, 14.8
→ Thursday: Expt. 2
  ↳ * bring laptops & printer adaptor
→ Friday: finish unit 1!

$LiNO_3$, $NaNO_3$, KNO_3, $RbNO_3$ or $CsNO_3$

4.75g nitrate salt

100 mL solution   i = 2

Π = 23 atm @ 25°C

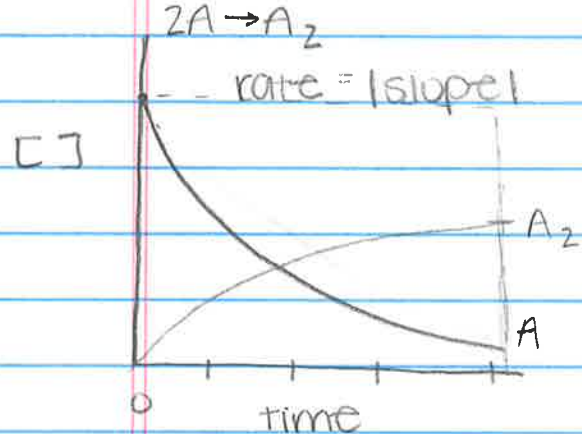
$\Pi = MRTi$ $R = 0.0821$ L·atm/mol·K

↳ $23\text{ atm} = M * \frac{0.0821\text{ L·atm}}{\text{mol·K}} * 298K * 2$

$M_{salt} = \frac{0.470\text{ mol unk}}{\text{L sol'n}} \rightarrow n_{unk} = \frac{0.470\text{ mol unk}}{L} * 0.100L = 0.0470$ mol unk

↳ $MM = \frac{4.75\text{g unk}}{0.0470\text{ mol unk}} = 101.1$ g/mol → $\boxed{KNO_3}$

$2A \rightarrow A_2$



suppose
↳ $\text{rate} = \frac{-\Delta[A]}{\Delta t} = 0.17 \frac{\text{mol A}}{\text{L·min}}$

what is the rate in terms of the production of A_2? → $\frac{\Delta[A_2]}{\Delta t}$

↳ $\text{rate} = \frac{\Delta[A_2]}{\Delta t} = \frac{0.17\text{ mol A}}{\text{L·min}} \left| \frac{1\text{ mol } A_2}{2\text{ mol A}} \right. = 0.085 \frac{\text{mol } A_2}{\text{L·min}}$

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rate law $A \rightarrow$ products

rate expression

$\text{rate} = k[A]^{0,1\text{ or }2}$

↑ rate constant

0 = 0-order rxn
1 = 1st order rxn
2 = 2nd-order rxn

$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ January 27th

Trial	$[N_2O_5]_0$ ← "initial conc. @ t=0"	Initial rate $= \frac{-\Delta[N_2O_5]}{\Delta t}$
1	0.300 mol/L	1.85×10^{-5} mol/L·s
2	0.500	3.10×10^{-5} mol/L·s
3	0.170	1.05×10^{-5} mol/L·s

rate $= R[N_2O_5]^{0,1,\text{ or } 2}$

↳ *take ANY 2 trials you want & make a RATIO

$\frac{1.85 \times 10^{-5}}{3.10 \times 10^{-5}} = \frac{R(0.300)}{R(0.500)}^{0,1,\text{ or } 2}$

↳ $0.597 = (0.6)^{0,1,\text{ or } 2}$

↳ 1st order !

→ rate $= R[N_2O_5]^1$

↳ * pick ANY trial & apply it to find R !

↳ $1.05 \times 10^{-5} = R[0.170]^1$

↳ $R = 6.18 \times 10^{-5}\ s^{-1}$

rate $= R[N_2O_5]^1$

↑

$\frac{mol}{L \cdot s} = \left(\frac{1}{s}\right)\left(\frac{mol}{L}\right)$ ← * for a FIRST ORDER expression/rxn

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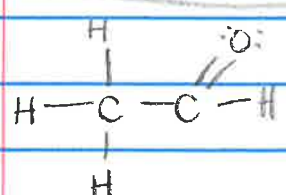


$\rightarrow CH_4 + CO$

ethanal CH_3CHO

Trial	$[CH_3CHO]_0$	initial rate
1	1.70 M	6.13×10^{-3} mol/L·s
2	2.80 M	1.57×10^{-2} mol/L·s
3	1.04 M	2.17×10^{-3} mol/L·s

$\frac{6.13 \times 10^{-3}}{2.17 \times 10^{-3}} = \frac{R(1.70)}{R(1.05)}^{0,1,\text{ or } 2}$ → $2.825 = (1.621)^{0,1,\text{ or } 2}$

↳ 2nd order

1.57×10^{-2} mol/L·s $= R[2.80]^2$

↳ $R = 2 \times 10^{-3}$ L/mol·s

What is the rate law? or rate expression? January 27th

- initial conc. for initial rate study → rate
- time-conc. study → rate

rate $= k[A]^{0,1,2}$ (order)

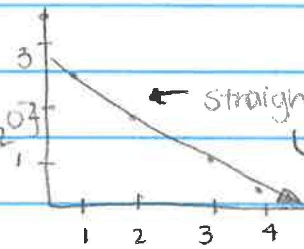
$k =$

Zero order time-concentration

$2N_2O \rightarrow 2N_2 + O_2$

Time	$[N_2O]$
0 hr	3.00 M
1 hr	2.37 M
2 hr	1.74 M
3 hr	1.11 M
4 hr	0.48 M

3.00 M = initial [ ]; 1 hr to 4 hr = $[N_2O]_t$ w/ time



← straight line
↳ indicative of 1st order rxns

rate $= k[N_2O]^0$
↳ rate $= k$ → units $= \frac{mol}{L \cdot hr}$

Time-conc. equation:

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

$y = mx + b$

Solve for k:

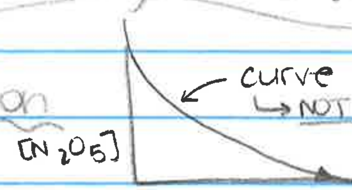
$1.11\,M = -k \cdot 3hr + 3.00\,M$

$k = 0.63\ mol/L \cdot hr$

What is $[N_2O]$ after 2.50 hr?
How long until $[N_2O]$ is 0.10 M?

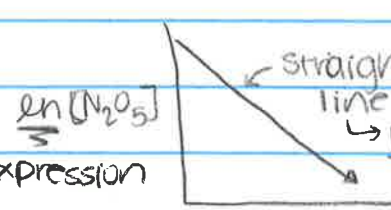
First order time-concentration

$2N_2O_5 \rightarrow 4NO_2 + O_2$



← curve
↳ NOT zero order!

Time	$[N_2O_5]$
0	2.330 M
1000	1.26 M
2000	0.681 M
3000	0.369 M
4000	0.199 M



← straight line
↳ means 1st order!

*time-conc. expression for 1st order

↳ $ln\left(\frac{[N_2O_5]_0}{[N_2O_5]_t}\right) = k \cdot t$

$ln[N_2O_5]_t = -kt + ln[N_2O_5]_0$

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$$\ln\left(\frac{[2.330]}{[1.260]}\right) = k \cdot 1000s$$

↳ $k = 6.1 \times 10^{-4}$ s^{-1}

→ Test for second order: