Today Ch 13 Sec 1-3
Sunday: Problem club with Ali 6-7:30 Epply 107
Monday: Section 4-6
Tuesday: expt 2

Kinetics

- Deals with the rate of a reaction (rate is always positive)

$\text{rate} = \frac{\Delta \text{dist}}{\Delta \text{time}}$ $\text{rate} = \frac{\Delta(\text{mol, conc})}{\Delta \text{time}}$

* all ionics are solid at room temperature

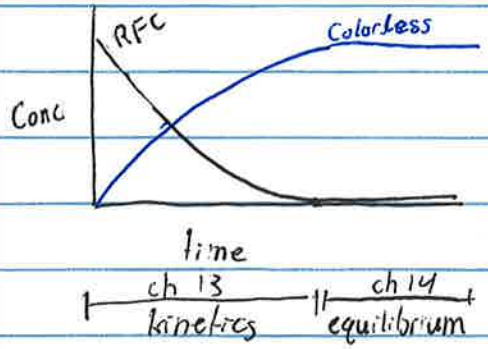
$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$ (fast) $\Delta H = -176\ kJ$

$2CO(g) + 2NO(g) \rightarrow CO_2(g) + N_2(g)$ (slow) $\Delta H = -746\ kJ$

(slow) ↑ kinetics

$\Delta H = -746\ kJ$ ↑ thermodynamics

$RFC + OCl^-(aq) \rightarrow$ colorless



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

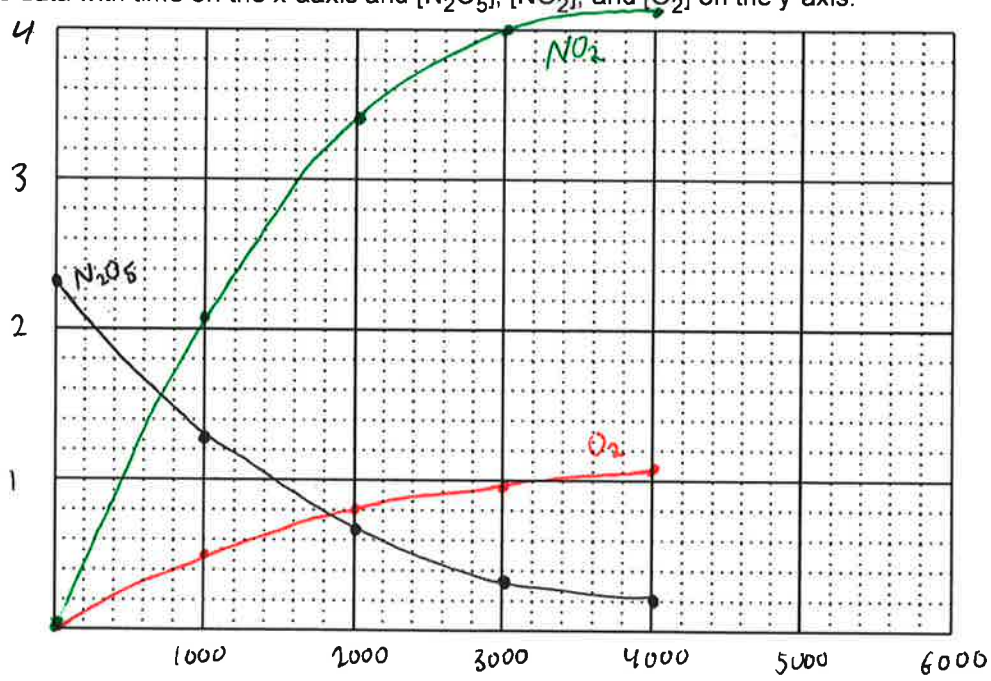
- $\text{rate} = |\text{slope}| = \frac{-\Delta[N_2O_5]}{\Delta t}$ $\text{rate} = \frac{+\Delta[NO_2]}{\Delta t}$ $\text{rate} = \frac{+\Delta[O_2]}{\Delta t}$
- slope decreases as time increases
- Rates of each are proportional to coefficients
  - ↳ NO_2 is 2x N_2O_5 for example

Chapter 13 Number 1 (13.1 – 13.3) (Unit 1) 25 January 2019

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

time	$[N_2O_5]$	$[NO_2]$	$[O_2]$
0 s	2.330 mol/L	0 mol/L	0 mol/L
1000 s	1.260	2.14	0.535
2000 s	0.681	3.298	0.8245
3000 s	0.369	3.922	0.9805
4000 s	0.199	4.262	1.0655

1. Graph these data with time on the x-aaxis and $[N_2O_5]$, $[NO_2]$, and $[O_2]$ on the y-axis.



2. Is this reaction slowing down or speeding up with time? Circle: **Slowing down** or **Speeding up**

3. Sketch a tangent line on the graph and estimate the rate at t = 1000 s in terms of rate = $-\Delta[N_2O_5]/\Delta t$. Make sure to use the right units.

4. Using your value from Question 3, what is the rate in terms of rate = $\Delta[NO_2]/\Delta t$ and rate = $\Delta[O_2]/\Delta t$

5. Would the rate of the reaction increase or decrease if one started with a larger $[N_2O_5]$?

Now try these problems from the book:

Section 13.1. (Rates) Problems 1, 2, 39, 52 and 54
Section 13.2. (Rate Law and Order) Problems 3 and 4
Section 13.3. (Initial rate method) Problems 5, 6, 7, 8, 40, 46, 60, 66 and 124

$$\frac{-\Delta[N_2O_5]}{2\Delta t} = \frac{\Delta[NO_2]}{4\Delta t} = \frac{\Delta[O_2]}{1\Delta t}$$

$\text{Rate} = k[N_2O_5]^{?}$ ← order of the reaction (typically 0, 1, or 2)

↑ rate constant

$2N_2O_5 \rightarrow 4NO_2 + O_2$

expt	initial $[N_2O_5]_0$	initial rate
1	0.300 mol/L	1.85×10^{-5} mol/L·s
2	0.500 mol/L	3.10×10^{-5} mol/L·s
3	0.165 mol/L	1.023×10^{-5} mol/L·s

$$\frac{1.85 \times 10^{-5}\ \text{mol/L·s}}{3.10 \times 10^{-5}\ \text{mol/L·s}} = \frac{k(0.300\ \text{mol/L})^{0,1,\text{or }2}}{k(0.500\ \text{mol/L})^{0,1,\text{or }2}}$$

$0.597 = (0.6)^{0,1,\text{or }2}$

$0.6 = (0.6)^1$

This reaction is first order

$\boxed{\text{rate} = k[N_2O_5]}$

Order → k

- What is the rate when $[N_2O_5] = 6.60$ mol/L

$\text{rate} = k[N_2O_5]^1$

$1.023 \times 10^{-5}\ \text{mol/L·s} = k[0.165\ \text{m/L}]^1$

$k = 6.2 \times 10^{-5}\ s^{-1}$

$\text{rate} = (6.2 \times 10^{-5}\ s^{-1})(6.60\ \text{mol/L})^1$

$\text{rate} = 4.092 \times 10^{-4}\ \text{mol/L·s}$

Rate = $k[\ ]^?$

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

expt	$[CH_3CHO]_o$	$Rate_o$
1	1.65 mol/L	5.45×10^{-3} mol/L·s
2	4.11 mol/L	33.78×10^{-3} mol/L·s
3	4.95 mol/L	

$$\frac{5.45 \times 10^{-3}\ mol/L \cdot s}{33.78 \times 10^{-3}\ mol/L \cdot s} = \frac{k(1.65\ mol/L)^{0,1,or\ 2}}{k(4.11\ mol/L)^{0,1,or\ 2}}$$

$$0.16 = (0.40)^{0,1,or\ 2}$$

2nd order

$$5.45 \times 10^{-3}\ mol/L \cdot s = k(1.65\ mol/L)^2$$

$$k = 2 \times 10^{-3}\ \frac{L}{mol \cdot s}$$

$$Rate = k[CH_3CHO]^2$$

$$Rate = \left(2 \times 10^{-3}\ \frac{L}{mol \cdot s}\right)(4.95\ mol/L)^2$$

$$Rate = 4.9 \times 10^{-2}\ mol/L \cdot s$$