Today 1/19 Sections 13.1 - 13.3

Sunday 7-8:30 tutoring in Epply 107

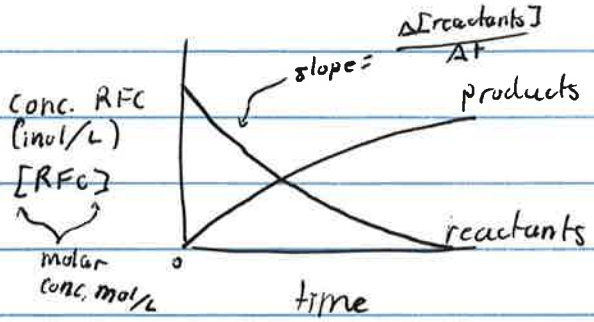
thermodynamics kinetics

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

$2CO_{(g)} + 2NO_{(g)} \longrightarrow N_2(g) + 2CO_2(g)$ $\Delta H = -746kJ$ rxn is slow

Demo

RFC + OCl^- $\longrightarrow$ Colorless products



$$\text{rate} = \frac{-\Delta \text{conc}_{\text{reactants}}}{\Delta t} = \frac{-\Delta[\text{reactants}]}{\Delta t}$$

↑ always has to be positive

$$\text{rate} = \frac{\Delta[\text{products}]}{\Delta t}$$

rate will change with passing time

Time-Concentration study

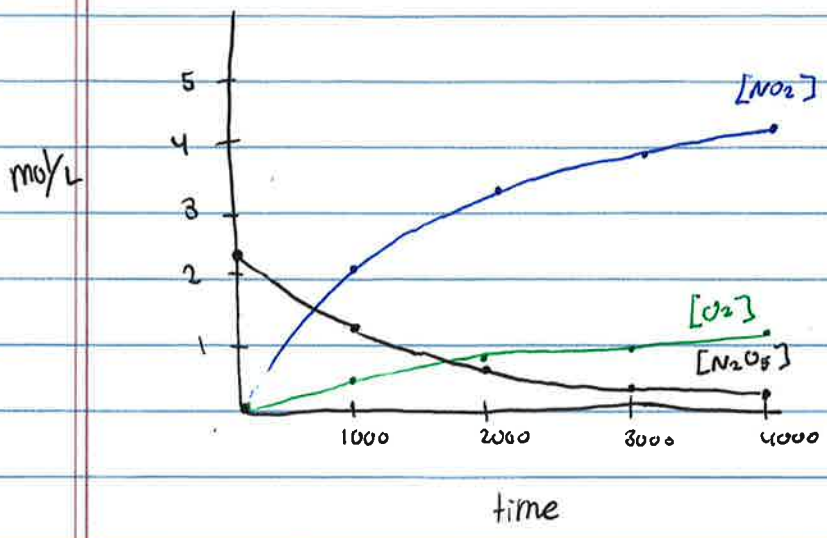
$2N_2O_5(g) \longrightarrow 4NO_2(g) + O_2(g)$

time	$[N_2O_5]$	difference	$[NO_2]$	$[O_2]$
0s	2.330 mol/L	1.07 mol/L	0	0
1000s	1.260 mol/L	1.649	2.14 mol/L	0.535 mol/L
2000s	0.681 mol/L		3.298 mol/L	0.8246 mol/L
3000s	0.369 mol/L	1.961	3.922 mol/L	0.9805 mol/L
4000s	0.199 mol/L	2.131	4.262 mol/L	1.0655 mol/L

difference from original amount

multiply difference by 2 (stoichiometry)

divide difference by 2



- When you find the rate at a specific time, t, draw a tangent line and find the slope.

$rate = \frac{-\Delta[N_2O_5]}{\Delta t}$ $\quad rate = \frac{\Delta[NO_2]}{\Delta t}$ $\quad rate = \frac{\Delta[O_2]}{\Delta t}$

estimate rate for 0-1000s

$rate_{N_2O_5} = \frac{-(1.26-2.33)}{1000-0}$

$= 1.07 \times 10^{-3}$ mol N_2O_5/L·s

$rate = \frac{\Delta[NO_2]}{\Delta t} = \frac{1.07\times10^{-3} mol\ N_2O_5}{L \cdot s} \left| \frac{4\ mol\ NO_2}{2\ mol\ N_2O_5} \right. = 2.14\times10^{-3} \frac{mol\ NO_2}{L \cdot s}$

- Goal is to determine rate law (rate expression)

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

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

Rate law

rate = $k[N_2O_5]^x$

experimental methods → Initial and initial rate study → rate law → find rate constant (k)

experimental methods → time-concentration study → rate law → find rate constant (k)

$1.023 \times 10^{-5} = k \cdot 0.165^x$ $\qquad$ $1.85 \times 10^{-5} = k \cdot 0.300^x$

create a ratio:

$$\frac{1.023 \times 10^{-5}}{1.85 \times 10^{-5}} = \frac{k(0.165)^x}{k(0.300)^x}$$ ← "order" Usually 0, 1, 2

$$\frac{1.023}{1.85} = \left(\frac{0.165}{0.300}\right)^x$$

$$.553 = (0.55)^x$$

$$x = 1$$

rate = $k[N_2O_5]^1$ ← first order rxn

↑ rate constant (will be the same for every expt.) ← does not change unless the temperature changes

$3.10 \times 10^{-5} \frac{mol}{L \cdot s} = k \cdot \left(0.500 \frac{mol}{L}\right)^1$

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