

[[class notes]] 2/20

Exam covers: ch 14, ch 15, lab

Thursday 2/

CHEMICAL KINETICS III

integrated rate law

$$\text{rate} = \frac{-\Delta[A]}{\Delta t} = \frac{-d[A]}{dt} = k[A]$$

step 1. rearrange $\frac{d[A]}{[A]} = -k dt$

step 2A. integrate $\int_{A_0}^{A_t} \frac{dA}{[A]} = \int_0^t -k dt$

step 2B. solve integral: $\ln[A]_t - \ln[A]_0 = -kt$

step 3. rearrange: $\ln[A]_t = -kt + \ln[A]_0$

$$y = mx + b$$

Alternate form $\ln \left[\frac{[A]_t}{[A]_0} \right] = -kt$

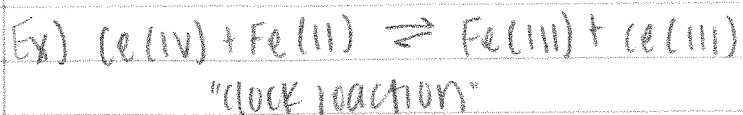


$$[A]_0 = 1.25 \times 10^{-3} \text{ M}$$

$$[A]_t = 0.31 \times 10^{-3} \text{ M}$$

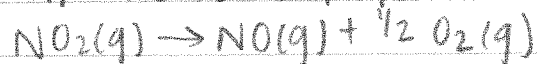
$$\ln(0.31 \times 10^{-3} \text{ M} / 1.25 \times 10^{-3} \text{ M}) = (0.17/\text{h})t$$

$$t = 8.2 \text{ h}$$



Second order differential rate law

- decomposition of nitrogen dioxide



$$\text{rate} = k[\text{NO}_2]^2 = \frac{-\Delta[\text{NO}_2]}{\Delta t} = -\frac{d[\text{NO}_2]}{dt}$$

integrated rate law

$$\frac{1}{[\text{NO}_2]_t} = kt + \frac{1}{[\text{NO}_2]_0}$$

→ plotting $1/[\text{NO}_2]_t$ vs time should yield a line
 with slope k and intercept $1/[\text{NO}_2]_0$.

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

Zero order differential rate law

- decomposition of nitrogen dioxide



$$\text{rate} = k \text{ (constant)}$$

★ Pt catalyst

rate is constant over time (concentration/time)

$$\text{rate} = \frac{-\Delta[\text{N}_2\text{O}]}{\Delta t} = k$$

$$[\text{N}_2\text{O}]_t = -kt + [\text{N}_2\text{O}]_0$$

→ plotting $[\text{N}_2\text{O}]$ vs time should yield a line w/ slope $-k$
 and intercept $[\text{N}_2\text{O}]_0$.

summary of rate law

	zero order	first order	second order
rate law	rate = k	rate = $k[A]$	rate = $k[A]^2$
integrated rate law	$[A]_t = -kt + [A]_0$	$\ln[A] = -kt + \ln[A]_0$	$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$
plot that produces straight line	$[A]$ vs. t	$\ln[A]$ vs. t	$\frac{1}{[A]}$ vs. t
relationship of rate constant to slope of straight line	slope = $-k$	slope = $-k$	slope = k

units of k

- 0 order: rate = k

$$\left(\frac{M}{s}\right) = \left(\frac{M}{s}\right)$$

$$k \text{ units} = \left(\frac{M}{s}\right)$$

- 1st order: rate = $k[A]$

$$\left(\frac{M}{s}\right) = k M$$

$$k \text{ units} = \left(\frac{1}{s}\right)$$

- 2nd order: rate = $k[A]^2$

$$\left(\frac{M}{s}\right) = k (M)^2$$

$$\left(\frac{M}{M^2 s}\right) = k$$

$$k \text{ unit} = \left(\frac{1}{M s}\right)$$