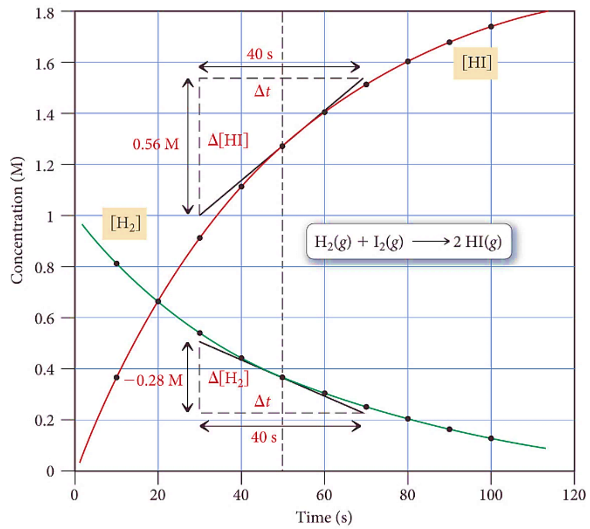
N8 – Kinetics Review



N10 – Mechanisms

1

$NO_{2(g)} + CO_{(g)} \rightarrow NO_{(g)} + CO_{2(g)}$	Rate$_{obs}$ = $k[NO_2]^2$
1. $NO_{2(g)} + NO_{2(g)} \rightarrow NO_{3(g)} + NO_{(g)}$	Rate = $k_1[NO_2]^2$ Slow
2. $NO_{3(g)} + CO_{(g)} \rightarrow NO_{2(g)} + CO_{2(g)}$	Rate = $k_2[NO_3][CO]$ Fast

2

$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$
The experimental rate law is:
$R = k[NO]^2\,[H_2]$

Step #1 $H_2(g) + 2NO(g) \rightarrow N_2O(g) + H_2O(g)$

Step #2 $N_2O(g) + H_2(g) \rightarrow N_2(g) + H_2O(g)$

Step #1 $H_2(g) + 2NO(g) \rightarrow N_2O(g) + H_2O(g)$

Step #2 $N_2O(g) + H_2(g) \rightarrow N_2(g) + H_2O(g)$

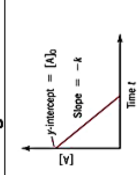
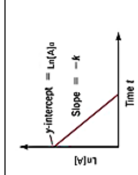
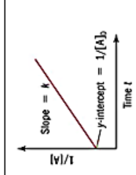
$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$

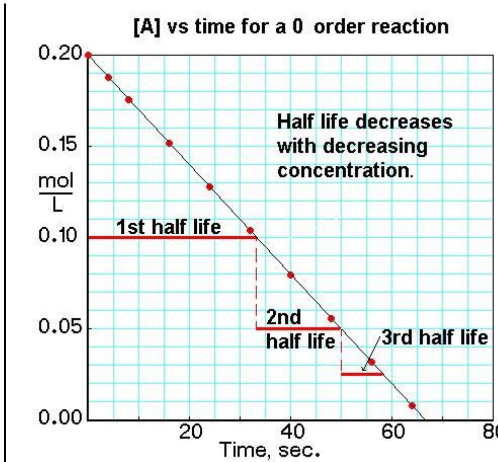
3

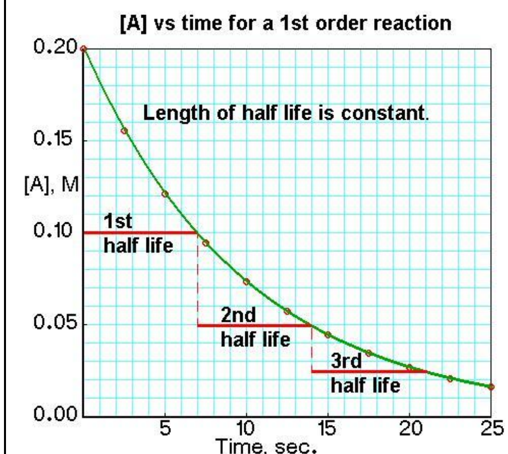
1. $2\,NO_{(g)} \Leftrightarrow N_2O_{2(g)}$	Fast
2. $H_{2(g)} + N_2O_{2(g)} \rightarrow H_2O_{(g)} + N_2O_{(g)}$	Slow Rate = $k_2[H_2][N_2O_2]$
3. $H_{2(g)} + N_2O_{(g)} \rightarrow H_2O_{(g)} + N_{2(g)}$	Fast
$2\,H_{2(g)} + 2\,NO_{(g)} \rightarrow 2\,H_2O_{(g)} + N_{2(g)}$	Rate$_{obs}$ = $k\,[H_2][NO]^2$

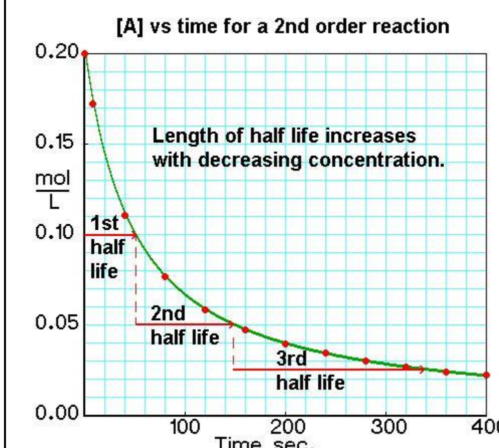
N9 – Rate Laws

Kinetics Summary Glue In - *See Kinetics Reference Sheet for More Details*

Differential Rate Law *Rate vs Concentration Data*			**Integrated Rate Law** *Graph the following versus time. The one that is linear tells you the order! Why? Because of Math. Ha!*					
Order	**Rate Law**	**Units on K**	**Memory Device**	**Y-axis**	**y = mx + b format**	**Straight Line Plot**	**k from Graph**	**Half Life Equation**
0th	k	M/sec	**C** *Concentration*	[A]	$[A]_t = -kt + [A]_0$		- slope	$t_{1/2} = \frac{[A]_0}{2k}$
1st	k [A]	1/sec	**N** *Natural Log*	Ln [A]	$Ln[A]_t = -kt + Ln[A]_0$		- slope	$t_{1/2} = \frac{0.693}{k}$
2nd	k [A]^2	1/M•sec	**R** *Reciprocal*	1/[A]	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$		slope	$t_{1/2} = \frac{1}{k\,[A]_0}$







N11 – Collision Theory and More

Elementary Step	Molecularity	Rate Law
A → products	Unimolecular	Rate = k[A]
A + A → products (2A → products)	Bimolecular	Rate = $k[A]^2$
A + B → products		Rate = k[A][B]
A + A + B → products (2A + B → products)	Termolecular	Rate = $k[A]^2[B]$
A + B + C → products		Rate = k[A][B][C]

$$k = Ae^{\left(\frac{-E_a}{RT}\right)}$$

$$\ln(k) = -\frac{E_a}{R}\left(\frac{1}{T}\right) + \ln(A)$$

- $-E_a / R$ is the slope when graphing ln(*k*) vs. (1/T)
- ln(*A*) is the y-intercept
- $E_a = -R(slope)$

Graphing ln(*k*) vs (1/T) and taking line of best fit can quickly yield a slope

$$ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$ or...

$$ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$