

Kinetics Problems (calculator required)

- The rate equation for the reaction: $2\text{NO}(g) + 2\text{H}_2(g) \rightarrow \text{N}_2(g) + 2\text{H}_2\text{O}(g)$ is second order in $\text{NO}(g)$ and first order in $\text{H}_2(g)$.
 - Write an equation for the rate of appearance of $\text{N}_2(g)$. (**rate = $k[\text{NO}]^2[\text{H}_2]$**)
 - If concentrations are expressed in mol/Litre, what units would the rate constant, **k**, have?
(**$\text{M}^{-2}\text{s}^{-1}$**)
 - Write an equation for the rate of disappearance of $\text{NO}(g)$. Would **k** in this equation have the same numerical value as **k** in the equation of part (a)? (**rate = $2k[\text{NO}]^2[\text{H}_2]$, yes**)

- For a reaction in which A and B combine to form C, the following data were obtained:

measured reaction rate (mol/L-s)	[A] (mol/L)	[B] (mol/L)
0.0007	0.30	0.15
0.0028	0.60	0.30
0.0014	0.30	0.30

- What is the rate law for the reaction? (**rate = $k[\text{A}][\text{B}]$**)
 - What is the numerical value of and units for the rate constant, **k**? (**$1.56 \times 10^{-2} \text{ M}^{-1}\text{s}^{-1}$**)
- The following data for the hydrolysis of $(\text{CH}_3)_3\text{CBr}$ in a solvent consisting of 10% water and 90% acetone were obtained at 25°C :

<u>t(h)</u>	<u>$[(\text{CH}_3)_3\text{CBr}], \text{ M}$</u>
0.00	0.1039
3.15	0.0896
4.10	0.0859
6.20	0.0776
8.20	0.0701
10.0	0.0639
26.0	0.0270

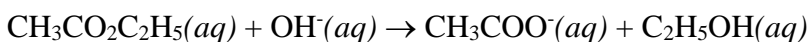
- Prepare a graph of concentration versus time, and use it to determine the initial reaction rate and the rate at 14.0 hours. (**$5.4 \times 10^{-3} \text{ M}\cdot\text{hr}^{-1}$, $2.6 \times 10^{-3} \text{ M}\cdot\text{hr}^{-1}$**)
- Show graphically that the hydrolysis of $(\text{CH}_3)_3\text{CBr}$ follows first order kinetics.
- Evaluate the rate constant at 25°C . (**$5.22 \times 10^{-2} \text{ hr}^{-1}$**)
- How many hours would it take to hydrolyze 80% of a sample of $(\text{CH}_3)_3\text{CBr}$ at 25°C ? (**31**)

4. A study of the reaction



at 593 K shows that it is first order and that 10.0% of the SO_2Cl_2 decomposes in 80.0 minutes.

- a) Calculate **k** for the reaction at 593 K. (**$1.3 \times 10^{-3} \text{ min}^{-1}$**)
b) How many minutes will it take for a 5.00 mmol sample of SO_2Cl_2 to decompose to 3.50 mmol? (**271**)
5. Ethyl Acetate ($\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$) reacts with hydroxide ion in aqueous solution according to the reaction:



The reaction is known to be second order. An experiment was carried out and the following data were obtained:

<u>Time (s)</u>	<u>M (of each reactant)</u>
0.0	0.01000
60.0	0.00917
120.0	0.00840
180.0	0.00775
240.0	0.00724
300.0	0.00675

- a) Determine the rate constant for the reaction. (**$0.16 \text{ M}^{-1}\text{s}^{-1}$**)
b) Determine the half-life for this reaction given the initial conditions above. (**617 s**)
c) Calculate the time required for 75% of the initial ethyl acetate to react. (**1851 s**)