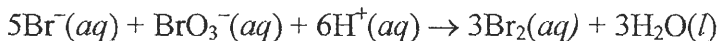


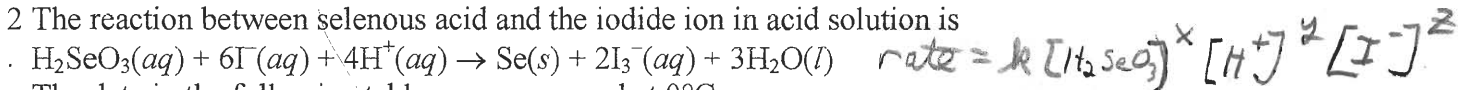
1. (2 Pts) The rate law for the chemical reaction



has been determined experimentally to be $\text{Rate} = k[\text{Br}^-][\text{BrO}_3^-][\text{H}^+]^2$. What is the overall order of the reaction?

4

2 The reaction between selenous acid and the iodide ion in acid solution is



The data in the following table were measured at 0°C.

Experiment	$[\text{H}_2\text{SeO}_3]_0 (M)$	$[\text{H}^+]_0 (M)$	$[\text{I}^-]_0 (M)$	Initial Rate $[\text{mol}/(\text{L} \cdot \text{s})]$
1	1.00×10^{-4}	2.00×10^{-2}	3.00×10^{-2}	5.30×10^{-7}
2	2.00×10^{-4}	2.00×10^{-2}	3.00×10^{-2}	1.06×10^{-6}
3	3.00×10^{-4}	4.00×10^{-2}	3.00×10^{-2}	6.36×10^{-6}
4	3.00×10^{-4}	8.00×10^{-2}	3.00×10^{-2}	2.54×10^{-5}
5	3.00×10^{-4}	8.00×10^{-2}	6.00×10^{-2}	2.04×10^{-4}
6	2.00×10^{-4}	2.00×10^{-2}	6.00×10^{-2}	8.48×10^{-6}

a. (6 Pts) Determine the order for each reactant.

for $[\text{H}_2\text{SeO}_3]$ use (Exp 2/1): $\frac{\text{rate}_2}{\text{rate}_1} = \frac{[\text{I}^-]_2^x}{[\text{I}^-]_1^x}$ or $\frac{1.06 \times 10^{-6}}{5.30 \times 10^{-7}} = \left(\frac{2 \times 10^{-4}}{1 \times 10^{-4}}\right)^x$

$2 = 2^x \quad x = 1$

for $[\text{H}^+]$ use (Exp 4/3): $\frac{\text{rate}_4}{\text{rate}_3} = \frac{[\text{H}^+]_4^y}{[\text{H}^+]_3^y}$ or $\frac{2.54 \times 10^{-5}}{6.36 \times 10^{-6}} = \left(\frac{8 \times 10^{-2}}{4 \times 10^{-2}}\right)^y$

$4 = 2^y \quad y = 2$

for $[\text{I}^-]$ use (Exp 5/4): $\frac{\text{rate}_5}{\text{rate}_4} = \frac{[\text{I}^-]_5^z}{[\text{I}^-]_4^z}$ or $\frac{2.04 \times 10^{-4}}{2.54 \times 10^{-5}} = \left(\frac{6 \times 10^{-2}}{3 \times 10^{-2}}\right)^z$

$8 = 2^z \quad z = 3$

b. (4 Pts) Determine the value of the rate constant and its units.

$$\text{rate} = k [\text{H}_2\text{SeO}_3]^1 [\text{H}^+]^2 [\text{I}^-]^3$$

Use Any DATA set (i.e. #1) $5.30 \times 10^{-7} = k [1 \times 10^{-4}] [2 \times 10^{-2}]^2 [3 \times 10^{-2}]^3$

$$k = 4.9 \times 10^5 \text{ M}^{-5} \cdot \text{s}^{-1}$$

3. (4 Pts) A second-order reaction starts with an initial concentration of 0.100 mol/L of the reactant. If the rate constant is $2.8 \times 10^{-2} \text{ L}/(\text{mol} \cdot \text{s})$, what is the time required to decrease the initial concentration to 0.050 mol/L?

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

$$\frac{1}{0.050} = 2.8 \times 10^{-2} (t) + \frac{1}{0.100}$$

$$t = 357 \text{ seconds}$$

4. (2 Pts) Which of the following statements is true concerning the reaction given below?



A) The reaction is second-order in $\text{H}_2\text{S}(g)$ and first-order in $\text{O}_2(g)$.

B) The reaction is first-order in $\text{H}_2\text{S}(g)$ and second-order in $\text{O}_2(g)$.

C) The rate law is $\text{Rate} = k[\text{H}_2\text{S}]^2[\text{O}_2]$.

D) The rate law is $\text{Rate} = k[\text{H}_2\text{S}][\text{O}_2]$.

E) The rate law may be determined only by experiment.

5. (4 Pts) The nuclide ^{96}Nb decays by a first-order process with a rate constant of $2.96 \times 10^{-2} \text{ h}^{-1}$. How long will it take for 78.0% of the initial amount of ^{96}Nb to be consumed?

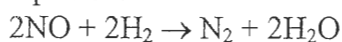
$$\ln [A]_t = -kt + \ln [A]_0$$

$$\ln \frac{[A]_t}{[A]_0} = -kt$$

$$\ln 0.22 = (-2.96 \times 10^{-2}) t$$

$$t = 51 \text{ hrs}$$

6. (3 Pts) Nitric oxide reacts with hydrogen at a measurable rate at 1000 K according to the following equation:



The experimental rate law is $\text{Rate} = k[\text{NO}]^2[\text{H}_2]$. If time is measured in minutes and concentration is measured in moles per liter, what are the units for the rate constant?

$$\frac{\text{M}}{\text{min}} = k \text{ M}^2 \text{ M}^1$$

$$\frac{\text{M}}{\text{min}} = k \text{ M}^3$$

$$k_{\text{units}} = \text{M}^{-2} \cdot \text{min}^{-1} = \text{L}^2 \cdot \text{mol}^{-2} \cdot \text{min}^{-1}$$

Turn off all cell phones. Show all work.

1. (4 Pts) A second-order reaction starts with an initial concentration of 0.100 mol/L of the reactant. If the rate constant is $2.6 \times 10^{-2} \text{ L}/(\text{mol} \cdot \text{s})$, what is the time required to decrease the initial concentration to 0.050 mol/L?

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

$$\frac{1}{0.050} = 2.6 \times 10^{-2} t + \frac{1}{0.100}$$

$$t = 384 \text{ seconds}$$

2. (4 Pts) The nuclide ^{96}Nb decays by a first-order process with a rate constant of $2.96 \times 10^{-2} \text{ h}^{-1}$. How long will it take for 95.0% of the initial amount of ^{96}Nb to be consumed?

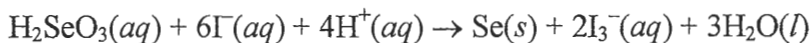
$$\ln [A]_t = -kt + \ln [A]_0$$

$$\ln \frac{[A]_t}{[A]_0} = -kt$$

$$\ln 0.050 = -2.96 \times 10^{-2} (t)$$

$$t = 101 \text{ hrs}$$

3. The reaction between selenous acid and the iodide ion in acid solution is


 The data in the following table were measured at 0°C .

Experiment	$[\text{H}_2\text{SeO}_3]_0 (\text{M})$	$[\text{H}^+]_0 (\text{M})$	$[\text{I}^-]_0 (\text{M})$	Initial Rate $[\text{mol}/(\text{L} \cdot \text{s})]$
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6	2.00×10^{-4}	2.00×10^{-2}	6.00×10^{-2}	8.48×10^{-6}

- a. (6 Pts) Determine the order for each reactant.

- b. (4 Pts) Determine the value of the rate constant and its units.

4. (3 Pts) Nitric oxide reacts with hydrogen at a measurable rate at 1000 K according to the following equation:



The experimental rate law is $\text{Rate} = k[\text{NO}]^2[\text{H}_2]$. If time is measured in minutes and concentration is measured in moles per liter, what are the units for the rate constant?

$$k_{\text{units}} = \text{M}^{-2} \cdot \text{min}^{-1} = \text{L}^2 \cdot \text{mol}^{-2} \cdot \text{min}^{-1}$$

5. (2 Pts) Which of the following statements is true concerning the reaction given below?



A) The reaction is second-order in $\text{H}_2\text{S}(g)$ and first-order in $\text{O}_2(g)$.

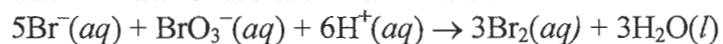
B) The reaction is first-order in $\text{H}_2\text{S}(g)$ and second-order in $\text{O}_2(g)$.

C) The rate law is $\text{Rate} = k[\text{H}_2\text{S}]^2[\text{O}_2]$.

D) The rate law is $\text{Rate} = k[\text{H}_2\text{S}][\text{O}_2]$.

E) The rate law may be determined only by experiment.

6. (2 Pts) The rate law for the chemical reaction



has been determined experimentally to be $\text{Rate} = k[\text{Br}^-][\text{BrO}_3^-][\text{H}^+]^2$. What is the overall order of the reaction?

4th