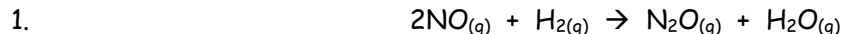


Answers: Rates of Reactions Practice Questions

Rate Laws:

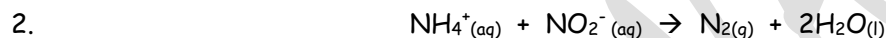


Initial Concentration (mol/L)		Initial Rate (mol/L.s)
$\text{NO}_{(g)}$	$\text{H}_{2(g)}$	
0.075	0.400	0.005
0.150	0.200	0.010
0.150	0.400	0.020

- a) Find the rate law. **Rate = $k[\text{NO}]^2[\text{H}_2]$**
 b) Determine the value of the rate constant.

$$0.005 = k (0.075)^2(0.400)$$

$$K = 2.22 \text{ L}^2/\text{mol}^2\text{s}$$

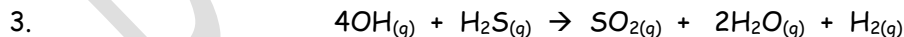


Initial Concentration (mol/L)		Initial Rate (mol/L.s)
$\text{NO}_2^-_{(aq)}$	$\text{NH}_4^+_{(aq)}$	
0.010	0.020	5.4×10^{-7}
0.020	0.020	10.8×10^{-7}
0.040	0.020	21.6×10^{-7}
0.020	0.0202	10.8×10^{-7}
0.020	0.0404	21.6×10^{-7}
0.020	0.0606	32.4×10^{-7}

- a) Write the rate law. **Rate = $k[\text{NO}_2][\text{NH}_4^+]$**
 b) Calculate the rate constant.
 $5.4 \times 10^{-7} = k(0.01)(0.02)$
 $K = 0.0027 \text{ L/mol}\cdot\text{s}$
 c) Calculate the initial rate if $[\text{NO}_2^-_{(aq)}] = 0.10 \text{ M}$ and $[\text{NH}_4^+_{(aq)}] = 0.10 \text{ M}$.

$$\text{Rate} = 0.0027(0.10)(0.10)$$

$$\text{Rate} = 2.7 \times 10^{-5} \text{ mol/L}\cdot\text{s}$$



Initial Concentration (mol/L)		Rate of Disappearance of $\text{H}_2\text{S}(\text{mol/L}\cdot\text{s})$
$\text{OH}_{(g)}$	$\text{H}_2\text{S}_{(g)}$	
1.3×10^{-8}	2.1×10^{-8}	1.4×10^{-6}
3.9×10^{-8}	2.1×10^{-8}	4.2×10^{-6}
3.9×10^{-8}	4.2×10^{-8}	8.4×10^{-6}

a) Write the rate law. $\text{Rate} = k[\text{OH}][\text{H}_2\text{S}]$

b) Calculate the rate constant.

$$1.4 \times 10^{-6} = k(1.3 \times 10^{-8})(2.1 \times 10^{-8})$$

$$K = 5.1 \times 10^9 \text{ L/mol}\cdot\text{s}$$

c) Calculate the rate of disappearance of H_2S when $[\text{OH}_{(g)}] = 1.7 \times 10^{-8} \text{ M}$ and $[\text{H}_2\text{S}_{(g)}] = 1.0 \times 10^{-8} \text{ M}$. What is the rate of disappearance of OH at the same time?

$$\text{Rate} = 5.1 \times 10^9 (1.7 \times 10^{-8})(1.0 \times 10^{-8})$$

$$\text{Rate} = 8.7 \times 10^{-7} \text{ mol/L}\cdot\text{s}$$

$$\text{Rate of disappearance of OH at the same time is } 4(8.7 \times 10^{-7}) = 3.5 \times 10^{-6} \text{ mol/L}\cdot\text{s}$$

4. The rate law for the reaction: $\text{A} + \text{B} + 2\text{C} \rightarrow \text{D} + \text{E}$ is $\text{rate} = k[\text{A}]^2[\text{C}]$.

a) Complete the chart.

Experiment	[A] (mol/L)	[B] (mol/L)	[C] (mol/L)	Initial rate (mol/L.min)	K
1	1.0	4.0	2.0	8.0	4.0
2	2.0	2.0	1.0	16	4.0

b) How can the rate constant be increased? **Increase temperature**

Mechanisms and Rate Laws:

5. The mechanism for a reaction is:



a) What is the overall reaction? $2\text{NO}_2\text{Cl} \rightarrow 2\text{NO}_2 + \text{Cl}_2$

b) What is the reaction intermediate? **Cl**

c) What is the rate law? $\text{Rate} = k[\text{NO}_2\text{Cl}]$

6. If a mechanism for a reaction is:

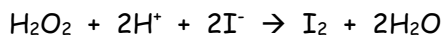


a) If the first step is the rate-determining step, which step is the fast step? **Second step**

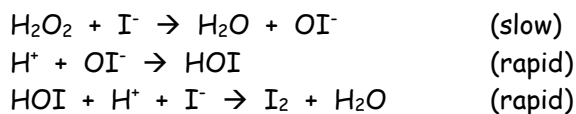
b) Write the rate law for the reaction. $\text{Rate} = k[\text{A}][\text{B}]$

c) What is the overall reaction? $2\text{A} + \text{B} \rightarrow \text{C} + 2\text{F}$

7. For the reaction of:



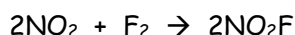
A proposed mechanism is:



For this mechanism to be consistent with the experimental data, what must the observed rate law be?

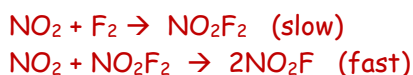


8. At low pressure, the reaction:



Follows the rate law: Rate = $k[\text{NO}_2][\text{F}_2]$

Suggest a mechanism that is consistent with the rate law.



9. For the reaction: $2\text{A} + \text{B} \rightarrow \text{C}$, the rate of formation of C was measured for a number of different initial concentrations of A and B, with the following results:

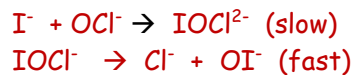
Initial Concentration (mol/L)		Rate of Appearance of C (mol/L.s)
A	B	
0.10	0.10	2.0×10^{-3}
0.20	0.10	8.0×10^{-3}
0.30	0.10	1.8×10^{-2}
0.20	0.20	8.0×10^{-3}
0.30	0.30	1.8×10^{-2}

- Write the rate law. Rate = $k[\text{A}]^2$
- Calculate the rate constant. $K = 0.20 \text{ L/mol}\cdot\text{s}$
- Suggest a two-step mechanism that is consistent with the experimental data.
 $2\text{A} \rightarrow \text{D}$ (slow)
 $\text{D} + \text{B} \rightarrow \text{C}$ (fast)

10. For the reaction: $\text{I}^- + \text{OCl}^- \rightarrow \text{Cl}^- + \text{OI}^-$, the following data was collected:

Initial Concentration (mol/L)		Rate of Production of Cl^- (mol/L.s)
I^-	OCl^-	
0.10	0.10	1.0×10^{-3}
0.20	0.10	2.0×10^{-3}
0.30	0.30	9.0×10^{-3}
0.30	0.60	1.8×10^{-2}

- Write the rate law. $\text{Rate} = k[\text{I}^-][\text{OCl}^-]$
- Calculate the rate constant. $K = 0.10 \text{ L/mol}\cdot\text{s}$
- Suggest a two-step mechanism that is consistent with the experimental data.



11. The reaction: $\text{NO}_2 + \text{CO} \rightarrow \text{CO}_2 + \text{NO}$ is known to be a one-step reaction at very high temperatures. At a much lower temperature, the following data was collected:

Initial Concentration (mol/L)		Rate of Production of CO_2 (mol/L.s)
NO_2	CO	
0.010	0.010	2.1×10^{-8}
0.020	0.020	8.4×10^{-8}
0.040	0.020	3.36×10^{-7}
0.020	0.040	8.4×10^{-8}

- Write the rate law. $\text{Rate} = k[\text{NO}_2]^2$
- Calculate the rate constant. $K = 2.1 \times 10^{-4} \text{ L/mol}\cdot\text{s}$
- Suggest a two-step mechanism that is consistent with the experimental data.

