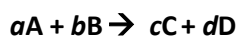


I. Chemical reaction and rate:



$$\text{Averaged Rate (M/s)} = -\frac{1}{a} \frac{\Delta[A]}{\Delta t} = -\frac{1}{b} \frac{\Delta[B]}{\Delta t} = \frac{1}{c} \frac{\Delta[C]}{\Delta t} = \frac{1}{d} \frac{\Delta[D]}{\Delta t}$$

II. Rate law:

Differential rate law:

Integrated rate law:

$$\text{Rate} = k [A]^n [B]^m \text{ not } k [A]^a [B]^b$$

$$-\frac{d[A]}{dt} = k \quad [A]_t = -kt + c$$

Unit of rate constant k : $M^{1-n}s^{-1}$, ex: 0 order ($M s^{-1}$); 1 order (s^{-1}); 2 order ($M^{-1}s^{-1}$); 3 order ($M^{-2}s^{-1}$)**Table 11-6** | Summary of the Kinetics for Reactions of the Type $aA \rightarrow$ Products That Are Zero, First, or Second Order in $[A]$

	Order		
	Zero	First	Second
Rate law	Rate = k	Rate = $k[A]$	Rate = $k[A]^2$
Integrated rate law	$[A] = -kt + [A]_0$	$\ln[A] = -kt + \ln[A]_0$	$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$
Plot needed to give a straight line	$[A]$ versus t	$\ln[A]$ versus t	$\frac{1}{[A]}$ versus t
Relationship of rate constant to the slope of straight line	Slope = $-k$	Slope = $-k$	Slope = k
Half-life	$t_{1/2} = \frac{[A]_0}{2k}$	$t_{1/2} = \frac{0.693}{k}$	$t_{1/2} = \frac{1}{k[A]_0}$

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III. Reaction mechanism:

elementary steps and rate **determine step**

1. Write out the overall balanced eq. identify the **reactants**, **products**, **intermediate**, and/or **catalyst**.
2. Write the rate law by using the rate determine elementary step **directly**
3. If the rate law contains non-reactant, use K_{eq} from other steps to derive the final rate law with **reactants if possible**.

IV. Arrhenius equation: note $R = 8.314J/mol$, T must use *Kelvin* not degree C

$$k = Ae^{-\frac{E_a}{RT}} \quad \ln \frac{k_1}{k_2} = \frac{E_a}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

- Catalyst is the only thing that can change the E_a and only E_a (it does not affect equilibrium).

Ch 11

11.I-II

1. **(L4_C)** What is the reaction order of Br^- for a reaction with the following rate law? $\text{Rate} = k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$ **[first]**
2. **(L4_A)** Consider the reaction with the rate law, $\text{Rate} = k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$.
By what factor does the rate change if the concentration of H^+ is quadrupled? Just put in the number as a whole number or fraction. **[16]**
3. **(L4_C)** Given the data below for the reaction, $2\text{A} + 2\text{B} + 4\text{C} \Rightarrow \text{D} + \text{E} + 3\text{F}$, the reaction is [x1] order in A, [x2] order in B, [x3] order in C and [x4] order overall. USE WORDS TO FILL IN THE BLANKS NOT NUMBERS (i.e., zero, first, second etc) !!!!! :

Experiment	Initial conc of A, mol/L	Initial conc of B, mol/L	Initial conc of C, mol/L	Initial rate, mol/L.s
1	0.1	0.2	0.4	2×10^{-3}
2	0.2	0.2	0.4	2×10^{-3}
3	0.3	0.4	0.4	4×10^{-3}
4	0.4	0.6	0.2	1.5×10^{-3}

[zero, first, two, total three]

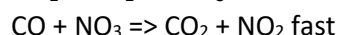
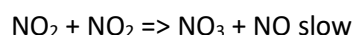
4. **(L5_C)** The reaction, $\text{AB} \Rightarrow \text{A(g)} + \text{B(g)}$, has a rate law, $\text{rate} = k[\text{AB}]^2$. Calculate the rate constant in $\text{L/mol}\cdot\text{s}$. If it takes 120 seconds to reach an $[\text{AB}]$ of 0.2 mol/L from an initial concentration of 0.8 mol/L. (Enter your answer to 3 decimal places) **[(0.031)]**
5. **(L5_A)** In a first order decomposition in which the rate constant is 0.5 sec^{-1} , how long will it take (in minutes) until 1.6 mol/L of the compound is left, if there was 4 mol/L at the start? Give your answer to 3 decimal places. **[0.031]**

11.III

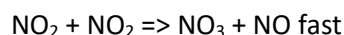
6. **(L6_C)** Consider the reaction, $\text{A} + \text{B} + \text{C} \Rightarrow \text{D}$, which is found to be first order in A and first order in B. Which step of the proposed mechanism must be slow in order to agree with this rate law?
 1. $\text{A(g)} + \text{B(g)} \Rightarrow \text{X(g)}$
 2. $\text{X(g)} + \text{C(g)} \Rightarrow \text{Y(g)}$
 3. $\text{Y(g)} \Rightarrow \text{D(g)}$**[1]**

7. **(L6_A)** For the reaction $\text{NO}_2(\text{g}) + \text{CO(g)} \Rightarrow \text{NO(g)} + \text{CO}_2(\text{g})$ at temperatures below 500 K, the rate law is $\text{rate} = k[\text{NO}_2]^2$. Which mechanism is consistent with this information?

Mechanism 1

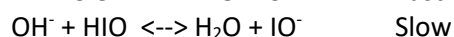
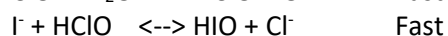


Mechanism 2



[1]

8. **(L6_C)** The proposed mechanism for a reaction $\text{ClO}^- + \text{I}^- \rightleftharpoons \text{IO}^- + \text{Cl}^-$ is:



Which of the following would be a rate law for the reaction? **[rate = $k[\text{ClO}^-][\text{I}^-]/[\text{Cl}^-]$]**

11.IV

9. **(L6_C)** A first order reaction has an activation energy of 48 kJ/mol and a frequency factor (Arrhenius constant) of $5 \times 10^{10} \text{ sec}^{-1}$. Calculate the rate constant at 27 °C. Use the nearest whole number. **[219]**
10. **(L6_A)** A first order reaction has a rate constant of 0.52 s^{-1} at 34.1 °C. if the activation energy is 63.6 kJ, calculate the temperature in °C at which the rate constant is 0.979 s^{-1} .

1. What is the reaction order of Br^- for a reaction with the following rate law? $\text{Rate} = k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$ **[first]**

2. Consider the reaction with the rate law, $\text{Rate} = k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$.

By what factor does the rate change if the concentration of H^+ is quadrupled? Just put in the number as a whole number or fraction. [16]

3. Given the data below for the reaction, $2\text{A} + 2\text{B} + 4\text{C} \Rightarrow \text{D} + \text{E} + 3\text{F}$, the reaction is [x1] order in A, [x2] order in B, [x3] order in C and [x4] order overall. USE WORDS TO FILL IN THE BLANKS NOT NUMBERS (i.e., zero, first, second etc) !!!!! :

Experiment	Initial conc of A, mol/L	Initial conc of B, mol/L	Initial conc of C, mol/L	Initial rate, mol/L.s
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3	0.3	0.4	0.4	4×10^{-3}
4	0.4	0.6	0.2	1.5×10^{-3}

[zero, first, first, total two]

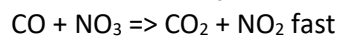
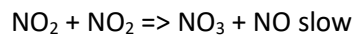
4. The reaction, $AB \Rightarrow A(g) + B(g)$, has a rate law, $\text{rate} = k[AB]^2$. Calculate the rate constant in $\text{L/mol}\cdot\text{s}$. If it takes 120 seconds to reach an $[AB]$ of 0.2 mol/L from an initial concentration of 0.8 mol/L. (Enter your answer to 3 decimal places) [(0.031]

5. In a first order decomposition in which the rate constant is 0.5 sec^{-1} , how long will it take (in minutes) until 1.6 mol/L of the compound is left, if there was 4 mol/L at the start? Give your answer to 3 decimal places. **[0.031]**

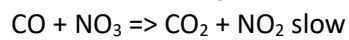
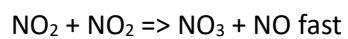
6. Consider the reaction, $A + B + C \Rightarrow D$, which is found to be first order in A and first order in B. Which step of the proposed mechanism must be slow in order to agree with this rate law?
1. $A(g) + B(g) \Rightarrow X(g)$
 2. $X(g) + C(g) \Rightarrow Y(g)$
 3. $Y(g) \Rightarrow D(g)$
- [1]

7. For the reaction $\text{NO}_2(\text{g}) + \text{CO}(\text{g}) \Rightarrow \text{NO}(\text{g}) + \text{CO}_2(\text{g})$ at temperatures below 500 K, the rate law is $\text{rate} = k [\text{NO}_2]^2$. Which mechanism is consistent with this information?

Mechanism 1

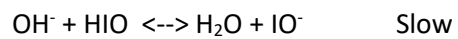
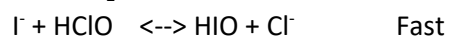


Mechanism 2



[1]

8. The proposed mechanism for a reaction $\text{ClO}^- + \text{I}^- \rightleftharpoons \text{IO}^- + \text{Cl}^-$ is:



Which of the following would be a rate law for the reaction? [**rate** = $k[\text{ClO}^-][\text{I}^-]/[\text{Cl}^-]$]

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