Name _____ Date _____ Period _____

ZornScience
zornscience.org

5.8 Reaction Mechanism and Rate Law

AP Chemistry

Write each rate law from the slow step. Show how the steps add up to the overall reaction.

1. A mechanism has three steps: step 1 is fast, step 2 is slow, and step 3 is fast.

(a) Which step is the rate-determining step?

(b) Explain why the overall reaction cannot go faster than this step.

2. Consider this mechanism. (L is a molecule that bonds to the metal.)

Step 1 (slow): $Mo(CO)_6 \rightarrow Mo(CO)_5 + CO$

Step 2 (fast): $Mo(CO)_5 + L \rightarrow Mo(CO)_5L$

(a) Write the overall reaction and identify the intermediate.

(b) Write the rate law.

(c) What is the order with respect to L? Explain why.

3. Consider this mechanism for the reaction of nitrogen monoxide with hydrogen.

Step 1 (slow): $2NO + H_2 \rightarrow N_2O + H_2O$

Step 2 (fast): $N_2O + H_2 \rightarrow N_2 + H_2O$

(a) Write the overall reaction.

(b) Write the rate law predicted by this mechanism and give the overall order.

CC BY-NC-SA 4.0 | zornscience.org

4. Consider this mechanism.

Step 1 (slow): $A + X \rightarrow AX$

Step 2 (fast): $AX + B \rightarrow AB + X$

(a) Write the overall reaction. Identify the catalyst and the intermediate.

(b) Write the rate law.

(c) What happens to the rate if [X] is doubled? Explain, even though X is not in the overall equation.

---

5. For $H_2 + 2ICl \rightarrow I_2 + 2HCl$, experiments show rate = $k[H_2][ICl]$. Which mechanism is consistent with this rate law? Justify your answer for each mechanism.

Mechanism A: Step 1 (slow): $H_2 + ICl \rightarrow HI + HCl$; Step 2 (fast): $HI + ICl \rightarrow I_2 + HCl$

Mechanism B: one step: $H_2 + 2ICl \rightarrow I_2 + 2HCl$

---

6. For $2A + B \rightarrow C$, experiments show rate = $k[A]^2$. Which step in this mechanism must be the slow step? Explain.

Step 1: $A + A \rightarrow A_2$

Step 2: $A_2 + B \rightarrow C$

---

7. For $2NO_2Cl \rightarrow 2NO_2 + Cl_2$, a student writes rate = $k[NO_2Cl]^2$ "because the coefficient of NO_2Cl is 2." Experiments show the reaction is first order in NO_2Cl. Explain the student's error and propose a slow first step that fits the data.

CC BY-NC-SA 4.0 | zornscience.org