Exercise 5.34 – Reaction mechanisms

Q534-01 A proposed mechanism for the reaction $2NO(g) + Br_2(g) \longrightarrow 2NOBr(g)$ is as follows:

$NO(g) + Br_2(g) \longrightarrow NOBr_2(g)$ slow
$NO(g) + NOBr_2(g) \longrightarrow 2NOBr(g)$ fast

If this mechanism is correct then the rate law could be expected to be which of the following:

A. rate = $k[NO][Br_2]$
B. rate = $k[NO]^2[Br_2]$
C. rate = $k[NO][NOBr_2]$
D. rate = $k[NO]^2$

Q534-02 The rate of the reaction $2A + B \longrightarrow$ Products, is consistent with the rate equation, rate = k[A][B].
Which reaction mechanism is consistent with this information?

A. $A + B \longrightarrow AB$ (slow)
$AB + A \longrightarrow$ Products (fast)

B. $A + A \longrightarrow A_2$ (slow)
$A_2 + B \longrightarrow$ Products (fast)

C. $A + B \longrightarrow AB$ (fast)

D. $A + A \longrightarrow A_2$ (fast)
$A_2 + B \longrightarrow$ Products (slow)

Q534-03 The following reaction, $X_2(g) + 2Y(g) \longrightarrow 2XY(g)$ has the proposed mechanism:

$X_2 \longrightarrow 2X$ slow
$X + Y \longrightarrow XY$ fast

Based on this information the rate expression for this reaction is:

A. rate = k[XY]
B. rate = $k[X_2][Y]^2$
C. rate = $k[X_2]$
D. rate = k[2X]

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Q534-04 The reaction of hydrogen and iodine monochloride is represented by this equation:

$$H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$$

This reaction is first order in H2(g) and also first order in ICl(g). Which of these proposed mechanisms can be consistent with the given information about this reaction?

Mechanism 1	$H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$	
Mechanism 2	$H_2(g) + ICl(g) \longrightarrow HCl(g) + HI(g)$	slow
	$HI(g) + ICl(g) \longrightarrow HCl(g) + I_2(g)$	fast

A. 1 only
B. 2 only
C. Both 1 and 2
D. Neither 1 nor 2

Q534-05 For the hypothetical reaction $2X + 2G \longrightarrow Q + 2M$, the rate expression is:

$$\text{Rate} = k[X]^2[G]$$

Which mechanism is most likely?

A. $2X + G \rightleftharpoons 2Q + R$ (fast equilibrium)
$Q + R + G \longrightarrow 2M$ (slow, rate determining)

B. $X + G \rightleftharpoons Q + R$ (fast equilibrium)
$R + X \longrightarrow 2M$ (slow, rate determining)

C. $X + X \rightleftharpoons X_2$ (fast equilibrium)
$X_2 + G \longrightarrow Q + T$ (slow, rate determining)
$T + G \longrightarrow 2M$ (fast)

D. $G + G \rightleftharpoons G_2$ (fast equilibrium)
$G_2 + X \longrightarrow Q + T$ (slow, rate determining)
$T + X \longrightarrow 2M$ (fast)

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Q534-06 The reaction between chloroform, $CHCl_3(g)$, and chlorine, $Cl_2(g)$, to form $CCl_4(g)$ and $HCl(g)$ is believed to occur by this series of steps.

Step 1: $Cl_2 \longrightarrow Cl(g) + Cl(g)$
Step 2: $CHCl_3(g) + Cl(g) \longrightarrow CCl_3(g) + HCl(g)$
Step 3: $CCl_3(g) + Cl(g) \longrightarrow CCl_4(g)$

If this reaction is first order in $CHCl_3$ and half order in Cl_2, which statement about the relative rates of step 1, 2, and 3 is correct?

A. Step 1 is the slowest.
B. Steps 1 and 2 must both be slow.
C. Step 2 must be slower than step 1.
D. Step 3 must be the slowest

Q534-07 The mechanism for the decomposition of nitrogen (V) oxide, has been identified as follows:

$$N_2O_5 \xrightarrow{k_1} NO_2 + NO_3 \text{ (slow)}$$

$$NO_2 + NO_3 \xrightarrow{k_2} NO_2 + O_2 + NO \text{ (fast)}$$

$$NO + N_2O_5 \xrightarrow{k_3} 3NO_2 \text{ (fast)}$$

The stoichiometric equation for this decomposition is:

A. $N_2O_5 \longrightarrow NO_2 + NO_2$
B. $N_2O_5 \longrightarrow NO_2 + O_2 + NO$
C. $2\ N_2O_5 \longrightarrow 4NO_2 + O_2$
D. $N_2O_5 + NO \longrightarrow 3NO_2$

Q534-08 The rate law consistent with the mechanism shown in question 07 above is:

A. rate = $k_1\ [N_2O_5]$
B. rate = $k_3\ [NO][N_2O_5]$
C. rate = $k_1k_2k_3\ [N_2O_5]^2$
D. rate = $k_2\ [NO_2][NO_3]$

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Q534-09 For the stoichiometric reaction:

$$CHCl_3(g) + Cl_2(g) \longrightarrow CCl_4(g) + HCl(g)$$

the rate law, rate = $k[CHCl_3][Cl_2]^{1/2}$ has been determined. The mechanism given below has been proposed.

step 1: $Cl_2 \rightleftharpoons 2Cl$
step 2: $CHCl_3 + Cl \longrightarrow CCl_3 + HCl$
step 3: $CCl_3 + Cl \longrightarrow CCl_4$

For this reaction, the rate determining step must be:

A. step 1.
B. step 2.
C. step 3
D. 1/2 times step 1

Q534-10 The ionic reaction:

$$3I^- + S_2O_8^{2-} \longrightarrow 2SO_4^{2-} + I_3^-$$

is found to be described by the experimental rate equation, rate = $k[I^-]\,[S_2O_8^{2-}]$. This suggests that:

A. the reaction occurs when three iodide ions collide simultaneous with one $S_2O_8^{2-}$ ion
B. there must be only one step in the overall reaction since the rate is first-order in both reactants
C. the rate of reaction is inhibited by the presence of I_3^-
D. a slow step in the overall reaction sequence may involve the collision of a single I^- ion with a single $S_2O_8^{2-}$ ion.
