SAMPLE PROBLEM D

For more help, go to the Math Tutor at the end of this chapter.

Nitrogen dioxide and fluorine react in the gas phase according to the following equation.

$$2NO_2(g) + F_2(g) \longrightarrow 2NO_2F(g)$$

A proposed mechanism for this reaction follows.

Step 1: $NO_2 + F_2 \longrightarrow NO_2F + F$ **(slow)**
Step 2: $F + NO_2 \longrightarrow NO_2F$ **(fast)**

Identify the rate-determining step, and write an acceptable rate law.

SOLUTION

If we combine these two steps, the intermediate, F, cancels out and we are left with the original equation. The first step is the slower step, and is considered the rate-determining step. We can write the rate law from this rate-determining step.

$$R = k\,[NO_2][F_2]$$

SAMPLE PROBLEM E

A reaction involving reactants X and Y was found to occur by a one-step mechanism: $X + 2Y \longrightarrow XY_2$. Write the rate law for this reaction, and then determine the effect of each of the following on the reaction rate:

a. doubling the concentration of X
b. doubling the concentration of Y
c. using one-third the concentration of Y

SOLUTION

Because the equation represents a single-step mechanism, the rate law can be written from the equation (otherwise, it could not be). The rate will vary directly with the concentration of X, which has an implied coefficient of 1 in the equation. And the rate will vary directly with the square of the concentration of Y, which has the coefficient of 2: $R = k[X][Y]^2$.

a. Doubling the concentration of X will double the rate ($R = k[2X][Y]^2$).
b. Doubling the concentration of Y will increase the rate fourfold ($R = k[X][2Y]^2$).
c. Using one-third the concentration of Y will reduce the rate to one-ninth of its original value ($R = k[X][\frac{1}{3}Y]^2$).

PRACTICE

Answers in Appendix E

1. The rate of a hypothetical reaction involving L and M is found to double when the concentration of L is doubled and to increase fourfold when the concentration of M is doubled. Write the rate law for this reaction.

2. At temperatures below 498 K, the following reaction takes place.

$$NO_2(g) + CO(g) \longrightarrow CO_2(g) + NO(g)$$

Doubling the concentration of NO_2 quadruples the rate of CO_2 formed if the CO concentration is held constant. However, doubling the concentration of CO has no effect on the rate of CO_2 formation. Write a rate-law expression for this reaction.

extension

Go to **go.hrw.com** for more practice problems that ask you to determine rate laws and effects on reaction rates.

Keyword: HC6RXKX