Lesson 38: Kinetics (Mechanisms) and Atmospheric Chemistry

text: 582-591, 745-754

what to know:

-concept of reaction mechanisms and related terms, §14-4, §14-5
-atmospheric chemistry and air pollution, §18-5
-role of catalysis in stratospheric ozone depletion and photochemical smog, §18-5
-acid rain and greenhouse effect, p-752

questions:

1. If the rate law expression for reaction, $A + 2B_2 \text{ ===> } C$ is, rate = $k[A]^o[B_2]^2$, we can conclude that the reaction is bimolecular and that the rate-determining elementary step involves a collision between two B_2 molecules. Explain.

2. Given the reaction, $CO + NO_2 \text{ ===> } CO_2 + NO$ (all gases), with a rate law, rate = $k[NO_2]^2$. Consider the following possible mechanisms:

   A. $CO + NO_2 \text{ ===> } CO_2 + NO$

   B. $2NO_2 \text{ ===> } N_2O_4$ (fast)
   $N_2O_4 + 2CO \text{ ===> } 2CO_2 + 2NO$ (slow)

   C. $2NO_2 \text{ ====> } NO_3 + NO$ (slow)
   $NO_3 + CO \text{ ====> } NO_2 + CO_2$ (fast)

   D. $2NO_2 \text{ ====> } 2NO + O_2$ (slow)
   $2CO + O_2 \text{ ====> } 2CO_2$ (fast)

   a. Which of the mechanisms is (are) consistent with this rate law for the overall reaction?
   b. Write the rate law expression for both elementary steps in mechanism B.

3. Write the rate law expression for the elementary step, $2\ NO_2(g) \text{ ====> } 2NO(g) + O_2(g)$

4. Given the overall reaction, $2NO + O_2 \text{ ====> } 2NO_2$, and the mechanism:
   $NO + O_2 \text{ <===> } NO_3$ (fast) $NO_3 + NO \text{ ====> } 2NO_2$ (slow)

   a. Write the rate law expression for the rate determining step.
   b. What substance is the common intermediate and does not appear in the rate law expression for the overall reaction?

5. Discuss the chemistry of ozone in the atmosphere.