ASSIGNMENT 4

CHEMISTRY 302

Due: 4:30 pm Friday 12 February 2010

1. Consider the following stratospheric reactions:

$$O_3 + h\nu \rightarrow O_2 + O \quad (1)$$

$$O_2 + h\nu \rightarrow 2O \quad (2)$$

$$O_2 + O + M \rightarrow O_3 + M \quad (3)$$

$$O_3 + O \rightarrow 2O_2 \quad (4)$$

$$H + O_3 \rightarrow HO + O_2 \quad (5)$$

$$HO + O \rightarrow H + O_2 \quad (6)$$

$$HO + O_3 \rightarrow HO_2 + O_2 \quad (7)$$

$$HO_2 + O \rightarrow HO + O_2 \quad (8)$$

$$Cl + O_3 \rightarrow ClO + O_2 \quad (9)$$

$$ClO + O \rightarrow Cl + O_2 \quad (10)$$

$$NO + O_3 \rightarrow NO_2 + O_2 \quad (11)$$

$$NO_2 + O \rightarrow NO + O_2 \quad (12)$$

   (a) For each chemical species, write the expression for the change in concentration with respect to time, assuming that all reactions are elementary processes.

   (b) If the concentrations of Cl and ClO are at a steady state, write the expressions for the ratio of their concentrations in terms of rate coefficients and the concentrations of the other species.

   (c) Write an expression for the stratospheric lifetime of O_3 in terms of the reactions which consume O_3.

2. The globally averaged concentration of OH is 5 $\times 10^5$ molec cm^{-3} and the total mass of the atmosphere is 5 $\times 10^{15}$ t.

   (a) Calculate the concentration of OH in pptv.

   (b) Estimate the number of moles of gases in the atmosphere, assuming an average M(air) = 30 g mol^{-1}.

   (c) Estimate the mass of OH in the atmosphere, assuming that its concentration in pptv is constant throughout the atmosphere.

   (d) Estimate the global rate of formation of OH in the atmosphere in tonnes per hour, under conditions where the residence time of OH in the atmosphere is 1.1 s.

3. Do Problem 30, Chapter 2, page 66.