Atmospheric Chemistry

Sample Questions for Final Exam:

1. We generally divide the atmosphere into 4 regions based on the dependence of temperature on altitude. What are those 4 regions? How are they defined? Where is the main layer of ozone located?

2. What do we mean by a bimolecular reaction? How is the rate coefficient for such a reaction defined? What are its units?

3. What wavelengths of solar radiation are absorbed by ozone? What wavelengths are absorbed by molecular oxygen? Write out the 4 main reactions that defined the Chapman mechanism for the ozone layer.

4. Define catalysis. What are the chemical reactions involved in the NO_x catalytic cycle for ozone loss? What do we mean by the "rate-determining step"?

5. What are the temporary reservoirs for NO_x? How do they impact the catalytic loss due to NO_x?

6. What is the main source for stratospheric NO_x? What are the characteristics of molecules that can be emitted at the surface and survive to reach the stratosphere where they can be sources of NO_x, ClO_x, etc.?

7. How is a photolysis rate defined? What is the equation for the lifetime of a molecule undergoing photolysis? Why is N_2O only photolyzed in the stratosphere while NO_2 is photolyzed in both the stratosphere and troposphere?

8. What is the source for hydrogen oxides (OH and HO_2) in the stratosphere and troposphere? What role does ozone photolysis play in the source of HO_x?

9. What are the reactions that constitute the catalytic cycle for ozone depletion by chlorine? How does NO_x impact the efficiency of this catalytic cycle? What are the primary reservoir species for chlorine in the stratosphere?

10. What are the primary sources for chlorine oxides in the stratosphere? Why are these such a large concern? Say something about natural versus anthropogenic sources. Say something about the past history of the sources.

11. What is the "ozone hole"? Where and when does it occur? What are the special conditions there that allow the ozone hole to form? What specific changes in chlorine chemistry occur to form the ozone hole? What role do nitrogen compounds play in ozone hole formation?

12. Contrast the Arctic and Antarctic polar stratospheres and how that impacts ozone.

13. How do variations in solar activity impact ozone and temperature in the stratosphere?

14. How do explosive volcanic eruptions affect the stratosphere?

15. What reaction initiates the oxidation of methane in the atmosphere? What are the ultimate products of methane oxidation? What are some of the important intermediate products of methane oxidation (i.e. ones with sufficiently long lifetimes to accumulate measureable concentrations in the atmosphere)?

16. How does methane (or other hydrocarbon) oxidation produce ozone? What is the key requirement?

17. What is the primary oxidizing agent in the troposphere?

18. What is meant by the NO_x-limited regime in the troposphere? What is meant by the VOC-limited regime? Will reducing NO_x always lead to ozone reduction? Explain.