ASL735 (Atmospheric Chemistry and Air Pollution)
Semester-I AY 2017-18
Minor-1 Exam (Aug 30, 2017)
Time 1 hour

Total Marks = 20

Q1. Consider the following reactions involving chlorine compounds:

$Cl + O_3 \rightarrow ClO + O_2$.....(R1)

$ClO + NO \rightarrow Cl + NO_2$.....(R2)

$ClO + O \rightarrow Cl + O_2$.....(R3)

$NO_2 + h\mu \rightarrow NO + O$.....(R4)

$O + O_2 + M \rightarrow O_3 + M$.....(R5)

Assume that the reactions are occurring at 30 km in the midlatitude stratosphere.

a) What is the net result of all the reactions? (Hint: You may multiply some of these reactions by a factor in order to eliminate some terms.)
b) Which of these reactions form a catalytic cycle that destroys ozone?
c) Derive a steady-state expression for the ratio of [Cl]/[ClO].

(Marks = 1 × 3 = 3)

Q2. The mean global stratospheric ozone column Is about 330 DU.

(i) What is the total number of ozone molecules in Earth's atmosphere?
(ii) What is the total mass of ozone in Earth's atmosphere?
(iii) What percentage the ozone is lost each year in the Antarctic ozone hole? [Note: The ozone hole's size is roughly 20×10^6 km^2, where we have defined the ozone hole size as the area which has experienced about 150 DU of loss since the 1970's.]

(Marks = 3)

Q3. In the following reactions identify the species that is oxidised and that being reduced (discuss any two species from each reaction).

a) $IO_3^- + I^- + H^+ \rightarrow I_2 + H_2O$
b) $NO_3^- + H^- + Cl \rightarrow NO + Cl_2 + H_2O$
c) $NO_3^- + Cu + H^+ \rightarrow NO_2 + Cu^{2+} + H_2O$

(Marks = 3)

Q4. (i) In surface air over the tropical oceans the mixing ratio of water vapor can be as high as 0.03 mol/mol. What is the molecular weight of this moist air?
(ii) A typical global concentration of hydroxyl (.OH) radicals is about 10^6 molecules cm^{-3}. What is the mixing ratio corresponding to this concentration at sea level and 298 K?

(Marks = 1.5 + 1.5 = 3)

Q5. Why does temperature increase with height in the lower stratosphere? Why does ozone concentration peak between 20-30 Km altitudes above the mean sea level?

(Marks = 1.5 + 1.5 = 3)

Q6. What is ozone hole and explain its formation mechanism? Why it occurs only in the polar regions and during springtime. Why ozone hole is more prominent over Antarctica compared to Arctic?

(Marks = 3+1+1 = 5)