Major Test
Atmospheric Chemistry and Aerosols (ASL808)

Time: 3.30 -5.30 PM Total Marks- 30
Date: 30.4.2010
Room V320

Q1 Briefly discuss the following:

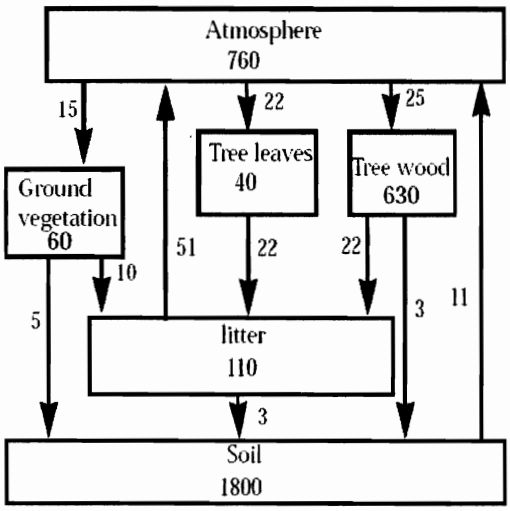
(i) Global Warming Potential
(ii) Perturbation to Climate
(iii) Runaway Greenhouse Gas Effect
(iv) Principal of Chemiluminescence and the pollutants that can be measured with this technique
(v) Ozone titration problem 5

Q. 2 (a) What is radiative forcing? Discuss it in detail in the context of greenhouse gases and aerosols. 3

Q. 2 (b) Assume Neptune to be 7.8×10^9 km from the Sun. Its albedo is 0.8. Calculate the effective temperature of Neptune assuming that the Sun is the only energy source with effective temperature of 5800 ^{0}K and radius 7×10^5 km (Stefan boltzman constant, $\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}) 3

Q. 3 (a) Explain in detail the carbonate chemistry in the ocean in relation to Carbon dioxide emissions in the atmosphere. Also discuss the positive feedback of ever increasing Carbon dioxide concentration on the environment considering ocean as one of the major sink of CO_2 . 4

Q. 3 (b) Consider the following global cycle of carbon between the atmosphere, the terrestrial vegetation, and the soil. Reservoirs are in units of Pg C (1 petagram = 1×10^{15} g) and flows are in units of Pg C yr^{-1}. Tree leaves eventually fall to produce litter. Calculate the lifetime of Carbon in the terrestrial vegetation reservoir against transfer to the litter and soil. 3



Q. 4 (a) Simulations with a general circulation model (GCM) have been used to investigate the climate sensitivity to large changes in atmospheric ozone. Explain qualitatively the results below. 4

(i) A simulation in which all O_3 above 30 km altitude is removed shows a large tropospheric warming (+1-3°C) and a very large stratospheric cooling (up to -80°C).

(ii)A simulation where all O_3 in the upper troposphere is removed shows a 1°C cooling of the Earth's surface, while a simulation where the same amount of O_3 is removed but in the lower troposphere shows no significant temperature change.

Q. 4 (b) What is the ozone concentration at 60 km ($T = 225\ ^0K$) altitude where $[O_2] = 10^{17}$ cm^{-3}. The rate constants for Chapman equations vary with temperature as follows:

$$k_2 = 6.0 \times 10^{-34}\left(\frac{T}{300}\right)^{-2.3}$$

$$k_4 = 8.0 \times 10^{-12}\exp\left(\frac{-2060}{T}\right)$$

The values of k_1 and k_3 do not vary with temperature and their values are 10^{-12} S^{-1} and 10^{-2} S^{-1} respectively. At this altitude, the concentrations of NO and NO_2 are low enough to ignore. Mixing ratio of oxygen is 0.21. 3

Q. 5 (a) What is green chemistry? Name 4 principals of green chemistry and give one example. 2.5

Q. 5 (b) How do you define acid rain in terms of pH? Given the same amount of emissions from thermal power plants assuming that they be the only source (per unit area) where do you expect more acidic rain amongst the regions of North and East India and why? Give at least 3 reasons. 2.5