Problem Set 5

1. Read COW 114-115, "Pollution Buildup in a Lake", then do

   Exercise 1 (Calculate the mass of pollutant in the lake in metric tons, the concentration of pollutant in kg/L, and the concentration of pollutant in ppmw as the time approaches infinity.)

   Exercise 3. Plot the metric tons of pollutant vs. time. Try to use an actual piece of graph paper (normal evenly spaced graph paper, not log-log or semi-log). If you cannot easily obtain graph paper, then plot the graph on a piece of plain paper that you have drawn a grid on with a ruler. Label the axes, to include a table showing the values of X and t asked for in the problem, and to plot the points and connect them with a curve.

2. a. Following the method in COW 104-106 (through equation 13) or the procedure described in lecture, calculate the pH of pristine rain given the current atmospheric CO_2 concentration of 395 ppmv. (Hint: Consider only the equilibrium with CO_2, not with SO_2 or any other atmospheric gas).

   b. A sample of rainwater is observed to have a pH of 7.4. If only atmospheric CO_2 at 395 ppmv and limestone dust ($CaCO_3$) are present in the atmosphere to alter the pH from a neutral value of 7, and if each raindrop has a volume of 0.02 cm^3, what mass in nanograms of calcium is present in each raindrop?

3. a. Consider the claim that 7 Gt/y of O_2 are consumed in combusting fossil fuels currently. Is this claim correct?

   (i) Make the simplest possible calculation for comparison, using data for global carbon dioxide emissions from fossil fuel in 2010. (Hint: see http://www.eia.gov/countries/data.cfm, International Energy Statistics, Carbon Dioxide, Emissions).
   (ii) Will the actual O_2 consumption be more or less than what you just calculated? Justify your claim with a brief qualitative argument. (Hint: See Cow pp 100-103.)

   b. If all the ultimately recoverable fossil fuels were to be completely combusted in one instant, how many metric tons of O_2 would be consumed? For simplicity, assume that all of the ultimately recoverable fossil fuel is in the form of 5000 Gt of coal, and that the coal has the chemical composition $CH_{0.8}$ (i.e. neglect bound water, ash, and other components of coal). Given the change in atmospheric O_2 stock that you calculated, evaluate the claim that atmospheric O_2 will be reduced to 13% (you can assume this means by volume) in 200 years due to fossil fuel combustion.