EES 217
Homework #4
Due April 2, 2008

1) Given the reactions below determine the amount of dissolved aluminum present in equilibrium with Gibbsite at a pH of 3.0, 6.0, and 10.0. What happens to the solubility of aluminum in equilibrium with Gibbsite($Al(OH)_3$) at 25 C with the varying pH? **SHOW ALL WORK!!!!!!!!**

Hint:

$Al(OH)_3 + 3H^+ = Al^{3+} + 3H_2O$	$K_{gib} = a_{Al3+} / a^3_H$	$\log K_{gib} = 8.1$
$Al^{3+} + H_2O = Al(OH)^{2+} + H^+$	$K_{1Al} = a_{Al(OH)2+} * a_H / a_{Al}$	$\log K_{1Al} = -4.987$
$Al^{3+} + 2H_2O = Al(OH)_2^+ + 2H^+$	$K_{2Al} = a_{Al(OH)+} * a^2_H / a_{Al}$	$\log K_{2Al} = -10.13$
$Al^{3+} + 3H_2O = Al(OH)_3 + 3H^+$	$K_{3Al} = a_{Al(OH)} * a^3_H / a_{Al}$	$\log K_{3Al} = -16.76$
$Al^{3+} + 4H_2O = Al(OH)_4^- + 4H^+$	$K_{4Al} = a_{Al(OH)-} * a^4_H / a_{Al}$	$\log K_{4Al} = -22.16$

Extra Hint : The total dissolve aluminum concentration is equal to the sum of the concentration of the individual species. ($\Sigma a_{Al3+} = a_{Al(OH)2+} + a_{Al(OH)2+} + a_{Al(OH)3} + a_{Al(OH)4}$) Write a single equation in terms of Al^{3+} , Kx, and pH and solve.

2. A forest soil has an average cation exchange capacity of 5 meq/ 100g, a base saturation of 20%. a thickness of 1 meter, and a bulk density of 1.8 g/cm^3. If 1m/y of pH 4.0 acid rain fell on the soil, how many years would it take for the hydrogen ions added from the atmosphere to equal the exchangeable base cations present in the soil.

3. A 0.01 molar $NaHCO_3$ solution is allowed to equilibrate with calcite at a $P(CO_2)$ of 0.1 atm at 25^{o}C . How much calcium (ppm) will the solution contain and what will be the pH?.