CE 311A: Environmental Quality and Pollution
Problem Set No. 2
Due in class on or before 28/8/17

Submission by due date is voluntary and carries no marks. Submitted work will be checked and returned with solutions.

Reading Assignment: Chapter 3 Nazaroff

1. In a closed bottle (no head space above the water), 10^{-3} moles of acetic acid was added to 1L of deionized water at 25°C. Compute the equilibrium concentrations of all the species present in solution? Given for acetic acid: pK_A = 4.7 at 25 °C.

2. A solution contains 10^{-2} moles/L of ammonia in deionized water. The solution is not exposed to air. Calculate the equilibrium concentrations of each chemical species in the water. Given for ammonium: pK_A = 9.23 at 25 °C

3. Oxalic acid (HOOCCOOH) is a diprotic acid with pK_1= 1.25 and pK_2=4.28. Compute the equilibrium pH of a 10^{-2} M solution of oxalic acid. (you may use a spreadsheet application)

4. *Law Dome* ice core data shows that in the year 1800, atmospheric CO_2 concentration was 280 ppm. Recent more detailed measurements at the Mauna Loa observatory at Hawaii shows that the annual average atmospheric CO_2 concentration increased from 315 ppm in 1960 to 395 ppm in 2013. Neglecting effects of all other components, compute the changes in pH of the rainwater due to this increase of atmospheric CO_2 concentrations between 1800-1960 and 1960-2013. Use the values of required equilibrium constants from those used in class.

5. (a) Determine the mass concentration of N_2 in water at 25 °C when the water is in equilibrium with the atmosphere.

(b) Compare your result with the equilibrium mass concentration of O_2 in water exposed to the atmosphere at 25 °C.

6. A 2 L jar, equipped with a tight-fitting lid that contains a rubber septum, is half-filled with water. At equilibrium, the air space has a volume of 1 L, a total pressure of 1 atm, and a

temperature of 298 K. Then 1 mg of formaldehyde (HCHO, MW = 30 g/mol) is injected through the septum into the water. Some of the formaldehyde escapes into the gas phase. Consider the situation when a new equilibrium is established. Determine (a) the equilibrium mass concentration of HCHO in water and (b) the equilibrium mole fraction of HCHO in air.

7. A 100mL sample of water is titrated with 0.02N H_2SO_4. The initial pH is 9.5, and 6.2 mL of acid is required to reach the pH 8.3 endpoint. An additional 9.8 mL is required to reach the 4.5 endpoint. Determine the species of alkalinity present and the concentration of each species.

8. A sample of water from a surface stream is analyzed for the common ions with the following results:

Ca^{2+} = 98 mg/L	Cl^- = 89 mg/L	HCO_3^- = 317 mg/L
Mg^{2+} = 22 mg/L	SO_4^{2-} = 125 mg/L	Na^+ = 71 mg/L

What is the percent error in cation anion balance. Calculate the ionic strength of the solution.

9. A synthetic sample of water is prepared by dissolving 200 mg glucose, 168 mg sodium bicarbonate, 120 mg magnesium sulfate and 111 mg calcium chloride in one liter distilled de-ionized water. Assuming that the complete dissociation of the salts occur leading to presence of Na_+, Mg_{2+}, Ca_{2+}, Cl_-, $SO_{4\,2-}$ and HCO_{3-} in addition to H_+ and OH_- ions, compute, Total alkalinity (TA), Hydroxyl alkalinity (HA), Carbonate alkalinity (CA), and Bicarbonate alkalinity (BA). Total hardness (TH), Carbonate hardness (CH), Bicarbonate hardness (BH), Calcium hardness (CaH), and Magnesium hardness (MgH), (Report alkalinity and hardness values as mg/L $CaCO_3$)