CHMY 361 **HANDOUT#6**

October 19, 2016

6 problems on 2 pages **HOMEWORK #4**

Due Thursday, Oct. 27

1. (a) From Table **A.5** (back of text), calculate the Henry's Law constant (i.e., equilibrium constant) for ***dissolving*** CO_2(g) in water (i.e., solubility) at 25°C. What units does this equilibrium constant have?

(b) Do the same as (a) at 37°C

(c) Convert the Henry's Law constants you obtained in (a) and (b) to the units of Table 6.1 (bars/mol fraction) and compare with the numbers found in Table 6.1.

2. When underwater diving (scuba diving), the total partial pressure of air that is breathed is equal to the hydrostatic pressure given by the depth of water. From Henry's Law one finds that much higher concentrations of N_2 and O_2 will dissolve in the water of the body than at sea level above water, providing sufficient time lapses to approach equilibrium. This poses a severe problem if the diver returns to the surface too quickly because micro bubbles form (a temporary, but potentially fatal condition know as "the bends"). This is because relative to the partial pressure at the surface, the N_2 is suddenly super-saturated. (The O_2 is not a problem because it is metabolized while the diver is submerged.)

A 140 lb person contains about 50 L of water (about 4/5 of which is intracellular). Assuming all of this water is saturated with dissolved N_2 gas, answer the following questions:

(a) How many mols of N_2 gas are dissolved in a person when the ***air*** pressure = 1 bar (assuming that the solubility is the same as in pure water? (Use Table 6.1 for 37° C.)

(b) How many liters of gas at 1 bar and 310 K does this number of mols equal?

(c) 1 atmosphere = 760 mm of Hg, and the density of Hg is 13.6 times that of water. What is 1 bar in units of meters of water, assuming the density of water is 1.00 kg/L?

(d) If a diver stays at a depth of **40 m** in water until equilibrium is reached, how many liters of N_2 gas would potentially be released in the form of microbubbles if the diver came to the surface very quickly? (*Remember, Henry's Law is just saying that the amount of a particular gas dissolved is directly proportional to the partial pressure of that gas in equilibrium with the liquid*.)

3. Consider a $1x10^{-5}$ M polymer solution inside a dialysis bag that is permeable to the ligand, A, but not to the polymer. The following measurements of the free ligand outside the bag and total ligand inside the bag are measured at equilibrium. The units are M.

From a Scatchard plot find K_d for the binding of A to its binding sites on the polymer and the number of binding sites per polymer molecule. (the notation 5E-07 means 5 x 10^{-7}, etc.)

$[A]_{out}$	$[A]_{in}$ total
5.00E-07	5.05E-05
1.00E-07	3.01E-05
2.00E-08	1.00E-05

4. The partition coefficient of solute B between water and ethanol cannot be directly measured because water and ethanol are completely miscible.
(a) Calculate this partition coefficient ([B(aq)]/ [B(ethanol)]) if the solubility of B in water = 0.10 M and the solubility of B in ethanol = 5.0 M at 25^{o} C.
From the data in (a), calculate the following:
(b) What is ΔG^{o} for the process ([B(aq)]/ [B(ethanol)]?
(c) What is ΔG^{o} for the process B(aq) --> B(s)?

5. Suppose in certain mitochondria, the oxidation of glucose products pumps protons into the intermembrane space between the double membrane to reach a pH of 5.0. In the interior of the mitochondrion, the pH is 7.0. In addition, the intermembrane space has an electric potential difference of +75 mV relative to the interior.

ATP is synthesized from the combined Gibbs energy change per mol of protons ($\Delta\mu$) flowing down the concentration gradient from the intermembrane space (out) to the interior (in) and from the change of electrical free energy coming from the voltage difference.

(a) What is $\Delta\mu$ for H^+(out) --> H^+(in) for this mitochondrion?

(b) Calculate the ΔG if a total of 4 moles of protons are transferred.

(c) What is the maximum number of moles of ATP that can be obtained from ADP and P at pH 7 when 4 moles of protons are transferred if [ATP]/[ADP] = 2.0 and [P] 0.005 M?

6. The osmotic pressure of sea water is known to be 25 bar at 273 K. Using this number:
(a) what is the activity of water in sea water at 273 K?
(b) what is the vapor pressure of sea water at 273 K, given that for pure water it is 612 Pa?
(c) what is the melting point of pure water ice in seawater?
(d) what is the boiling point of this sea water, assuming the activity is the same as at 273 K.?