1. Adenosine triphosphate can be hydrolyzed to give adenosine diphosphate:

ATP-4(aq)  + H2O(l) ↔ ADP-3(aq) + H3O+(l) + HPO-24

 Calculate the fraction of adenosine that exists in each form (ATP & ADP) at pH = 7 at 298 K and 310 K. Assume the buffer keeps the pH @ 7 no matter how much ATP is hydrolyzed. HPO4 concentration is at 0.006 M.

1. What is the total entropy change for mixing 855 mL of tea @ 85⃝C with 15 mL of lemon juice at 3⃝C? Be sure to consider everything that changes. Assum the pressure is constant and state any additional assumptions that you make.
2. Human hemoglobin is a tetramer comprised of two alpha beta subunits and two beta subunits. This tetramer can fall apart by dissociating into two alpha-beta dimers:

 (αβ)2  ↔ 2 αβ

1. Starting with *G= ∑niµi* for a mixture, derive the following expression for the free energy upon dissociation: ∆Grxn = ∆G⃝rxn  + RT ln a2αβ/a(αβ)2
2. For the tetramer to dimer dissociation reaction, Gary Ackers has measured ∆G⃝rxn to be 32.6 kJ/mol and ∆H⃝rxn to be -16.8 kJ/mol at 21.5⃝C. Calculate the ∆Grxn, Keq, and ∆S⃝rxn for the system at equilibrium at this temp. Would you say that the assembly of the tetramer from dimers at this temp is enthalpically or entropically driven?
3. Using the value for Keq determine in part B above, calculate the concentration of dimers in a 1.00 $×$10-4  M solution of hemoglobin. Calculate the fraction of total heme that is in the dimer. If we want less than 5% of our signal in an experiment that moniters heme absorption to be due to dimers, are we ok with this concentration? Hint: set up a reaction table letting x = the concentration of tetramer that dissociates and use the full quadratic equation when solving for x. You will repeat this activity in part D, so work out the formulas in general, and then put in the numbers. Assume activity coefficients = 1.
4. If we now wish to study a mutant which Keq = 1.00 $×$ 10-3 , can we use the same concentration in part C and still have less than 5% of the absorption signal due to dimers? What fraction of heme is in tetramer now? If not 95%, do we need a higher or lower concentration of hemoglobin?

1. We want to prepare 500 mL of pH = 7.4 of carbonic acid buffer. pKa1 = 6.37 and pKa2 = 10.25. You have the following stock solutions available:

 0.100 M NaHCO3

 3.00 M HCl

 3.00 M NaOH

What volumes of what solutions must be mixed to make the buffer? State your strategy and any approximations before you begin.

What are the equilibrium concentration of all species present? Hint: there are 6 solutes

1. An osmotic pressure apparatus with a capillary tube is used to determine the molecular weight of a protein using the standard formula for osmotic pressure: $π$ = RT$\left[protein\right]$. When 3.997 g of protein is dissolved in 125 ml of buffer (dilute), the rise of solution in the capillart tube is 12.67 cm. Calculate the molecular weight of the protein. The density of water is 0.997 g/mL at 298 K.

Given that Kf = 1.86 K kg/mol and Kb = 0.51 K kg/mol for water, could you determine the molecular weight with good accuracy using freezing point depression or melting point elavation? Ignore protein denaturization in answering.