Biology 3550
Physical Principles in Biology
Fall Semester 2017

Quiz 5
4 December 2017

25 points total.
Please write your name on each page.

In your answers you should:

- Show your work or provide an explanation for an answer.
- Use correct units and the correct number of significant figures (One extra significant figure is allowable.)
- Express numerical answers as decimal values, using scientific notation for numbers outside of the range from 0.01 to 1,000 or -0.01 to -1,000.

Some of the problems require a result from an earlier one. If you are not able to solve the earlier problem, you may assume a value for the number needed in the later one.

Some possibly useful constants:

The Boltzmann constant: $1.3806 \times 10^{-23}\,\mathrm{J \cdot K^{-1}}$
The gas constant: $8.314\,\mathrm{J \cdot mol^{-1}K^{-1}} = 0.082\,06\,\mathrm{L \cdot atm \cdot K^{-1}mol^{-1}}$
Avogadro's number: 6.02×10^{23}

1. A scientist at BigBucks Pharmaceutical Inc. is studying a small protein as a potential therapeutic agent. He is particularly interested in the protein's tendency to unfold under physiological conditions. Using a spectroscopic method that can distinguish folded and unfolded states of the protein, the scientist finds that 10% of the molecules unfold when a sample is warmed to 40°C. There are no partially unfolded molecules detectable under these conditions.

   (a) (12 pts) Calculate the equilibrium constant for unfolding of the protein, K_{u}, at 40°C.

(b) Calculate the standard free energy change for unfolding, $\Delta G_{\mathrm{u}}^{\circ}$, at 40°C.

(c) Using a calorimeter, the scientist has measured the enthalpy change for unfolding, ΔH_{u}, at 40°C, obtaining a value of $13\,\mathrm{kJ/mol}$. Calculate the entropy change for unfolding at this temperature.

2. (5 pts) The protein being studied contains 77 amino acid residues. Using the approach discussed in class, calculate an estimate of the change in conformational entropy, ΔS_{conf}, for the unfolding of the protein. Experess your answer on a molar basis.

3. (4 pts) Briefly explain the important assumptions that underlie the calculation of ΔS_{conf} in problem 2.

4. (4 pts) Your calculated values of ΔS_{u} and ΔS_{conf} should be very different. Briefly explain why these two values are so different, in molecular and thermodynamic terms.