20.110/2.772 Fall 2005

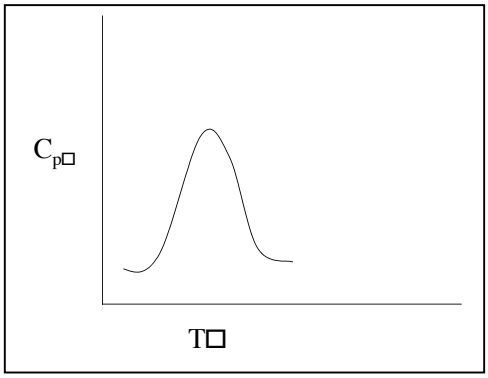
Recitations 3-4
Week of Sep 20

1. State functions: An ideal gas is initially at the following conditions: V = 1 L, P = 1 atm, T = 298K (State 0). It is subjected to the following cycle, where each step between states is reversible:
   Step 1: Isothermal expansion to 2 L (State 1)
   Step 2: Adiabatic expansion to 3 L (State 2)
   Step 3: Isothermal compression to 1.5 L (State 3)
   Step 4: Adiabatic compression to 1 L (State 0)

   Calculate the heat, work, and change in internal energy for the gas at each step. For one complete round of the cycle, what is the net value of q? the net value of w? the net value of ΔU?

2. Heat of Unfolding of a Protein: Proteins in solution are folded into 3D structures that are stabilized by many non-covalent bonds between the amino acids. As the temperature of a protein solution increases, these bonds become less stable and the protein undergoes a denaturation process where it unfolds and interacts more with water. The enthalpy of this reaction can be measured by microcalorimetry at constant pressure, where the value $C_{P,\,protein} = (\partial H/\partial T)_P$ for a dilute solution is determined relative to the solvent and as a function of temperature. A typical set of experimental data is shown in the figure.

Privalov and coworkers[1] have measured determined C_P (T) for the protein lysozyme and found the data for one of the domains fit the following form, where ΔC_p is relative to the solvent



$$\Delta C_p = \Delta C_P(T_t) + b\,(T - T_t) + c\,(T^2 - T_t^2)$$

In this expression, T_t refers to the temperature at the peak of the transition, and all temperatures are in K. Determine the enthalpy of denaturation of lysozyme if T_t = 41.5°C, b = 0.3158 J/K^2-mol and c = 0.462 x 10^{-3} J/K^3-mol. The temperature range for the transition is 20-60°C.

[1] Y.V. Griko, E. Friere, G. Privalov, H. van Dael, P.L. Privalov, J. Mol. Biol., 252, 447-459 (1995)