Handin 9 Entropy and Applications, Focusing on Chemical Reactivity

1. Calculate the entropy change of the system, surroundings, and the total change in entropy for an isothermal expansion of 1.00 mole of an ideal gas at 298.2 K. The gas is initially at 5.00 bar and expands to a final pressure of 1.00 bar against a constant external pressure of 1.00 bar.

2. Calculate the entropy change for the system and surroundings for the hydrolysis of ethylacetate at 298.2 K:

$$CH_3COOCH_2CH_3\ (l) + H_2O\ (l) \rightarrow CH_3COOH\ (l) + CH_3CH_2OH\ (l)$$

substance	$\Delta_f H_i^\circ$ (kJ mol^{-1})	S_i° (J K^{-1} mol^{-1})
ethylacetate, $CH_3COOCH_2CH_3$ (l)	-480.57	259.4
H_2O (l)	-285.83	69.91
acetic acid, CH_3COOH (l)	-484.5	159.8
ethanol, CH_3CH_2OH (l)	-277.69	160.7

3. Find the number of constituents and thermodynamic components for a solution prepared by adding solid $NaHSO_4$ to water. Include the dissociation of water as a source of H^+. Relate the number of thermodynamic components to the number of independent chemical reactions and the number of chemical constraints. Give the independent chemical reaction(s) and the chemical constraint(s) that you considered.

4. A 0.10 M NaCl aqueous solution is separated from pure water by a semi-permiable membrane. The height difference between the solution and the pure solvent is h and the corresponding equilibrium osmotic pressure is π. The system and the surroundings are in equilibrium. Assume the molar volume of the solvent in the solution is essentially the pure molar volume. Construct a isolated composite system with this membrane system and the surroundings. Consider the transfer of dn_A moles of solvent from the pure solvent through the membrane into the solution. Consider h = 0 as the reference height. Relate P_{ext} and T_{surr} with P_A, P_B, and T, where P_A is the pressure at h = 0 for the pure solvent and P_B is the pressure at h = 0 for the NaCl solution. Relate dU, đq, đw, and dV for the total composite, the surroundings, the system (A and B), and for the pure solvent (A) and the NaCl solution (B).