Chemistry 311

Physical Chemistry

Homework Assignment # 3

Due: Monday, October 4, 2004

1. Methane is heated from 298 K to 500 K at constant pressure. Find (a) ΔU, (b) ΔH, (c) w, and (d) ΔS for the process. $C_{P,m} = 23.64 + 47.86\times10^{-3}\ T - 1.92\times10^{5}/T^{2}$.

2. One mole of ideal gas initially at 20 bar and 300 K is allowed to instantaneously ($P_{ext} = 0$!) expand to 2 bar pressure in an irreversible process that lowers the temperature of the system to 283.2 K. Sketch a reversible path that consists of an isothermal expansion followed by an adiabatic expansion which connects the initial and final states on a P-V diagram. The thermal surroundings remain at 300 K throughout the process. Find (a) w (actual, not w_{rev}!), (b) q (actual, not q_{rev}!), (c) ΔU, (d) ΔH, (e) ΔS, (f) ΔS_{surr} and (g) ΔS_{univ}.

3. Acetic acid ($C_2H_4O_2$) freezes at 16.6 °C. A flask containing several moles of acetic acid at 16.6 °C is lowered into a large ice-water bath at 0 °C. When it is removed, it is found that exactly 1 mol of acetic acid has frozen. For acetic acid, $\Delta_f H° = 11.45$ kJ mol^{-1}. (a) What is the entropy change for the acetic acid? (b) What is the entropy change for the water bath? Is the freezing of acetic acid under these conditions a spontaneous process?

4. A gas is kept compressed in a perfectly insulated cylinder by a perfectly insulated piston. The piston is released and the gas pressure forces the piston out of the cylinder until the internal and external pressures are the same. (a) Do you think this will be a spontaneous process? (b) Is this an adiabatic process? (c) What is the entropy change of the system? (d) Do you expect the entropy of the Universe to change as a result of this process? Why or Why not?