Exam 2: Practice Problems

1. Calculate the work, heat, internal energy, and entropy involved when 1 mol of ideal gas is compressed adiabatically from $T_1 = 300$ K to $T_2 = 400$ K. Assume C_V is temperature independent and equal to 10 J/K·mol.

2. An environmental chemist is studying ways to convert CO and NO (two pollutants in auto exhaust) to CO_2 and N_2 and needs to know the enthalpy of reaction. He knows:

   $CO\ (g) + \frac{1}{2} O_2\ (g) \rightarrow CO_2\ (g)$ $\qquad \Delta H_A = -283.0$ kJ

   $N_2\ (g) + O_2\ (g) \rightarrow 2NO\ (g)$ $\qquad \Delta H_B = 180.6$ kJ

   What is the enthalpy of the reaction she is interested in? Is the reaction endo- or exothermic?

3. The differential equation defining enthalpy is: $dH = TdS + VdP$. Use this equation to derive the Maxwell relation:

$$\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$$

4. From statistical mechanics, we know that the entropy is given by:

$$\overline{S}/R = \frac{7}{2} + \ln\left[\left(\frac{2\pi M k_B T}{h^2}\right)^{3/2} \frac{\overline{V}}{N_A}\right] + \ln g_{e1} - \ln\left(1 - e^{-\Theta_B/T}\right) + \frac{\Theta_B/T}{e^{\Theta_B/T} - 1} + \ln\left(\frac{T}{\sigma\Theta_A}\right)$$

   Label the pieces of this equation that originate from the translational, rotational, vibrational, and electronic partition functions. (You can ignore the 7/2 term as it comes from several different partition functions).

5. Which statement about the Helmholtz and Gibbs energies is NOT true?
   a. Helmholtz energies are defined for processes at constant V and T
   b. PV is the difference between Helmholtz and Gibbs energies
   c. Gibbs energies are defined for processes at constant P and T
   d. The Gibbs and Helmholtz energies are state functions
   e. The Gibbs and Helmholtz energies can determine the spontaneity only for isolated systems

6. The entropy of an <u>isolated</u> system will continue to ______________ until no more spontaneous processes occur, in which case the system will be at _____________.

7. From Maxwell's relationships, we derived the following expression $\left(\frac{\partial H}{\partial P}\right)_T = V - T\left(\frac{\partial V}{\partial T}\right)_P$. Use this expression to calculate $\left(\frac{\partial H}{\partial P}\right)_T$ for a gas that obeys the equation of state: *P(V-B)* = *nRT* where *B* is a constant.