Exam 2: Practice Problems

Here are some practice problems for the exam. This certainly doesn't exhaust the possibilities of exam question topics (see the review sheet for more potential topics), but should give the 'flavor' of the types of questions I might ask. For example, there are a lot of definitions in these chapters (again, see review sheet), but there is only one example of a definition question below. We'll go over these Monday if desired.

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

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

   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).

4. 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 _____________.
5. 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.

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

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

7. The heat energy associated with a constant pressure process (q_P) is equal to:
   a. ΔU
   b. ΔS
   c. ΔA
   d. ΔH
   e. ΔG
   f. C_p
   g. C_v

8. There is an ensemble of 4 total systems (A = 4). Each system can be in one of four different states of equal energy. The number of systems in each state are a_1, a_2, a_3, and a_4. Give the values of a_1, a_2, a_3, and a_4 that maximize the entropy of the ensemble. (6 pt)

   a_1 = a_2 = a_3 = a_4 =