CHM 1046
Professor Fowler
Chapter 18 Homework

1. An exothermic reaction at standard conditions (298 K and 1 atm) has $q_c = -5.00$ kJ/mole (heat released) and $\Delta V = +4.93 \times 10^{-2}$ m^3/mole (volume increases).
   a. Use $w = -P\Delta V$ to determine the work performed by the gas in both J and kJ.
   Use $P = 1.01325 \times 10^5$ J/m^3 (equivalent to 1 atm) in your equation.
   This works in the equation because 1 J/m^3 = 1 $kg/(m \cdot s^2)$ = 1 Pa. (See Table 9.1.)
   Put the result for J in proper scientific notation.
   Count the correct number of significant digits and round your result properly.
   Show all signs, units, and conversion factor equations. (1 pt)

   b. Use $\Delta U = q + w$ to determine the change in internal energy in both J and kJ.
   Put result for J in proper scientific notation. Count the correct number of significant decimal places. Show all signs, units, and conversion factor equations. (1 pt)

   c. Use $\Delta H = \Delta U + P\Delta V$ to determine the change in enthalpy in both J and kJ.
   Put result for J in proper scientific notation. Count the correct number of significant digits and round your result properly. Show all signs, units, and conversion factor equations. (1 pt)

2. An endothermic reaction has ΔH^o = + 100.0 kJ/mole and ΔS^o = + 0.268 kJ/(K·mole).
   a. Review Example 18.04. Determine ΔG^o (at 298 K) in kJ/mole.
      Count the significant digits. Show all signs, units, and conversion factor equations.
      (1 pt)

   b. Review Figure 16.12 in OpenStax.
      Review the last page of the chapter 18 class notes, including example 18.10, also.
      Find the temperature range where the reaction is spontaneous ($\Delta G_T^o < 0$).
      Show all signs, units, and conversion factor equations. (1 pt)

3. A reaction has ΔG^o = 2.478 kJ/mole.
   a. Review Examples 18.09 and 18.10. Convert ΔG^o to J/mole.
      Then, find the value of the thermodynamic equilibrium constant (K).
      Show all signs, units, and conversion factor equations. (1 pt)

   b. Use $\Delta G = \Delta G^o + (RT)\ln[Q]$ to determine ΔG in J/mole, then in kJ/mole,
      when the thermodynamic reaction quotient (Q) is 7.388.
      Show all signs, units, and conversion factor equations.
      Count the number of significant digits properly. (1 pt)

4. Methanol combusts as follows: $CH_3OH_{(liq)} + \left(\frac{3}{2}\right)O_{2(g)} \rightleftharpoons CO_{2(g)} + 2H_2O_{(g)}$.
   a. Review Example 18.07 and review problem 10 in the chapter 14 homework. Then, write the thermodynamic equilibrium constant expression for the methanol reaction. (1 pt)

   b. Review Examples 18.05 and 18.09. Find ΔG^o for the methanol reaction using a summation equation with ΔG^o_f values from Appendix G. Do not omit liquids from the summation equation. Show all signs, units, and conversion factors. Explain why the reaction would be spontaneous, or not, at standard state. (1 pt)

5. Review Examples 18.08 and 18.09. Suppose a reaction has K = 155 at standard state. Use the value of K to find ΔG^o. Show all signs, units, and conversion factors. Explain how this tells you which direction is favored for the reaction. (1 pt)