CH353 – Physical Chemistry I
Spring 2013, Unique 52575

Homework, Week 3

1. We are caught up to last week's 1st law problems. Please review them.

2. A 1 L sample of 2.00 mol Ar gas is expanded isothermally at 0˚C to a final volume of 5 L a) reversibly, b) against a constant external pressure equal to the final pressure of the gas, and c) freely (against no external pressure). Determine q, w, ΔU, and ΔH for these three processes.

3. A monatomic gas obeys the following equation of state:

$$P(V_m - b) = RT$$

Show that for a reversible, adiabatic expansion of a monatomic gas,

$$\left(\frac{T_2}{T_1}\right)^{\frac{3}{2}} = \left(\frac{V_{m,1} - b}{V_{m,2} - b}\right)$$

(Hint, knowing the expansion is adiabatic, find simple expressions for dw and dU and equate them.)

4. 1.00 mol of a monatomic ideal gas is initially held at 300 K and 1.0 atm. The gas is heated to 400 K reversibly at constant volume. Determine q, w, and ΔU.

5. An ideal monatomic gas at 273.15 K and 1 bar is expanded adiabatically from 22.7 L to 45.4 L. What is the final temperature of the system?

6. If you were on the surface of the moon you would need to wear a space suit with thermal insulation. In exploring the moon you might generate 4 kJ of heat per kg of mass per hour. If your body retains all of this heat because the insulation, how much would your temperature change per hour during this activity? How long would you recommend for such a moon walk? Assume your body mass is 65 kg and that your heat capacity is approximately that of water ($C_{p,m}(H_2O_{(l)}) = 75.29$ J K^{-1} mol^{-1}).