Show your work on numerical problems to receive credit. This homework is due on Wednesday, September 9, at class time.

1. Consider the effects of the temperature dependence of $C_p$.
   a. The $C_p$ for lead at 25 °C is 26.44 Jmol⁻¹K⁻¹. Find the change in enthalpy for 100.0-g of lead when it is heated from 25 °C to 250 °C assuming its $C_p$ does not change with temperature.

   b. A better value for the $C_p$ for lead may be given as:

   $$C_p (\text{Jmol}^{-1}\text{K}^{-1}) = 22.13 + (11.72 \times 10^{-3}) T + (0.96 \times 10^{-5}) T^2$$

   where $T$ is in K. Calculate again the change in enthalpy for 100.0-g of lead when it is heated from 25 °C to 250 °C assuming its $C_p$ does change as indicated with temperature.

   c. Assuming the answer to part b is the better answer, what is the percent error in ignoring the temperature dependence of $C_p$ compared to taking it into account?

2. 2.0-mol of an ideal gas is initially confined in a piston arrangement at a temperature of 25 °C and a pressure of 2.5 × 10⁵ Pa.

   a. The gas is cooled at constant volume to a pressure of 1.5 × 10⁵ Pa and is then expanded to a volume of 1.25 × 10¹ m³ and heated to return the pressure to 1.5 × 10⁵ Pa. How much work is done on the system in this process? Refer to Figure 2.3a.

   b. Starting from the initial conditions in the statement of the problem (not the final conditions from part a) the gas is now heated at constant pressure to reach a volume of 1.25 × 10¹ m³. The gas is now cooled until its pressure reaches 1.5 × 10⁵ Pa. How much work is done on the system in this process? Refer to Figure 2.3b.

   c. Since the final conditions and initial conditions are the same in both processes, the internal energy change, $\Delta U$, is the same in both processes. If one assumes an ideal gas, it is found that the internal energy of the gas only depends on temperature and the expression for the heat capacity at constant volume ($C_v = \left(\frac{\partial U}{\partial T}\right)_v$) may be used to find the change in internal energy if $C_v$ is known. Assume $C_v$ is $\frac{3}{2}R$, typical for a monatomic ideal gas, and find $\Delta U$ for the processes in part a or part b (note the answer is the same).

   d. What is the value of $q$ in part a?

   e. What is the value of $q$ in part b?