Homework, Week 2

1. Calculate the work (in Joules) done for each of the following examples:
   a) McQuarrie and Simon textbook (1.8 kg) is carried up three flights of stairs with a horizontal displacement of 10 m.
   b) An ideal gas expands isothermally from 1.0 L to 1.9 L at 25˚C against a constant external pressure of 1.0 atm.
   c) HCl gas, behaving as a van der Waals gas, is compressed isothermally and reversibly from 1.9 L to 1.0 L at 25˚C at an initial pressure of 14.0 atm. (For $HCl_{(g)}$, $a = 5.536$ atm L^2 mol^{-2} and $b = 3.049$ x 10^{-2} L mol^{-2}.)

2. A gas at room temperature is sealed in a container with strong rigid walls. It is then heated vigorously.

   a) Determine whether ΔU, q, and w of the system are positive, negative, or zero during the heating.

   b) The container is then cooled to its original temperature. Determine whether ΔU, q, and w of the system are positive, negative, or zero during the cooling.

   c) If the heating is step 1 and the cooling is step 2, determine the signs of $(\Delta U_1 + \Delta U_2)$, $(q_1 + q_2)$, and $(w_1 + w_2)$.

3. A chemical reaction takes place in a container with a cross-sectional area of 1 m^2. As a result of this reaction, a piston is pushed out 500 cm against an external pressure of 1.0 atm. Calculate the work done by the system.

For each of the following transformations, determine whether q, w, ΔU, and ΔH of the system are greater than zero, less than zero, or equal to zero.

4.   a) Air is sealed in a container with rigid walls and then heated from room temperature to 90˚C.

   b) Gas in a cylinder 5.0 L in volume is compressed by a constant external pressure of 4.0 atm to a final volume of 1.0 L.

   c) Water is heated in an open beaker in a laboratory from room temperature to 100˚C.

   d) The battery of your laptop discharges completely, performing 100 J of electrical work and releasing 25 J of heat into the room.