1. One mole of an ideal gas with \( C_V = \frac{3}{2}R \) undergoes the transformations described in the following list from an initial state described by \( T = 300 \text{ K} \) and \( P = 1.00 \text{ bar} \). Calculate \( q, w, \Delta U, \Delta H \), and \( \Delta S \) for each process.
   a. The gas is heated to 450 K at a constant external pressure of 1.00 bar.
   b. The gas is heated to 450 K at a constant volume corresponding to the initial volume.
   c. The gas undergoes a reversible isothermal expansion at 300 K until the pressure is half of its initial value.

2. Calculate \( \Delta S_{\text{surroundings}} \) and \( \Delta S_{\text{total}} = \Delta S + \Delta S_{\text{surroundings}} \) for each of the processes described in Problem 1. Which of the processes is a spontaneous \( (\Delta S_{\text{total}} > 0) \) process? Note that the state of the surroundings for each part is as follows:
   a. 450 K, 1 bar
   b. 450 K, 1 bar
   c. 300 K, 0.500 bar

3. a. Calculate \( \Delta S \) if 1 mol of liquid water is heated from 0º to 100ºC under constant pressure if \( C_{P,m} = 75.291 \text{ J K}^{-1} \text{ mol}^{-1} \).
   b. The melting point of water at the pressure of interest is 0ºC and the enthalpy of fusion is 6.0095 kJ mol\(^{-1}\). The boiling point is 100ºC and the enthalpy of vaporization is 40.6563 kJ mol\(^{-1}\). Calculate \( \Delta S \) for the transformation \( \text{H}_2\text{O}(s, 0ºC) \rightarrow \text{H}_2\text{O}(g, 100ºC) \).

4. One mole of \( \text{H}_2\text{O}(l) \) is compressed from a state described by \( P = 1.00 \text{ bar} \) and \( T = 298 \text{ K} \) to a state described by \( P = 800 \text{ bar} \) and \( T = 450 \text{ K} \). In addition, \( \alpha = 2.07 \times 10^{-4} \text{ K}^{-1} \) and the density can be assumed to be constant at the value 997 kg m\(^{-3}\). Calculate \( \Delta S \) for this transformation, assuming that \( \kappa = 0 \). You will need the Appendix in Levine, and see Section 4.6.