c) Calculate ΔH^{ig} and ΔS^{ig} of HCN for a change of state from 1 bar, 0 °C to 15000 mmHg, 1000 °C. Report the results for enthalpy in J/mol and in Btu/lbmol; report entropy in J/mol K and Btu/lbmol °F.
Additional data: The following identities may be helpful:

$$\int \left(\frac{a/x}{\sinh(a/x)}\right)^2 dx = a\,\coth(a/x)$$

$$\int \left(\frac{a/x}{\cosh(a/x)}\right)^2 dx = -a\,\tanh(a/x)$$

$$\int \left(\frac{a/x}{\sinh(a/x)}\right)^2 \frac{dx}{x} = \frac{a\ \coth(a/x)}{x} - \ln\big(\sinh(a/x)\big)$$

$$\int \left(\frac{a/x}{\cosh(a/x)}\right)^2 \frac{dx}{x} = \frac{-a\ \tanh(a/x)}{x} + \ln\big(\cosh(a/x)\big)$$

Problem 5.8: a) What is the residual volume of saturated liquid water at 1 bar?
b) Estimate the residual volume of ethanol vapor at 1 bar and 100 °C.
c) Use the generalized graphs to calculate the entropy change of 1 mole of ethanol undergoing isothermal compression from 1 bar to 100 bar along the critical isotherm.

Problem 5.9: n-Octane is compressed reversibly at constant temperature along the critical isotherm until the critical point is reached. The initial pressure is 1 bar. The pressure takes place in a closed system. Use the Lee-Kesler method to calculate the following:
a) What is the entropy change of n-octane?
b) Calculate the heat that must be supplied to the system to maintain isothermal conditions.
c) Calculate the necessary amount of work.

Problem 5.10: Propane is isothermally compressed from 0.01 bar, −51.4 °C to 17 bar. The process takes place reversibly in a closed system.
a) Draw the PV graph of the process.
b) Calculate the entropy change of propane.
c) How much heat is exchanged between the system and its surroundings? Is this heat added to or removed from the system?
Additional data: Use the Lee-Kesler graphs for enthalpy and entropy. The saturation pressure of propane at −51.4 °C is 0.66 bar. Take the ideal-gas C_P of propane at these conditions to be constant and equal to 67 J/mole K.

Problem 5.11: Isobutane is heated in a heat exchanger from 1 bar from 220 K to 1 bar, 300 K. ~~300 K~~ Use the SRK equation to calculate the following: