ASSIGNMENT 05
CHE221A

1. Consider a cylinder fitted with a piston that contains 2 mol of H2O in a container at 1000K. Calculate how much work is required to isothermally and reversibly compress this gas from 10L to 1 L, in each of the following cases:

   (a) Use the ideal gas model for water.
   (b) Use the Redlich–Kwong equation to relate P, v, and T:

$$P = \frac{RT}{v-b} - \frac{a}{T^{\frac{1}{2}}v(v+b)}$$

   where, a = 14.24 and b = 2.11 x 10^-5 both in SI units
   (c) Use the Steam tables.

   Compare these three methods

2. Two moles of a van der Waals fluid are maintained at a temperature T= 0.95Tc, in a volume of 200 cm^3. Find the mole number and volume of each phase. Use the van der Waals constants of oxygen.

3. In the vicinity of the triple point the vapor pressure of liquid ammonia (in Pascals) is represented by

$$lnP = 24.38 - (\frac{3063}{T})$$

   This is the equation of the liquid-vapor boundary curve in a P-T diagram. Similarly, the vapor pressure of solid ammonia is

$$lnP = 27.92 - (\frac{3754}{T})$$

   What are the temperature and pressure at the triple point? What are the latent heats of sublimation and vaporization?

4. Show that the van der Waals equation of state does not satisfy the criteria of intrinsic stability for all values of the parameters. Sketch the curves of P versus V for constant T (the isotherms of the gas) and show the region of local instability.

5. Determine the second and third virial coefficients using the van der Waals and Redlich–Kwong equation of state.

6. At -30°C, the saturation pressure of ethane is 10.6 bar. Calculate the densities of the liquid and vapor phases using the Peng–Robinson equation. Compare to the reported values for the liquid and vapor densities of 0.468 and 0.0193 g/cm^3.

7. Calculate the volume occupied by 50 kg of propane at 35 bar and 50°C, using the following:
    a. The ideal gas model
    b. The Redlich–Kwong equation of state
    c. The Peng–Robinson equation of state
    d. The compressibility charts