Assignment for Chapter 2
(Answers are in parenthesis)

1. Express the volume expansivity and the isothermal compressibility as functions of density ρ and its partial derivatives. For water at 323K (50°C) and 1 bar, $\kappa = 44.18\text{x}10^{-6}$ bar^{-1}. To what pressure must water be compressed at 323 K (50°C) to change its density by 1%? Assume that κ is independent of P. **[226.2 bar]**
2. For liquid water the isothermal compressibility is given by: $\kappa = \frac{c}{V(P+b)}$

   where c, b are functions of temperature only. If 1 kg of water is compressed isothermally and reversibly from 1 to 500 bars at 333K, how much work is required? At 333K, b = 2700 bar and c = 0.125 cm^{-3} g^{-1}. **[0.516 J/gm]**
3. Calculate the reversible work done in compressing 0.0283 m^3 of mercury at a constant temperature of 0°C from 1 atm to 3000 atm. The isothermal compressibility of mercury at 0°C is: $\kappa = 3.9 \text{ x } 10^{-6} - 0.1 \text{ x } 10^{-9}$ P; where P is in atm and κ is in atm^{-1}. **[0.52J]**
4. A substance for which κ is a constant undergoes an isothermal, mechanically reversible process from initial state (P_1, V_1) to final state (P_2, V_2), where V is molar volume. (a) Starting with the definition of κ, show that the path of the process is described by: V = A(T) exp(-κP); (b) Determine an exact expression which gives the isothermal work done on 1 mol of this constant -κ substance. [$P_1V_1 - P_2V_2 + (V_1 - V_2)/\kappa$]
5. For methyl chloride at 373.15 K (100°C) the second and third virial coefficient s are: B = -242.5 cm^3 mol^{-1}; C = 25 200 cm^6 mol^{-2}. Calculate the work of mechanically reversible, isothermal compression of 1 mol of methyl chloride 1 bar to 55 bars at 100°C. Base calculations on the following form of the virial equation: $Z = 1 + \frac{B}{V} + \frac{C}{V^2}$ **[12.62 kJ/mol, 12.596 kJ/mol]**
6. Calculate V for sulfur hexafluoride at 75°C and 15 bar by the following equations: (a) The truncated virial equation with the following experimental values of virial coefficients: B = -194 cn^3 mol^{-1}; C = 15300 cm^6 mol^{-2} (b) The truncated virial equation, with a value of B from the generalized Pitzer correlation. (c) The Redlich/Kwong equation (d) The Soave/Redlich/Kwong equation (e) The Peng/Robinson equation. **[1722, 1734, 1714, 1727, 1701cm3/mol];** For sulfur hexafluoride, T_c = 318.7 K, P_c = 37.6 bar, V_c = 198 cm^3 mol^{-1}, and ω = 0.286.
7. Use the Soave/Redlich/Kwong equation to calculate the molar volumes of saturated liquid and saturated vapor for propane at 40C for which the vapour pressure is 13.71 bar. **[104.7, 1480.7 cm3/mol]**
8. A 30-m^3 tank contains 14 m^3 of liquid n-butane in equilibrium with its vapor at 298.15 K (25°C). Estimate the mass of n-butane vapor in the tank. The vapor pressure of n-butane at the given temperature is 2.43 bar. **[98.2 kg]**
9. A rigid 0.35-m^3 vessel at 25°C and 2200kpa holds ethane; what pressure develops if it is heated to 220°C? **[42.7 bar]**
10. To what pressure does one fill a 0.15-m^3 vessel at 25°C for storing 40 kg of ethylene in it? **[79.7 bar]**
11. Liquid water at 25°C and 1 bar fills a rigid vessel. If heat is added to the water until its temperature reaches 50°C, what pressure is developed? The average value of β between 25 and 50°C is 36.2 x 10^{-5} K^{-1}. The value of κ at 1 bar and 50°C is 4.42 x 10^{-5} bar^{-1}, and may be assumed independent of P. The specific volume of liquid water at 25°C is 1.0030 cm^3 g^{-1}. **[206 bar]**
12. A two-phase system of liquid water and water vapor in equilibrium at 8000 kPa consists of equal volumes of liquid and vapor. If the total volume is 0.15 m^3, what is the total enthalpy H^t and what is the total entropy S^t? **[80173.5kJ, 192.15 kJ/K]**