WEEK 5

Single-Phase Systems
(Continued)

Ideal Gas Mixture

- One mole of an ideal gas at 0ºC and 1 atm occupies 22.415 liters
- T in the gas law equation refers to the absolute temperature
- Values of the gas constant in different units are in the book
- Example 5.2-1 on page 192 in class (part 1)
- Example 5.2-2 on page 195 in class
- Example 5.2-3 on page 195 in class
- Page 196, section 5.2c Ideal Gas Mixtures: $p_A = y_A.P$. p_A is the pressure that would be exerted by n_A moles of A alone in the same total volume V at the same temperature T of the mixture.
- $P = P_A + P_B + P_C + \ldots$

Ideal Gas Mixture

- $v_A = y_A V$
- $V = v_A + v_B + v_C + \dots$
- v_A is the volume occupied by n_A moles of A alone in the same total volume P at the same temperature T of the mixture.
- Example 5.2-5 on page 197

5.3 Equations of State for Nonideal Gases

- Some gases deviate from ideal gas behaviors (especially at low and/or high pressure)
- Page 241– Phase diagram tells us about conditions substance exists as a solid, liquid or a gas.
- The highest temperature a species can coexist in 2 phases (liquid and vapor) is the critical temperature (Tc). The corresponding P is the critical pressure P_c.
- The critical conditions are used to generate empirical equations for nonideal gases.

5.3b Virial equations of state

- Virial Equation $$\frac{P\hat{V}}{RT} = 1 + \frac{B}{\hat{V}} + \frac{C}{\hat{V}^2} + \frac{D}{\hat{V}^3} + \ldots$$
- After truncation $$\frac{P\hat{V}}{RT} = 1 + \frac{B}{\hat{V}}$$
- Page 201-- ω :Pitzer acentric factor: a parameter that accounts for geometry and polarity of molecule
- Steps in estimating volume
  - a) T_c and P_c (page 628)
  - b) Calculate reduced temperature $T_r = T/T_c$
  - C) Estimate B

$$B_0 = 0.083 - \frac{0.422}{T_r^{1.6}}$$

$$B_1 = 0.139 - \frac{0.172}{T_r^{4.2}}$$

$$B = \frac{RT_c}{P_c}\left(B_0 + \omega B_1\right)$$

  - Substitute to calculate P or $\hat{V}$

5.3c Cubic equations of state

- Soave-Redlich-Kwong (SRK)
- Redlich-Kwong
- Peng-Robinson

Equations 5.3-6 to 5.3-12 (page 203)

- Example 5.3-2 (in class)

5.4 Compressibility Factor Equation of State

- Compressibility factor:

$$Z = \frac{P\hat{V}}{RT}$$

- Compressibility factor equation of state

$$P\hat{V} = ZRT$$

- Example 5.4-1 (Page 206)

HMK p 215 # 5.5, p 230 # 5.55, P 231 # 5.58