<물리화학 Homework #1>

1. Explain how the compression factor varies with pressure and describe how it reveals information about intermolecular interactions in real gas.

2. The mass density of water vapour at 327.6 atm and 776.4 K is 133.2 kg/m^3. Given that for water Tc=647.4 K, Pc=218.3 atm, a=5.464 dm^6·atm/mol^2, b=0.03049 dm^3/mol, and M=18.02 g/mol, calculate (a) the molar volume. Then calculate the compression factor (b) from the data, (c) from the virial expansion of the vd*W* equation.

3. Prof. D.J. Ahn proposed the following equation of state:

$$p = \frac{RT}{V_m} - \frac{B}{{V_m}^2} + \frac{C}{{V_m}^3}$$

Show that the equation leads to critical behavior. Find the critical constants(V_c, T_c, P_c) of the gas in terms of B and C and an expression for the critical compression factor(Z_c).

4. Equations 1.19a and 1.19b are expansions in p and $1/V_m$ respectively. Find the relation between B,C and B′,C′

$$p\mathrm{Vm} = \mathrm{RT}(1 + \mathrm{B}'p + \mathrm{C}'p^2 + \cdots) \qquad (1.19a)$$

$$p\mathrm{Vm} = \mathrm{RT}(1 + \frac{B}{Vm} + \frac{C}{Vm^2} + \cdots) \qquad (1.19b)$$

5. Show that the equation leads to critical behavior. Find the critical constants of the gas in terms of *a* and *b* and an expression for the critical compression factor.

1) van der Waals $$p = \frac{RT}{V_m - b} - \frac{a}{{V_m}^2}$$

2) Berthelot $$p = \frac{RT}{V_m - b} - \frac{a}{T{V_m}^2}$$

3) Dieterici $$p = \frac{RTe^{-a/RTV_m}}{V_m - b}$$