<물리화학 Homework #1>

1. The mass density of water vapour at 327.6 atm and 776.4 K is 133.2 kg/m^3. Given that for water T_c = 647.4 K, p_c = 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.

2. Express the vd*W* equation of state as a virial expansion in powers of $1/V_m$ and obtain expressions for *B* and *C* in terms of the parameters *a* and *b*. The expansion you will need is

$(1 - x)^{-1} = 1 + x + x^2 + \ldots$

Measurements on argon gave *B* = −21.7 cm^3/mol and *C* = 1200 cm^6/mol^2 for the virial coefficients at 273 K. What are the values of *a* and *b* in the corresponding vd*W* equation of state?

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

$$p = \frac{RT}{V_m - b} - \frac{a}{TV_m^2}$$ (Berthelot Equation of State)

4. A scientist 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 behaviour. Find the critical constants of the gas in terms of *B* and *C* and an expression for the critical compression factor.

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

$$pV_m = RT(1 + B'p + C'p^2 + \cdots) \qquad (1.19a)$$

$$pV_m = RT\left(1 + \frac{B}{V_m} + \frac{C}{V_m^2} + \cdots\right) \qquad (1.19b)$$